



US 20040175407A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2004/0175407 A1**
McDaniel (43) **Pub. Date: Sep. 9, 2004**

(54) **MICROORGANISM COATING
COMPONENTS, COATINGS, AND COATED
SURFACES**

(75) Inventor: **C. Steven McDaniel**, Austin, TX (US)

Correspondence Address:
C. Steven McDaniel
McDaniel & Associates, P.C.
P.O. Box 2244
Austin, TX 78767-2244 (US)

(73) Assignee: **REACTIVE SURFACES, LTD.**

(21) Appl. No.: **10/792,516**

(22) Filed: **Mar. 3, 2004**

Related U.S. Application Data

- (63) Continuation of application No. 10/655,345, filed on Sep. 4, 2003.
(60) Provisional application No. 60/409,102, filed on Sep. 9, 2002.

Publication Classification

- (51) **Int. Cl.⁷** **C12M 1/34; A61F 2/00**
(52) **U.S. Cl.** **424/423; 435/287.2**

(57) **ABSTRACT**

Disclosed herein are novel paints and coatings comprising a cell-based particulate material. Specifically disclosed herein is cell-based particulate material prepared from microorganisms for use as a coating component. Also disclosed herein are methods of preparing a coating that comprises a cell-based particulate material.

MICROORGANISM COATING COMPONENTS, COATINGS, AND COATED SURFACES

[0001] This application claims the benefit of U.S. patent application Ser. No. 10/655,345, entitled "Biological Active Coating Components, Coatings, and Coated Surfaces," filed Sep. 4, 2003; and Provisional Patent Application Entitled "Bioactive Protein Paint Additive, Paint, and Painted Various," Ser. No. 60/409,102, filed Sep. 9, 2002, each incorporated herein in their entirety by reference.

BACKGROUND OF THE INVENTION

[0002] A. Field of the Invention

[0003] The present invention relates generally to the field of coatings (e.g., paints) and other surface treatments that comprise a cell-based particulate material. More specifically, the present invention relates to coatings such as paints or clear coatings that comprise a microorganism-based particulate material. The invention further relates to the use of a cell-based particulate material as a biodegradable coating component.

[0004] B. Description of the Related Art

[0005] A microorganism, such as a bacterium, a fungus, or an algae, is considered an undesirable contaminant in a coating and/or film. A coating, film, substrate, or a combination thereof may be detrimentally affected by the presence of a living microorganism. For example, a living microorganism can alter viscosity due to damage to a cellulosic viscosifier; alter a rheological property by increasing the gelling of a coating; produce an undesirable color alteration ("discoloration") by production of a colorizing agent; produce undesirable gas and increase foam in a coating; produce an undesirable odor; alter (e.g., lower pH); damage a preservative; produce slime; reduce adhesion by a film; increase corrosion of a metal surface by moisture production by a microorganism; increase corrosion of a metal surface by film damage; or damage a wooden surface by colonization (e.g., fungal colonization). These changes can lead to the coating and/or film becoming unsuitable for use.

[0006] The undesirable growth of a microorganism is generally more prevalent in a water-borne coating, as the solvent component of a solvent borne-coating usually acts as a preservative. However, a film is generally susceptible to such damage by growth of a microorganism after loss of a solvent (e.g., evaporation) during film formation. Additionally, various bacteria (e.g., *Bacillus* spp.) and fungi produce spores, which are cells that are relatively durable to unfavorable conditions (e.g., cold, heat, dehydration, a biocide) and may persist in a coating and/or film for months or years prior to germinating into a damaging colony of cells.

[0007] Examples of bacteria commonly found to contaminate a coating and/or film include *Pseudomonas* spp., *Aerobacter* spp., *Enterobacter* spp., *Flavobacterium* spp. (e.g., *Flavobacterium marinum*), or *Bacillus* spp. Examples of fungi commonly found to contaminate a coating and/or film include *Aureobasidium pullulans*, *Alternaria dianthicola*, or *Phoma pigmentivora*. Examples of algae commonly found to contaminate a coating and/or film include *Oscillatoria* sp., *Scytonema* sp., or *Proteococcus* sp. Techniques are known to those of ordinary skill in the art for determining microbial contamination of a coating and/or coating component (see, for example, "ASTM Book of Standards, Volume 06.01,

Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D3274-95, D4610-98, D2574-00, D3273-00, D3456-86, D5589-97 and D5590-00, 2002; and "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," 2002). Various methods of coating preparation to reduce microbial contamination and/or prevent microbial growth in a coating or film are known in the art [see, for example, Flick, E. W. "Handbook of Paint Raw Materials, Second Edition," 263-285 and 879-998, 1989; in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp 261-267 and 654-661, 1995; in "Paint and Surface Coatings, Theory and Practice, Second Edition," (Lambourne, R. and Strivens, T. A., Eds.), pp. 193-194, 371-382 and 543-547, 1999; Wicks, Jr., Z. W., Jones, F. N., Pappas, S. P. "Organic Coatings, Science and Technology, Volume 1: Film Formation, Components, and Appearance," pp. 318-320, 1992; Wicks, Jr., Z. W., Jones, F. N., Pappas, S. P. "Organic Coatings, Science and Technology, Volume 2: Applications, Properties and Performance," pp. 145, 309, 319-323 and 340-341, 1992; in "Paints, Coatings and Solvents, Second, Completely Revised Edition," (Stoye, D. and Freitag, W., Eds.) pp 6, 127 and 165, 1998; In "Waterborne Coatings and Additives," 202-216, 1995; in "Handbook of Coatings Additives," pp. 177-224, 1987; and in "PCI Paints & Coatings Industry," pp. 56, 58, 60, 62, 64, 66-68, 70, 72 and 74, July 2003]. In conducting such tests, microorganisms such as Gram-negative Eubacteria including *Alcaligenes faecalis* (ATCC No. 8750), *Pseudomonas aeruginosa* (ATCC Nos. 10145 and 15442), *Pseudomonas fluorescens* (ATCC No. 13525), *Enterobacter aerogenes* (ATCC No. 13048), *Escherichia coli* (ATCC No. 11229), *Proteus vulgaris* (ATCC No. 8427), *Oscillatoria* sp. (ATCC No. 29135), and *Calothrix* sp. (ATCC No. 27914); Gram-positive Eubacteria including *Bacillus subtilis* (ATCC No. 27328), *Brevibacterium ammoniagenes* (ATCC No. 6871), and *Staphylococcus aureus* (ATCC No. 6538); filamentous fungi including *Aspergillus oryzae* (ATCC No. 10196), *Aspergillus flavus* (ATCC No. 9643), *Aspergillus niger* (ATCC Nos. 9642 and 6275), *Aureobasidium pullulans* (ATCC No. 9348), *Penicillium* sp. (ATCC No. 12667), *Penicillium citrinum* (ATCC No. 9849), *Penicillium funiculosum* (ATCC No. 9644), *Cladosporium cladosporioides* (ATCC No. 16022), *Trichoderma viride* (ATCC No. 9645), *Ulocladium atrum* (ATCC No. 52426), *Alternaria alternata* (ATCC No. 52170), and *Stachybotrys chartarum* (ATCC No. 16026); yeast including *Candida albicans* (ATCC No. 11651); and Protista including *Chlorella* sp. (ATCC No. 7516), *Chlorella vulgaris* (ATCC No. 11468), *Chlorella pyrenoidosa* (UTEX No. 1230), *Chlorococcum oleofaciens* (UTEX No. 105), *Ulothrix acuminata* (UTEX No. 739), *Ulothrix gigas* (ATCC No. 30443), *Scenedesmus quadricauda* (ATCC No. 11460), *Trentepohlia aurea* (UTEX No. 429), and *Trentepohlia odorata* (CCAP No. 483/4); have been used as positive control contaminants of a coating.

[0008] There have been descriptions of cell components and cells incorporated into some materials. U.S. patent Publication No. 2002/0106361 A1 discusses a marine antifungal enzyme for use in a marine coating. Immobilized enzymes in a latex are discussed in the April 2002 edition of "Emulsion Polymer Technologies," by the Paint Research Association website http://www.pra.org.uk/publications/emulsion/emulsion_highlights-2002.htm. Recombinant *Escherichia coli* cells have been cryoimmobilized in poly-

(vinyl)alcohol gel spheres (Rainina, E. I. et al., 1996). Whole *Flavobacterium* sp. cells or cell membranes have been described as immobilized to glass membrane using poly(carbamoyl sulfonate) and poly(ethyleneimine) (Gaberlein, S. et al., 2000a). *Escherichia coli* cells were fixed behind a polycarbonate membrane (Mulchandani, A. et al., 1998a; Mulchandani, A. et al., 1998b). Recombinant *Escherichia coli* cells were admixed in low melting point agarose and applied to membrane that was affixed to a fiber optic sensor (Mulchandani, A. et al., 1998c). Recombinant *Moraxella* sp. cells were admixed in 75% (w/w) graphite powder and 25% (w/w) mineral oil and placed into an electrode cavity (Mulchandani, P. et al., 2001b). Additional sensors using OPH have been described (Mulchandani, A. et al., 2001). A cell extract has been immobilized onto silica beads and porous glass (Munnecke, D. M., 1979; Munnecke, D. M., 1978). Recombinant *Escherichia coli* cells have been immobilized in a poly(vinylalcohol) cryogel (Hong, M. S. et al., 1998; Efremenko, E. N. et al., 2002; Kim, J.-W. et al., 2002). Recombinant *Escherichia coli* has been immobilized to polypropylene fabric by absorption of the cells to the fabric (Mulchandani, A. et al., 1999b).

[0009] However, there is still a need for environmentally friendly (e.g., biodegradable) materials for novel coatings and other surface treatments that remain active and stable for significant time. Additionally, there is still a need for materials that give color, opacity, protection from light damage (e.g., UV light), camouflage appearance, and other desirable properties to coatings and other surface treatments.

SUMMARY OF THE INVENTION

[0010] A surprising and unexpected aspect of the present invention is the discovery of the suitability of a cell-based particulate material, particularly a microorganism-based particulate material, for use as a purposefully included surface treatment component. This discovery is surprising due to the problem of damage by living cells, particularly those of microorganisms, to surface treatments (e.g., coatings, waxes, textile finishes, waxes, elastomers, adhesives, sealants) and/or a surface (e.g., wood, metal), as is known to those of skill in the art and described herein. Though it is preferred in many embodiments that a cell-based particulate material of the present invention is sterile while used in a surface treatment. In the practice of the present invention, cell-based particulate materials are contemplated for use as various coating and surface treatment components such as pigments, fillers, light stabilizers, binders, rheology control agents, and other embodiments described herein. To the best of the inventor's knowledge, this selection of cell-based particulate materials as a surface treatment component is counter to the core teachings of the art as related to surface treatments.

[0011] As used herein, a "surface treatment" refers to compositions applied to a surface, and examples of such compositions specifically contemplated include a coating (e.g., a paint, a clear coat), a textile finish, a wax, elastomer, an adhesive, or a sealant. Such surface treatments are known to one of ordinary skill in the respective arts of coatings, textile finishes, waxes, elastomers, adhesives, and/or sealants, and any technique or composition described herein or would be known to one of ordinary skill in these arts may be applied in the practice of the present invention in light of the disclosures herein of the utility of cell-based particulate material as a component of a surface treatment.

[0012] The present invention provides compositions and methods for use of a cell-based particulate material as a component of a surface treatment. A cell-based particulate material refers to particulate material prepared from a cell or virus. More specifically, the present invention provides compositions and methods for incorporating preparations of cells or viruses, particularly microorganism derived cells, into surface treatments as a particulate material. In the practice of the present invention, a preferred surface treatment is a coating. In the practice of the present invention, a preferred cell-based particulate material comprises a sterilized and/or attenuated cell-based particulate material, wherein the majority or all of the cell-based particulate material has been killed and/or reduced in pathogenicity.

[0013] The invention provides a coating or other surface treatment comprising a cell-based particulate material. A further disclosure of the present invention is the preparation of a cell-based particulate material with a limited number of processing and/or purification steps from the organism from which it was produced. In preferred aspects, the cell-based particulate material comprises a cell wall, a silica based shell/exoskeleton/cell wall (e.g., a test, a frustule), a pellicle, a viral proteinaceous outer coat, or a combination thereof.

[0014] In some embodiments, a cell-based particulate material of the present invention, such as a whole cell particulate material or a cell-fragment particulate material will be of a greater molecular weight or mass per particle than other coating or surface treatment components. It is contemplated that the insolubility of a cell-based particulate material of the present invention will be enhanced by a greater average molecular weight. For example, the cell wall component (e.g., peptidoglycan) of a single bacterial cell may be millions of kilo Daltons of molecular weight, while most coating or other surface treatment components are typically less than 1,000 kDa (1.66×10^{-18} g) in weight per individual molecule or particle.

[0015] In some embodiments, the average weight per single particle ("primary particle") of a cell-based particulate material of the present invention may be measured in "wet weight," which is the weight of the particle prior to a drying or an extraction step that would remove the liquid component of a cell (e.g., the aqueous component of the cell's cytoplasm). In certain aspects, the "wet weight" of a cell-based particulate material of the present invention (e.g., a whole cell particulate material) that has its liquid component replaced by some other liquid (e.g., an organic solvent) may also be measured in "wet weight." The "dry weight" refers to the average per particle weight of a cell-based particulate material after the majority of the liquid component has been removed. The term "majority" refers 50% to 100%, including all intermediate ranges and combinations thereof, with the greater values preferred (e.g., 85% to 100%). In general embodiments, it is contemplated that the dry weight of a cell-based particulate material of the present invention will typically be 5% to 30% the wet weight, including all intermediate ranges and combinations thereof, as it is usual for 70% to 95% of a cell to be water. Any technique for measuring cell or particle size, volume, density, etc. used by those of ordinary skill in these arts for various insoluble particulate materials (e.g., pigments) used as coating, paint, or surface treatment components may be applied to a cell-based particulate material of the present invention to determine wet or dry weight values, particle

size, particle density, etc. Additionally, various examples of specific techniques are described herein (see, for example, the "Incorporation of a Particulate Material into a Coating" section of the Detailed Description herein). Further, such measurements of cell size, shape, density, numbers, etc. is known to those of ordinary skill in the art of microbiology. For example, the average number of particles, size, shape, etc. of a cell-based particulate material of the present invention may be microscopically determined for a given volume and weight of material, whether prepared as a "wet weight" or "dry weight material," and the average particle weight, density, volume, etc. calculated.

[0016] In additional embodiments, it is contemplated that a cell-based particulate material of the present invention, including those prepared from a cell comprising a silica based shell/exoskeleton/cell wall (e.g., a test, a frustule), will comprise one or more biomolecules that contribute to average molecular weight of the particles of cell-based particulate material. A "biomolecule" as used herein is any molecule comprising carbon synthesized by a living cell and comprised as part of a cell-based particulate material. In most embodiments, the biomolecule was part of the cell or virus from which the cell-based particulate material of the present invention is produced, and is retained as part of the cell-based particulate material. In general embodiments, it is contemplated that a cell-based particulate material prepared from a cell comprising a silica-based shell/exoskeleton/cell wall or other non-biomolecule component (e.g., a diatom-based particulate material), will comprise a per particle average, by wet or dry weight, of 0.000001% to 100% of one or more biomolecules, including all intermediate ranges and combinations thereof. It is contemplated that in certain embodiments, all detectable amounts of the non-biomolecule component (e.g., a silica based shell/exoskeleton/cell wall) may be removed by one or more processing steps, producing a cell-based particulate material comprising, by wet or dry weight, 100% or one or more biomolecules. Examples of the intermediate ranges and combinations for the minimum per particle average biomolecule wet or dry weight value for a cell-based particulate material of the present invention includes 0.00001%, 0.0001%, 0.001%, 0.01%, 0.10%, 1.00%, 2.00%, 3.0%, 4.0%, 5.0%, 7.5%, 10.0%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 99%, 99.9%, 100%, etc.

[0017] In certain embodiments, the average wet or dry molecular weight of a single particle of a cell-based particulate material of the present invention may be 8.3×10^{-20} g (50 kDa) to 2.5×10^{-7} g (1.5×10^{14} kDa), including all intermediate ranges and combinations thereof. Examples of wet or dry weight intermediate ranges and combinations thereof minimum and/or maximum values include 8.3×10^{-20} g (50 kDa), 1.0×10^{-19} g (60 kDa), 1.2×10^{-19} g (72 kDa), 1.4×10^{-19} g (84 kDa), 1.6×10^{-19} g (96 kDa), 1.8×10^{-19} g (108 kDa), 2.0×10^{-19} g (120 kDa), 2.25×10^{-19} g (135 kDa), 2.5×10^{-19} g (151 kDa), 2.75×10^{-19} g (166 kDa), 3.0×10^{-19} g (181 kDa), 3.5×10^{-19} g (211 kDa), 4.0×10^{-19} g (241 kDa), 5.0×10^{-19} g (301 kDa), 6.0×10^{-19} g (361 kDa), 7.0×10^{-19} g (422 kDa), 8.0×10^{-19} g (482 kDa), 9.0×10^{-19} g (542 kDa), 1.0×10^{-18} g (602 kDa), 1.25×10^{-18} g (753 kDa), 1.5×10^{-18} g (903 kDa), 1.66×10^{-18} g (1,000 kDa), 1.75×10^{-18} g (1,053 kDa), 2.0×10^{-18} g (1,204 kDa), 2.5×10^{-18} g (1,506 kDa), 2.75×10^{-18} g (1,656 kDa), 3.0×10^{-18} g (1,807 kDa), 3.25×10^{-18} g (1,957 kDa), 3.5×10^{-18} g (2,108 kDa), 3.75×10^{-18} g

(2,258 kDa), 4.0×10^{-18} g (2,409 kDa), 5.0×10^{-18} g (3,011 kDa), 6.0×10^{-18} g (3,613 kDa), 7.0×10^{-18} g (4,215 kDa), 8.0×10^{-18} g (4,818 kDa), 9.0×10^{-18} g (5,420 kDa), 1.0×10^{-17} g (6,022 kDa), 2.0×10^{-17} g (1.2×10^4 kDa), 3.0×10^{-17} g (1.8×10^4 kDa), 4.0×10^{-17} g (2.4×10^4 kDa), 5.0×10^{-17} g (3.0×10^4 kDa), 6.0×10^{-17} g (3.6×10^4 kDa), 7.0×10^{-17} g (4.2×10^4 kDa), 8.0×10^{-17} g (4.8×10^4 kDa), 9.0×10^{-17} g (5.4×10^4 kDa), 1.0×10^{-16} g (6.0×10^4 kDa), 2.0×10^{-16} g (1.2×10^5 kDa), 3.0×10^{-16} g (1.8×10^5 kDa), 4.0×10^{-16} g (2.4×10^5 kDa), 5.0×10^{-16} g (3.0×10^5 kDa), 6.0×10^{-16} g (3.6×10^5 kDa), 7.0×10^{-16} g (4.2×10^5 kDa), 8.0×10^{-16} g (4.8×10^5 kDa), 9.0×10^{-16} g (5.4×10^5 kDa), 1.0×10^{-15} g (6.0×10^5 kDa), 2.0×10^{-15} g (1.2×10^6 kDa), 3.0×10^{-15} g (1.8×10^6 kDa), 4.0×10^{-15} g (2.4×10^6 kDa), 5.0×10^{-15} g (3.0×10^6 kDa), 6.0×10^{-15} g (3.6×10^6 kDa), 7.0×10^{-15} g (4.2×10^6 kDa), 8.0×10^{-15} g (4.8×10^6 kDa), 9.0×10^{-15} g (5.4×10^6 kDa), 1.0×10^{-14} g (6.0×10^6 kDa), 2.0×10^{-14} g (1.2×10^7 kDa), 3.0×10^{-14} g (1.8×10^7 kDa), 4.0×10^{-14} g (2.4×10^7 kDa), 5.0×10^{-14} g (3.0×10^7 kDa), 6.0×10^{-14} g (3.6×10^7 kDa), 7.0×10^{-14} g (4.2×10^7 kDa), 8.0×10^{-14} g (4.8×10^7 kDa), 9.0×10^{-14} g (5.4×10^7 kDa), 1.0×10^{-13} g (6.0×10^7 kDa), 2.0×10^{-13} g (1.2×10^8 kDa), 3.0×10^{-13} g (1.8×10^8 kDa), 4.0×10^{-13} g (2.4×10^8 kDa), 5.0×10^{-13} g (3.0×10^8 kDa), 6.0×10^{-13} g (3.6×10^8 kDa), 7.0×10^{-13} g (4.2×10^8 kDa), 8.0×10^{-13} g (4.8×10^8 kDa), 9.0×10^{-13} g (5.4×10^8 kDa), 1.0×10^{-12} g (6.0×10^8 kDa), 2.0×10^{-12} g (1.2×10^9 kDa), 3.0×10^{-12} g (1.8×10^9 kDa), 4.0×10^{-12} g (2.4×10^9 kDa), 5.0×10^{-12} g (3.0×10^9 kDa), 6.0×10^{-12} g (3.6×10^9 kDa), 7.0×10^{-12} g (4.2×10^9 kDa), 8.0×10^{-12} g (4.8×10^9 kDa), 9.0×10^{-12} g (5.4×10^9 kDa), 1.0×10^{-11} g (6.0×10^9 kDa), 2.0×10^{-11} g (1.2×10^{10} kDa), 3.0×10^{-11} g (1.8×10^{10} kDa), 4.0×10^{-11} g (2.4×10^{10} kDa), 5.0×10^{-11} g (3.0×10^{10} kDa), 6.0×10^{-11} g (3.6×10^{10} kDa), 7.0×10^{-11} g (4.2×10^{10} kDa), 8.0×10^{-11} g (4.8×10^{10} kDa), 9.0×10^{-11} g (5.4×10^{10} kDa), 1.0×10^{-10} g (6.0×10^{10} kDa), 2.0×10^{-10} g (1.2×10^{11} kDa), 3.0×10^{-10} g (1.8×10^{11} kDa), 4.0×10^{-10} g (2.4×10^{11} kDa), 5.0×10^{-10} g (3.0×10^{11} kDa), 6.0×10^{-10} g (3.6×10^{11} kDa), 7.0×10^{-10} g (4.2×10^{11} kDa), 8.0×10^{-10} g (4.8×10^{11} kDa), 9.0×10^{-10} g (5.4×10^{11} kDa), 1.0×10^{-9} g (6.0×10^{11} kDa), 2.0×10^{-9} g (1.2×10^{12} kDa), 3.0×10^{-9} g (1.8×10^{12} kDa), 4.0×10^{-9} g (2.4×10^{12} kDa), 5.0×10^{-9} g (3.0×10^{12} kDa), 6.0×10^{-9} g (3.6×10^{12} kDa), 7.0×10^{-9} g (4.2×10^{12} kDa), 8.0×10^{-9} g (4.8×10^{12} kDa), 9.0×10^{-9} g (5.4×10^{12} kDa), 1.0×10^{-8} g (6.0×10^{12} kDa), 2.0×10^{-8} g (1.2×10^{13} kDa), 3.0×10^{-8} g (1.8×10^{13} kDa), 4.0×10^{-8} g (2.4×10^{13} kDa), 5.0×10^{-8} g (3.0×10^{13} kDa), 6.0×10^{-8} g (3.6×10^{13} kDa), 7.0×10^{-8} g (4.2×10^{13} kDa), 8.0×10^{-8} g (4.8×10^{13} kDa), 9.0×10^{-8} g (5.4×10^{13} kDa), 1.0×10^{-7} g (6.0×10^{13} kDa), 2.0×10^{-7} g (1.2×10^{14} kDa), etc. These values encompass various specifically contemplated values and ranges for both whole cell and cell fragment-based particulate material of the present invention. However, it is contemplated that the average wet or dry molecular weight of a single particle of a whole cell-based particulate material of the present invention may be 1.0×10^{-17} g (6,022 kDa) to 2.5×10^{-7} g (1.5×10^{14} kDa), including all intermediate ranges and combinations thereof. Additionally, based upon a typical diameter of 1.0 to 10 μ m and 1.0 to 100 μ m for a prokaryotic cell and eukaryotic cell, respectively, it is contemplated that a prokaryotic whole cell-based particulate material of the present invention will typically range in wet or dry weight from 1.0×10^{-17} g (6,022 kDa) to 2.0×10^{-10} g (1.2×10^{11} kDa), and a eukaryotic whole cell-based particulate material of the present invention will typically range in wet or dry

weight from 1.0×10^{-17} g (6,022 kDa) to 2.5×10^{-7} g (1.5×10^{14} kDa), including all intermediate ranges and combinations thereof, respectively.

[0018] In certain embodiments, a cell-based particulate material of the present invention may comprise cellulose (e.g., an algae-based particulate material). However, as described above, most previously described coating or surface treatment components, including those comprising cellulose, are of lower average molecular weight than many embodiments of the cell-based particulate material of the present invention. Additionally, cellulose materials (e.g., nitrocellulose, cellulose acetate) previously described in the art have typically undergone a chemical modification step such as nitration, esterification, hydrophobe modification, etc. usually made to enhance cellulose's solubility in a coating or surface treatment's liquid component. However, as preferred embodiments of the present invention relates to particulate material that is an insoluble material (e.g., a cell-based particulate material used as a pigment), it is contemplated that a solubility enhancing chemical modification of the cellulose component of the cell-based particulate material of the present invention will be less prevalent or absent. Further, as it is preferred that a cell-based particulate material of the present invention is prepared by as few steps as possible, in certain embodiments a cell-based particulate material of the present invention may be prepared from a cell that comprises cellulose without a chemical modification step. However, in other embodiments, a cell-based particulate material of the present invention comprising cellulose may undergo a chemical modification-processing step. In some aspects, a cell-based particulate material of the present invention may be prepared from a cell that comprises cellulose with a chemical modification step that does not chemically modify the cellulose component of the cell-based particulate material. In further aspects, a cell-based particulate material of the present invention may be prepared from a cell that comprises cellulose with a chemical modification step other than esterification of the cellulose component of the cell-based particulate material. In other embodiments, a cell-based particulate material of the present invention may be prepared from a cell that comprises cellulose with a chemical modification step to a chemical moiety of cellulose other than a cellulose's hydroxyl moiety. In further aspects, a cell-based particulate material of the present invention may be prepared from a cell that comprises cellulose in a form that differs from other types of cellulose materials used in coating or surface treatments. For example, in some aspects, the cell-based particulate material that comprises cellulose is prepared from cells that may not have been used in other types of cellulose materials, to produce a microorganism-based particulate material (e.g., an algae-based particulate material), a whole-cell particulate material, a unicellular-based particulate material, an oligocellular-based particulate material, or a combination thereof. Additionally, a cellulose material such as nitrocellulose, cellulose ester, etc., is prepared as a purified cellulose material, wherein other cellular biomolecules are of low initial content and/or have been stringently removed by processing to insure batch to batch consistency in the chemical composition of the cellulose material. In another example, the cell-based particulate material that comprises cellulose will comprise one or more additional biomolecules other than cellulose (e.g., proteinaceous materials, lipids, etc.) retained from the cell used to produce the cell-based

particulate material. Such a plurality of cellular biomolecules is contemplated as fewer processing steps are preferred in the preparation of a cell-based particulate material of the present invention. In certain embodiments, it is contemplated that a cell-based particulate material of the present invention comprising cellulose will comprise 0.000001% to 100% cellulose, including all intermediate ranges and combinations thereof, wherein the cellulose is a chemically modified cellulose or cellulose that has not undergone a chemical modification step. Specific examples of intermediate ranges and combinations thereof for cellulose content of a cell-based particulate material of the present invention include 0.000001% to 90%, 0.000001% to 85%, 0.000001% to 80%, 0.000001% to 75%, 0.000001% to 70%, 0.000001% to 65%, 0.000001% to 60%, 0.000001% to 55%, 0.000001% to 50%, 0.000001% to 45%, 0.000001% to 40%, 0.000001% to 35%, 0.000001% to 30%, 0.000001% to 25%, 0.000001% to 20%, 0.000001% to 15%, 0.000001% to 10%, 0.000001% to 5%, 0.000001% to 1%, etc.

[0019] In preferred aspects, the organism from which the cell-based particulate material is processed is a unicellular or oligocellular organism. In many aspects, the cell-based particulate material comprises a microorganism-based particulate material. In specific aspects, the microorganism-based particulate material comprises an Archaea, a Eubacteria, a fungi, a Protista, a bacteriophage, or a combination thereof.

[0020] In some facets, the microorganism-based particulate material comprises an Archaea. In particular facets, the Archaea comprises Acidianus, Acidilobus, Aeropyrum, Archaeoglobus, Caldvirga, Desulfurococcus, Ferroglobus, Ferroplasma, Haloarcula, Halobacterium, Halobaculum, Halococcus, Haloferax, Halogeometricum, Halomicrobium, Halorhabdus, Halorubrum, Haloterrigena, Hyperthermus, Ignicoccus, Metallosphaera, Methanobacterium, Methanobrevibacter, Methanocalculus, Methanocaldococcus, Methanococcoides, Methanococcus, Methanocorpusculum, Methanoculleus, Methanofollis, Methanogenium, Methanohalobium, Methanohalophilus, Methanolacinia, Methanolobus, Methanomicrobium, Methanomicrococcus, Methanoplanus, Methanopyrus, Methanosaeta, Methanosalsum, Methanosarcina, Methanosphaera, Methanospirillum, Methanothermobacter, Methanothermococcus, Methanothermus, Methanotherx, Methanotorris, Natrialba, Natronobacterium, Natronococcus, Natronomonas, Palaeococcus, Picrophilus, Pyrobaculum, Pyrococcus, Pyrodictium, Pyrolobus, Staphylothermus, Stetteria, Stygiolobus, Sulfolobus, Sulfophobococcus, Sulfurisphaera, Thermococcus, Thermofilum, Thermoplasma, Thermoproteus, Thermosphaera, Vulcanisaeta, or a combination thereof.

[0021] In other facets, the microorganism-based particulate material comprises a Eubacteria. In specific facets, the Eubacteria comprises Abiotrophia, Acetitomaculum, Acetohalobium, Acetonema, Achromobacter, Acidimicrobium, Acidithiobacillus, Acidobacterium, Acidocella, Acrocarpospora, Actinoalloteichus, Actinobacillus, Actinobaculum, Actinocorallia, Aequorivita, Afipia, Agreia, Agrococcus, Ahrensia, Albibacter, Albidovulum, Alcanivorax, Alicyclophilus, Alicyclobacillus, Alkalibacterium, Alkaliimnicola, Alkalipirillum, Alkanindiges, Aminobacterium, Aminomonas, Ammonifex, Ammoniphilus, Anaerococcus, Anaerobacter, Anaerobaculum, Anaerobranca, Anaerococcus, Anaerofilum, Anaeromusa, Anaerophaga, Anaeroplasm,

Anaerosinus, Anaerostipes, Anaerovorax, Aneurinibacillus, Angiococcus, Anoxybacillus, Antarctobacter, Aquabacter, Aquabacterium, Aquamicrobium, Aquifex, Arcobacter, Arhodomonas, Asanoa, Atopobium, Azoarcus, Azorhizophilus, Azospira, Bacteriovorax, Bartonella, Beutenbergia, Bilophila, Blastococcus, Blastomonas, Bogoriella, Bosea, Brachymonas, Brackiella, Brenneria, Brevibacillus, Bulleidia, Burkholderia, Caenibacterium, Caldicellulosiruptor, Caldithrix, Caloramator, Caloranaerobacter, Caminibacter, Caminicella, Carbophilus, Carboxydibacchium, Carboxydocella, Carboxydotherrnus, Catenococcus, Catenuloplanes, Cellulosimicrobium, Chelatococcus, Chlorobaculum, Chryseobacterium, Chrysiogenes, Citricoccus, Collinsella, Colwellia, Conexibacter, Coprothermobacter, Couchioplanes, Crossiella, Cryobacterium, Cryptosporangium, Dechloromonas, Deferribacter, Deffluibacter, Dehalobacter, Delftia, Demetria, Dendrosporobacter, Denitrovibrio, Dermacoccus, Desemzia, Desulfacinum, Desulfatobacterium, Desulfobacca, Desulfobacula, Desulfocapsa, Desulfocella, Desulfofaba, Desulfofrigus, Desulfofustis, Desulfohalobium, Desulfomusa, Desulfonatronovibrio, Desulfonatronum, Desulfonauticus, Desulfonispota, Desulfo-regula, Desulforhabdus, Desulforhopalus, Desulfospira, Desulfosporosinus, Desulfotalea, Desulfotignum, Desulfovirga, Desulfurobacterium, Desulfuromusa, Dethiosulfobacterium, Devosia, Dialister, Diaphorobacter, Dichelobacter, Dictyoglomus, Dietzia, Dolosicoccus, Dorea, Eggerthella, Empedobacter, Enhygromyxa, Eremococcus, Ferrimonas, Filifactor, Filobacillus, Finegoldia, Flexistipes, Formivibrio, Friedmanniella, Frigoribacterium, Fulvimonas, Fusibacter, Gallicola, Garciella, Gelidibacter, Gelria, Gemmatimonas, Gemmobacter, Geobacillus, Geobacter, Georgenia, Geothrix, Geovibrio, Glaciecola, Gluconacetobacter, Gracilibacillus, Granulicatella, Grimontia, Halanaerobacter, Halanaerobium, Haliangium, Halobacillus, Halocella, Halonatronum, Halothermothrix, Halothiobacillus, Helcococcus, Heliophilum, Helioresistis, Herbidospota, Hippea, Holdemania, Holophaga, Hydrogenobacter, Hydrogenobaculum, Hydrogenophilus, Hydrogenothermus, Hydrogenovibrio, Hymenobacter, Ignavigranum, Iodobacter, Isobaculum, Janibacter, Kineococcus, Kineosphaera, Kitasatospora, Knoellia, Kocuria, Kozakia, Kribbella, Kutzneria, Kytococcus, Lachnobacterium, Laribacter, Lautropia, Lechevalieria, Leifsonia, Leisingera, Lentzea, Leucobacter, Limnobacter, Listonella, Lonepinella, Luteimonas, Luteococcus, Macrooccus, Macromonas, Magnetospirillum, Mannheimia, Maricaulis, Marinibacillus, Marinitoga, Marinobacterium, Marinospirillum, Marmoricola, Meiothermus, Methylocapsa, Methylopila, Methylosarcina, Microbulbifer, Microlunatus, Micromonas, Microsphaera, Microvirgula, Modestobacter, Mogibacterium, Moorella, Moritella, Muricauda, Mycetocella, Mycoplana, Myroides, Natroniella, Natronincola, Nautilia, Nesterenkonia, Nonomuraea, Novosphingobium, Oceanimonas, Oceanobacillus, Oceanobacter, Octadecabacter, Oenococcus, Oleiphilus, Oligotropha, Olsenella, Opitutus, Orenia, Ornithinococcus, Ornithinimicrobium, Oxalicibacterium, Oxalophagus, Oxobacter, Paenibacillus, Pandoraea, Papillibacter, Paralactobacillus, Paraliobacillus, Parascardovia, Paucimonas, Pectobacterium, Pelczaria, Pelospora, Pelotomaculum, Peptoniphilus, Petrotoga, Phascolarctobacterium, Phocoenobacter, Photorhabdus, Pigmentiphaga, Planomicrobium, Planotetraspora, Plantibacter, Plesiocystis, Polaribacter, Prauserella, Propioniferax, Propionimicrobium,

Propionispora, Propionivibrio, Pseudaminobacter, Pseudoalteromonas, Pseudobutyrvibrio, Pseudoramibacter, Pseudorhodobacter, Pseudospirillum, Pseudoxanthomonas, Psychroflexus, Psychromonas, Psychroserpens, Ralstonia, Ramlibacter, Raoultella, Rathayibacter, Rhodothermus, Roseateles, Roseburia, Roseiflexus, Roseinatronobacter, Roseospirillum, Roseovarius, Rubritepida, Ruegeria, Sagittula, Salana, Salegentibacter, Salinibacter, Salinivibrio, Sanguibacter, Scardovia, Schineria, Schwartzia, Sedimentibacter, Shewanella, Shuttleworthia, Silicibacter, Skermania, Slackia, Sphingobium, Sphingomonas, Sphingopyxis, Spirilliplanes, Sporanaerobacter, Sporobacter, Sporobacterium, Sporotomaculum, Staleya, Stappia, Starkeya, Stenotrophomonas, Sterolibacterium, Streptacidiphilus, Streptomonospora, Subtercola, Succiniclasticum, Succinispota, Sulfobacter, Sulfurospirillum, Sutterella, Suttonella, Syntrophobotulus, Syntrophothermus, Syntrophus, Telluria, Tenacibaculum, Tepidibacter, Tepidimonas, Tepidiphilus, Terasakiella, Terracoccus, Tessaracoccus, Tetragenococcus, Tetrasphaera, Thalassomonas, Thauera, Thermanobacter, Thermanaeromonas, Thermanaerovibrio, Thermicanus, Thermithiobacillus, Thermoanaerobacterium, Thermobifida, Thermobispora, Thermobranchium, Thermocrinis, Thermocarpus, Thermodesulforhabdus, Thermodesulfobacterium, Thermohydrogenium, Thermomonas, Thermosyntropha, Thermoterrabacterium, Thermovenabulum, Thermovibrio, Thiakalimicrobium, Thialkalivibrio, Thioalkalivibrio, Thiobaca, Thiomonas, Tindallia, Tolomonas, Turicella, Turicibacter, Ureibacillus, Verrucosispota, Victivallis, Virgibacillus, Vogesella, Weissella, Williamsia, Xenophilus, Zavarzinia, Zooshikella, Zymobacter, or a combination thereof.

[0022] In additional facets, the Eubacteria comprises a Gram-positive Eubacteria. In particular facets, a Gram-positive Eubacteria comprises Acetobacterium, Actinokinetospora, Actinomadura, Actinomyces, Actinoplanes, Actinopolyspora, Actinosynnema, Aerococcus, Aeromicrobium, Agromyces, Amphibacillus, Amycolatopsis, Arcanobacterium, Arthrobacter, Aureobacterium, Bacillus, Bifidobacterium, Brachybacterium, Brevibacterium, Brochothrix, Carnobacterium, Caryophanon, Catellatospora, Cellulomonas, Clavibacter, Clostridium, Coprococcus, Coriobacterium, Corynebacterium, Curtobacterium, Dactylosporangium, Deinobacter, Deinococcus, Dermabacter, Dermatophilus, Desulfotomaculum, Enterococcus, Erysipelothrix, Eubacterium, Exiguobacterium, Falcivibrio, Frankia, Gardnerella, Gemella, Geodermatophilus, Glycomyces, Gordonia, Intraspangium, Jonesia, Kibdelosporangium, Kineospora, Kitasatospora, Kurthia, Lactobacillus, Lactococcus, Leuconostoc, Listeria, Marinococcus, Melissococcus, Microbacterium, Microbispora, Micrococcus, Micromonospora, Microtetraspora, Mobiluncus, Mycobacterium, Nocardia, Nocardioidea, Nocardiosis, Oerskovia, Pediococcus, Peptococcus, Peptostreptococcus, Pilimelia, Planobispora, Planococcus, Planomonospora, Promicromonospora, Propionibacterium, Pseudonocardia, Rarobacter, Renibacterium, Rhodococcus, Rothia, Rubrobacter, Ruminococcus, Saccharococcus, Saccharomonospora, Saccharopolyspora, Saccharothrix, Salinicoccus, Sarcina, Sphaerobacter, Spirillospora, Sporichthya, Sporohalobacter, Sporolactobacillus, Sporosarcina, Staphylococcus, Streptoalloteichus, Streptococcus, Streptomyces, Streptosporangium, Syntrophospota, Terrabacter, Thermacetogenium, Thermoactinomyces, Thermo-

naerobacter, Thermoanaerobium, Thermomonospora, Trichococcus, Tsukamurella, Vagococcus, or a combination thereof.

[0023] In further facets, the microorganism-based particulate material comprises a Gram-negative Eubacteria. In specific facets, the Gram-negative Eubacteria comprises Acetivibrio, Acetoanaerobium, Acetobacter, Acetomicrobium, Acidaminobacter, Acidaminococcus, Acidiphilium, Acidomonas, Acidovorax, Acinetobacter, Aeromonas, Agitococcus, Agrobacterium, Agromonas, Alcaligenes, Allochrochromatium, Alteromonas, Alysia, Aminobacter, Anaabaena, Anaerobiospirillum, Anaerorhabdus, Anaerovibrio, Anealomicrobium, Ancylobacter, Angulomicrobium, Aquaspirillum, Archangium, Arsenophonus, Arthrosira, Asticcacaulis, Azomonas, Azorhizobium, Azospirillum, Azotobacter, Bacteroides, Bdellovibrio, Beggiatoa, Beijerinckia, Blastobacter, Blastochloris, Bordetella, Borrelia, Brachyspira, Bradyrhizobium, Brevundimonas, Brucella, Budvicia, Butiauxella, Butyrivibrio, Calothrix, Campylobacter, Capnocytophaga, Cardiobacterium, Caulobacter, Cedecea, Cellulophaga, Cellvibrio, Centipeda, Chitinophaga, Chlorobium, Chloroflexus, Chlorogloeopsis, Chloroherpeton, Chondromyces, Chromobacterium, Chromohalobacter, Chromococcidiopsis, Citrobacter, Cobetia, Comamonas, Crinalium, Cupriavidus, Cyclobacterium, Cylandrospermum, Cystobacter, Cytophaga, Dermocarpella, Derxia, Desulfobacter, Desulfobacterium, Desulfobulbus, Desulfococcus, Desulfomicrobium, Desulfomonile, Desulfonema, Desulfosarcina, Desulfovibrio, Desulfurella, Desulfuromonas, Dichotomicrobium, Ectothiorhodospira, Edwardsiella, Eikenella, Enhydrobacter, Ensifer, Enterobacter, Erwinia, Erythrobacter, Erythromicrobium, Escherichia, Ewingella, Fervidobacterium, Fibrobacter, Filomicrobium, Fischerella, Flammeovirga, Flavobacterium, Flectobacillus, Flexibacter, Flexithrix, Francisella, Frateuria, Fusobacterium, Gemmata, Gemmiger, Gloeobacter, Gloeocapsa, Gluconobacter, Haemophilus, Hafnia, Haliscomenobacter, Haloanaerobium, Halobacteroides, Halochromatium, Halomonas, Halorhodospira, Helicobacter, Heliobacillus, Heliobacterium, Herbaspirillum, Herpetosiphon, Hirschia, Hydrogenophaga, Hyphomicrobium, Hyphomonas, Ilyobacter, Isochromatium, Isosphaera, Janthiobacterium, Kingella, Klebsiella, Kluyvera, Labrys, Lachnospira, Lamprocystis, Lampropedia, Leclercia, Legionella, Leminorella, Leptospira, Leptospirillum, Leptothrix, Leptotrichia, Leucothrix, Lysobacter, Malonomonas, Marinilabilia, Marichromatium, Marinobacter, Marinomonas, Megamonas, Megasphaera, Melittangium, Meniscus, Mesophilobacter, Metallogenium, Methylobacillus, Methylobacterium, Methylococcus, Methylomonas, Methylophaga, Methylophilus, Methylovorus, Microscilla, Mitsukella, Moellerella, Moraxella, Morganella, Morococcus, Myxococcus, Myxosarcina, Nannocystis, Neisseria, Nevskia, Nitrobacter, Nitrococcus, Nitrosococcus, Nitrosomonas, Nitrospira, Nitrospira, Nostoc, Obesumbacterium, Oceanospirillum, Ochrobactrum, Oligella, Oscillatoria, Oxalobacter, Pantoea, Paracoccus, Pasteurella, Pectinatus, Pedobacter, Pedomicrobium, Pelobacter, Pelodictyon, Persicobacter, Phaeospirillum, Phenyllobacterium, Photobacterium, Phyllobacterium, Pirellula, Planctomyces, Plesiomonas, Pleurocapsa, Polyangium, Porphyrobacter, Porphyromonas, Pragia, Prevotella, Propionigenium, Propionispira, Prosthecobacter, Prosthecochloris, Prosthecomicrobium, Proteus, Providencia, Pseudanabaena,

Pseudomonas, Psychrobacter, Rahnella, Rhabdochromatium, Rhizobacter, Rhizobium, Rhizomonas, Rhodobacter, Rhodobium, Rhodoblastus, Rhodobaca, Rhodocista, Rhodocyclus, Rhodoferax, Rhodomicrobium, Rhodopila, Rhodoplanes, Rhodopseudomonas, Rhodospirillum, Rhodothalassium, Rhodovibrio, Rhodovulum, Rikenella, Roseobacter, Roseococcus, Rugamonas, Rubrivivax, Ruminobacter, Runella, Salmonella, Saprospira, Scytonema, Sebaldeia, Selenomonas, Seliberia, Serpens, Serpulina, Serratia, Shigella, Simonsiella, Sinorhizobium, Sphaerotilus, Sphingobacterium, Spirillum, Spirochaeta, Spirosoma, Spirulina, Sporocytophaga, Sporomusa, Stella, Stigmatella, Streptobacillus, Succinimonas, Succinivibrio, Sulfobacillus, Synechococcus, Synechocystis, Syntrophobacter, Syntrophococcus, Syntrophomonas, Tatumella, Taylorella, Thermochromatium, Thermodesulfobacterium, Thermoleophilum, Thermomicrobium, Thermonema, Thermosiphon, Thermotoga, Thermus, Thiobacillus, Thiocapsa, Thiococcus, Thiocystis, Thiodictyon, Thiohalocapsa, Thiolamprovirus, Thiomicrospira, Thiorhodovibrio, Thiothrix, Tissierella, Tolypothrix, Treponema, Vampirovibrio, Variovorax, Veillonella, Verrucomicrobium, Vibrio, Vitreoscilla, Weissella, Wolinella, Xanthobacter, Xanthomonas, Xenococcus, Xenorhabdus, Xylella, Xylophilus, Yersinia, Yokenella, Zobellia, Zoogloea, Zymomonas, Zymophilus, or a combination thereof.

[0024] In some aspects, the microorganism-based particulate material comprises a fungi. In some facets, the fungi comprises Aciculoconidium, Agaricostilidium, Ambrosiomyces, Arxiozyma, Arxula, Ascoidea, Babjevia, Bensingtonia, Blastobotrys, Botryozyma, Bullera, Bulleromyces, Candida, Cephaloscypha, Chionosphaera, Citeromyces, Clavicipora, Cryptococcus, Cystofilobasidium, Debaryomyces, Dekkera, Dipodascopsis, Dipodascus, Endomyces, Eremothecium, Erythrobacillus, Fellomyces, Filobasidiella, Filobasidium, Galactomyces, Geotrichum, Hanseniaspora, Hyalodendron, Issatchenkia, Itersonilia, Kloeckera, Kluyveromyces, Kockovaella, Kurtzmanomyces, Leucosporidium, Lipomyces, Lodderomyces, Malassezia, Metschnikowia, Moniliella, Mrakia, Myxozyma, Nadsonia, Oosporidium, Pachysolen, Phaffia, Pichia, Protomyces, Pseudozyma, Reniforma, Rhodospiridium, Rhodotorula, Saccaromycopsis, Saccharomyces, Saccharomycodes, Saitoella, Saturnispora, Schizoblastosporion, Schizosaccharomyces, Sporidiobolus, Sporobolomyces, Sporopachydermia, Stephanoscypha, Sterigmatomyces, Sterigmatosporidium, Sympodiomyces, Sympodiomycopsis, Taphrina, Tilletiaria, Tilletiopsis, Torulaspora, Trichosporon, Trichosporonoides, Trigonopsis, Tsuchiyaea, Wickerhamia, Wickerhamiella, Williopsis, Xanthophyllomyces, Yarrowia, Zygoascus, Zygosaccharomyces, Zygozima, or a combination thereof.

[0025] In other aspects, the microorganism-based particulate material comprises a Protista. In particular facets, the Protista comprises Acetabularia, Achnanthes, Amphidinium, Ankistrodesmus, Anophryoides, Aphanomyces, Astasia, Asterionella, Blepharisma, Botrydiopsis, Botrydium, Botryococcus, Bracteacoccus, Brevilegnia, Bulbochaete, Caenomorphia, Cephaloscypha, Ceratium, Chaetoceros, Chaetophora, Characiosiphon, Chlamydomonas, Chlorella, Chloridella, Chlorobotrys, Chlorococcum, Chromulina, Chroodactylon, Chrysamoeba, Chrysocapsa, Cladophora, Closterium, Cocconeis, Coelastrum, Cohnilembus, Colacium, Coleps, Colpidium, Colpoda, Cosmarium, Cryp-

toglena, Cyclidium, Cyclotella, Cylandrocystis, Derbesia, Dexiostoma, Dictyosphaerium, Dictyuchus, Didinium, Dinobryon, Distigma, Draparnaldia, Dunaliella, Dysmorphococcus, Enteromorpha, Entosiphon, Eudorina, Euglena, Euplotes, Eustigmatos, Flintiella, Fragilaria, Fritschiella, Glaucoma, Gonium, Gonyaulax, Gymnodinium, Gyropaigne, Haematococcus, Halophytophthora, Heterosigma, Hyalotheca, Hydrodictyon, Khawkinia, Lagenidium, Lepidolegnia, Mallomonas, Mantoniella, Melosira, Menoidium, Mesanophrys, Mesotaenium, Metopus, Micrasterias, Microspora, Microthamnion, Mischochococcus, Monodopsis, Mougeotia, Nannochloropsis, Navicula, Nephroselmis, Nitzschia, Ochromonas, Oedogonium, Ophiocytium, Opisthonecta, Oxyrrhis, Pandorina, Paramecium, Paranophrys, Paraphysomonas, Parmidium, Pedastrum, Peranema, Peridinium, Peronophythora, Petalomonas, Phacus, Pithophora, Plagiopyla, Plasmopara, Platyophrya, Plectospira, Pleodorina, Pleurochloris, Pleurococcus, Pleurotaenium, Ploetia, Polyedriella, Porphyridium, Proocentrum, Prototheca, Pseudocharaciopsis, Pseudocohnilembus, Pyramimonas, Pythiopsis, Pythium, Rhabdomonas, Rhizochromulina, Rhizoclonium, Rhodella, Rhodosorus, Rhynchopus, Saprolegnia, Scenedesmus, Scytomonas, Selenastrum, Skeltonema, Spathidium, Sphaerocystis, Spirogyra, Spirostomum, Spondylium, Staurastrum, Stauroneis, Stentor, Stephanodiscus, Stephanosphaera, Stichococcus, Stigeoclonium, Synedra, Synura, Tetracystis, Tetradron, Tetrahymena, Tetraselmis, Thalassiosira, Thaumatomastix, Thraustotheca, Trachelomonas, Trebouxia, Trentepohlia, Tribonema, Trimyema, Ulothrix, Uronema, Vaucheria, Vischeria, Volvox, Vorticella, Xanthidium, Zygnema, or a combination thereof.

[0026] In additional aspects, the microorganism-based particulate material comprises a virus. In some aspects, the virus is a bacteriophage. In particular facets, the bacteriophage comprises Inoviridae genus Inovirus, Leviviridae, Microviridae, Myoviridae, Podoviridae, Siphoviridae, or a combination thereof. In additional facets, the bacteriophage comprises 10/I, 149, 212/XV, 24/II, 249, 371/XXIX, 5, 8, A-1 (L), A19, A-4 (L), A-41, alpha 3, AN-10, AN-15, AN-20, AN-22, AN-24, B1, B40-8, B5, BK1, D20, E1, F [HER 346], F1, fr, hp, I, If1, If2, II, III, IV, J1, Mc-4, Minetti, MOR-1, MS2, Mu-1, N-1, N1 [N], N3 [Cay], N4 [X-5-A], N8 [Horse], Ox6, P/SW1a [NCMB 384], P1, P22 [PLT-22(22)], PEa1 (h), PEa7, phi 92, phi R, phi V-1, phi X174, phi-S1, ps 1, Q-beta, R 17, R-1, S13, S-a, SP10, SP8, T2, T3, T6, V, VD13, Vi I, wy, XP5, ZIK/1, or a combination thereof. In further facets, the bacteriophage comprises 10 [L286], 11, 11 [WI 386], 113, 118, 12 [WI 3106], 120, 13 [J1 263], 138, 14 [J2106], 145, 163, 17, 17 [formerly 13], 18 [formerly 7], 184, 19 [formerly 5], 2, 2 [J1 328], 20 [formerly 4], 205, 221, 22653 [Carvajal's strain 1], 23 [Olsen phage], 236, 239, 24B, 250, 256 (R), 282 (S), 36, 37, 4 [J2101], 42, 46, 49B, 4S, 50Br, 53 alpha, 547, 57, 60, 6A, 6B, 6C, 7 [L2 106], 73, 8 [L2 305], 9 [WI 3263], 92, A, A1, Ac 20, Ac 21, Ac 24, AN-11, AN-12, AN-13, AN-14, AN-16, AN-17, AN-18, AN-19, AN-21, AN-23, AN-25, AN-26, AP211, AS-1, B56-3, BG3, BK3, Bo 1, Bo 3, Bo 4, Bo 6 I, Bo 6 II, Bo 6 III, Bo 7, C, C204, C33, C36, Cb3, Cb6, Cb8r, CDC29, CDC42D, CDC47, CDC52, CDC52A, CDC53, CDC79, CDC80, CDC81, CDC83A, chi, D, D-10, D-34, DLC 2921/49, DS6A, enterococcus phage 1A, enterococcus phage 1B, eTAmy+, F-68, FCZ, G [HER 276], G178, HER-1 [7Lindberg], HER-10 [F8Lindberg], HER-16 [M4 Lindberg],

HER-17 [M6Lindberg], HER-18 [F116L], HER-2 [16Lindberg], HER-3, HER-4 [24Lindberg], HER-5 [31Lindberg], HER-6 [44Lindberg], HER-9 [F7Lindberg], IMI strain A, IMI strain C, IMI strain D, IMI strain J, IMI strain K, *Lactobacillus plantarum* phage, LG, M-4, Mc-2, MU9, *Mycobacterium smegmatis* phage, N-4, NCPPB 1507 [4S], NCPPB 1508 [4L], NCPPB 782 [E1], NRS 201, NRS 605, P14, P4 sid1, Pa, PAV-1, Pb, PB2, Pc, Pf, phage UTAK, phi Ea100, phi Ea104, phi Ea116C, phi Ea125, phi W-14, phiXcs70am-3, *Propionibacterium acnes* phage, Ps-G3, r1589, r187, r196, r638, r71, RA105, rED220, rEDa41, rEDb44, rEDb45, rEDb50, RH23, RH88, rJ3, S-20, S-5, SL-1, SPP1, T-150, T7M (Meselson), UV1, UV375, UV47, *Vibrio* sp. phage, w, X1 [IMET 5013], X10 [IMET 5057], X24 [IMET 5056], X3 [IMET 5015], X5 [IMET 5017], XP1, XP2, XP3, XP4, XP8, ZJ/2, or a combination thereof.

[0027] In other aspects, the cell-based material comprises a multicellular-based particulate material. In general facets, the multicellular-based particulate material comprises a plant-based particulate material. In specific facets, the plant-based particulate material comprises a corn-based particulate material.

[0028] In general embodiments, cell-based particulate material comprises 0.000001% to 65% of the coating or surface treatment by weight or volume including all intermediate ranges and combinations thereof. Specific examples of such intermediate ranges and combinations thereof of the cell-based particulate material by weight or volume in a coating or other surface treatment include 1% to 65%, 2% to 65%, 3% to 65%, 4% to 65%, 5% to 65%, 6% to 65%, 7% to 65%, 8% to 65%, 9% to 65%, 10% to 65%, 11% to 65%, 12% to 65%, 13% to 65%, 14% to 65%, 15% to 65%, 16% to 65%, 17% to 65%, 18% to 65%, 19% to 65%, 20% to 65%, etc.

[0029] The invention provides various additional embodiments. In general embodiments, a cell-based particulate material comprises 0.000001% to 65% of the coating or other surface treatment composition by weight or volume, including all intermediate ranges and combinations thereof. In specific embodiments, the cell-based particulate material is a whole cell particulate material or a cell fragment particulate material. In other embodiments, the cell-based particulate material comprises a microorganism-based particulate material. In some aspects, the microorganism-based particulate material comprises a whole cell particulate material. In alternative aspects, the cell-based particulate material comprises a cell fragment microorganism-based particulate material.

[0030] In other embodiments, the coating or other surface treatment is 5 um to 5000 um thick upon the surface, including all intermediate ranges and combinations thereof. Specific examples of such intermediate ranges and combinations thereof of a coating's, other surface treatment's, and/or individual layer thereof's thickness upon a surface include 6 um to 5000 um, 7 um to 5000 um, 8 um to 5000 um, 9 um to 5000 um, 10 um to 5000 um, 11 um to 5000 um, 12 um to 5000 um, 13 um to 5000 um, 14 um to 5000 um, 15 um to 5000 um, 16 um to 5000 um, 17 um to 5000 um, 18 um to 5000 um, 19 um to 5000 um, 20 um to 5000 um, 21 um to 5000 um, 22 um to 5000 um, 23 um to 5000 um, 24 um to 5000 um, 25 um to 5000 um, 5 um to 4500 um, 5 um to 4000 um, 5 um to 3500 um, 5 um to 3000 um, 5 um to 2500

um, 5 um to 2000 um, 5 um to 1750 um, 5 um to 1500 um, 5 um to 1250 um, 5 um to 1000 um, 5 um to 900 um, 5 um to 800 um, 5 um to 700 um, 5 um to 600 um, 5 um to 500 um, 5 um to 450 um, 5 um to 400 um, 5 um to 350 um, 5 um to 300 um, 5 um to 250 um, 5 um to 200 um, 5 um to 175 um, 5 um to 150 um, 5 um to 125 um, 5 um to 100 um, 5 um to 90 um, 5 um to 80 um, 5 um to 70 um, 5 um to 60 um, 5 um to 50 um, 5 um to 40 um, 5 um to 30 um, 5 um to 25 um, 7.5 um to 500 um, 10 um to 500 um, 15 um to 500 um, 7.5 um to 250 um, 10 um to 250 um, 12.5 um to 250 um, 15 um to 250 um, 7.5 um to 150 um, 10 um to 150 um, 12.5 um to 150 um, 15 um to 150 um, etc.

[0031] In particular aspects, the coating or other surface treatment comprises a multicoat system. In an additional aspect, the multicoat system comprises 2 to 10 layers. In a particular facet, one layer of the multicoat system comprises the cell-based particulate material. In a further aspect, a plurality of layers of the multicoat system comprises the cell-based particulate material. In certain facets, each layer of the multicoat system is a coating or other surface treatment 5 um to 5000 um thick, including all intermediate ranges and combinations thereof. In particular aspects, the multicoat system comprises a sealer, a water repellent, a primer, an undercoat, a topcoat, or a combination thereof. In specific facets, the multicoat system comprises a topcoat. In particular facets, the topcoat comprises the cell-based particulate material. In the case of a multicoat system comprising a plurality of layers that comprises a cell-based particulate material of the present invention, the cell-based particulate material comprised within a specific layer may be the same or different as the cell-based particulate material comprised within another layer.

[0032] In some embodiments, the coating comprises a paint. In other embodiments, the coating comprises a clear coating. In some aspects, the clear coating comprises a lacquer, a varnish, a shellac, a stain, a water repellent coating, or a combination thereof. In general aspects, the coating or surface treatment comprises a binder, a liquid component, a colorant, an additive, or a combination thereof. In some facets, the coating or surface treatment comprises a buffer. In particular aspects, the buffer comprises a bicarbonate.

[0033] In certain embodiments, the coating or other surface treatment is a coating or other surface treatment that is capable of film formation. In some aspects, the film formation occurs by a thermoplastic physical change of the coating or surface treatment, a thermosetting chemical change of the coating or surface treatment, or a combination thereof. In certain aspects, film formation (e.g., thermosetting film formation) occurs by crosslinking of a binder. In some facets, film formation occurs by crosslinking of a plurality of binders. In further facets, film formation (e.g., thermosetting film formation) occurs by irradiating the coating or surface treatment. In general aspects, film formation occurs at ambient conditions, baking conditions, or a combination thereof. In particular aspects, film formation (e.g., thermosetting film formation, thermoplastic film formation) occurs at baking conditions. In other aspects, baking conditions is between 40° C. and 110° C., including all intermediate ranges and combinations thereof. Examples of specific intermediate ranges for baking conditions include 40° C. to 50° C., or 40° C. to 65° C. In preferred embodiments, the cell-based particulate material will partly or fully

retain a desired characteristic (e.g., a physical property, a biochemical property, color, etc.) during and/or after contact with the baking condition, an irradiation, a thermosetting chemical reaction, a thermoplastic physical change, or a combination thereof. In some facets, the coating or surface treatment produces a self-cleaning film upon film formation.

[0034] In general aspects, the coating or surface treatment comprises a volatile component and a non-volatile component. In general facets, the coating or surface treatment undergoes film formation (e.g., thermoplastic film formation) by loss of part of the volatile component. In other facets, the volatile component comprises a volatile liquid component. In particular facets, the volatile liquid component comprises a solvent, a thinner, a diluent, or a combination thereof. In other aspects, the non-volatile component comprises a binder, a colorant, a plasticizer, a coating or surface treatment additive, a cell-based particulate material of the present invention, or a combination thereof.

[0035] In certain alternative embodiments, the coating or surface treatment is a non-film forming coating or surface treatment. In particular aspects, the non-film forming coating or surface treatment comprises a non-film formatting binder. In some aspects, the non-film forming coating or surface treatment comprises a coating or surface treatment component in a concentration that is insufficient to produce a solid film. In some facets, the coating or surface treatment component that is insufficient to produce a solid film comprises a binder that contributes to thermoplastic film formation, thermosetting film formation, or a combination thereof. In particular facets, the coating or surface treatment component that is insufficient to produce a solid film comprises a binder, catalyst, initiator, or combination thereof. Though the concentration which is insufficient for a coating or surface treatment component to produce film formation in a coating or surface treatment may be empirically determined by an assay, such as those described herein for film formation, such an insufficient concentration may easily be achieved by selection of a concentration of 0%, wherein the coating or surface treatment lacks the film-forming component.

[0036] In other alternative embodiments, the coating or surface treatment produces a temporary film. In specific aspects, the temporary film has a poor resistance to a coating or surface treatment remover. In particular facets, the temporary film has a poor abrasion (e.g., scrub) resistance, a poor solvent resistance, a poor water resistance, a poor weathering property, a poor adhesion property, a poor micro-organism/biological resistance property, or a combination thereof. A poor resistance and/or poor quality property for a coating or surface treatment can be empirically determined by assays described herein or as would be known to one of ordinary skill in the art in light of the present disclosure.

[0037] In general embodiments, the coating comprises an architectural coating, an industrial coating, a specification coating, or a combination thereof. In additional aspects, the coating specifically comprises an architectural coating. In particular aspects, the architectural coating comprises a wood coating, a masonry coating, an artist's coating, or a combination thereof. In some facets, the architectural coating has a pot life of at least 12 months at ambient conditions. In general aspects, the architectural coating undergoes film formation at ambient conditions. In other aspects, the coating comprises an industrial coating. In further aspects, the

industrial coating comprises an automotive coating, a can coating, a sealant coating, a marine coating, or a combination thereof. In particular facets, the industrial coating undergoes film formation at baking conditions. In additional aspects, the coating comprises a specification coating. In particular facets, the specification coating comprises a camouflage coating, a pipeline coating, traffic marker coating, aircraft coating, a nuclear power plant coating, or a combination thereof. In particular facets, the specification coating comprises a camouflage coating. In specific facets, the camouflage coating comprises a camouflage pigment. In particular facets, the camouflage pigment is a cell-based particulate material of the present invention. In farther facets, the cell-based particulate material camouflage pigment absorbs infrared radiation.

[0038] In many embodiments, a coating comprises a water-borne coating, a solvent borne coating, or a powder coating. In particular aspects, the coating comprises a water-borne coating. In certain facets, the water-borne coating is a latex coating. In additional facets, the water-borne coating has a density of 1.20 kg/L to 1.50 kg/L, including all intermediate ranges and combinations thereof. In other aspects, the coating comprises a solvent-borne coating. In further facets, the solvent-borne coating has a density of 0.90 kg/L to 1.2 kg/L, including all intermediate ranges and combinations thereof.

[0039] In other aspects, the coating has a viscosity of 100 P to 1000 P, including all intermediate ranges and combinations thereof, upon a surface immediately after application. In some embodiments, the viscosity of the coating varies during preparation ("mixing"), during storage (e.g., in a container), during application, and upon a surface. The medium-shear viscosity ("coating consistency") refers to the viscosity of a coating during preparation, and in most embodiments will be between 60 Ku and 140 Ku, including all intermediate ranges and combinations thereof. Specific examples of medium-shear viscosity intermediate ranges and combinations thereof include 70 Ku to 110 Ku, 80 Ku to 100 Ku, 90 Ku to 95 Ku, 72 Ku to 95 Ku, etc. During storage and upon a surface, a coating is typically subject to lower shear forces (e.g., gravity), and it is will be preferred that a coating possess a viscosity and other rheological properties (e.g., leveling, sag, syneresis, settling) to retain suitable dispersion of coating components during storage and form a uniform layer upon a surface. It is contemplate that in most embodiments, the low-shear viscosity (e.g., the viscosity prior to application, viscosity upon a surface immediately after application) of a coating will be between 100 P to 3000 P, including all intermediate ranges and combinations thereof. Specific examples of low-shear viscosity intermediate ranges and combinations thereof include 100 P to 2500 P, 100 P to 2000 P, 100 P to 1500 P, 100 P to 1000 P, 125 P to 3000 P, 150 P to 3000 P, 175 P to 3000 P, 200 P to 3000 P, 225 P to 3000 P, 250 P to 3000 P, 275 P to 3000 P, 300 P to 3000 P, 125 P to 2500 P, 150 P to 2000 P, 175 P to 1500 P, 200 P to 1000 P, 250 P to 1000 P, etc. The high-shear viscosity ("application viscosity") refers to the viscosity of a coating during application, and typically is less than the low-shear viscosity to allow ease of application. In particular aspects, the coating has a high-shear viscosity of 0.5 P to 2.5 P, including all intermediate ranges and combinations thereof. Specific examples of high-shear viscosity intermediate ranges and combinations thereof include 0.5 P to 2.0 P, 0.5 P to 1.5 P, 0.5 P to 1.0 P, 0.5 P to 0.75 P, 0.6 P

to 2.5 P, 0.75 P to 2.5 P, 1.0 P to 2.5 P, 1.5 P to 2.5 P, 2.0 P to 2.5 P, 0.75 P to 2.0 P, 1.0 P to 2.0 P, etc.

[0040] In many embodiments, the coating comprises a binder. In many aspects, the binder comprises a thermoplastic binder, a thermosetting binder, or a combination thereof. In certain aspects, the coating comprises a thermoplastic binder. In particular facets, such a coating produces a film by thermoplastic film formation. In other aspects, the coating comprises a thermosetting binder. In further facets, such a coating produces a film by thermosetting film formation.

[0041] In some embodiments, the binder comprises an oil-based binder. In particular aspects, the oil-based binder comprises an oil, an alkyd, an oleoresinous binder, a fatty acid epoxide ester, or a combination thereof. In further facets, such an oil-based binder coating produces a layer 15 μm to 25 μm thick upon the vertical surface, including all intermediate ranges and combinations thereof, or 15 μm to 40 μm thick upon the horizontal surface, including all intermediate ranges and combinations thereof. In further aspects, the binder comprises an oil. In other aspects, the binder comprises an alkyd. In specific aspects, the binder comprises an oleoresinous binder. In some aspects, the binder comprises a fatty acid epoxide ester.

[0042] In other embodiments, the binder comprises a polyester resin. In certain aspects, polyester resin comprises a hydroxy-terminated polyester. In other aspects, the polyester resin comprises a carboxylic acid-terminated polyester. In additional facets, the coating comprises a polyester resin and a urethane, an amino resin, or a combination thereof.

[0043] In some embodiments, the binder comprises a modified cellulose. In certain aspects, the modified cellulose comprises a cellulose ester, a nitrocellulose or a combination thereof. In certain facets, the modified cellulose comprises a cellulose ester. In other facets, the modified cellulose comprises a nitrocellulose. In further aspects, the coating comprises a modified cellulose and an amino binder, an acrylic binder, urethane binder, or a combination thereof.

[0044] In additional embodiments, the binder comprises a polyamide. In specific aspects, the coating comprises a polyamide and an epoxide.

[0045] In certain embodiments, the binder comprises an amino resin. In some aspects, the coating comprises an amino resin and an acrylic binder, an alkyd resin, a polyester binder, or a combination thereof.

[0046] In additional embodiments, the binder comprises an urethane binder. In particular aspects, the coating comprises an urethane binder and a polyol, an amine, an epoxide, a silicone, a vinyl, a phenolic, a triacrylate, or a combination thereof.

[0047] In some embodiments, the binder comprises a phenolic resin. In further aspects, the coating comprises a phenolic resin and an alkyd resin, an amino resin, a blown oil, an epoxy resin, a polyamide, a polyvinyl resin, or a combination thereof.

[0048] In other embodiments, the binder comprises an epoxy resin. In additional aspects, the coating comprises an epoxy resin and an amino resin, a phenolic resin, a polyamide, a ketimine, an aliphatic amine, or a combination thereof. In particular facets, the epoxy resin comprises a

cycloaliphatic epoxy binder. In further facets, the coating comprises cycloaliphatic epoxy binder and a polyol.

[0049] In additional embodiments, the binder comprises a polyhydroxyether binder. In further aspects, the coating comprises a polyhydroxyether binder and an epoxide, a polyurethane comprising an isocyanate moiety, an amino resin, or a combination thereof.

[0050] In further embodiments, the binder comprises an acrylic resin. In additional aspects, the coating comprises an acrylic resin and an epoxide, a polyurethane comprising an isocyanate moiety, an amino resin, or a combination thereof.

[0051] In some embodiments, the binder comprises a polyvinyl binder. In further embodiments, the coating comprises a polyvinyl binder and an alkyd, a urethane, an amino-resin, or a combination thereof.

[0052] In certain embodiments, the binder comprises a rubber resin. In some aspects, the rubber resin comprises a chlorinated rubber resin, a synthetic rubber resin, or a combination thereof. In additional facets, the coating comprises a rubber resin and an acrylic resin, an alkyd resin, a bituminous resin, or a combination thereof.

[0053] In specific embodiments, the binder comprises a bituminous binder. In additional aspects, the coating comprises a bituminous binder and an epoxy resin.

[0054] In further embodiments, the binder comprises a polysulfide binder. In specific aspects, the coating comprises a polysulfide binder and a peroxide, a binder comprising an isocyanate moiety, or a combination thereof.

[0055] In additional embodiments, the binder comprises a silicone binder. In further aspects, the coating comprises a silicone binder and an organic binder.

[0056] In many embodiments, the coating comprises a liquid component. In general aspects, the liquid component comprises a solvent, a thinner, a diluent, a plasticizer, or a combination thereof. In other aspects, the liquid component comprises a liquid organic compound, an inorganic compound, water, or a combination thereof.

[0057] In some embodiments, the liquid component comprises a liquid organic compound. In certain aspects, the liquid organic compound comprises a hydrocarbon, an oxygenated compound, a chlorinated hydrocarbon, a nitrated hydrocarbon, a miscellaneous organic liquid component, a plasticizer, or a combination thereof.

[0058] In particular embodiments, the liquid organic compound comprises a hydrocarbon. In certain aspects, the hydrocarbon comprises an aliphatic hydrocarbon, a cycloaliphatic hydrocarbon, a terpene, an aromatic hydrocarbon, or a combination thereof. In additional facets, the hydrocarbon comprises an aliphatic hydrocarbon. In further facets, the aliphatic hydrocarbon comprises a petroleum ether, pentane, hexane, heptane, isododecane, a kerosene, a mineral spirit, a VMP naphtha or a combination thereof. In other aspects, the hydrocarbon comprises a cycloaliphatic hydrocarbon. In some facets, the cycloaliphatic hydrocarbon comprises cyclohexane, methylcyclohexane, ethylcyclohexane, tetrahydronaphthalene, decahydronaphthalene, or a combination thereof. In other aspects, the hydrocarbon comprises a terpene. In additional facets, the terpene comprises wood terpentine oil, pine oil, α -pinene, β -pinene, dipentene,

D-limonene, or a combination thereof. In particular aspects, the hydrocarbon comprises an aromatic hydrocarbon. In some facets, the aromatic hydrocarbon comprises benzene, toluene, ethylbenzene, xylene, cumene, a type I high flash aromatic naphtha, a type II high flash aromatic naphtha, mesitylene, pseudocumene, cymol, styrene, or a combination thereof.

[0059] In other embodiments, the liquid organic compound comprises an oxygenated solvent. In certain aspects, the oxygenated solvent comprises an alcohol, an ester, a glycol ether, a ketone, an ether, or a combination thereof. In some aspects, the oxygenated solvent comprises an alcohol. In further aspects, the alcohol comprises methanol, ethanol, propanol, isopropanol, 1-butanol, isobutanol, 2-butanol, tert-butanol, amyl alcohol, isoamyl alcohol, hexanol, methylisobutylcarbinol, 2-ethylbutanol, isooctyl alcohol, 2-ethylhexanol, isodecanol, cyclohexanol, methylcyclohexanol, trimethylcyclohexanol, benzyl alcohol, methylbenzyl alcohol, furfuryl alcohol, tetrahydrofurfuryl alcohol, diacetone alcohol, trimethylcyclohexanol, or a combination thereof. In other aspects, the oxygenated solvent comprises an ester. In particular facets, the ester comprises methyl formate, ethyl formate, butyl formate, isobutyl formate, methyl acetate, ethyl acetate, propyl acetate, isopropyl acetate, butyl acetate, isobutyl acetate, sec-butyl acetate, amyl acetate, isoamyl acetate, hexyl acetate, cyclohexyl acetate, benzyl acetate, methyl glycol acetate, ethyl glycol acetate, butyl glycol acetate, ethyl diglycol acetate, butyl diglycol acetate, 1-methoxypropyl acetate, ethoxypropyl acetate, 3-methoxybutyl acetate, ethyl 3-ethoxypropionate, isobutyl isobutyrate, ethyl lactate, butyl lactate, butyl glycolate, dimethyl adipate, glutarate, succinate, ethylene carbonate, propylene carbonate, butyrolactone, or a combination thereof. In certain aspects, the oxygenated solvent comprises a glycol ether. In other facets, the glycol ether comprises methyl glycol, ethyl glycol, propyl glycol, isopropyl glycol, butyl glycol, methyl diglycol, ethyl diglycol, butyl diglycol, ethyl triglycol, butyl triglycol, diethylene glycol dimethyl ether, methoxypropanol, isobutoxypropanol, isobutyl glycol, propylene glycol monoethyl ether, 1-isopropoxy-2-propanol, propylene glycol mono-n-propyl ether, propylene glycol n-butyl ether, methyl dipropylene glycol, methoxybutanol, or a combination thereof. In specific aspects, the oxygenated solvent comprises a ketone. In some facets, the ketone comprises acetone, methyl ethyl ketone, methyl propyl ketone, methyl isopropyl ketone, methyl butyl ketone, methyl isobutyl ketone, methyl amyl ketone, methyl isoamyl ketone, diethyl ketone, ethyl amyl ketone, dipropyl ketone, diisopropyl ketone, cyclohexanone, methylcyclohexanone, trimethylcyclohexanone, mesityl oxide, diisobutyl ketone, isophorone, or a combination thereof. In particular aspects, the oxygenated solvent comprises an ether. In additional facets, the ether comprises diethyl ether, diisopropyl ether, dibutyl ether, di-sec-butyl ether, methyl tert-butyl ether, tetrahydrofuran, 1,4-dioxane, metadioxane, or a combination thereof.

[0060] In some embodiments, the liquid organic compound comprises a chlorinated hydrocarbon. In specific aspects, the chlorinated hydrocarbon comprises methylene chloride, trichloromethane, tetrachloromethane, ethyl chloride, isopropyl chloride, 1,2-dichloroethane, 1,1,1-trichloroethane, trichloroethylene, 1,1,2,2-tetrachloroethane, 1,2-dichloroethylene, perchloroethylene, 1,2-dichloropropane, chlorobenzene, or a combination thereof.

[0061] In further embodiments, the liquid organic compound comprises a nitrated hydrocarbon. In specific aspects, the nitrated hydrocarbon comprises a nitroparaffin, N-methyl-2-pyrrolidone, or a combination thereof.

[0062] In additional embodiments, the liquid organic compound comprises a miscellaneous organic liquid. In some aspects, the miscellaneous organic liquid comprises carbon dioxide, acetic acid, methylal, dimethylacetal, N,N-dimethylformamide, N,N-dimethylacetamide, dimethylsulfoxide, tetramethylene sulfone, carbon disulfide, 2-nitropropane, N-methylpyrrolidone, hexamethylphosphoric triamide, 1,3-dimethyl-2-imidazolidinone, or a combination thereof.

[0063] In specific embodiments, the liquid organic compound comprises a plasticizer. In general facets, the plasticizer comprises an adipate, an azelate, a citrate, a chlorinated plasticizer, an epoxide, a phosphate, a sebacate, a phthalate, a polyester, a trimellitate, or a combination thereof. In specific facets, the plasticizer comprises di(2-ethylhexyl) azelate; di(butyl) sebacate; di(2-ethylhexyl) phthalate; di(isononyl) phthalate; dibutyl phthalate; butyl benzyl phthalate; di(isooctyl) phthalate; di(dodecyl) phthalate; tris(2-ethylhexyl) trimellitate; tris(isononyl) trimellitate; di(2-ethylhexyl) adipate; di(isononyl) adipate; acetyl tri-n-butyl citrate; an epoxy modified soybean oil; 2-ethylhexyl epoxystallate; isodecyl diphenyl phosphate; tricresyl phosphate; isodecyl diphenyl phosphate; tri-2-ethylhexyl phosphate; an adipic acid polyester; an azelaic acid polyester; a bisphenoxyethylformal, or a combination thereof.

[0064] In other embodiments, the liquid component comprises an inorganic compound. In specific aspects, the inorganic compound comprises ammonia, hydrogen cyanide, hydrogen fluoride, hydrogen cyanide, sulfur dioxide, or a combination thereof.

[0065] In many embodiments, the liquid component comprises water. In particular aspects, the liquid component comprising water further comprises methanol, ethanol, propanol, isopropyl alcohol, tert-butanol, ethylene glycol, methyl glycol, ethyl glycol, propyl glycol, butyl glycol, ethyl diglycol, methoxypropanol, methyldipropylene glycol, dioxane, tetrahydrofuran, acetone, diacetone alcohol, dimethylformamide, dimethyl sulfoxide, ethylbenzene, tetrachloroethylene, p-xylene, toluene, diisobutyl ketone, trichloroethylene, trimethylcyclohexanol, cyclohexyl acetate, dibutyl ether, trimethylcyclohexanone, 1,1,1-trichloroethane, hexane, hexanol, isobutyl acetate, butyl acetate, isophorone, nitropropane, butyl glycol acetate, 2-nitropropane, methylene chloride, methyl isobutyl ketone, cyclohexanone, isopropyl acetate, methylbenzyl alcohol, cyclohexanol, nitroethane, methyl tert-butyl ether, ethyl acetate, diethyl ether, butanol, butyl glycolate, isobutanol, 2-butanol, propylene carbonate, ethyl glycol acetate, methyl acetate, methyl ethyl ketone, or a combination thereof.

[0066] In general embodiments, the coating comprises a colorant. In some aspects, the colorant comprises a pigment, a dye, a pH indicator, or a combination thereof. In specific aspects, the colorant comprises a pigment. In some aspects, the cell-based particulate material comprises 0.000001% to 100% of the pigment, including all intermediate ranges and combinations thereof. In particular facets, the pigment volume concentration ("PVC") of the coating is 0.000001% to 70%, including all intermediate ranges and combinations thereof. An example of a specific PVC intermediate range is

20 % to 70%. In other aspects, the pigment comprises a corrosion resistance pigment, a camouflage pigment, a color property pigment, an extender pigment, or a combination thereof. In some facets, the pigment comprises barium ferrite; borosilicate; burnt sienna; burnt umber; calcium ferrite; cerium; chrome orange; chrome yellow; chromium phosphate; cobalt-containing iron oxide; fast chrome green; gold bronze powder; luminescent; magnetic; molybdate orange; molybdate red; oxazine; oxysulfide; polycyclic; raw sienna; surface modified pigment; thiazine; thioindigo; transparent cobalt blue; transparent cobalt green; transparent iron blue; transparent zinc oxide; triarylcarbonium; zinc cyanamide; zinc ferrite; or a combination thereof.

[0067] In particular aspects, the pigment comprises a corrosion resistance pigment. In some facets, the corrosion resistance pigment comprises aluminum flake, aluminum triphosphate, aluminum zinc phosphate, ammonium chromate, barium borosilicate, barium chromate, barium metaborate, basic calcium zinc molybdate, basic carbonate white lead, basic lead silicate, basic lead silicochromate, basic lead silicosulfate, basic zinc molybdate, basic zinc molybdate-phosphate, basic zinc molybdenum phosphate, basic zinc phosphate hydrate, bronze flake, calcium barium phosphosilicate, calcium borosilicate, calcium chromate, calcium plumbate, calcium strontium phosphosilicate, calcium strontium zinc phosphosilicate, dibasic lead phosphite, lead chromosilicate, lead cyanamide, lead suboxide, lead sulfate, mica, micaceous iron oxide, red lead, steel flake, strontium borosilicate, strontium chromate, tribasic lead phosphosilicate, zinc borate, zinc borosilicate, zinc chromate, zinc dust, zinc hydroxy phosphite, zinc molybdate, zinc oxide, zinc phosphate, zinc potassium chromate, zinc silicophosphate hydrate, zinc tetraoxylchromate, or a combination thereof. In specific facets, the coating comprising the corrosion resistance pigment is a metal surface coating, a primer, or a combination thereof.

[0068] In other aspects, the pigment comprises a camouflage pigment. In specific facets, the camouflage pigment comprises an anthraquinone black, a chromium oxide green, a cell-based particulate material of the present invention, or a combination thereof. In specific facets, the camouflage pigment reduces the ability of the coating to be detected by a device that measures infrared radiation.

[0069] In further embodiments, the pigment comprises a color property pigment. In additional aspects, the color property pigment comprises a black pigment, a brown pigment, a white pigment, a pearlescent pigment, a violet pigment, a blue pigment, a green pigment, a yellow pigment, an orange pigment, a red pigment, a metallic pigment, a cell-based particulate material of the present invention, or a combination thereof. In certain facets, a color property pigment is a cell-based particulate material of the present invention, and various examples of colored cells capable of being used in a colored cell-based particulate material of the present invention are described herein. In particular facets, the color property pigment comprises aniline black; anthraquinone black; carbon black; copper carbonate; graphite; iron oxide; micaceous iron oxide; manganese dioxide, azo condensation, metal complex brown; antimony oxide; basic lead carbonate; lithopone; titanium dioxide; white lead; zinc oxide; zinc sulphide; titanium dioxide and ferric oxide covered mica, bismuth oxychloride crystal, dioxazine violet, carbazole Blue; cobalt blue; indanthrone;

phthalocyanine blue; Prussian blue; ultramarine; chrome green; hydrated chromium oxide; phthalocyanine green; anthrapyrimidine; arylamide yellow; barium chromate; benzimidazolone yellow; bismuth vanadate; cadmium sulfide yellow; complex inorganic color; diarylide yellow; disazo condensation; flavanthrone; isoindoline; isoindolinone; lead chromate; nickel azo yellow; organic metal complex; yellow iron oxide; zinc chromate; perinone orange; pyrazolone orange; anthraquinone; benzimidazolone; BON arylamide; cadmium red; cadmium selenide; chrome red; dibromanthrone; diketopyrrolo-pyrrole; lead molybdate; perylene; pyranthrone; quinacridone; quinophthalone; red iron oxide; red lead; toluidine red; tonor; β -naphthol red; aluminum flake; aluminum non-leafing, gold bronze flake, zinc dust, stainless steel flake, nickel flake, nickel powder, or a combination thereof.

[0070] In general embodiments, the pigment comprises an extender pigment. In particular aspects, the extender pigment is a cell-based particulate material of the present invention. In some aspects, the extender pigment comprises a barium sulphate, a calcium carbonate, a kaolin, a calcium sulphate, a silicate, a silica, an alumina trihydrate, a cell-based particulate material, or a combination thereof.

[0071] In some embodiments, the coating comprises a pH indicator. In some aspects, the pH indicator is a colorimetric or a fluorimetric indicator. Examples of colorimetric include Alizarin, Alizarin S, Brilliant Yellow, Lacmoid, Neutral Red, Rosolic Red, a cell-based particulate material of the present invention, or a combination thereof. In specific instances, the colorimetric indicator is a pH indicator that undergoes a color change between pH 8 to pH 9. Examples of fluorimetric indicators include SNARF-1, BCECF, HPTS, Fluorescein, a cell-based particulate material of the present invention, or a combination thereof. In certain embodiments, the fluorescence indicator has reduced fluorescence at a lower pH. In specific instances, the fluorimetric indicator is a pH indicator that undergoes a fluorescence change between pH 8 to pH 9. Additional pH indicators are described, for example, in "Using Acid-Base Indicators to Visually Estimate the Ph of Solutions," by Marcia L. Gillette, Chemical Education Resources, Incorporated, 1995.

[0072] In general embodiments, the coating comprises an additive. In some aspects, the additive comprises 0.000001% to 20.0% by weight, including all intermediate ranges and combinations thereof, of the coating. In specific facets, the additive comprises an accelerator, an adhesion promoter, an antifoamer, anti-insect additive, an antioxidant, an antiskinning agent, a buffer, a catalyst, a coalescing agent, a corrosion inhibitor, a defoamer, a dehydrator, a dispersant, a drier, electrical additive, an emulsifier, a filler, a flame/fire retardant, a flattening agent, a flow control agent, a gloss aid, a leveling agent, a marproofing agent, a preservative, a silicone additive, a slip agent, a surfactant, a light stabilizer, a rheological control agent, a wetting additive, a cryopreservative, a xeroprotectant, or a combination thereof.

[0073] In additional aspects, the additive comprises a preservative. In specific aspects, the preservative comprises an in-can preservative, an in-film preservative, or a combination thereof. In general aspects, the preservative comprises a biocide. In particular facets, the biocide comprises a bactericide, a fungicide, an algicide, or a combination

thereof. In specific facets, the preservative comprises 1-(3-chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride; 1,2-benzisothiazoline-3-one; 1,2-dibromo-2,4-dicyanobutane; 1,3-bis(hydroxymethyl)-5,5-dimethylhydantoin; 1-methyl-3,5,7-triaza-1-azonia-adamantane chloride; 2-bromo-2-nitropropane-1,3-diol; 2-(4-thiazolyl)benzimidazole; 2-(hydroxymethyl)-amino-2-methyl-1-propanol; 2(hydroxymethyl)-aminoethanol; 2,2-dibromo-3-nitrilopropionamide; 2,4,5,6-tetrachloro-isophthalonitrile; 2-mercaptobenzo-thiazole; 2-methyl-4-isothiazolin-3-one; 2-n-octyl-4-isothiazoline-3-one; 3-iodo-2-propynyl N-butyl carbamate; 4,5-dichloro-2-N-octyl-3(2H)-isothiazoline; 4,4-dimethylloxazolidine; 5-chloro-2-methyl-4-isothiazolin-3-one; 5-hydroxy-methyl-1-aza-3,7-dioxabicyclo (3.3.0.) octane; 6-acetoxy-2,4-dimethyl-1,3-dioxane; 7-ethyl bicyclooxazolidine; a combination of 1,2-benzisothiazoline-3-one and hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine; a combination of 1,2-benzisothiazoline-3-one and zinc pyrithione; a combination of 2-(thiocyanomethyl-thio)benzothiazole and methylene bis(thiocyanate); a combination of 4-(2-nitrobutyl)-morpholine and 4,4'-(2-ethylnitrotrimethyl-ene) dimorpholine; a combination of 4,4-dimethyl-oxazolidine and 3,4,4-trimethyloxazolidine; a combination of 5-chloro-2-methyl-4-isothiazolin-3-one and 2-methyl-4-isothiazolin-3-one; a combination of carbendazim and 3-iodo-2-propynyl N-butyl carbamate; a combination of carbendazim, 3-iodo-2-propynyl N-butyl carbamate and diuron; a combination of chlorothalonil and 3-iodo-2-propynyl N-butyl carbamate; a combination of chlorothalonil and a triazine compound; a combination of tributyltin benzoate and alkylamine hydrochlorides; a combination of zinc-dimethyldithiocarbamate and zinc 2-mercaptobenzo-thiazole; a copper soap; a metal soap; a mercury soap; a mixture of bicyclic oxazolidines; a tin soap; an alkylamine hydrochloride; an amine reaction product; barium metaborate; butyl parahydroxybenzoate; carbendazim; copper(II) 8-quinolinolate; diodomethyl-p-tolysulfone; dithio-2,2-bis(benzmethylamide); diuron; ethyl parahydroxybenzoate; glutaraldehyde; hexahydro-1,3,5-triethyl-s-triazine; hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine; hydroxymethyl-5,5-dimethylhydantoin; methyl parahydroxybenzoate; N-butyl-1,2-benzisothiazolin-3-one; N-(trichloromethylthio) phthalimide; N-cyclopropyl-N-(1-dimethylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine; N-trichloromethyl-thio-4-cyclohexene-1,2-dicarboximide; p-chloro-m-cresol; phenoxyethanol; phenylmercuric acetate; poly(hexamethylene biguanide) hydrochloride; potassium dimethyldithiocarbamate; potassium N-hydroxymethyl-N-methyl-dithiocarbamate; propyl parahydroxybenzoate; sodium 2-pyridinethiol-1-oxide; tetra-hydro-3,5-di-methyl-2H-1,3,5-thiadiazine-2-thione; tributyltin benzoate; tributyltin oxide; tributyltin salicylate; zinc pyrithione; sodium pyrithione; copper pyrithione; zinc oxide; a zinc soap; or a combination thereof.

[0074] In other aspects, the additive comprises a wetting additive, a dispersant, or a combination thereof. In specific facets, the wetting additive and/or the dispersant comprises the additive comprises a combination of an unsaturated polyamine amide salt and a lower molecular weight acid; a polycarboxylic acid polymer alkylolammonium salt; a combination of a long chain polyamine amide salt and a polar acidic ester; a hydroxyfunctional carboxylic acid ester; a non-ionic wetting agent, or a combination thereof. In particular facets, the wetting additive comprises an ethylene oxide molecule comprising a hydrophobic moiety; a surfac-

tant; pine oil; a metal soap; calcium octoate; zinc octoate; aluminum stearate; zinc stearate; bis(2-ethylhexyl)sulfosuccinate; (octylphenoxy)polyethoxyethanol octylphenyl-polyethylene glycol; nonyl phenoxy poly (ethylene oxy) ethanol; ethylene glycol octyl phenyl ether, or a combination thereof. In other facets, the dispersant comprises tetra-potassium pyrophosphate, a phosphate ester surfactant; a particulate material, a calcium carbonate coated with fatty acid, a modified montmorillonite clay, a caster wax, or a combination thereof.

[0075] In further aspects, the additive comprises an anti-foamer, a defoamer, or a combination thereof. In particular facets, the anti-foamer and/or the defoamer comprises an oil; a mineral oil; a silicon oil; a fatty acid ester; dibutyl phosphate; a metallic soap; a siloxane; a wax; an alcohol comprising six to ten carbons; a pine oil, or a combination thereof. In additional facets, the anti-foamer and/or the defoamer further comprise an emulsifier, a hydrophobic silica, or a combination thereof.

[0076] In additional aspects, the additive comprises a rheological control agent. In particular facets, the rheological control agent comprises a thickener, a viscosifier, or a combination thereof. In particular facets, the rheology control agent comprises a silicate; a montmorillonite silicate; aluminum silicate, a bentonite, magnesium silicate, a cellulose ether, a hydrogenated oil, a polyacrylate, a polyvinylpyrrolidone, a urethane, a methyl cellulose, a hydroxyethyl cellulose, hydrogenated castor oil; a hydrophobically modified ethylene oxide urethane; a titanium chelate, a zirconium chelate, a cell-based particulate material of the present invention, or a combination thereof.

[0077] In specific aspects, the additive comprises a corrosion inhibitor. In some facets, the corrosion inhibitor comprises a chromate, a phosphate, a molybdate, a wollastonite, a calcium ion-exchanged silica gel, a zinc compound, a borosilicate, a phosphosilicate, a hydrotalcite, or a combination thereof. In other facets, the corrosion inhibitor comprises an in-can corrosion inhibitor, a flash corrosion inhibitor, or a combination thereof. In further facets, the in-can corrosion inhibitor and/or the flash corrosion inhibitor comprises sodium nitrate, sodium benzoate, ammonium benzoate, 2-amino-2-methyl-propan-1-ol, or a combination thereof.

[0078] In particular aspects, the additive comprises a light stabilizer. In specific facets, the light stabilizer comprises a UV absorber, a radical scavenger, or a combination thereof. In certain embodiments, a cell-based particulate material of the present invention may comprise a biomolecule capable of absorbing UV light (e.g., carotenoid, a chlorophyll, a phycobilin, a biomolecule-silica particulate material, etc.), and thus function as a UV absorber. In particular facets, the UV absorber comprises a hydroxybenzophenone, a hydroxyphenylbenzotriazole, a hydroxyphenyl-S-triazine, an oxalic anilide, yellow iron oxide, a cell-based particulate material of the present invention, or a combination thereof. In other embodiments, a cell-based particulate material comprises a biomolecule capable of chemically reacting with a chemical radical or other chemically reactive species to inhibit ("scavenge," "quench") an undesirable chemical reaction promoted by the chemical radical or other chemical reactive species. In other facets, the radical scavenger comprises a sterically hindered amine; bis(1,2,2,6,6,-pentamethyl-4-piperidinyl)

ester, bis(2,2,6,6,-tetramethyl-1-isooctyloxy-4-piperidinyl) ester, a cell-based particulate material of the present invention, or a combination thereof.

[0079] In some aspects, the additive comprises a buffer. In specific facets, the buffer comprises a bicarbonate, a monobasic phosphate buffer, a dibasic phosphate buffer, Trizma base, a 5 zwitterionic buffer, triethanolamine, or a combination thereof. In further facets, the bicarbonate comprises an ammonium bicarbonate. In particular facets, the concentration of the buffer in the coating or other surface treatment is 0.000001 M to 2.0 M, including all intermediate ranges and combinations thereof.

[0080] In some aspects, the additive comprises a cryopreservative, a xeroprotectant, or a combination thereof. In some aspects, the cell-based particulate material comprises 0.000001% to 80%, by weight or volume, a cryopreservative, a xeroprotectant, or a combination thereof. In some facets, the cryopreservative comprises glycerol, DMSO, a protein, a sugar of 4 to 10 carbons, or a combination thereof. In other facets, the xeroprotectant comprises glycerol, a glycol, a mineral oil, a bicarbonate, DMSO, a sugar of 4 to 10 carbons, or a combination thereof.

[0081] In some embodiments, the coating or surface treatment is a multi-pack coating or surface treatment, which is a composition wherein different components are stored in a plurality of containers (e.g., a kit). In particular aspects, the multi-pack coating is stored in a two to five containers prior to application to a surface. In specific aspects, 0.000001% to 100% of the cell-based particulate material, including all intermediate ranges and combinations thereof, is stored in a container of the multi-pack coating, and at least one coating component is stored in another container of the multi-pack coating. In some aspects, the container that stores the cell-based particulate material further stores an additional coating component. In particular facets, the additional coating component comprises a preservative, a wetting agent, a dispersing agent, a buffer, a liquid component, a rheological modifier, a cryopreservative, a xeroprotectant, or a combination thereof.

[0082] In particular embodiments, the coating is a coating capable of being applied to a surface by a spray applicator.

[0083] In other embodiments, the cell-based particulate material is microencapsulated.

[0084] The invention further provides a coating or a paint comprising, in various further aspects, a cell-based particulate material, a microorganism-based particulate material, a whole cell particulate material, a unicellular-based particulate material, an oligocellular-based particulate material, a cell-based particulate material wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa and/or 0.000001% to 100% a biomolecule, or a combination thereof.

[0085] The invention specifically provides a coating or paint comprising 0.000001% to 65% by weight or volume, including all intermediate ranges and combinations thereof, a cell-based particulate material, a microorganism-based particulate material, a whole cell particulate material, a unicellular-based particulate material, an oligocellular-based particulate material, a cell-based particulate material wherein the average wet molecular weight or dry molecular

weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa and/or 0.000001% to 100% a biomolecule, or a combination thereof.

[0086] The invention provides a coating or paint, the improvement comprising inclusion of a cell-based particulate material, a microorganism-based particulate material, a whole cell particulate material, a unicellular-based particulate material, an oligocellular-based particulate material, a cell-based particulate material wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa and/or 0.000001% to 100% a biomolecule, or a combination thereof.

[0087] The invention provides a coating or paint, the improvement comprising inclusion of 0.000001% to 65% by weight or volume, including all intermediate ranges and combinations thereof, a cell-based particulate material, a microorganism-based particulate material, a whole cell particulate material, a unicellular-based particulate material, an oligocellular-based particulate material, a cell-based particulate material wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa and/or 0.000001% to 100% a biomolecule, or a combination thereof.

[0088] The invention provides a multi-pack coating or paint, wherein a container comprises a cell-based particulate material, a microorganism-based particulate material, a whole cell particulate material, a unicellular-based particulate material, an oligocellular-based particulate material, a cell-based particulate material wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa and/or 0.000001% to 100% a biomolecule, or a combination thereof.

[0089] The invention provides a multi-pack coating or paint, wherein a container comprises 0.000001% to 65%, by weight or volume of the coating or paint, including all intermediate ranges and combinations thereof, a cell-based particulate material, a microorganism-based particulate material, a whole cell particulate material, a unicellular-based particulate material, an oligocellular-based particulate material, a cell-based particulate material wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa and/or 0.000001% to 100% a biomolecule, or a combination thereof.

[0090] The invention provides a multi-pack coating or paint, the improvement comprising inclusion of a container comprising, a cell-based particulate material, a microorganism-based particulate material, a whole cell particulate material, a unicellular-based particulate material, an oligocellular-based particulate material, a cell-based particulate material wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa and/or 0.000001% to 100% a biomolecule, or a combination thereof.

[0091] The invention provides a multi-pack coating or paint, the improvement comprising inclusion of a container comprising 0.000001% to 65%, by weight or volume of the

coating or paint, including all intermediate ranges and combinations thereof, a cell-based particulate material, a microorganism-based particulate material, a whole cell particulate material, a unicellular-based particulate material, an oligocellular-based particulate material, a cell-based particulate material wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa and/or 0.000001% to 100% a biomolecule, a cryopreservative, a xeroprotectant, or a combination thereof.

[0092] The invention also provides a non-film forming coating comprising a cell-based particulate material.

[0093] The invention provides an elastomer comprising a cell-based particulate material.

[0094] The invention provided a filler comprising a cell-based particulate material.

[0095] The invention provides an adhesive comprising a cell-based particulate material.

[0096] The invention provides a sealant comprising a cell-based particulate material.

[0097] The invention provides a material applied to a textile, comprising a cell-based particulate material.

[0098] The invention provides a wax comprising a cell-based particulate material.

[0099] The invention provides a surface treatment comprising a cell-based particulate material. In certain embodiments, the surface treatment is a coating, a paint, a non-film forming coating, an elastomer, an adhesive, an sealant, a material applied to a textile, or a wax.

[0100] The invention provides a surface treatment, comprising 0.000001% to 65% by weight or volume, including all intermediate ranges and combinations thereof, a cell-based particulate material, a microorganism-based particulate material, a whole cell particulate material, a unicellular-based particulate material, an oligocellular-based particulate material, a cell-based particulate material wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa and/or 0.000001% to 100% a biomolecule, or a combination thereof.

[0101] The invention provides a surface treatment, the improvement comprising inclusion of a cell-based particulate material, a microorganism-based particulate material, a whole cell particulate material, a unicellular-based particulate material, an oligocellular-based particulate material, a cell-based particulate material wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa and/or 0.000001% to 100% a biomolecule, or a combination thereof.

[0102] The invention provides a surface treatment, the improvement comprising inclusion of 0.000001% to 65% by weight or volume, including all intermediate ranges and combinations thereof, a cell-based particulate material, a microorganism-based particulate material, a whole cell particulate material, a unicellular-based particulate material, an oligocellular-based particulate material, a cell-based particulate material wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based

particulate material is 6,022 kDa to 1.5×10^{14} kDa and/or 0.000001% to 100% a biomolecule, or a combination thereof.

[0103] The invention provides a method of making a surface treatment, comprising the step of adding to and/or admixing a cell-based particulate material, a microorganism-based particulate material, a whole cell particulate material, a unicellular-based particulate material, an oligo-cellular-based particulate material, a cell-based particulate material wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa and/or 0.000001% to 100% a biomolecule, or a combination thereof; with at least one additional surface treatment component.

[0104] The invention provides a method of making a surface treatment, a coating, a paint, a non-film forming coating, an elastomer, a filler, an adhesive, a sealant, a material applied to a textile, or a wax, comprising a cell-based particulate material, comprising the steps of: obtaining a cell or a virus; processing the cell or virus by sterilizing, attenuating, concentrating, drying, milling, extracting, resuspending, temperature maintaining, permeabilizing, disrupting, chemically modifying, encapsulating, or a combination thereof, to produce a cell-based particulate material; and adding and/or admixing the cell-based particulate material with at least one additional surface treatment component, coating component, paint component, non-film forming coating component, elastomer component, filler component, adhesive component, material applied to a textile component, or wax component, wherein a surface treatment, a coating, a paint, a non-film forming coating, an elastomer, a filler, an adhesive, a sealant, a material applied to a textile, or a wax, comprising the cell-based particulate material is produced.

[0105] The invention provides a surface treatment comprising a cell-based particulate material produced by the process which comprises obtaining a cell or a virus; processing the cell or virus by sterilizing, attenuating, concentrating, drying, milling, extracting, resuspending, temperature maintaining, permeabilizing, disrupting, chemically modifying, encapsulating, or a combination thereof, to produce a cell-based particulate material; and adding and/or admixing the cell-based particulate material with at least one additional surface treatment component, wherein a surface treatment comprising the cell-based particulate material is produced.

[0106] The invention provides a multi-pack paint, wherein a container comprises 100 parts by volume paint, wherein a second container comprises three parts by volume of a whole cell particulate material composition, and wherein each part of the whole cell particulate material composition comprises 1 mg per milliliter of whole cell particulate material and 50% glycerol. In certain aspects, the invention provides a composition prepared by adding the cell-based particulate material to glycerol, admixing with glycerol and/or suspending in glycerol. In other facets, the glycerol is at a concentration of about 50%. In specific facets, the cell-based particulate material comprised in glycerol at a concentration of about 3 mg of the cell-based particulate material to 3 ml of 50% glycerol. In certain facets, the composition is prepared by adding, suspending, and/or

admixing the cell-based particulate material comprised in glycerol to the coating at a concentration of about 3 ml glycerol comprising cell-based particulate material to 100 ml of coating. The cell-based particulate material may also be added to, suspended in, and/or admixed with a liquid component such as glycerol prior to adding to and/or admixing with the coating. The numbers are exemplary only and do not limit the use of the invention. The concentration was chosen merely to be compatible with the amount of cell-based particulate material that can be added to and/or admixed with one example of a coating (e.g., a paint) without affecting the integrity of the paint itself.

[0107] The invention provides, in certain preferred embodiments, a composition comprising a coating and a cell-based particulate material produced by the process which comprises the following steps: obtaining a culture of cells; concentrating the cells and removing the culture media; disrupting the cell structure; drying the cells; and adding and/or admixing the cell-based particulate material to the coating. In some aspects, the composition is prepared by the additional step of suspending the disrupted cells in a solvent prior to adding the cells to the coating. Any compatible amount may be used within the scope of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0108] One skilled in the art will readily appreciate that the present invention is well adapted to carry out the objects and obtain the ends and advantages mentioned as well as those inherent therein. It should be understood, however, that the compositions, cell-based particulate materials, compounds, coatings, paints, films, methods, procedures, and techniques described herein are presently representative of preferred embodiments. These techniques are intended to be exemplary, are given by way of illustration only, and are not intended as limitations on the scope. Other objects, features, and advantages of the present invention will be readily apparent to one skilled in the art from the following detailed description; specific examples and claims; and various changes, substitutions, other uses and modifications that may be made to the invention disclosed herein without departing from the scope and spirit of the invention or as defined by the scope of the appended claims.

[0109] As used herein, except for the claims, the terms "a," "an," "the," "other," and "said" means one or more. As used herein in the claim(s), when used in conjunction with the words "comprises" or "comprising," the words "a," "an," "the," "other," or "said" may mean one or more than one. As used herein "another" may mean at least a second or more.

[0110] All patents and publications mentioned in this specification are indicative of the levels of those skilled in the art to which the invention pertains. All patents and publications so referenced are herein incorporated by reference to the same extent as if each individual publication was specifically and individually indicated to be incorporated by reference.

[0111] As would be known to one of ordinary skill in the art, many variations of nomenclature are commonly used to refer to a specific chemical composition. Accordingly, several common alternative names may be provided herein in quotations and parentheses/brackets, or other grammatical

technique, adjacent to a chemical composition's preferred designation when referred to herein. Additionally, many chemical compositions referred to herein are further identified by a Chemical Abstracts Service registration number. As would be known to those of ordinary skill in the art, the Chemical Abstracts Service provides a unique numeric designation, denoted herein as "CAS No.," for specific chemicals and some chemical mixtures, which unambiguously identifies a chemical composition's molecular structure.

[0112] In various embodiments described herein, exemplary values are specified as a range. Examples of such ranges cited herein include, for example, a temperature for growth and/or preparation of a microorganism, a chemical moiety's content in a coating component, a coating component's content in a coating composition and/or film, a coating component's mass, a glass transition temperature ("T_g"), a temperature for a chemical reaction (e.g., film formation, chemical modification of a coating component), the thickness of a coating and/or film upon a surface, etc. It will be understood that herein the phrase "including all intermediate ranges and combinations thereof" associated with a given range is all integers and sub-ranges comprised within a cited range. For example, citation of a range "0.03% to 0.07%, including all intermediate ranges and combinations thereof" is specific values within the cited range, such as, for example, 0.03%, 0.04%, 0.05%, 0.06%, and 0.07%, as well as various combinations of such specific values, such as, for example, 0.03%, 0.06% and 0.07%, 0.04% and 0.06%, or 0.05% and 0.07%, as well as sub-ranges such as 0.03% to 0.05%, 0.04% to 0.07%, or 0.04% to 0.06%, etc. Example 6 provides additional descriptions of specific numeric values within a cited range. The phrase "or a combination thereof" refers to any combination (e.g., any sub-set) of a set of listed components.

[0113] A. Cells

[0114] In general embodiments, a preferred cell use in a cell-based particulate material of the present invention comprises a durable structure at the cell-external environment interface, such as, for example, a cell wall, a silica based shell ("test"), a silica based exoskeleton ("frustule"), a pellicle, proteinaceous outer coat, or a combination thereof. In typical embodiments, a preferred cell is obtained from an organism is a unicellular and/or oligocellular organism, as it is contemplated that particulate matter may be prepared from such an organism without a step to separate one or more cells from a multicellular tissue or organism (e.g., a plant) into a smaller average particle size suitable for preparation of a coating or other surface treatment.

[0115] As used herein, "unicellular" refers to 1 cell that generally does not live in contact with a second cell. As used herein, "oligocellular" refers to 2 to 100 cells, including all intermediate ranges and combinations thereof, which generally live in contiguous contact with each other. Common specific types of oligocellular biological material includes 2 contacting cells ("dicellular"), three contacting cells ("tricellular") and four contacting cells ("tetracellular"). As used herein, "multicellular" refers to 101 or more (e.g., hundreds, thousands, millions, billions, trillions), including all intermediate ranges and combinations thereof, which generally live in contiguous contact with each other. In embodiments wherein the cellular material is derived from a unicellular

biological material (e.g., many microorganisms), the composition is known herein as a "unicellular-based particulate material." In embodiments wherein the cellular material is derived from an oligocellular biological material (e.g., certain microorganisms, tissues), the composition is known herein as an "oligocellular-based particulate material," as well as a "dicellular-based particulate material," "tricellular-based particulate material," or "tetracellular-based particulate material," as appropriate. In embodiments wherein the cellular material is derived from a multicellular biological material (e.g., many eukaryotic organisms such as visible plants), the composition is known herein as a "multicellular-based particulate material." A cell-based particulate material of the present invention may be referred to herein based upon the type of biological material from which it was derived, including taxonomic/phylogenetic classification or biochemical composition, as well as one or more processing steps used in its preparation. Examples of such lexography for a cell-based particulate material of the present invention include a "eukaryotic-based particulate material," a "prokaryotic-based particulate material," a "plant-based particulate material," a "microorganism-based particulate material," a "Eubacteria-based particulate material," an "Archaea-based particulate material," a "fungi-based particulate material," a "yeast-based particulate material," a "Protista-based particulate material," an "algae-based particulate material," a "Chrysophyta-based particulate material," a "Methanobacteria-based particulate material," a "*Microscilla aggregans*-based particulate material," a "bacteriophage HER-6 [44Lindberg]-based particulate material," a "bacteria and algae-based particulate material," a "peptidoglycan-based particulate material," a "pellicle-based particulate material," an "attenuated viral-based particulate material," a "sterilized microorganism-based particulate material," an "encapsulated *Streptomyces*-based particulate material," etc.

[0116] It is contemplated that one may obtain biological materials such as viruses (e.g., bacteriophages), cells (e.g., microorganisms), tissues, and organisms (e.g., plants) from an environmental source as would be known to one of ordinary skill in the art [see, for example, "Environmental Biotechnology Isolation of Biotechnological Organisms From Nature (Labeda, D. P., Ed.), 1990]. However, many live cultures, seeds, organisms, etc. of previously isolated and characterized biological materials have been conveniently cataloged and stored by public depositories and/or commercial vendors for the ease of use by those of ordinary skill in the art. Additionally, the identification of a biological material, particularly microorganisms, usually comprises characterization of suitable growth conditions for the cell, such as energy source (e.g., a digestible organic molecule), vitamin requirements, mineral requirements, pH conditions, light conditions, temperature, etc. [see, for example, "Bergey's Manual of Determinative Bacteriology Ninth Edition" (Hensyl, W. R., Ed.), 1994; "The Yeasts—A Taxonomic Study—Fourth Revised and Enlarged Edition" (Kurtzman, C. P. and Fell, J. W., Eds.), 1998; and "The Springer Index of Viruses" (Tidona, C. A. and Darai, G., Eds.), 2001]. Such biological materials and information about appropriate growth conditions is readily obtainable from the biological culture collection and/or commercial vendor that stores the biological material. As would be known by one of ordinary skill in the art, hundreds of such biological culture collections currently exist, and the loca-

tion of a specific biological material may be identified using a database such as that maintained by the World Data Center for Microorganisms (<http://wdcm.nig.ac.jp/fsearch.html>; National Institute of Genetics, WFCC-MIRCEN World Data Center for Microorganisms, 1111 Yata, Mishima, Shizuoka, 411-8540 JAPAN). Specific examples of biological culture collections referred to herein include the American Type Culture Collection ("ATCC"; P.O. Box 1549, Manassas, Va. 20108-1549, U.S.A), the Culture Collection of Algae and Protozoa ("CCAP"; CEH Windermere, The Ferry House, Far Sawrey, Ambleside, Cumbria LA22 0LP, United Kingdom), the Collection de l'Institut Pasteur ("CIP"; Institut Pasteur, 28 Rue du Docteur Roux, 75724 Paris Cedex 15, France), the Deutsche Sammlung von Mikroorganismen und Zellkulturen ("DSMZ"; GmbH, Mascheroder Weg 1B, D-38124 Braunschweig, Germany), the IHEM Biomedical Fungi and Yeasts Collection ("IHEM"; Scientific Institute of Public Health—Louis Pasteur, Mycology Section, Rue J. Wytsmanstraat 14, B-1050 Brussels), the Japan Collection of Microorganisms ("JCM"; Institute of Physical and Chemical Research (RIKEN), Wako, Saitama 351-0198, Japan), the Collection of the Laboratorium voor Microbiologie en Microbiele Genetica ("LMG"; Rijksuniversiteit, Ledeganckstraat 35, B-9000, Gent, Belgium), the MUCL (Agro)Industrial Fungi & Yeasts Collection ("MUCL," Mycothèque de l'Université catholique de Louvain, Place Croix du Sud 3, B-1348 Louvain-la-Neuve), the Pasteur Culture Collection of Cyanobacteria ("PCC"; Unité de Physiologie Microbienne, Institut Pasteur, 28 rue du Docteur Roux, 75724 Paris Cedex 15, France), the All-Russian Collection of Microorganisms ("VKM"; Russian Academy of Sciences, Institute of Biochemistry and Physiology of Microorganisms, 142292 Pushchino, Moscow Region, Russia), and the University of Texas ("UTEX"; Department of Botany, The University of Texas at Austin, Austin, Tex. 78713-7640).

[0117] Certain cells are capable of growth in environmental conditions harmful to many other types of cells, such as conditions of extreme temperature, salt or pH. This durability in the biomolecule composition of such cells makes them preferred in certain embodiments wherein maximum durability of a cell-based particulate material, including the durability of a biomolecule of the cell-based particulate material that contributes to a property other than the particulate nature of the material (e.g., a biomolecule colorant, an enzyme, etc.) is desired in similar conditions in a coating or other surface treatment composition. For example, it is contemplated that a hyperthermophile-based particulate material of the present invention will find particular usefulness in coatings where thermal extremes may be likely, including extremes of temperature that may occur during film formation. As used herein, a "hyperthermophile" typically grows in temperatures considered herein to be a baking temperature for a coating (e.g., >40° C.). However, as many cell types described herein or as would be known to one of ordinary skill in the art can grow at or slightly above this definition (e.g., 40° C.-45° C.), the examples of hyperthermophiles given herein will focus on cells typically capable of growth at ranges that extend above 45° C. As used herein, an "extreme halophile" is capable of living in salt-water conditions of 1.5 M (8.77% w/v) sodium chloride to about 2.7 M (15.78% w/v) or more sodium chloride. It is contemplated that an extreme halophile's biomolecule components will be relatively resistant to ionic-salt components of a

coating or other surface treatment. As used herein, an "extreme acidophile" is capable of growing in pH 1-6, while an "extreme alkaliphile" is capable of growing in pH 8-14.

[0118] The selection of a cell, particularly a microorganism, as a colorant is counter to many core teachings in the art of coatings and surface treatments regarding microorganisms being undesirable due to their ability to discolor a coatings and surface treatments. However, in the present invention, a cell may instead be selected for preparation of a cell-based particulate material of the present invention due to its ability to alter the optical properties (e.g., color, gloss, etc.) of a coating or other surface treatment. In certain embodiments, a cell comprising a biomolecule colorant may be used as a colorant, such as a color property pigment or extender. In other embodiments, a biomolecule colorant may diffuse from the cell-based particulate material of the present invention in a surface treatment, or be added to the surface treatment as a dye. Examples of organisms that produce a biomolecule that confers color include photosynthetic plant cells, cyanobacteria, anoxygenic phototrophic bacteria, eukaryotic algae, and certain types of Archaea, fungal cells, and bacterial cells described herein or as would be known to one of ordinary skill in the art. These cells produce a biomolecule that typically absorb light in the visible spectrum, which ranges from 400 nm to 720 nm wavelengths. A cell-based particulate material of the present invention that is not particularly colored may be selected as an extender pigments or fillers in a surface treatment.

[0119] It is contemplated that a colored cell-based particulate material of the present invention typically will comprise one or more biomolecule colorants such as an anthocyanin, chlorophyll (e.g., chlorophyll a, chlorophyll b), a phycobilin, a bacteriochlorophyll (e.g., bacteriochlorophyll a, bacteriochlorophyll b, bacteriochlorophyll c, bacteriochlorophyll d, bacteriochlorophyll e, bacteriochlorophyll g), a carotenoid, or a combination thereof. In the arts of biology and microbiology, such a biomolecule colorant is referred to as a "pigment." However, the word "pigment" refers to insoluble particulate material in the art of coatings, paints, and other surface treatments. For clarity, a biologically produced colored molecule or fluor, including a biomolecule that may not possess a strong visible color but absorbs and/or fluoresces in the UV or infrared regions of the spectrum, are referred to herein as a "biomolecule colorant." The word "pigment" remains as is understood in the arts of coatings, paints, and other surface treatments, with the disclosure herein that a cell-based particulate material of the present invention, particularly one comprising a biomolecule colorant, can be used as a pigment.

[0120] In vivo, an anthocyanin (e.g., anthophy) is typically red, blue, or violet, a chlorophyll or bacteriochlorophyll typically produces a green color, phycobilin typically produces a bluish or red color, and a carotenoid often produces a yellow or orange color. Examples of a phycobilin include phycoerythrin (red), phycocyanin (blue), and allophycocyanin (blue-green). The colors of cells are often dominated by a carotenoid. Examples of carotenoids and associated colors that have been observed in vivo, include: β -carotene (yellow), γ -carotene (yellow), chlorobactene (green), isorenieratene (brown), lycopene (violet), lycopene (red), lycopene (violet), fucoxanthin (yellow-brown), sproxanthin (orange), flexixanthin (red), okenone (violet-red, pink-rose), rhodopin (violet, green), rhodopinal (violet), spheroidenone

(red), spirilloxanthin (pink-red, violet-red, brown-red, red), tetrahydrospirilloxanthin (yellow-orange-brown), an anthophylls (yellow-green or brown), zeaxanthin (yellow), or a combination thereof. As would be understood by those of skill in the art, most colored cells comprise a plurality of colorants that produce a particular hue.

[0121] 1. Microorganisms

[0122] In general embodiments, a preferred organism for use in a cell-based particulate material of the present invention comprises a microorganism, as such an organism is typically unicellular and/or oligocellular in structure, often comprises a durable structure at the cell-external environment interface, or a combination thereof.

[0123] a. Prokaryotic Organisms

[0124] Prokaryotic organisms are generally classified in the Kingdom Monera as Archaea ("Archaeobacteria") or Eubacteria ("bacteria"). Prokaryotic organisms are generally of small cellular size, which allows a greater flexibility in use in different surface treatment embodiments. Common cell shapes for the Kingdom Monera include bacilli, which is rod-shaped, cocci, which is spherical, and spirochete, which is helical. These characteristic shapes are often associated with whether the cell is typically unicellular in life, such as in the case of bacilli and spirochetes, or whether the

cell is oligocellular clusters or chains in life, such as is in the case of cocci.

[0125] Certain prokaryotic microorganisms lack a durable cell wall, and though they may be used as a coating or other surface treatment component, they are less preferred for use as a cell-based particulate material in the present invention. Examples of such prokaryotes that lack a cell wall include the mycoplasmas of the genera *Anaeroplasm*, *Asteroleplasma*, *Mycoplasma*, *Spiroplasma*, and *Ureaplasma*; the Archaea genera *Thermoplasma*. Additionally, intracellular parasites such as Chlamydiae (e.g., Chlamydia, Chlamydo-phila, Parachlamydia, Simkania, Waddlia) are less preferred due to the increased cell growth requirements and usual pathogenicity of such cells. Examples of preferred prokaryotic microorganisms for use as a cell-based particulate material of the present invention are described below.

(1) Archaea

[0126] The domain Archaea is noted for comprising many organisms capable of living in environmental conditions that most other cells cannot endure. The cell wall of Archaea typically comprises pseudopeptidoglycan, a macromolecular polymer comprising polysaccharide and peptide or polypeptide components, as well as glycoprotein, protein, polysaccharide, or a combination thereof. Examples of Archaea size and shapes are shown at Table 1 below.

TABLE 1

Examples of Archaea Cell's Size and Shape			
Genus	Size	Shape	Number
Acidianus	0.5–2.0 μm	Co	S
Archaeoglobus	0.4–1.3 μm	Co	S, P
Desulfurococcus	0.5–1.0 μm	Co	S
Haloarcula	0.3–1.0 μm \times 1.0–6.0 μm^* or 1.0–3.0 μm^{**}	R*, or Tr**, Rc**	S
Halobacterium	0.5–1.2 μm \times 1.0–6.0 μm	R	S
Halococcus	0.8–1.5 μm	Co	S, P, T, TT, OC
Haloferax	1.0–3.0 μm \times 2.0–3.0 μm	R	S
Hyperthermus	1.5 μm	Co	S, P, MC
Metallosphaera	0.8–1.2 μm	Co	S
Methanobacterium	0.5–1.0 μm	R, CR	S
Methanobrevibacter	0.6 μm \times 0.8–2.0 μm	R, O, Co	P, OL
Methanococcoides	1.0 μm	Co	S, P
Methanococcus	1.0–2.0 μm	Co	S
Methanocorpusculum	1.0 μm	Co	S
Methanoculleus	1.0–2.0 μm	Co	S
Methanogenium	1.0–3.0 μm	Co	S
Methanohalobium	0.5–1.5 μm	Co	S
Methanohalophilus	0.5–3.0 μm	Co	S, P
Methanolacinia	0.6 μm \times 1.5–2.5 μm	R	S
Methanolobus	1.0 μm	Co	S, OC
Methanomicrobium	0.7 μm \times 1.5–2.0 μm	CR	S
Methanoplanus	0.1–0.3 μm \times 1.5–3.0 μm	Co, Pl	S
Methanosarcina	1.0 μm	Co	S, OC
Methanosphaera	0.6–1.2 μm	Co	S, P
Methanospirillum	0.4–0.5 μm \times 7.0–10.0 μm	CR	S, OL, ML
Methanothermus	0.3–0.4 μm \times 1.0–3.0 μm	R	S, OL
Methanothrix	0.8–1.2 μm \times 2.0–3.0 μm	R	OL
Natronobacterium	0.5–1.0 μm \times 2.0–15.0 μm	R	S
Natronococcus	1.0–2.0 μm	Co	S, P, T, TT, OC
Pyrobaculum	0.5 μm \times 1.5–8.0 μm	R	S, OL
Pyrococcus	0.8–2.5 μm	Co	S, P
Pyrodictium	0.2 μm \times 0.3–2.5 μm	Dk	OL

TABLE 1-continued

<u>Examples of Archaea Cell's Size and Shape</u>			
Genus	Size	Shape	Number
Staphylothermus	0.5–15.0 μm	Co	S, P, OL
Sulfolobus	0.8–2.0 μm	Co	S
Thermococcus	0.5–3.0 μm	Co	S
Thermofilum	0.15–0.35 $\mu\text{m} \times 1.0$ –100.0 μm	R	S
Thermoproteus	0.4 $\mu\text{m} \times 1.0$ –100.0 μm	R	S

Shape: R = rod; CR = curved rod; O = ovoid, oval; Co = cocci, coccoid; Tr = flat-tri-angle; Pl = plate-shape; Rc = flat rectangle; Dk = dish-shaped.
 Number: S = unicellular; P = cell pairs; T = triad of cells; TT = tetrad of cells; OC = oligocellular cluster; MC = multicellular cluster; OL = oligocellular chain; ML = multicellular chain.

[0127] Examples of biological culture collection sources for Archaea are shown at Table 2 below.

TABLE 2

<u>Examples of Archaea Culture Sources</u>	
Genus	Examples of Culture Collection Strains
Acidianus	DSMZ Nos. 3772, 1651 and 3191
Acidilobus	DSMZ No. 11585
Aeropyrum	DSMZ No. 11879
Archaeoglobus	DSMZ Nos. 4304, 4139, 5631 and 11195
Caldivirga	DSMZ No. 13496; JCM No. 10306
Desulfurococcus	DSMZ Nos. 3822, 2161 and 2162
Ferroglobus	DSMZ No. 10642
Ferroplasma	DSMZ No. 12658
Haloarcula	DSMZ Nos. 12282, 4426, 6131, 3752, 11927, 8905 and 3756
Halobacterium	DSMZ Nos. 3754 and 3750
Halobaculum	DSMZ No. 9297
Halococcus	DSMZ Nos. 14522, 1307, 5350 and 8989
Haloferax	DSMZ Nos. 4425, 4427, 1411 and 3757
Halogeometricum	DSMZ No. 11551; JCM No. 10706
Halomicrobium	DSMZ No. 12286
Halorhabdus	DSMZ No. 12940
Halorubrum	DSMZ Nos. 10284, 5036, 1137, 3755, 14210 and 8800
Haloterrigena	DSMZ Nos. 11552 and 5511
Hyperthermus	DSMZ No. 5456
Ignicoccus	DSMZ Nos. 13165 and 13166
Metallosphaera	DSMZ Nos. 10039 and 5348
Methanobacterium	DSMZ Nos. 3387, 863, 7095, 5982, 1535, 2611, 11106, 3108, 2257, 11074, 3266 and 2956
Methanobrevibacter	DSMZ Nos. 15163, 1125, 11111, 11139, 11501, 11977, 7256, 1093, 861, 3107, 11995, 11979 and 11976
Methanocalculus	DSMZ Nos. 14092, 12632 and 14648
Methanocaldococcus	DSMZ Nos. 4213, 11812, 2661 and 12094
Methanococcoides	DSMZ Nos. 6242, 2657 and 7059
Methanococcus	DSMZ Nos. 2067, 1224 and 1537
Methanocorpusculum	DSMZ Nos. 3027, 4179, 4855, 3823 and 4274
Methanoculleus	DSMZ Nos. 3045, 13459, 1498, 6216, 2772, 4273 and 2373
Methanofollis	DSMZ Nos. 14661, 4140 and 2702
Methanogenium	DSMZ Nos. 1497, 2832, 3596 and 4553
Methanohalobium	DSMZ Nos. 3721 and 5814
Methanohalophilus	DSMZ Nos. 3094, 5219, 7471 and 5700
Methanolacinia	DSMZ No. 2545
Methanolobus	DSMZ Nos. 7082, 5435, 9005, 2278 and 3029
Methanomicrobium	DSMZ No. 1539
Methanomicrococcus	DSMZ No. 13328
Methanoplanus	DSMZ Nos. 3599, 2279 and 11571
Methanopyrus	DSMZ No. 6324
Methanosaeta	DSMZ No. 3671
Methanosalsum	DSMZ No. 4017
Methanosarcina	DSMZ Nos. 2834, 14042, 800, 13486, 2053, 12914, 3028, 4659, 1825 and 1232
Methanosphaera	DSMZ Nos. 4103 and 3091
Methanospirillum	DSMZ No. 864
Methanothermobacter	DSMZ Nos. 7466, 2133, 1053, 7268, 6529 and 2970

TABLE 2-continued

Examples of Archaea Culture Sources	
Genus	Examples of Culture Collection Strains
Methanothermococcus	DSMZ Nos. 14208 and 2095
Methanothermus	DSMZ Nos. 2088 and 3496
Methanotherx	DSMZ Nos. 6194
Methanotorris	DSMZ No. 5666
Natrialba	DSMZ Nos. 13077, 12278, 3394 and 12281
Natronobacterium	DSMZ No. 3393
Natronococcus	DSMZ Nos. 10524 and 3396
Natronomonas	DSMZ No. 2160
Palaeococcus	DSMZ Nos. 13482
Picrophilus	DSMZ Nos. 9789 and 9790
Pyrobaculum	DSMZ Nos. 7523, 13514, 4184, 13380 and 4185
Pyrococcus	DSMZ Nos. 3638, 12428 and 3773
Pyrodictium	DSMZ Nos. 6158, 2708 and 2709
Pyrolobus	DSMZ No. 11204
Staphylothermus	DSMZ Nos. 12710 and 3639
Stetteria	DSMZ No. 11227
Stygiolobus	DSMZ No. 6296
Sulfolobus	DSMZ Nos. 639, 7519, 6482, 5389 and 1616
Sulfophobococcus	DSMZ No. 11193
Sulfurisphaera	DSMZ No. 12421
Thermococcus	DSMZ Nos. 11906, 12767, 12819, 10322, 11836, 2476, 10152, 12820, 10395, 11113, 5473, 10394, 10343, 9503, 12597, 12349, 5262, 12768 and 2770
Thermofilum	DSMZ Nos. 2475
Thermoplasma	DSMZ Nos. 1728 and 4299
Thermoproteus	DSMZ Nos. 2338, 2078 and 5263
Thermosphaera	DSMZ No. 11486
Vulcanisaeta	DSMZ Nos. 14429 and 14430

[0128] Archaea are often purple, red, pink, orange-brown, yellow, green, gray or white. Specific examples of colored Archaea genera, with exemplary colors, include: Haloarcula (pink to red), Halobacterium (pink to red), Halococcus (pink to red), Haloferax (pink to red), Natronobacterium (pink to red), Natronococcus (pink to red), and Archaeoglobus (green-black, and fluorescent at 420 nm).

[0129] Examples of Archaea hyperthermophile genera with exemplary temperature growth ranges include Acidianus (45° C.-96° C.), Archaeoglobus (65° C.-95° C.), Desulfurococcus (70° C.-95° C.), Hyperthermus (95° C.-107° C.), Metallosphaera (50° C.-80° C.), Methanobacterium (37° C.-68° C.), Methanococcus (35° C.-91° C.), Methanohalobium (50° C.-55° C.), Methanosarcina (30° C.-55° C.), Methanothermus (83° C.-88° C.) (35° C.-65° C.), Pyrobaculum (74° C.-103° C.), Pyrococcus (70° C.-103° C.), Pyrodictium (80° C.-110° C.), Staphylothermus (65° C.-98° C.), Sulfolobus (55° C.-87° C.), Thermococcus (50° C.-98° C.), Thermofilum (70° C.-95° C.), and Thermoproteus (70° C.-97° C.). Examples of Archaea extreme halophile genera with exemplary NaCl growth ranges include Haloarcula (1.5-4.0 M), Halobacterium (1.5-4.0 M), Halococcus (1.5-4.0 M), Haloferax (1.5-4.0 M), Methanohalobium (0.01-2.0 M), Methanohalophilus (0.5-2.0 M), Natronobacterium (1.5-4.0 M), Natronococcus (1.5-4.0 M), and Pyrodictium (0.02-2.05 M). Examples of Archaea extreme alkaliphile and/or extreme acidophile genera with exemplary pH growth ranges include Acidianus (pH 1.0-6.0), Archaeoglobus (pH 4.5-7.5), Desulfurococcus (pH 4.5-7.0), Haloarcula (pH 5.0-8.0), Halobacterium (pH 5.0-8.0), Halococcus (pH 5.0-8.0), Haloferax (pH 5.0-8.0), Metallosphaera (pH 1.0-4.5), Methanococcus (pH 5.0-9.0), Methanohalophilus (pH 7.5-9.5), Natronobacterium (pH 8.5-11.0), Natronococcus

(pH 8.5-11.0), Pyrobaculum (pH 5.0-7.0), Pyrococcus (pH 5.0-7.0), Pyrodictium (pH 5.0-7.0), Sulfolobus (pH 1.0-6.0), Thermococcus (pH 4.0-8.0), Thermofilum (pH 4.0-6.7), and Thermoproteus (pH 2.5-6.0).

(2) Eubacteria

[0130] Eubacteria cell walls typically comprise peptidoglycan, a macromolecular polymer comprising polysaccharide and peptide or polypeptide components, as well as glycoprotein, protein, polysaccharide, lipid, or a combination thereof. Often, the members of the Eubacteria phyla are divided into Gram-positive Eubacteria and Gram-negative Eubacteria (e.g., Cyanobacteria, Proteobacteria, Spirochetes) based on biochemical and structural differences between the cell wall and/or associated cell membrane of the organisms.

(i) Gram-Positive Eubacteria

[0131] As used herein "Gram-positive Eubacteria" refers to Eubacteria comprising a cell wall that typically stains positive with Gram stain reaction (Scherrer, R., 1984) and/or generally is not surrounded by a phospholipid bilayer ("outer cell membrane"). Examples of Gram-positive Eubacteria size and shapes are shown at Table 3 below.

TABLE 3

Examples of Gram-positive Eubacteria Cell's Size and Shape			
Genus	Size	Shape	Number
Acetobacterium	0.8-1.2 $\mu\text{m} \times 1.5-2.5 \mu\text{m}$	R, O	S, P, OL
Actinomyces	0.2-1.0 $\mu\text{m} \times 2.0-5.0 \mu\text{m}$	R	S, P, OL

TABLE 3-continued

Examples of Gram-positive Eubacteria Cell's Size and Shape			
Genus	Size	Shape	Number
Aerococcus	1.0–2.0 μm	Sp	TT
Aeromicrobium	0.5 μm \times 0.5–1.2 μm	R, Co	S
Agromyces	0.3–1.0 μm	R	S
Amphibacillus	0.3–0.5 μm \times 0.9–1.9 μm	R	S
Arcanobacterium	0.3–0.8 μm \times 1.0–5.0 μm	R	OL
Arthrobacter	0.8–1.2 μm \times 1.0–8.0 μm	R	S, P, OC
Aureobacterium	0.4–0.6 μm \times 0.6–3.0 μm	R	S, OC
Bacillus	0.5–2.5 μm \times 1.2–10.0 μm	R	P, OL
Bifidobacterium	0.5–1.3 μm \times 1.5–8.0 μm	R	S, P, OL
Brachybacterium	0.5–0.75 μm \times 1.5–2.5 μm	R	S
Brevibacterium	0.6–1.2 μm \times 1.5–6.0 μm	R	S, P
Brochothrix	0.6–0.7 μm \times 1.0–2.0 μm	R	S, OL, ML
Carnobacterium	0.5–0.7 μm \times 1.0–2.0 μm	R	S, P, OL
Caryophanon	1.4–3.2 μm \times 1.0–2.0 μm	R	S
Cellulomonas	0.5–0.6 μm \times 2.0–5.0 μm	R	P
Clavibacter	0.4–0.75 μm \times 0.8–2.5 μm	R	P
Clostridium	0.3–2.0 μm \times 1.5–20.0 μm	R	P, OL
Coprococcus	0.8–1.5 μm	Sp	P, OL
Coriobacterium	0.4–1.2 μm \times 0.5–2.0 μm	R	ML
Corynebacterium	0.3–0.8 μm \times 1.5–8.0 μm	R	S, P
Curtobacterium	0.4–0.6 μm \times 0.6–3.0 μm	R	S, P
Deinobacter	0.6–1.2 μm \times 1.5–4.0 μm	R	P, OL
Deinococcus	0.5–3.5 μm	Sp	P, TT
Dermabacter	0.5–0.6 μm \times 1.0–2.0 μm	R	S
Desulfotomaculum	0.3–1.5 μm \times 3.0–9.0 μm	R	S
Enterococcus	0.6–2.0 μm \times 0.6–2.5 μm	Sp, O	P, OL
Erysipelothrix	0.2–0.4 μm \times 0.8–2.5 μm	R	S
Eubacterium	0.2–2.0 μm \times 0.3–10.0 μm	R	S, P, OL
Exiguobacterium	1.1–1.2 μm \times 1.4–3.2 μm	R	S
Falcvibrio	0.4–0.6 μm \times 1.2–6.0 μm	CR	S, P
Gardnerella	0.5 μm \times 1.5–2.5 μm	R	S
Gemella	0.5–0.8 μm \times 0.5–1.4 μm	Sp	P, OL
Jonesia	0.3–0.5 μm \times 2.0–3.0 μm	R	S
Kurthia	0.8–1.2 μm \times 2.0–4.0 μm	R	OL, ML
Lactobacillus	0.5–1.2 μm \times 1.0–10.0 μm	R	OL
Lactococcus	0.5–1.2 μm \times 0.5–1.5 μm	Sp, O	P, OL
Leuconostoc	0.5–0.7 μm \times 0.7–1.2 μm	Sp, O	P, OL
Listeria	0.4–0.5 μm \times 0.5–2.0 μm	R	S, OL
Marinococcus	1.0–2.0 μm	Sp	S, P, TT
Melissococcus	0.8–1.0 μm \times 0.8–1.5 μm	O	OL
Microbacterium	0.4–0.8 μm \times 1.0–4.0 μm	R	S, P
Micrococcus	0.5–2.0 μm	Sp	P, TT, OC

TABLE 3-continued

Examples of Gram-positive Eubacteria Cell's Size and Shape			
Genus	Size	Shape	Number
Mobiluncus	0.4–0.6 μm \times 1.2–4.0 μm	CR	S, P
Mycobacterium	0.2–0.7 μm \times 1.0–10.0 μm	R	S, OL
Nocardia	0.5–1.2 μm	R, Co	S, OL
Pediococcus	1.0–2.0 μm	Sp	P, TT
Peptococcus	0.3–1.2 μm	Sp	P, OL, OC
Peptostreptococcus	0.5–1.2 μm	Sp	P, TT, OC, OL
Planococcus	1.0–1.2 μm	Sp	S, P, TT
Propionibacterium	0.5–0.8 μm \times 1.0–5.0 μm	R	S, P, OL
Rarobacter	0.2–0.3 μm \times 0.8–1.0 μm	R	S
Renibacterium	0.3–1.0 μm \times 1.0–1.5 μm	R	P, OL
Rothia	0.8–1.2 μm \times 1.0–5.0 μm	R	S
Rubrobacter	0.8–1.0 μm \times 1.0–4.0 μm	R	S
Ruminococcus	0.3–1.5 μm \times 0.7–1.8 μm	Sp, O	P, OL
Saccharococcus	1.0–1.5 μm	Sp	OC
Salinicoccus	1.0–1.5 μm	Sp	P, TT
Sarcina	1.8–3.0 μm	Sp	OC
Sphaerobacter	0.4–1.2 μm \times 1.5–5.0 μm	R	S, P
Sporohalobacter	0.6–0.8 μm \times 2.5–13.0 μm	R	S
Sporolactobacillus	0.7–0.8 μm \times 3.0–5.0 μm	R	S, P, OL
Sporosarcina	1.0–2.0 μm \times 2.0–3.0 μm	R	P, TT
Staphylococcus	0.5–1.5 μm	Sp	S, P, OC
Streptococcus	0.5–2.0 μm	Sp, O	P, OL
Syntrophospora	0.3–2.0 μm \times 1.5–20.0 μm	R	P, OL
Terrabacter	0.6–1.2 μm \times 2.0–6.0 μm	R	S
Thermacetogenium	0.6–1.0 μm \times 2.0–5.0 μm	R	S
Thermoanaerobacter	0.5–0.8 μm \times 4.0–8.0 μm	R	S, P, OL
Thermoanaerobium	0.8–1.0 μm \times 2.0–20.0 μm	R	S, P, OL
Trichococcus	1.0–1.5 μm \times 1.0–2.5 μm	Sp, O	OL, ML
Tsukamurella	0.5–0.8 μm \times 1.0–5.0 μm	R	S, P, OC
Vagococcus	0.5–1.2 μm \times 0.5–2.0 μm	Sp, O, R	S, P, OL

Shape: R = rod; CR = curved rod; O = ovoid, oval; Sp = spherical; Co = cocci, coccoid.

Number: S = unicellular; P = cell pairs; TT = tetrad of cells; OC = oligocellular cluster; OL = oligocellular chain; ML = multicellular chain.

[0132] Examples of biological culture collection sources for Gram-positive Eubacteria are shown at Table 4 below.

TABLE 4

Examples of Gram-positive Eubacteria Culture Sources	
Genus	Examples of Culture Collection Strains
Acetobacterium	ATCC Nos. 29683, 43740, 51201, 51794 and 51795
Actinokineospora	ATCC No. 49499; DSMZ Nos. 44650, 44258 and 44260
Actinomadura	ATCC Nos. 13723, 14816, 25469, 27103 and 27298
Actinomyces	DSMZ Nos. 43014, 6844, 8577, 9169 and 43327
Actinoplanes	ATCC Nos. 12427, 14538, 14539, 15330 and 15349
Actinopolyspora	ATCC Nos. 27976, 35862 and 49777
Actinosynnema	ATCC Nos. 29888 and 31280
Aerococcus	ATCC Nos. 10400, 51268, BAA-253 and BAA-464
Aeromicrobium	ATCC Nos. 49363 and 51598
Agromyces	ATCC Nos. 13930, 25173, 51762 and 51764
Amphibacillus	ATCC No. 51415; DSMZ Nos. 13869 and 13869
Amycolatopsis	ATCC Nos. 13685, 14930, 27624 and 31181
Arcanobacterium	ATCC Nos. 19411, 51727 and 9345
Arthrobacter	ATCC Nos. 11442, 11624, 13344, 13346 and 13347
Aureobacterium	ATCC No. 700176
Bacillus	ATCC Nos. 10206, 10208, 10545, 10702 and 10716
Bifidobacterium	ATCC Nos. 11863, 15423, 15697, 15698 and 15703
Brachybacterium	ATCC Nos. 43885, 51843, 51844, 700067 and 700068
Brevibacterium	DSMZ Nos. 20657, 20660, 20579, 10718 and 20302
Brochothrix	ATCC Nos. 11509 and 43754

TABLE 4-continued

<u>Examples of Gram-positive Eubacteria Culture Sources</u>	
Genus	Examples of Culture Collection Strains
Carnobacterium	ATCC Nos. 27865, 35677, 49516, 49517 and 49837
Caryophanon	ATCC Nos. 15219 and 33098
Catellatospora	ATCC Nos. 49365 and 49964
Cellulomonas	ATCC Nos. 15724, 21399, 21681, 25174 and 25835
Clavibacter	ATCC Nos. 10202 and 43178
Clostridium	ATCC Nos. 10000, 10092, 10132, 10388 and 49002
Coprococcus	ATCC Nos. 27758, 27759, 27759, 27761 and 29549
Coriobacterium	ATCC No. 49209; DSMZ No. 20642
Corynebacterium	ATCC Nos. 10234, 10340, 10700, 10848 and 11036
Curtobacterium	ATCC Nos. 12813, 15828, 15830, 15831 and 19096
Dactylosporangium	ATCC Nos. 23490, 23491, 31203, 31222 and 31570
Deinobacter	ATCC No. 43672; DSMZ No. 3963
Deinococcus	ATCC Nos. 13939, 19172, 27603 and 35074
Dermabacter	ATCC No. 49369; DSMZ No. 7083
Dermatophilus	ATCC Nos. 14637 and 51576
Desulfotomaculum	ATCC Nos. 19858, 23193, 49208, 49756 and 700205
Enterococcus	ATCC Nos. 10100, 11576, 12755, 14025, 14432 and 19433
Erysipelothrix	ATCC No. 10734; DSMZ Nos. 5055 and 14972
Eubacterium	ATCC Nos. 10825, 17233, 25540, 25541 and 25546
Exiguobacterium	ATCC Nos. 21665 and 35652
Falcvibrio	ATCC Nos. 43063 and 43064
Frankia	ATCC No. 33255; DSMZ No. 43829
Gardnerella	ATCC No. 14018; DSMZ No. 4944
Gemella	ATCC Nos. 10379, 27527, 700627 and 700632
Geodermatophilus	ATCC No. 25080; DSMZ No. 43160
Glycomyces	ATCC Nos. 43155, 43156 and 49849
Gordonia	ATCC Nos. 14352, 25594, 27808, 27863 and 33609
Intrasporangium	ATCC No. 23552; DSMZ No. 43043
Jonesia	ATCC No. 14870; DSMZ No. 20603
Kibdelosporangium	ATCC Nos. 39323, 49844 and 55061
Kineospora	ATCC No. 29727; DSMZ Nos. 43858, 44387 and 44388
Kitasatospora	ATCC No. 49931 and 29755
Kurthia	ATCC Nos. 10538, 14757, 43195 and 49154
Lactobacillus	ATCC Nos. 10012, 10386, 10697, 10863 and 11305
Lactococcus	ATCC Nos. 11007, 43199, 43920, 43921 and 700018
Leuconostoc	ATCC Nos. 10830, 10882, 12291, 15520 and 23065
Listeria	ATCC Nos. 13932, 19119, 19120, 35897 and 35967
Marinococcus	ATCC Nos. 27964 and 49811
Melissococcus	ATCC No. 35311; LMG 20360
Microbacterium	ATCC Nos. 13345, 13348, 15354, 15953 and 15954
Microbispora	ATCC Nos. 12950, 27303 and BAA-20
Micrococcus	ATCC Nos. 10054, 11731, 14344, 14399 and 15935
Micromonospora	ATCC Nos. 12452, 13634, 15835, 15838 and 21773
Microtetraspora	ATCC Nos. 23057, 23058, 27301 and 31725
Mobiluncus	ATCC Nos. 35239 and 35241
Mycobacterium	ATCC Nos. 10142, 10143, 11152, 11440 and 11564
Nocardia	ATCC Nos. 10904, 11092, 14629, 14898 and 15076
Nocardioidea	ATCC No. 14870; DSMZ Nos. 20603 and 15529
Nocardopsis	ATCC Nos. 21944, 27442, 31511, 35940 and 51300
Oerskovia	ATCC No. 35306; DSMZ Nos. 43852, 46000 and 20577
Pediococcus	ATCC Nos. 10791, 11308, 12697, 19371 and 25740
Peptococcus	ATCC No. 27731; DSMZ No. 20475
Peptostreptococcus	ATCC No. 27337; DSMZ Nos. 2949 and 9536
Pilimelia	ATCC Nos. 25603 and 25604
Planobispora	ATCC Nos. 23867 and 53773
Planococcus	ATCC Nos. 14404, 25977 and 43650
Planomonospora	ATCC Nos. 23864, 23865, 51587 and 51588
Promicromonospora	ATCC No. 15908; DSMZ Nos. 43110 and 44121
Propionibacterium	ATCC Nos. 11827, 11829, 13673, 14073 and 25562
Pseudonocardia	ATCC Nos. 13181, 15104, 15776, 15778 and 19285
Rarobacter	ATCC Nos. 49628 and 51544
Renibacterium	ATCC No. 33209; DSMZ No. 20767
Rhodococcus	ATCC Nos. 10146, 11048, 12483, 12974 and 14346
Rothia	ATCC Nos. 14189, 25296 and 49040
Rubrobacter	ATCC No. 51242; DSMZ Nos. 5868 and 9941
Ruminococcus	ATCC Nos. 19208, 27210, 27340, 27752 and 27756
Saccharococcus	ATCC No. 43124; DSMZ No. 4749
Saccharomonospora	ATCC Nos. 15345, 31295, 33517, 43670 and 43724
Saccharopolyspora	ATCC Nos. 11635, 15347, 20501, 49460 and 49842
Saccharothrix	ATCC Nos. 23892, 31497, 35108, 35109 and 51364
Salinicoccus	ATCC Nos. 49258, 49259 and BAA-722
Sarcina	ATCC Nos. 29068 and 33910

TABLE 4-continued

Examples of Gram-positive Eubacteria Culture Sources	
Genus	Examples of Culture Collection Strains
Sphaerobacter	DSMZ No. 20745
Spirillospora	ATCC No. 14541; DSMZ No. 43034
Sporichthya	ATCC No. 23823; DSMZ Nos. 44723 and 43042
Sporohalobacter	ATCC No. 35059; DSMZ No. 3070
Sporolactobacillus	ATCC Nos. 15538, 700379 and 700380
Sporosarcina	ATCC Nos. 11859, 13881, 23301 and 23304
Staphylococcus	ATCC Nos. 10209, 10390, 11249, 11631 and 25923
Streptoalloteichus	ATCC No. 31158; DSMZ No. 44523
Streptococcus	ATCC Nos. 10009, 10096, 10556, 10558 and 11824
Streptomyces	ATCC Nos. 10137, 10147, 10246, 10382 and 19893
Streptosporangium	ATCC Nos. 12428, 21393, 21807, 21906 and 25212
Syntrophospora	DSMZ Nos. 3014A and 3014B
Terrabacter	ATCC No. 21109; DSMZ No. 20308
Thermacetogenium	DSMZ No. 12270
Thermoactinomyces	ATCC Nos. 14570, 15734, 33205, 49853 and 49854
Thermoanaerobacter	ATCC Nos. 31936, 31960, 33488, 35047 and 49915
Thermoanaerobium	DSMZ Nos. 7040, 1457, 9766, 9003 and 9769
Thermomonospora	ATCC Nos. 19995 and 43196
Trichococcus	ATCC Nos. 35945, 51221 and BAA-296
Tsukamurella	ATCC Nos. 15530, 25938 and 700081
Vagococcus	ATCC Nos. 49515, 51200, 700839 and BAA-289

[0133] As would be known to those of ordinary skill in the art, the following genera are noted for growing as filamentous cellular structures (e.g., hyphae): Actinokineospora, Actinomadura, Actinoplanes, Actinopolyspora, Actinosynema, Amycolatopsis, Catellatospora, Dactylosporangium, Dermatophilus, Frankia, Geodermatophilus, Glycomyces, Gordonia, Intraspangium, Kibdelosporangium, Kineospora, Kitasatospora, Microbispora, Micromonospora, Microtetraspora, Nocardioidea, Nocardiosis, Oerskovia, Pilimelia, Planobispora, Planomonospora, Promicromonospora, Pseudonocardia, Rhodococcus, Saccharomonospora, Saccharopolyspora, Saccharothrix Spirillospora, Sporichthya, Streptoalloteichus, Streptomyces, Streptosporangium, Thermoactinomyces, and Thermomonospora. Often, the filamentous cellular material may be readily broken up into particulate material (e.g., rod or coccoid cells or cellular material) by physical force. It is contemplated that a processing of these genera, and other filamentous genera of cells, may include a step of application of physical force (e.g., shearing, sonication, etc.) and/or contact with chemicals to convert the filamentous cellular material into a preferred cell-based particulate material of the present invention that is more conveniently dispersed in a coating or other surface treatment. The size ranges for the diameter of the filamentous cellular structures and particulate material is generally within the ranges described for the other Gram-positive cells in Table 3. For example, Nocardia grows as a filamentous material whose diameter is shown at Table 3, but easily fragments spontaneously or with mechanical force into rods or coccoid cellular material. It is contemplated that in embodiments wherein cells grow both as filamentous cellular material and particulate cellular material, the particulate cellular material may be readily obtained by steps such settling of the larger filamentous material in a liquid culture while the particulate material remains suspended (e.g., centrifugation), filtration, etc., as well as processing step that converts the filamentous material into particulate material.

[0134] Specific examples of colored Gram-positive Eubacteria species, with exemplary colors, include: *Micrococcus luteus* (yellow; ATCC Nos. 10054 and 10240, DSMZ Nos. 20030 and 1605), *Marinococcus halophilus* (yellow-orange; ATCC No. 27964, DSMZ No. 20408), *Deinococcus proteolyticus* (orange-red; ATCC No. 35074, DSMZ No. 20540), *Deinococcus radiophilus* (orange-red; ATCC No. 27603, DSMZ No. 20551), *Deinococcus radiopugnans* (orange-red; ATCC No. 19172, DSMZ No. 12027), *Deinococcus radiodurans* (red; ATCC Nos. 13939 and 35073, DSMZ Nos. 20539 and 46620), *Propionibacterium thoenii* (red-brown to orange; DSMZ Nos. 20276 and 20275), *Propionibacterium acidipropionici* (white; DSMZ Nos. 4900 and 20272), *Propionibacterium lymphophilum* (white; DSMZ No. 4903), *Micrococcus lylae* (cream-white; ATCC Nos. 27566 and 27569, DSMZ Nos. 20315 and 20318), *Propionibacterium avidum* (white to cream; DSMZ No. 4901), *Propionibacterium acnes* (white to gray; DSMZ Nos. 1897 and 20458), *Propionibacterium granulosum* (gray to white; DSMZ No. 20700), *Propionibacterium jensenii* (pink to white; DSMZ Nos. 20535 and 20274), and *Propionibacterium freudenreichii* (pink or tan; DSMZ Nos. 20271 and 4902). Additional examples of colored Gram-positive Eubacteria genera, with exemplary colors, include: Brachybacterium (white to pale yellow), Brevibacterium (yellow-orange or purple-gray), Aureobacterium (yellow), Cellulomonas (yellow), Clavibacter (yellow or blue-gray), Curtobacterium (yellow or orange), Planococcus (yellow-orange), Exiguobacterium (pale orange), Mycobacterium (pink, orange, or yellow), Nocardia (white, tan, brown, red, pink, orange, purple, or gray), Rubrobacter (reddish-pink), Salinicoccus (pink or red), Salinicoccus (pink or red), Deinobacter (pink or red), Dermabacter (cream-white), Sporosarcina (cream to orange), Staphylococcus (white, cream, yellow, or orange), Thermoanaerobacter (white), and Tsukamurella (white to orange).

[0135] Some genera of Gram-positive Eubacteria typically grow in extreme environmental conditions. Examples of Gram-positive hyperthermophile genera with exemplary

temperature growth ranges include *Clostridium* (10° C.-65° C.), *Desulfotomaculum* (20° C.-70° C.), *Rubrobacter* (46° C.-48° C.), *Saccharococcus* (68° C.-78° C.), *Sphaerobacter* (55° C.), *Thermacetogenium* (55° C.-58° C.), *Thermoanaerobacter* (35° C.-78° C.), and *Thermoanaerobium* (45° C.-75° C.). Examples of Gram-positive extreme halophile genera with exemplary NaCl growth ranges include *Aerococcus* (1.71 M), *Marinococcus* (0.09-3.42 M), *Planococcus* (0.17-2.57 M), *Sporohalobacter* (0.5-2.0 M), and *Staphylococcus* (1.71 M). Examples of Gram-positive extreme alkaliphile genera with exemplary pH growth ranges include *Aerococcus* (pH 9.6), *Amphibacillus* (pH 10), *Enterococcus* (pH 9.6), and *Exiguobacterium* (pH 6.5-11.5).

(ii) Gram-Negative Eubacteria

[0136] As used herein “Gram-negative Eubacteria” refers to Eubacteria comprising a cell wall that typically stains negative with Gram stain reaction (see, for example, Scherrer, R., 1984) and/or generally is surrounded by an outer cell membrane. As would be known to those of ordinary skill in the art, a few types of “Gram-negative Eubacteria” do not stain well using a standard Gram stain procedure, however, these bacteria can be classified as a Gram-negative Eubacteria by the presence of an outer cell membrane, a morphological feature typically not present in a Gram-positive Eubacteria.

[0137] Examples of Gram-negative Eubacteria size and shapes are shown at Table 5 below.

TABLE 5

Examples of Gram-negative Eubacteria Cell's Size and Shape			
Genus	Size	Shape	Number
<i>Acetivibrio</i>	0.4–0.8 μm \times 4.0–10.0 μm	R	P, OL
<i>Acetoanaerobium</i>	0.8 μm \times 1.0–5.0 μm	R	S
<i>Acetobacter</i>	0.6–0.8 μm \times 1.0–4.0 μm	R	S, P, OL
<i>Acetomicrobium</i>	0.6–0.8 μm \times 2.0–7.0 μm	CR	S
<i>Acidaminobacter</i>	0.5–0.6 μm \times 1.5–3.7 μm	R	S, P
<i>Acidaminococcus</i>	0.6–1.0 μm	Co	P
<i>Acidiphilium</i>	0.3–1.2 μm \times 0.6–4.2 μm	R	S
<i>Acidomonas</i>	0.8–1.0 μm \times 1.5–3.0 μm	R	S, P
<i>Acidovorax</i>	0.2–0.7 μm \times 1.0–5.0 μm	R	S, OL
<i>Acinetobacter</i>	0.9–1.6 μm \times 1.5–2.5 μm	V	P, OL
<i>Aeromonas</i>	0.3–1.0 μm \times 1.0–3.5 μm	R	S, P, OL
<i>Agitococcus</i>	1.0–1.5 μm	Sp	S
<i>Agrobacterium</i>	0.6–1.0 μm \times 1.5–3.0 μm	R	S, P
<i>Agromonas</i>	0.6–1.0 μm \times 2.0–7.0 μm	R	S
<i>Alcaligenes</i>	0.5–1.0 μm \times 0.5–2.6 μm	R, Co	S
<i>Allochrocatium</i>	1–2 \times 2–4 μm	R	S
<i>Alteromonas</i>	0.7–1.5 μm \times 1.8–3.0 μm	R, CR	S
<i>Alysiella</i>	0.6 μm	Sp	P, TT, OL, ML
<i>Aminobacter</i>	0.5–0.9 μm \times 1.0–3.0 μm	R	S
<i>Anabaena</i>	2.0–20.0 μm	0, Sp	OL
<i>Anaerobiospirillum</i>	0.6–0.8 μm \times 3.0–15.0 μm	Sl	S
<i>Anaerorhabdus</i>	0.3–1.5 μm \times 1.0–3.0 μm	R	S, P, OL
<i>Anaerovibrio</i>	0.6–0.9 μm \times 1.5–3.5 μm	CR, Sl	S
<i>Ancalomicrobium</i>	1.0 μm	Cn	S
<i>Ancylobacter</i>	0.3–1.0 μm \times 1.0–3.0 μm	CR	S
<i>Angulomicrobium</i>	1.1–1.5 μm	Te	S
<i>Aquaspirillum</i>	0.7–0.9 μm \times 3.6–43.0 μm	R	S
<i>Archangium</i>	0.6–0.8 μm \times 6.0–12.0 μm	R	S
<i>Arsenophonus</i>	0.4–0.6 μm \times 7.0–10.0 μm	R	S
<i>Arthrosira</i>	3.0–12.0 μm	Sl	OL
<i>Asticcacaulis</i>	0.5–0.7 μm \times 1.0–3.0 μm	R	S
<i>Azomonas</i>	2.0 μm	R, C	S, P, OC
<i>Azorhizobium</i>	0.5–0.6 μm \times 1.5–2.5 μm	R	S
<i>Azospirillum</i>	0.9–1.2 μm	V, R	S
<i>Azotobacter</i>	1.5–2.0 μm	0	S, P, OC, OL
<i>Bacteroides</i>	0.6–0.9 μm \times 1.5–3.5 μm	R	S
<i>Bdellovibrio</i>	0.2–0.5 μm	R	S
<i>Beggiatoa</i>	2.0–10.0 μm \times 1.0–200.0 μm	Cy	S, OL
<i>Beijerinckia</i>	0.5–1.5 μm \times 1.7–4.5 μm	R, CR	S
<i>Blastobacter</i>	0.5–1.0 μm \times 1.0–5.0 μm	O	S
<i>Blastochloris</i>	0.6–2.5 μm \times 0.6–5.0 μm	R	S
<i>Bordetella</i>	0.2–0.5 μm \times 0.5–2.0 μm	C	S, P, OL
<i>Borrelia</i>	0.2–0.5 μm \times 3.0–20.0 μm	H	S
<i>Brachyspira</i>	0.2 μm \times 1.7–6.0 μm	H	S
<i>Bradyrhizobium</i>	0.5–0.9 μm \times 1.2–3.0 μm	R	S
<i>Brevundimonas</i>	0.4–0.6 μm \times 1.0–2.0 μm	R, V, Fu	S
<i>Brucella</i>	0.5–0.7 μm \times 0.6–1.5 μm	R, Co	S, P, OC, OL
<i>Budvicia</i>	0.3 μm \times 1.8 μm	R	S
<i>Buittiauxella</i>	0.3 μm \times 1.8 μm	R	S
<i>Butyrivibrio</i>	0.4–0.6 μm \times 2.0–5.0 μm	CR	S

TABLE 5-continued

Examples of Gram-negative Eubacteria Cell's Size and Shape			
Genus	Size	Shape	Number
Calothrix	2.5–18.0 μm	0	OL
Campylobacter	0.2–0.5 $\mu\text{m} \times 0.5$ –5.0 μm	V	S
Capnocytophaga	0.4–0.6 $\mu\text{m} \times 2.5$ –5.7 μm	R	S
Cardiobacterium	0.5–0.75 $\mu\text{m} \times 1.0$ –3.0 μm	R	S, P, OL
Caulobacter	0.4–0.6 $\mu\text{m} \times 1.0$ –2.0 μm	R, V, Fu	S
Cedecea	0.5–0.6 $\mu\text{m} \times 1.0$ –2.0 μm	R	S
Cellulophaga	0.3–0.8 $\mu\text{m} \times 1.5$ –15.0 μm	R	S
Cellvibrio	0.2–0.5 $\mu\text{m} \times 1.0$ –1.3 μm	R	S
Centipeda	0.65 $\mu\text{m} \times 4.0$ –17.0 μm	Sr	S
Chitinophaga	0.5–0.8 $\mu\text{m} \times 40.0 \mu\text{m}$	R	S
Chlorobium	0.3–1.1 $\mu\text{m} \times 0.4$ –3.0 μm	R, 0, Sp	OL
Chloroflexus	0.5–1.0 $\mu\text{m} \times 2.0$ –6.0 μm	R	OL, ML
Chlorogloeopsis	2.0–8.0 μm	Cy	OL
Chloroherpeton	0.6–1.0 $\mu\text{m} \times 8.0$ –20.0 μm	R	S
Chondromyces	1.0–1.2 $\mu\text{m} \times 3.0$ –8.0 μm	Cy	S
Chromobacterium	0.6–0.9 $\mu\text{m} \times 1.5$ –3.5 μm	R	S, P, OL
Chromohalobacter	0.6–1.0 $\mu\text{m} \times 1.5$ –4.0 μm	R	S
Chroococcidiopsis	3.0–4.0 μm	Sp, Co	OC
Citrobacter	1.0 $\mu\text{m} \times 2.0$ –6.0 μm	R	S, P
Cobetia	0.8–1.1 $\mu\text{m} \times 1.5$ –3.0 μm	R	S
Comamonas	0.5–1.0 $\mu\text{m} \times 1.0$ –4.0 μm	R	s, p
Crinalium	1.0–1.5 μm	R	OL
Cupriavidus	0.7–0.9 $\mu\text{m} \times 0.9$ –1.3 μm	C, R	S
Cyclobacterium	0.8–1.5 $\mu\text{m} \times 0.3$ –0.7 μm	Rg	S
Cylindrospermum	3.0–6.0 μm	Sp	OL
Cystobacter	0.6–0.8 $\mu\text{m} \times 8.0$ –15.0 μm	R	S
Cytophaga	0.3–0.8 $\mu\text{m} \times 1.5$ –15.0 μm	R	S
Dermocarpella	2.0–3.0 μm	O	OC
Derxia	1.0–2.0 $\mu\text{m} \times 3.0$ –6.0 μm	R	S, OL
Desulfobacter	0.5–2.4 $\mu\text{m} \times 1.7$ –7.0 μm	R, O, V	S, P, OC
Desulfobacterium	0.7–3.0 $\mu\text{m} \times 1.5$ –2.8 μm	R	S, P, OC
Desulfobulbus	0.6–1.3 $\mu\text{m} \times 1.5$ –2.5 μm	R, O	S, P
Desulfococcus	1.4–2.3 μm	Sp	S, P, OC
Desulfomicrobium	0.6 $\mu\text{m} \times 1.3 \mu\text{m}$	R, O	S, P, OC
Desulfomonile	0.8–1.0 $\mu\text{m} \times 5.0$ –10.0 μm	R	S, P, OC
Desulfonema	3.0–8.0 $\mu\text{m} \times 2.5$ –13.0 μm	R	OL, ML
Desulfosarcina	1.0–1.5 $\mu\text{m} \times 1.5$ –2.5 μm	R, O	S, P, OC
Desulfovibrio	0.5–1.3 $\mu\text{m} \times 0.8$ –5.0 μm	Sl, V	S
Desulfurella	0.4–0.8 $\mu\text{m} \times 1.0$ –4.0 μm	R, O	S, P, OC
Desulfuromonas	0.4–0.8 $\mu\text{m} \times 1.0$ –4.0 μm	R, O	S, P, OC
Dichotomicrobium	0.8–1.8 $\mu\text{m} \times 0.8$ –2.0 μm	Sp, Te	S
Ectothiorhodospira	0.5–1.5 μm	R, V	S
Edwardsiella	1.0 $\mu\text{m} \times 2.0$ –3.0 μm	R	s
Eikenella	0.3–0.4 $\mu\text{m} \times 1.5$ –4.0 μm	R	S
Enhydrobacter	0.5–0.7 $\mu\text{m} \times 1.0$ –5.0 μm	R	S, P, OL
Ensifer	0.7–1.1 $\mu\text{m} \times 1.0$ –1.9 μm	R	S, P
Enterobacter	0.6–1.0 $\mu\text{m} \times 1.2$ –3.0 μm	R	S
Erwinia	0.5–1.0 $\mu\text{m} \times 1.0$ –3.0 μm	R	S, P, OL
Erythrobacter	0.3–0.4 $\mu\text{m} \times 2.0$ –5.0 μm	R	S
Erythromicrobium	0.7–1.0 $\mu\text{m} \times 1.6$ –2.5 μm	R	S
Escherichia	1.1–1.5 $\mu\text{m} \times 2.0$ –6.0 μm	R	s, p
Ewingella	0.6–0.7 $\mu\text{m} \times 1.0$ –1.8 μm	R	S
Fervidobacterium	0.5–0.55 $\mu\text{m} \times 1.0$ –2.5 μm	R	S, P, OL
Fibrobacter	0.4–0.8 $\mu\text{m} \times 0.8$ –2.0 μm	R, O	S
Filomicrobium	0.5–0.7 $\mu\text{m} \times 1.5$ –4.0 μm	Fu	S
Fischerella	2.0–8.0 μm	0	OL
Flammovirga	0.3–0.8 $\mu\text{m} \times 1.5$ –15.0 μm	R	S
Flavobacterium	0.5 $\mu\text{m} \times 1.0$ –3.0 μm	R	S
Flectobacillus	0.3–2.0 $\mu\text{m} \times 1.0$ –31.0 μm	H, V, CR	S
Flexibacter	0.2–0.6 $\mu\text{m} \times 10.0$ –50.0 μm	R	S
Flexithrix	0.2–0.6 $\mu\text{m} \times 10.0$ –50.0 μm	R	S, ML
Francisella	0.2 $\mu\text{m} \times 0.2$ –0.7 μm	R	S
Frateuria	0.5–0.7 $\mu\text{m} \times 0.7$ –3.5 μm	R	S, P
Fusobacterium	0.6–0.9 $\mu\text{m} \times 1.5$ –3.5 μm	R	S
Gemmata	1.4–3.0 $\mu\text{m} \times 1.4$ –3.0 μm	Co, O	S
Gemmiger	1.0 $\mu\text{m} \times 0.9$ –2.5 μm	O	OL
Gloeobacter	2.0–3.0 $\mu\text{m} \times 1.5 \mu\text{m}$	O, R	S, OC
Gloeocapsa	3.0–30.0 μm	Sp	S, OC
Gluconobacter	0.5–1.0 $\mu\text{m} \times 2.6$ –4.2 μm	R, Ep	S, P, OL
Haemophilus	0.2–0.4 $\mu\text{m} \times 0.4$ –2.0 μm	R, 0, Sp	S
Hafnia	1.0 $\mu\text{m} \times 2.0$ –5.0 μm	R	S
Haliscomenobacter	0.4–0.5 $\mu\text{m} \times 3.0$ –5.0 μm	R	OL, ML

TABLE 5-continued

Examples of Gram-negative Eubacteria Cell's Size and Shape			
Genus	Size	Shape	Number
Haloanaerobium	0.9–1.1 $\mu\text{m} \times 2.0\text{--}2.6 \mu\text{m}$	R	S
Halobacteroides	0.5 $\mu\text{m} \times 10.0\text{--}20.0 \mu\text{m}$	R, CR	S
Halochromatium	1–2 $\times 2\text{--}4 \mu\text{m}$	R	S
Halomonas	0.6–0.8 $\mu\text{m} \times 1.6\text{--}1.9 \mu\text{m}$	R	S
Halorhodospira	0.5–1.5 μm	R, V	S
Helicobacter	0.5–1.0 $\mu\text{m} \times 2.5\text{--}5.0 \mu\text{m}$	H	S
Heliobacillus	1.0 $\mu\text{m} \times 7.0\text{--}10.0 \mu\text{m}$	R	S
Heliobacterium	1.0 $\mu\text{m} \times 4.0\text{--}10.0 \mu\text{m}$	R, O	S
Herbaspirillum	0.6–0.7 μm	V, H	S
Herpetosiphon	0.5–1.5 $\mu\text{m} \times 5.0\text{--}150.0 \mu\text{m}$	R	OL, ML
Hirschia	0.5–1.0 $\mu\text{m} \times 0.5\text{--}6.0 \mu\text{m}$	R, O	S
Hydrogenophaga	0.3–0.6 $\mu\text{m} \times 0.6\text{--}5.5 \mu\text{m}$	R	s, p
Hyphomicrobium	0.3–1.2 $\mu\text{m} \times 1.0\text{--}3.0 \mu\text{m}$	R, O	S
Hyphomonas	0.5–1.0 $\mu\text{m} \times 1.0\text{--}3.0 \mu\text{m}$	R, O	S
Ilyobacter	0.7–1.0 $\mu\text{m} \times 1.3\text{--}3.0 \mu\text{m}$	R	P, OL
Isochromatium	1–2 $\times 2\text{--}4 \mu\text{m}$	R	S
Isosphaera	2.0–2.5 μm	Sp	OL, ML
Janthinobacterium	0.8–1.2 $\mu\text{m} \times 2.5\text{--}6.0 \mu\text{m}$	R	S, P, OL
Kingella	1.0 μm	R	P, OL
Klebsiella	0.3–1.0 $\mu\text{m} \times 0.6\text{--}6.0 \mu\text{m}$	R	S, P, OL
Kluyvera	0.5–0.7 $\mu\text{m} \times 2.0\text{--}3.0 \mu\text{m}$	R	S
Labrys	1.1–1.3 $\mu\text{m} \times 1.3\text{--}1.5 \mu\text{m}$	Tr	S
Lachnospira	0.4–0.6 $\mu\text{m} \times 2.0\text{--}4.0 \mu\text{m}$	CR	S
Lamprocystis	3.0–3.5 μm	Co	S
Lampropedia	1.0–1.5 $\mu\text{m} \times 1.0\text{--}2.5 \mu\text{m}$	R	OC
Leclercia	1.0–1.3 $\mu\text{m} \times 2.1\text{--}3.6 \mu\text{m}$	R	S
Legionella	0.3–0.9 $\mu\text{m} \times 2.0\text{--}20.0 \mu\text{m}$	R	S
Leminorella	0.3 $\mu\text{m} \times 1.8 \mu\text{m}$	R	S
Leptospira	0.1 $\mu\text{m} \times 6.0\text{--}24.0 \mu\text{m}$	H	S
Leptospirillum	0.2–0.4 $\mu\text{m} \times 0.9\text{--}1.1 \mu\text{m}$	V, Sl	S
Leptothrix	0.6–1.4 $\mu\text{m} \times 1.0\text{--}12.0 \mu\text{m}$	R	S, P, OL
Leptotrichia	0.8–1.5 $\mu\text{m} \times 5.0\text{--}15.0 \mu\text{m}$	R	S
Leucothrix	1.0–1.5 μm	R	OL, ML
Lysobacter	0.2–0.5 $\mu\text{m} \times 1.0\text{--}70.0 \mu\text{m}$	R	S
Malonomonas	0.4 $\mu\text{m} \times 3.1\text{--}4.0 \mu\text{m}$	R	S, P, OL, OC
Marinilabilia	0.3–0.8 $\mu\text{m} \times 1.5\text{--}15.0 \mu\text{m}$	R	S
Marichromatium	1–2 $\times 2\text{--}4 \mu\text{m}$	R	S
Marinobacter	0.3–0.6 $\mu\text{m} \times 2.0\text{--}3.0 \mu\text{m}$	R	S
Marinomonas	0.7–1.5 $\mu\text{m} \times 1.8\text{--}3.0 \mu\text{m}$	R, CR	S
Megamonas	0.8–3.0 $\mu\text{m} \times 3.0\text{--}20.0 \mu\text{m}$	R	S
Megasphaera	1.3–2.0 μm	Co	P, OL
Melittangium	0.6–0.8 $\mu\text{m} \times 5.0\text{--}12.0 \mu\text{m}$	R	S
Meniscus	0.7–1.0 $\mu\text{m} \times 2.0\text{--}3.0 \mu\text{m}$	R, CR	S
Mesophilobacter	0.5–0.6 $\mu\text{m} \times 1.0\text{--}2.0 \mu\text{m}$	R, Co	S
Metallogenium	0.2–1.5 μm	Co	OL
Methylobacillus	0.3–0.5 $\mu\text{m} \times 0.8\text{--}2.0 \mu\text{m}$	R	S
Methylobacterium	0.8–1.0 $\mu\text{m} \times 1.0\text{--}8.0 \mu\text{m}$	R	S
Methylococcus	1.0 Mm	Co	P
Methylomonas	0.5–1.0 $\mu\text{m} \times 1.0\text{--}4.0 \mu\text{m}$	R, CR	S
Methylophaga	0.2 Mm	R	S
Methylophilus	0.3–0.6 $\mu\text{m} \times 0.8\text{--}1.5 \mu\text{m}$	R	S, P
Methylovorus	0.5–0.6 $\mu\text{m} \times 1.0\text{--}1.3 \mu\text{m}$	R	S, P
Microscilla	0.2–0.5 $\mu\text{m} \times 10.0\text{--}100.0 \mu\text{m}$	R	S
Mitsuokella	0.7–1.5 $\mu\text{m} \times 1.2\text{--}1.5 \mu\text{m}$	OR	S
Moellerella	0.3 $\mu\text{m} \times 1.8 \mu\text{m}$	R	S
Moraxella	1.0–1.5 $\mu\text{m} \times 1.5\text{--}2.5 \mu\text{m}$	R, Co	P, OL
Morganella	0.6–0.7 $\mu\text{m} \times 1.0\text{--}1.7 \mu\text{m}$	R	S
Morococcus	1.0 μm	Co	OC
Myxococcus	0.4–0.7 $\mu\text{m} \times 2.0\text{--}10.0 \mu\text{m}$	R	S
Myxosarcina	3.0–4.0 μm	Sp, Co	OC
Nannocystis	1.1–2.0 $\mu\text{m} \times 1.5\text{--}5.0 \mu\text{m}$	R	S
Neisseria	0.6–1.0 μm	Co	S, P
Nevskia	1.0–6.0 $\mu\text{m} \times 3.0\text{--}12 \mu\text{m}$	R	OL
Nitrobacter	0.5–0.8 $\mu\text{m} \times 1.0\text{--}2.0 \mu\text{m}$	R	S
Nitrococcus	1.5 μm	Sp	S, P
Nitrosococcus	1.5–1.8 $\mu\text{m} \times 1.7\text{--}2.5 \mu\text{m}$	Sp, Ep	S
Nitrosomonas	0.7–1.5 $\mu\text{m} \times 1.0\text{--}2.4 \mu\text{m}$	R, Co	S
Nitrospira	0.3–0.8 $\mu\text{m} \times 1.0\text{--}8.0 \mu\text{m}$	Sl	S
Nitrospira	0.3–0.4 $\mu\text{m} \times 0.8\text{--}1.0 \mu\text{m}$	V, Sl	S
Nostoc	2.0–8.0 μm	O, Sp, R	OL
Obesumbacterium	0.8–2.0 $\mu\text{m} \times 1.5\text{--}100.0 \mu\text{m}$	R	S

TABLE 5-continued

Examples of Gram-negative Eubacteria Cell's Size and Shape			
Genus	Size	Shape	Number
Oceanospirillum	0.8–1.2 $\mu\text{m} \times 2.6\text{--}3.6 \mu\text{m}$	R	S
Ochrobactrum	0.5–0.7 $\mu\text{m} \times 0.6\text{--}1.5 \mu\text{m}$	R	S
Oligella	1.0 μm	R	P
Oscillatoria	1.0 μm	O	OL
Oxalobacter	0.4–0.6 $\mu\text{m} \times 1.2\text{--}1.5 \mu\text{m}$	R, CR	S
Pantoea	0.5–1.0 $\mu\text{m} \times 1.0\text{--}3.0 \mu\text{m}$	R	S
Paracoccus	0.5–0.9 $\mu\text{m} \times 0.9\text{--}1.2 \mu\text{m}$	R, Co	S, P, OC
Pasteurella	0.3–1.0 $\mu\text{m} \times 1.0\text{--}2.0 \mu\text{m}$	R, O, Sp	S, P, OL
Pectinatus	0.7–0.9 $\mu\text{m} \times 3.0\text{--}30.0 \mu\text{m}$	R	S
Pedobacter	0.5 $\mu\text{m} \times 1.0\text{--}3.0 \mu\text{m}$	R	S
Pedomicrobium	0.4–2.0 $\mu\text{m} \times 0.4\text{--}2.5 \mu\text{m}$	O, Sp	S
Pelobacter	0.5–0.8 $\mu\text{m} \times 1.2\text{--}6.0 \mu\text{m}$	R	S, P, OL
Pelodictyon	0.6–1.2 $\mu\text{m} \times 1.2\text{--}2.5 \mu\text{m}$	R, O	S, OC
Persicobacter	0.3–0.8 $\mu\text{m} \times 1.5\text{--}15.0 \mu\text{m}$	R	S
Phaeospirillum	0.7–1.5 μm	SI	S
Phenylobacterium	0.7–1.0 $\mu\text{m} \times 1.0\text{--}2.0 \mu\text{m}$	R, Co	S, P, OL
Photobacterium	0.8–1.3 $\mu\text{m} \times 1.8\text{--}2.4 \mu\text{m}$	R	S
Phyllobacterium	0.4–0.8 $\mu\text{m} \times 0.8\text{--}2.0 \mu\text{m}$	R	S
Pirellula	0.5–3.0 $\mu\text{m} \times 1.0\text{--}5.0 \mu\text{m}$	O	S, OL
Planctomyces	1.0–1.5 μm	Co, O	S, OL
Plesiomonas	0.8–1.0 $\mu\text{m} \times 3.0 \mu\text{m}$	R	S
Pleurocapsa	2.0–3.0 μm	Sp	OC
Polyangium	0.6–1.2 $\mu\text{m} \times 3.0\text{--}8.0 \mu\text{m}$	R	S
Porphyrobacter	0.4–0.8 $\mu\text{m} \times 1.1\text{--}2.0 \mu\text{m}$	PI	S
Porphyromonas	0.5–0.8 $\mu\text{m} \times 1.0\text{--}3.0 \mu\text{m}$	R	S
Pragia	0.3 $\mu\text{m} \times 1.8 \mu\text{m}$	R	S
Prevotella	0.6–0.9 $\mu\text{m} \times 1.5\text{--}3.5 \mu\text{m}$	R	S
Propionigenium	0.5–0.6 $\mu\text{m} \times 0.5\text{--}2.0 \mu\text{m}$	R	S, P, OL
Propionispira	1.0 $\mu\text{m} \times 7.0 \mu\text{m}$	CR, H	S
Prostheco bacter	0.5–0.9 $\mu\text{m} \times 2.0\text{--}5.0 \mu\text{m}$	Fu, V	S
Prosthecochloris	0.5–0.7 $\mu\text{m} \times 0.5\text{--}1.2 \mu\text{m}$	Sp, R	S, OL, OC
Prosthecomicrobium	0.8–1.2 μm	Co, R	S
Proteus	0.4–0.8 $\mu\text{m} \times 1.0\text{--}3.0 \mu\text{m}$	R	S
Providencia	0.6–0.8 $\mu\text{m} \times 1.5\text{--}2.5 \mu\text{m}$	R	S
Pseudanabaena	1.0–3.0 μm	R	OL
Pseudomonas	0.5–1.0 $\mu\text{m} \times 1.5\text{--}5.0 \mu\text{m}$	R	S
Psychrobacter	0.9–1.3 $\mu\text{m} \times 1.5\text{--}3.8 \mu\text{m}$	Co, R	S
Rahnella	0.5–0.7 $\mu\text{m} \times 2.0\text{--}3.0 \mu\text{m}$	R	S
Rhabdochromatium	1–2 \times 2–4 μm	R	S
Rhizobacter	0.9–1.3 $\mu\text{m} \times 2.1\text{--}2.5 \mu\text{m}$	R	S
Rhizobium	0.5–0.9 $\mu\text{m} \times 1.2\text{--}3.0 \mu\text{m}$	R	S
Rhizomonas	0.5–1.2 μm	R	S
Rhodobaca	0.8–1.1 $\mu\text{m} \times 1.5 \mu\text{m}$	Co, R	S, P
Rhodobacter	0.5–1.2 μm	R, O	S, OC
Rhodobium	0.6–2.5 $\mu\text{m} \times 0.6\text{--}5.0 \mu\text{m}$	R	S
Rhodoblastus	0.6–2.5 $\mu\text{m} \times 0.6\text{--}5.0 \mu\text{m}$	R	S
Rhodocista	0.7–1.5 μm	SI	S
Rhodocyclus	0.3–1.0 μm	R	S
Rhodoferax	0.7 $\mu\text{m} \times 2\text{--}3 \mu\text{m}$	CR	S
Rhodomicrobium	1.0–1.2 μm	O, R	S
Rhodopila	1.6–1.8 μm	Sp, O	S
Rhodoplanes	0.6–2.5 $\mu\text{m} \times 0.6\text{--}5.0 \mu\text{m}$	R	S
Rhodopseudomonas	0.6–2.5 $\mu\text{m} \times 0.6\text{--}5.0 \mu\text{m}$	R	S
Rhodospirillum	0.7–1.5 μm	SI	S
Rhodothalassium	0.7–1.5 μm	SI	S
Rhodovibrio	0.7–1.0 μm	SI	S
Rhodovulum	0.5–1.2 μm	R, O	S, OC
Rikenella	0.15–0.3 $\mu\text{m} \times 0.3\text{--}1.5 \mu\text{m}$	R	S
Roseobacter	0.6–0.9 $\mu\text{m} \times 1.0\text{--}2.0 \mu\text{m}$	R, O	S
Roseococcus	0.9–1.3 $\mu\text{m} \times 1.3\text{--}1.6 \mu\text{m}$	Co	S
Rubrivivax	0.6–2.5 $\mu\text{m} \times 0.6\text{--}5.0 \mu\text{m}$	CR	S
Rugamonas	0.8–0.9 $\mu\text{m} \times 2.4\text{--}4.0 \mu\text{m}$	R	S
Ruminobacter	0.9–1.2 $\mu\text{m} \times 1.0\text{--}3.0 \mu\text{m}$	R, O	S
Runella	0.5–0.9 $\mu\text{m} \times 2.0\text{--}4.5 \mu\text{m}$	R, CR	S
Salmonella	0.7–1.5 $\mu\text{m} \times 2.0\text{--}5.0 \mu\text{m}$	R	S
Saprospira	0.5–3.0 $\mu\text{m} \times 1.5\text{--}5.5 \mu\text{m}$	R	OL, ML
Scytonema	2.0–20.0 μm	Sp	OL
Sebaldella	0.3–0.5 $\mu\text{m} \times 2.0\text{--}12.0 \mu\text{m}$	R	S, P, OL
Selenomonas	0.9–1.1 $\mu\text{m} \times 3.0\text{--}6.0 \mu\text{m}$	CR	S, P, OL
Seliberia	0.5–0.8 $\mu\text{m} \times 1.0\text{--}12.0 \mu\text{m}$	R	S
Serpens	0.3–0.4 $\mu\text{m} \times 8.0\text{--}12 \mu\text{m}$	R	S, P
Serpulina	0.3–0.4 $\mu\text{m} \times 7.0\text{--}9.0 \mu\text{m}$	H	S

TABLE 5-continued

Examples of Gram-negative Eubacteria Cell's Size and Shape			
Genus	Size	Shape	Number
Serratia	0.5–0.8 μm \times 0.9–2.0 μm	R	S
Shigella	0.3 μm \times 1.8 μm	R	S
Simonsiella	0.5–1.3 μm \times 2.0–8.0 μm	R	OL
Sinorhizobium	0.5–0.9 μm \times 1.2–3.0 μm	R	S
Sphaerotilus	1.2–2.5 μm \times 2.0–10.0 μm	R	OL
Sphingobacterium	0.5 μm \times 1.0–3.0 μm	R	S
Spirillum	1.4–1.7 μm \times 14.0–60.0 μm	H	S
Spirochaeta	0.2–0.75 μm \times 5.0–250.0 μm	H	S
Spirosoma	0.5–1.0 μm \times 1.5–6.0 μm	R, CR	S
Spirulina	1.0–5.0 μm	R	OL
Sporocytophaga	0.3–0.5 μm \times 5.0–8.0 μm	R	S
Sporomusa	0.5–1.0 μm \times 1.0–8.0 μm	CR	S
Stella	0.7–3.0 μm	St	s, p
Stigmatella	0.6–0.8 μm \times 4.0–10.0 μm	R	S
Streptobacillus	0.1–0.7 μm \times 1.0–5.0 μm	R	S, OL
Succinimonas	1.0–1.5 μm \times 1.2–3.0 μm	R	S
Succinivibrio	0.4–0.6 μm \times 1.0–7.0 μm	CR, H	S
Sulfobacillus	0.6–0.8 μm \times 1.0–3.0 μm	R	P, OL
Synechococcus	3.0 μm	R, Co	S
Synechocystis	2.0–7.0 μm	Sp, Co	S, OC
Syntrophobacter	0.6–1.0 μm \times 1.0–35.0 μm	R	S
Syntrophococcus	1.0–1.3 μm	Co	P
Syntrophomonas	0.5–1.0 μm \times 2.0–7.0 μm	R	S
Tatumella	0.6–0.8 μm \times 0.9–3.0 μm	R	S
Taylorella	0.7 μm \times 0.7–1.8 μm	R	S
Thermochromatium	1–2 \times 2–4 μm	R	S
Thermodesulfobacterium	0.3 μm \times 0.9–2.5 μm	R, O	S, P, OC
Thermoleophilum	0.4 μm \times 0.7–1.5 μm	R	S
Thermomicrobium	1.3–1.8 μm \times 3.0–6.0 μm	R	S, P
Thermoneema	0.3 μm \times 60.0–200.0 μm	R	S
Thermosipho	0.5 μm \times 3.0–4.0 μm	R	OL
Thermotoga	0.6 μm \times 1.5–11.0 μm	R	S
Thermus	0.5–0.8 μm \times 5.0–10.0 μm	R	OL
Thiobacillus	0.5 μm \times 1.0–4.0 μm	R	S
Thiocapsa	1.0–3.0 μm	Sp, O	S, P, TT, OC
Thiococcus	1.0–3.0 μm	Sp, O	S, P, TT, OC
Thiocystis	2.5–3.0 μm	Sp, O	S, OC
Thiodictyon	1.5–2 \times 3–8 μm	R	S
Thiohalocapsa	1.0–3.0 μm	Sp, O	S, P, TT, OC
Thiolamprovum	1.5–3.0 μm	Sp	S, OC
Thiomicrospira	0.2–0.3 μm \times 1.0–2.0 μm	Sl	S
Thiothrix	1.0–1.5 μm	R	OL, ML
Tissierella	0.6–0.9 μm \times 2.0–20.0 μm	R	S
Tolypothrix	2.5–18.0 μm	O	OL
Treponema	0.1–0.4 μm \times 5.0–20.0 μm	H	S
Vampirovibrio	0.3–0.6 μm	R	S
Variovorax	0.5–0.6 μm \times 1.2–3.0 μm	R	S, P
Veillonella	0.3–0.5 μm	Co	P, OL, OC
Verrucomicrobium	0.8–1.0 μm \times 1.0–3.8 μm	R	S
Vibrio	0.5–0.8 μm \times 1.4–2.6 μm	R, CR	S
Vitreoscilla	1.0–3.0 μm	Cy	OL, ML
Weeksella	0.6 μm \times 2.0–3.0 μm	R	S
Wolinella	0.5–1.0 μm \times 2.0–6.0 μm	R, CR, H	S
Xanthobacter	0.4–1.0 μm \times 0.8–6.0 μm	R	S
Xanthomonas	0.4–0.7 μm \times 0.7–1.8 μm	R	S
Xenococcus	2.0–3.0 μm	Sp	OC
Xenorhabdus	0.3–2.0 μm \times 2.0–10.0 μm	R	S
Xylella	0.25–0.35 μm \times 0.9–3.5 μm	R	S
Xylophilus	0.4–0.8 μm \times 0.6–3.3 μm	R	S, P, OL
Yersinia	0.5–0.8 μm \times 1.0–3.0 μm	R	S
Yokenella	1.0–1.3 μm \times 2.1–3.6 μm	R	S
Zobellia	0.3–0.8 μm \times 1.5–15.0 μm	R	S
Zoogloea	1.0–1.3 μm \times 2.1–3.6 μm	R	S

TABLE 5-continued

<u>Examples of Gram-negative Eubacteria Cell's Size and Shape</u>			
Genus	Size	Shape	Number
Zymomonas	2.0 μm \times 1.0–1.4 μm	R	S
Zymophilus	0.7–1.0 μm \times 3.0–30.0 μm	R	S, P, OL

Shape: H = helical; V = vibrioid, vibrios; R = rod; CR = curved rod; O = ovoid, oval; Sp = spherical; Co = cocci, coccoid; Cy = cylinder; Cn = conical; Rg = ring, u-shape; Ep = ellipsoidal; Sl = spiral; Fu = fusiform; Sr = serpentine; St = flat-star; Pl = pleomorphic; Te = tetrahedral; Tr = triangle; Pl = plate-shape.
 Number: S = unicellular; P = cell pairs; TT = tetrad of cells; OC = oligocellular cluster; MC = multicellular cluster; OL = oligocellular chain; ML = multicellular chain.

[0138] Examples of biological culture collection sources for Gram-negative Eubacteria are shown at Table 6 below.

TABLE 6

<u>Examples of Gram-negative Eubacteria Culture Sources</u>	
Genus	Examples of Culture Collection Strains
Acetivibrio	ATCC Nos. 33288 and 33324
Acetoanaerobium	ATCC Nos. 35199
Acetobacter	ATCC Nos. 12873, 12875, 12876, 15973 and 23753
Acetomicrobium	ATCC Nos. 43122; DSMZ Nos. 20678 and 20664
Acidaminobacter	DSMZ No. 2784
Acidaminococcus	ATCC Nos. 25085; DSMZ No. 20731
Acidiphilium	ATCC No. 27807; DSMZ No. 700 and 11245
Acidomonas	ATCC Nos. 43581; DSMZ No. 5432
Acidovorax	ATCC Nos. 10200, 11228, 17505, 33996 and 49665
Acinetobacter	ATCC Nos. 14987, 15149, 15309, 17906 and 19606
Aeromonas	ATCC Nos. 10801, 11163, 7966, 9071 and 49568
Agitococcus	DSMZ No. 5822
Agrobacterium	ATCC Nos. 25651, 25652, 25657, 31113 and 700001
Agromonas	ATCC Nos. 43045; DSMZ No. 12412
Alcaligenes	ATCC Nos. 15246, 23653, 29712 and 55938
Allochromatium	DSMZ Nos. 173, 174, 180, 182 and 1376
Alteromonas	ATCC Nos. 27126 and 29332
Alysiella	ATCC Nos. 15532 and 29469
Aminobacter	ATCC Nos. 23314, 49932 and 49933
Anabaena	ATCC Nos. 22664, 29413, 29414, 43530 and 55755
Anaerobiospirillum	ATCC Nos. 29305 and 700432
Anaerorhabdus	ATCC Nos. 25662
Anaerovibrio	ATCC Nos. 33276; DSMZ No. 3074
Ancalomicrobium	ATCC Nos. 23632; DSMZ No. 4722
Ancylobacter	ATCC Nos. 21373 and 25396
Angulomicrobium	ATCC Nos. 43934; DSMZ No. 5895
Aquaspirillum	ATCC Nos. 11331, 11332, 11334, 11335 and 12638
Archangium	ATCC Nos. 25200 and 29036
Arsenophonus	ATCC Nos. 49151; DSMZ No. 15247
Arthrospira	ATCC Nos. 29408
Asticcacaulis	ATCC Nos. 15261 and 27554
Azomonas	ATCC Nos. 12334, 12523 and 12838
Azorhizobium	ATCC Nos. 43989; DSMZ No. 5975
Azospirillum	ATCC Nos. 29145, 29707, 35119, 43709 and 51182
Azotobacter	ATCC Nos. 12518, 12981, 13544, 4412 and 29662
Bacteroides	ATCC Nos. 12290, 23745, 27754, 29327 and 29572
Bdellovibrio	ATCC Nos. 15143 and 27051
Beggiatoa	ATCC No. 33555; DSMZ No. 1416
Beijerinckia	ATCC Nos. 19361, 33962, 33963 and 33964
Blastobacter	ATCC Nos. 43293, 43294 and 43295
Blastochloris	DSMZ Nos. 133, 134, 136, 729 and 13255
Bordetella	ATCC Nos. 10380, 10580, 15237, 35086 and 51730
Borrelia	ATCC Nos. 35210, 43381, 49835, 51383 and 51557
Brachyspira	ATCC Nos. 27164, 29796, 43994, 51139 and 51933
Bradyrhizobium	ATCC Nos. 10324, 49852, 700350 and 35644
Brevundimonas	DSMZ Nos. 4736, 4731, 4732, 4737 and 7226
Brucella	ATCC Nos. 23365, 23459 and 25840
Budvicia	ATCC Nos. 35566; DSMZ No. 5075
Buttiauxella	ATCC Nos. 33320, 33993, 51604, 51605 and 51607
Butyrivibrio	ATCC Nos. 19171, 29175 and 29550

TABLE 6-continued

<u>Examples of Gram-negative Eubacteria Culture Sources</u>	
Genus	Examples of Culture Collection Strains
Calothrix	ATCC Nos. 27901 and 27905
Campylobacter	ATCC Nos. 15296, 29428, 33236, 33237 and 33238
Capnocytophaga	ATCC Nos. 27872, 33612, 33624, 35978 and 51502
Cardiobacterium	ATCC Nos. 14900; DSMZ No. 8339
Caulobacter	ATCC Nos. 11764, 15253, 15257, 15260 and 21756
Cedecea	ATCC Nos. 33431, 33432 and 33855
Cellulophaga	ATCC Nos. 23169, 23178, 700862 and 700863
Cellvibrio	ATCC Nos. 13127
Centipeda	ATCC Nos. 35019; DSMZ No. 2778
Chitinophaga	ATCC Nos. 43595; DSMZ No. 2588
Chlorobium	ATCC Nos. DSMZ No. 245, 266 and 269
Chloroflexus	ATCC Nos. 29365; DSMZ No. 9485, 9486 and 635
Chlorogloeopsis	ATCC Nos. 27181 and 27193
Chloroherpeton	ATCC Nos. 35110
Chondromyces	DSMZ No. 436
Chromobacterium	ATCC Nos. 12472; DSMZ Nos. 11369 and 30191
Chromohalobacter	ATCC Nos. 17056, 43984, 43985 and BAA-138
Chroococcidiopsis	ATCC Nos. 27900 and 29379
Citrobacter	ATCC Nos. 10053, 11102, 11811, 25405 and 8090
Cobetia	ATCC Nos. 27129 and 35142
Comamonas	ATCC Nos. 11330, 11996, 700936 and 700038
Crinalium	ATCC Nos. 49662
Cupriavidus	ATCC Nos. 43291; DSMZ No. 13513
Cyclobacterium	ATCC Nos. 25205; DSMZ No. 745
Cylindrospermum	ATCC Nos. 29204 and 29412
Cystobacter	ATCC Nos. 25194; DSMZ No. 2262
Cytophaga	ATCC Nos. 12208, 19072, 19326, 23177 and 33406
Dermocarpella	ATCC Nos. 29376
Derxia	ATCC Nos. 15994; DSMZ No. 723
Desulfobacter	ATCC Nos. 33911, 43915, 43918 and 43919
Desulfobacterium	ATCC Nos. 43914, 43938 and 49792
Desulfobulbus	ATCC Nos. 33891, 43118 and 700652
Desulfococcus	ATCC Nos. 33890; DSMZ Nos. 5651, 2059 and 2650
Desulfomicrobium	ATCC No. 51164; DSMZ Nos. 5918, 4194 and 5918
Desulfomonile	ATCC Nos. 49306; DSMZ No. 6799
Desulfonema	ATCC Nos. 33961 and 35288
Desulfosarcina	DSMZ No. 2060
Desulfovibrio	ATCC Nos. 13541, 14822, 19364, 19996 and 29098
Desulfurella	ATCC Nos. 51451; DSMZ Nos. 5264, 10409 and 10410
Desulfuromonas	ATCC Nos. 51529, 51701 and 700295
Dichotomicrobium	ATCC Nos. 49408; DSMZ No. 5002
Ectothiorhodospira	ATCC Nos. 43036, 49921 and 51935; DSMZ No. 241
Edwardsiella	ATCC Nos. 15469, 33202, 33379 and 15947
Eikenella	ATCC Nos. 23834; DSMZ No. 8340
Enhydrobacter	ATCC Nos. 27094
Ensifer	ATCC Nos. 33212
Enterobacter	ATCC Nos. 10699, 12868, 15038, 23373 and 13048
Erwinia	ATCC Nos. 11417, 14976, 23376, 29573 and 35998
Erythrobacter	ATCC Nos. 33941 and 700002
Erythromicrobium	ATCC No. 700003; DSMZ No. 8510
Escherichia	ATCC Nos. 25922, 21073, 29907, 29943 and 29990
Ewingella	ATCC Nos. 33850; DSMZ No. 4580
Fervidobacterium	ATCC Nos. 35602 and 49647
Fibrobacter	ATCC Nos. 19169 and 43854
Filomicrobium	ATCC Nos. 35158; DSMZ No. 5304
Fischerella	ATCC Nos. 27929 and 29114
Flammeovirga	ATCC Nos. 23126 and 23132; DSMZ No. 3659
Flavobacterium	ATCC Nos. 11947, 12524, 13524, 14231, 17061 and 27551
Flectobacillus	ATCC Nos. 29496; DSMZ No. 103
Flexibacter	ATCC Nos. 23079, 23086, 23087, 23090 and 23103
Flexithrix	ATCC Nos. 23163; DSMZ No. 6795
Francisella	ATCC Nos. 25015; DSMZ No. 7535
Frateuria	ATCC Nos. 12301; DSMZ No. 6220
Fusobacterium	ATCC Nos. 10953, 25286, 25533, 25556 and 25557
Gemmata	DSMZ No. 5831
Gemmiger	ATCC Nos. 27749
Gloeobacter	ATCC Nos. 29082
Gloeocapsa	ATCC Nos. 29115 and 29159
Gluconobacter	ATCC Nos. 11894, 12302, 14835, 43781 and 49207
Haemophilus	ATCC Nos. 10014, 10211, 11116, 13252 and 19417
Hafnia	ATCC Nos. 11604 and 13337; DSMZ No. 30163

TABLE 6-continued

<u>Examples of Gram-negative Eubacteria Culture Sources</u>	
Genus	Examples of Culture Collection Strains
Haliscamenobacter	ATCC Nos. 27775; DSMZ No. 1100
Haloanaerobium	ATCC Nos. 33744, 51327, 700103 and 700560
Halobacteroides	ATCC Nos. 35273; DSMZ Nos. 6639 and 5150
Halochromatium	ATCC No. 700202; DSMZ Nos. 11080 and 4395
Halomonas	ATCC Nos. 12084, 14400, 19717, 27122 and 27125
Halorhodospira	DSMZ Nos. 244, 1059 and 2110c
Helicobacter	ATCC Nos. 35683, 43504, 43772, 49286 and 51101
Heliobacillus	ATCC Nos. 43427; DSMZ No. 6151
Heliobacterium	ATCC Nos. 43375 and 51547
Herbaspirillum	ATCC Nos. 19308, 35892 and BAA-806
Herpetosiphon	ATCC Nos. 23076, 23779 and 53756
Hirschia	ATCC Nos. 49814; DSMZ No. 5838
Hydrogenophaga	ATCC Nos. 17724, 33667, 33668, 49743, BAA-304
Hyphomicrobium	ATCC Nos. 19614, 27483, 27484, 27495 and 27499
Hyphomonas	ATCC Nos. 15444, 33879, 33880, 33882 and 33886
Ilyobacter	ATCC Nos. 35898 and 49679
Isochromatium	DSMZ Nos. 176 and 177
Isosphaera	ATCC Nos. 43644; DSMZ No. 9630
Janthinobacterium	ATCC Nos. 12473; DSMZ Nos. 9628 and 1522
Kingella	ATCC Nos. 23330, 33394 and 51147
Klebsiella	ATCC Nos. 10031, 12833, 700834 and 13883
Kluyvera	ATCC Nos. 14236, 14237, 51603 and 51609
Labrys	ATCC Nos. 43932; DSMZ No. 5896
Lachnospira	ATCC Nos. 19207; DSMZ No. 3073
Lamprocystis	DSMZ No. 229
Lampropedia	ATCC Nos. 11041
Leclercia	ATCC Nos. 23216; DSMZ No. 5077
Legionella	ATCC Nos. 33462, 33623, 33733, 33761 and 35072
Leminorella	ATCC Nos. 33998, 33999 and 43012
Leptospira	ATCC Nos. 23468, 23469, 23477, 23479 and 23582
Leptospirillum	ATCC Nos. 53992; DSMZ Nos. 14647, 2705 and 1928
Leptothrix	ATCC Nos. 43182; DSMZ No. 10617
Leptotrichia	ATCC Nos. 14201 and 700907
Leucothrix	ATCC Nos. 25107; DSMZ No. 2157
Lysobacter	ATCC Nos. 21123, 29479, 29482, 29489 and 53042
Malonomonas	DSMZ No. 5091
Marinilabilia	ATCC Nos. 19041 and 19043; DSMZ No. 1449
Marichromatium	DSMZ Nos. 203, 204, 1591 and 1711
Marinobacter	ATCC Nos. 27132 and 700491
Marinomonas	ATCC Nos. 27118, 27119 and 700492
Megamonas	ATCC Nos. 25560; DSMZ No. 1672
Megasphaera	ATCC Nos. 17752 and 43236
Melittangium	ATCC Nos. 25944; DSMZ No. 14877
Meniscus	ATCC Nos. 29398
Mesophilobacter	DSMZ No. 9142
Metallogenium	VKM No. B-457 and B-459
Methylobacillus	ATCC Nos. 29475 and 51484
Methylobacterium	ATCC Nos. 14718, 14821, 21611, 27329 and 27886
Methylococcus	ATCC Nos. 19069
Methylomonas	ATCC Nos. 20563, 21369, 31226, 35067 and 43722
Methylophaga	ATCC Nos. 33145, 35842 and BAA-297
Methylophilus	ATCC Nos. 39866; DSMZ Nos. 5898 and 6813
Methylovorus	ATCC Nos. 49758; DSMZ No. 6874
Microscilla	ATCC Nos. 23129, 23134, 23182 and 23190
Mitsuokella	ATCC Nos. 27723 and BAA-307
Moellerella	ATCC Nos. 35017; DSMZ No. 5076
Moraxella	ATCC Nos. 10900, 10973, 11748, 14659 and 14688
Morganella	ATCC Nos. 21116; DSMZ Nos. 30164 and 14850
Morococcus	ATCC Nos. 33486
Myxococcus	ATCC Nos. 23093, 25202, 25203, 25232 and 25565
Myxosarcina	ATCC Nos. 29377 and 29378
Nannocystis	ATCC Nos. 25965; DSMZ No. 71
Neisseria	ATCC Nos. 10555, 13115, 14685, 14686 and 14687
Nevskia	DSMZ No. 11499
Nitrobacter	ATCC Nos. 25391 and 25388
Nitrococcus	ATCC Nos. 25380
Nitrosococcus	ATCC Nos. 19707
Nitrosomonas	ATCC Nos. 25978 and 49181
Nitrospira	ATCC Nos. 25196
Nitrospira	ATCC Nos. 43039; DSMZ No. 10035
Nostoc	ATCC Nos. 27895 and 27904
Obesumbacterium	ATCC Nos. 12841; DSMZ No. 2777

TABLE 6-continued

<u>Examples of Gram-negative Eubacteria Culture Sources</u>	
Genus	Examples of Culture Collection Strains
Oceanospirillum	ATCC Nos. 11336, 12754, 27509 and 33336
Ochrobactrum	ATCC Nos. 19286 and BAA-119
Oligella	ATCC Nos. 17960 and 35578
Oscillatoria	ATCC Nos. 27906 and 27930
Oxalobacter	ATCC Nos. 35274; DSMZ Nos. 4420 and 5502
Pantoea	ATCC Nos. 11530, 12287, 14589, 29227 and 31623
Paracoccus	ATCC Nos. 13543, 25364, 49631, 49632 and 49673
Pasteurella	ATCC Nos. 10544, 12555, 13360, 14385 and 23273
Pectinatus	ATCC Nos. 29359 and 33332
Pedobacter	DSMZ Nos. 12126, 2366, 11725 and 12145
Pedomicrobium	ATCC Nos. 33116, 33121, 33122 and 43615
Pelobacter	ATCC Nos. 49970 and 49973
Pelodictyon	DSMZ No. 728
Persicobacter	ATCC Nos. 23140 and 23155; DSMZ No. 3658
Phaeospirillum	DSMZ Nos. 120, 118, 119, 113 and 114
Phenyllobacterium	ATCC Nos. 35972; DSMZ No. 1986
Photobacterium	ATCC Nos. 11040, 17911, 25521, 25915 and 51760
Phyllobacterium	ATCC Nos. 43590 and 43591
Pirellula	ATCC Nos. 27377 and 49069
Planctomyces	ATCC Nos. 29201, 43296 and 49424
Plesiomonas	ATCC Nos. 14029; DSMZ No. 8224
Pleurocapsa	ATCC Nos. 29386 and 29387
Polyangium	ATCC Nos. 15384 and 53080
Porphyrobacter	DSMZ Nos. 11032, 9434, 9435, 10594 and 12079
Porphyromonas	ATCC Nos. 25260, 29147, 33141, 33277 and 35406
Pragia	ATCC Nos. 49100; DSMZ No. 5563
Prevotella	ATCC Nos. 15032, 15930, 19188, 19189 and 25261
Propionigenium	DSMZ Nos. 9537 and 2376
Propionispira	ATCC Nos. 33732; DSMZ No. 2179
Prostheco bacter	ATCC Nos. 25309, 27091, 700199 and 700200
Prosthecochloris	DSMZ No. 271, 260, 272 and 1685
Prosthecomicrobium	ATCC Nos. 23633, 23634, 27827, 35022 and 27833
Proteus	ATCC Nos. 10005, 12454, 19692, 33519 and 13315
Providencia	ATCC Nos. 12013, 14505, 25825, 25828 and 35612
Pseudanabaena	ATCC Nos. 29344 and 29207
Pseudomonas	ATCC Nos. 10144, 10145, 10205, 10757 and 27853
Psychrobacter	ATCC Nos. 15174, 17955, 17958, 700361 and 700754
Rahnella	ATCC Nos. 15552; DSMZ No. 4594
Rhabdochromatium	DSMZ No. 5261
Rhizobacter	ATCC Nos. 43776; DSMZ No. 11587
Rhizobium	ATCC Nos. 10004, 10034, 11157, 11325 and 13335
Rhizomonas	ATCC Nos. 51296 and 51297
Rhodobacter	ATCC Nos. 11166, 17023, 33485 and 35703; CIP No. 105439; JCM No. 9340; DSMZ No. 11550
Rhodobium	DSMZ Nos. 2698, 2780, 11290 and 11349
Rhodoblastus	DSMZ Nos. 137, 142 and 145; LMG No. 4300
Rhodobaca	ATCC No. 700920
Rhodocista	ATCC Nos. 51373 and 51374; DSMZ No. 9894
Rhodocyclus	ATCC Nos. 25093; DSMZ Nos. 168 and 109
Rhodoferax	ATCC Nos. 49786, 49787 and 700587
Rhodomicrobium	ATCC Nos. 17100; DSMZ No. 162
Rhodopila	DSMZ No. 161
Rhodoplanes	ATCC No. 51906; DSMZ Nos. 11907, 5909 and 13233
Rhodopseudomonas	ATCC Nos. 17000, 35601, 49724 and 51105; DSMZ No. 12706
Rhodospirillum	ATCC Nos. 11170, 27871 and 43720
Rhodothalassium	ATCC No. 35888; DSMZ No. 2132
Rhodovibrio	ATCC No. 35394; DSMZ Nos. 9154 and 9895
Rhodovulum	DSMZ Nos. 2781, 4868, 12328, 12329 and 2351
Rikenella	ATCC Nos. 29728
Roseobacter	ATCC Nos. 33942 and 700781; DSMZ No. 12440
Roseococcus	ATCC No. 700004; DSMZ No. 8511
Rugamonas	ATCC Nos. 43154
Rubrivivax	ATCC Nos. 17011 and 49846; DSMZ No. 149
Ruminobacter	ATCC Nos. 29744; DSMZ No. 1361
Runella	ATCC Nos. 29530
Salmonella	ATCC Nos. 10398, 43975 and 14028
Saprospira	ATCC Nos. 23116; DSMZ No. 2844
Scytonema	ATCC Nos. 29171
Seibaldella	ATCC Nos. 33386
Selenomonas	ATCC Nos. 12561, 27093, 35185, 43527 and 43528
Seliberia	VKM No. B-1340

TABLE 6-continued

<u>Examples of Gram-negative Eubacteria Culture Sources</u>	
Genus	Examples of Culture Collection Strains
Serpens	ATCC Nos. 29606
Serpulina	ATCC Nos. 49776, 51140 and 51284
Serratia	ATCC Nos. 11367, 11634, 13477, 14460, 15928 and 8100
Shigella	ATCC Nos. 11060, 11836, 12027, 12022 and 25931
Simonsiella	ATCC Nos. 15533, 27395 and 29431
Sinorhizobium	ATCC Nos. 10310, 35423, 49357, 51690 and 51692
Sphaerotilus	ATCC Nos. 13338 and 13503
Sphingobacterium	ATCC Nos. 33298, 33300, 43320, 51969 and 49537
Spirillum	ATCC Nos. 19553 and 33017
Spirochaeta	ATCC Nos. 19044, 25082, 25083, 27000 and 33939
Spirosoma	ATCC Nos. 23276; DSMZ No. 74
Spirulina	ATCC Nos. 53843, 53844 and 53871
Sporocytophaga	ATCC Nos. 10010; DSMZ No. 11118
Sporomusa	ATCC Nos. 35899, 35900, 49682, 49683 and 700346
Stella	ATCC Nos. 43930 and 43931
Stigmatella	ATCC Nos. 25190 and 25191
Streptobacillus	ATCC Nos. 14075; DSMZ No. 12112
Succinimonas	DSMZ No. 2873
Succinivibrio	ATCC Nos. 19716; DSMZ No. 3072
Sulfobacillus	ATCC Nos. 51911 and 700253
Synechococcus	ATCC Nos. 29404 and 33912
Synechocystis	PCC Nos. 6308, 6714, 7008, 7919 and 9220
Syntrophobacter	DSMZ Nos. 10017, 10092 and 2805
Syntrophococcus	ATCC Nos. 43584; DSMZ No. 3224
Syntrophomonas	DSMZ Nos. 3441, 4212 and 2245A
Tatumella	ATCC Nos. 33301; DSMZ No. 5000
Taylorella	ATCC Nos. 35865 and 700933
Thermochromatium	DSMZ No. 3771
Thermodesulfobacterium	DSMZ Nos. 2178, 12571, 14290, 1276 and 8975
Thermoleophilum	ATCC Nos. 35263 and 35268
Thermomicrobium	DSMZ No. 5159
Thermonema	ATCC Nos. 43542; DSMZ Nos. 5718 and 10300
Thermosipho	DSMZ No. 5309, 13481, 12029 and 6568
Thermotoga	ATCC Nos. 43589, 51869, BAA-301, BAA-488 and BAA-489
Thermus	ATCC Nos. 25105, 27634, 27978, 31556 and 31674
Thiobacillus	ATCC Nos. 23642, 23645, 27977 and 43788
Thiocapsa	ATCC Nos. 43172 and 700894
Thiococcus	DSMZ Nos. 226 and 227
Thiocystis	DSMZ Nos. 215, 207 and 198
Thiodictyon	DSMZ Nos. 232 and 234
Thiohalocapsa	DSMZ No. 6210
Thiolamprovum	DSMZ No. 3802
Thiomicrospira	ATCC Nos. 27801, 33889, 35932, 51452 and 700858
Thiorhodovibrio	DSMZ No. 6702
Thiothrix	ATCC Nos. 49747, 49749 and 49788
Tissierella	ATCC Nos. 25539; DSMZ Nos. 9508 and 6911
Tolypothrix	ATCC Nos. 20335 and 27914
Treponema	ATCC Nos. 27087, 33096, 33520, 33768 and 35534
Vampirovibrio	ATCC Nos. 29753
Variovorax	ATCC Nos. 17549; DSMZ No. 30034 and 7516
Veillonella	ATCC Nos. 10790, 12641, 17743, 17746 and 17747
Verrucomicrobium	ATCC Nos. 43997; DSMZ No. 4136
Vibrio	ATCC Nos. 11558, 14048, 14126, 14390 and 15338
Vitreoscilla	ATCC Nos. 15218, 15551 and 43189
Weeksella	ATCC Nos. 43766
Wolinella	ATCC Nos. 29543 and 33567; DSMZ No. 1740
Xanthobacter	ATCC Nos. 35674, 35867, 43847, 700314 and 53272
Xanthomonas	ATCC Nos. 10017, 10199, 10201, 10731 and 33913
Xenococcus	ATCC Nos. 29373 and 29375
Xenorhabdus	ATCC Nos. 19061, 33569, 35271 and 49110
Xylella	ATCC Nos. 35868; DSMZ No. 10026
Xylophilus	ATCC Nos. 29074; DSMZ No. 7250
Yersinia	ATCC Nos. 11960, 23715, 29912, 33640, 9610 and 29909
Yokenella	ATCC Nos. 35313; DSMZ No. 5079
Zobellia	ATCC No. 14397, DSMZ No. 2061 and 12802
Zoogloea	ATCC Nos. 19544, 25935, 700687, 19123 and 19324
Zymomonas	ATCC Nos. 10988; DSMZ No. 424
Zymophilus	ATCC Nos. 49689 and 49691

[0139] As would be recognized by those of ordinary skill in the art, certain cells, such as, for example, those of the genera *Ancalomicrobium*, *Asticcacaulis*, *Caulobacter*, *Dichotomicrobium*, *Filomicrobium*, *Hirschia*, *Hyphomicrobium*, *Hyphomonas*, *Labrys*, *Pedomicrobium* and *Prostheco bacter*, generally have one or more prosthecae (e.g., 1 -10) extending from the main cell body. A prosthecae is a spike-like extension of the cell, and generally comprises the cell wall and/or cell membrane. Typically, a prosthecae ranges in size from 0.1-0.7 μm x 0.1-40.0 μm . It is contemplated that such cells may produce a cell-based particulate material of the present invention of 0.1 -0.7 μm diameter for use in a surface treatment by application of a processing step such as physical force (e.g., shearing, sonication) to fragment a prosthecae from the main cell body.

[0140] Specific examples of colored Gram-negative Eubacteria species, with exemplary colors, include: *Xenorhabdus beddingii* (blue; ATCC No. 49110; DSMZ No. 4764), *Xenorhabdus poinarii* (blue; ATCC No. 35272; DSMZ No. 4768), *Vibrio nigrapulchritudo* (blue; ATCC Nos. 27043 and 33901), *Pseudomonas viridiflava* (blue-green; ATCC No. 13222; DSMZ No. 11124), *Cytophaga marinoiflava* (yellow, ATCC No. 19326; DSMZ No. 3653), *Cytophaga fermentans* (yellow; ATCC No. 19072), *Escherichia hermannii* (yellow; ATCC No. 33651; DSMZ No. 4560), *Microscilla aggregans* (yellow; ATCC No. 23190), *Flexibacter aurantiacus* (yellow; ATCC No. 23108; DSMZ No. 6792), *Flexibacter sancti* (yellow; ATCC No. 23092; DSMZ No. 784), *Planctomyces brasiliensis* (yellow; ATCC No. 49424; DSMZ No. 5305), *Acetomicrobium flavidum* (yellow; ATCC No. 43122; DSMZ No. 20664), *Cellulophaga lytica* (yellow, ATCC Nos. 23169 and 23178, DSMZ Nos. 7489 and 2039), *Enterobacter sakazakii* (yellow; ATCC No. 12868; DSMZ No. 4485), *Pseudomonads mendocina* (yellow; ATCC Nos. 25411 and 25413), *Vibrio fischeri* (yellow; ATCC No. 14546; DSMZ No. 507), *Vibrio logei* (yellow; ATCC Nos. 15382 and 35079), *Xanthobacter agilis* (yellow; ATCC No. 43847; DSMZ No. 3770), *Xanthobacter autotrophicus* (yellow; ATCC No. 35674; DSMZ No. 432), *Xanthobacter flavus* (yellow; ATCC No. 35867; DSMZ No. 338), *Pseudomonas alcaligenes* (yellow-orange; ATCC No. 14909; DSMZ No. 50342), *Pseudomonas mendocina* (yellow-orange; DSMZ No. 50017), *Spirochaeta aurantia* (yellow-orange; ATCC No. 25082, DSMZ No. 1902), *Cytophaga aurantiaca* (orange; ATCC No. 12208; DSMZ No. 3654), *Herpetosiphon aurantiacus* (orange; ATCC No. 23779; DSMZ No. 785), *Herpetosiphon geysericola* (orange; ATCC No. 23076; DSMZ No. 7119), *Microscilla marina* (orange; ATCC No. 23134; DSMZ No. 4236), *Microscilla sericea* (orange; ATCC Nos. 23182 and 23186), *Microscilla furvescens* (orange; ATCC No. 23129), *Flexibacter flexilis* (orange; ATCC No. 23089; DSMZ No. 6793), *Flexibacter elegans* (orange; ATCC No. 23112; DSMZ No. 3317), *Flammeovirga aprica* (orange; ATCC Nos. 23126 and 23132; DSMZ No. 3659), *Persicobacter diffluens* (orange; ATCC Nos. 23140 and 23155; DSMZ No. 3658), *Flexibacter polymorphus* (peach; ATCC No. 27820; DSMZ No. 9678), *Cytophaga latercula* (orange-red; ATCC No. 23177; DSMZ No. 2041), *Saprospira grandis* (orange-red; ATCC No. 23175; DSMZ No. 2844), *Erwinia persicinus* (red; ATCC Nos. 35998 and 700561), *Flexibacter litoralis* (red; ATCC No. 23117; DSMZ No. 6794), *Flexibacter roseolus* (red; ATCC No. 23087; DSMZ No. 9546), *Flexibacter rubber* (red; ATCC No. 23103; DSMZ No. 9560),

Spirochaeta halophila (red; ATCC No. 29478; DSMZ No. 10522), *Vibrio gazogenes* (red; ATCC Nos. 29988 and 43066), *Planctomyces maris* (red; ATCC No. 29201; DSMZ No. 8797), *Hyphomonas jannaschiana* (brown; ATCC No. 33882; DSMZ No. 5153), *Lysobacter brunescens* (yellow to brown; ATCC No. 29483; DSMZ No. 6979), *Lysobacter enzymogenes* (yellow to brown; ATCC No. 21123; DSMZ No. 2043), *Lysobacter antibioticus* (Orange or pink to brown; ATCC No. 29480; DSMZ No. 2045), *Marinilabilia agarovorans* (pink to salmon; ATCC Nos. 19041 and 19043; DSMZ No. 1449), *Azospirillum brasilense* (pink; ATCC No. 29145, DSMZ No. 1690), *Cyclobacterium marinum* (pink; ATCC No. 25205, DSMZ No. 745), *Flectobacillus major* (pink; ATCC No. 29496, DSMZ No. 103), *Methylomonas methanica* (pink; ATCC Nos. 35067 and 51626), *Acidiphilium cryptum* (Pink or white; DSMZ Nos. 2389, 2390, 2613 and 9467), *Acidiphilium organovorum* (white; ATCC No. 43141), *Acidiphilium lipoferum* (pink; ATCC No. 29707; DSMZ No. 1691), *Flexibacter canadensis* (white; ATCC No. 29591; DSMZ No. 3403), *Pedobacter heparinus* (yellow-gray; ATCC No. 13125, DSMZ No. 2366), and *Lysobacter gummosus* (yellow-gray; ATCC No. 29489; DSMZ No. 6980).

[0141] Additional examples of colored Gram-negative Eubacteria genera, with exemplary colors, include: Archangium, Chondromyces, Cystobacter, Melittangium, Myxococcus, Nannocystis, Polyangium, and Stigmatella, which may be yellow, orange, or red; as well as Chromobacterium (violet); Janthinobacterium (violet); Chromohalobacter (violet-blue to brown); Oscillatoria (blue-green, red, blackish); Pseudanabaena (blue-green, red); Spirulina (blue-green, red); Spirosoma (pale yellow); Chitinophaga (yellow); Pantoea (yellow); Variovorax (yellow); Xanthobacter (yellow); Xanthomonas (yellow); Cytophaga (yellow, orange, or red), Herpetosiphon (red, orange, or yellow); Thermus (yellow, orange, red); Flavobacterium (yellow to orange); Flexibacter (yellow to orange), Microscilla (yellow or orange); Thermonema (orange); Capnocytophaga (orange-red); Methylobacterium (pink to orange-red); Thermoleophilum (red-pink); Thermomicrobium (red-pink); Filomicrobium (red); Runella (pale pink); Haliscomenobacter (pink); Isosphaera (pink), Desulfuromonas (pink to reddish brown); Lysobacter (cream, pink, yellow-brown); Agrobacterium (light beige); Marinobacter (white to beige); Arsenophonus (gray-white); Aminobacter (white to light yellow); Halomonas (white to yellow); Rhizobacter (white to yellowish); Desulfurella (whitish); Zymomonas (white to cream); Azorhizobium (cream); Meniscus (chalky-white); and Acidomonas (white).

[0142] In certain aspects, it is contemplated that cell-based particulate material and extracted colorants from such material may be used as a fluorescent colorant. For example, the genera *Phenylobacterium* can produce a greenish fluorescent colorant.

[0143] In specific aspects, it is contemplated that cell-based particulate material and extracted colorants from such material may be used as a pH indicator colorant. Such a pH indicator colorant may be useful in monitoring a variety of metabolic, enzymatic, or chemical reactions that generate hydronium or hydroxy species. For example, the carotenoid flexirubin changes color from yellow in acid to neutral conditions to purple, red or red-brown in alkali conditions, and visa versa. It is contemplated that flexirubin, and cell-

based particulate material that comprises flexirubin, may be used as pH indicator colorant. Examples of cells that normally comprise flexirubin, and exemplary non-alkali colors, include: *Flexibacter filiformis* (golden yellow; ATCC No. 29495, DSMZ No. 527), *Cytophaga allerginae* (yellow; ATCC No. 35408), *Cytophaga arvensicola* (yellow-orange; ATCC No. 51264, DSMZ No. 3695), *Cytophaga hutchinsonii* (yellow; ATCC No. 33406, DSMZ No. 1761), *Flavobacterium hydatidis* (yellow; ATCC No. 29551, DSMZ No. 1761), *Flavobacterium johnsoniae* (yellow; ATCC Nos. 17061 and 29585, DSMZ Nos. 2064 and 425), *Flavobacterium columnare* (golden-yellow; ATCC No. 23463), *Zobellia uliginosa* (golden-yellow; ATCC No. 14397, DSMZ No. 2061), *Flavobacterium pectinovorum* (yellow; ATCC No. 19366, DSMZ No. 6368), *Flavobacterium psychrophilum* (yellow; ATCC Nos. 49418 and 49511, DSMZ No. 3660), and *Flavobacterium saccharophilum* (yellow; ATCC No. 49530, DSMZ No. 1811).

[0144] In some embodiments, a cell may be endogenously coated with a metallic compound. Such cells are contemplated for use in the present invention as a metallic pigment and/or anti-corrosion pigment. Examples of such cells include those of the genera *Pedomicrobium*, *Planctomyces* and *Metallogenium*, which are often coated with a manganese oxide, an iron oxide, or a combination thereof. For example, *Pedomicrobium americanum* (ATCC No. 43615) is typically coated with a combination of iron oxide and manganese oxide, *Pedomicrobium ferrugineum* (ATCC No. 33116 and 33119) is typically coated with an iron oxide, *Pedomicrobium manganicum* (ATCC No. 33121) and cell of the genera *Metallogenium* are typically coated with a manganese oxide. Such iron oxide and/or manganese oxide materials may confer a yellow to brown color to the cell, though cells comprising iron oxide materials are often red-brown, and cells comprising manganese oxide are often green (e.g., olive). As would be known to those of ordinary skill in the art, various cells may internalize metals (e.g., gold, silver, selenium, etc.), and may possess magnetic properties (e.g., alignment in a magnetic field), as is common in magnetotactic bacteria. An example of such an additional metal comprising cell include the magnetotactic genera *Magnetospirillum*.

[0145] Some Gram-negative Eubacteria typically grow in extreme environmental conditions. Examples of Gram-negative hyperthermophiles with exemplary temperature growth ranges include *Acetomicrobium* (58-73° C.), *Chlorobium tepidum* (55° C. to 56° C.), *Chloroflexus aurantiacus* (20-66° C.; ATCC Nos. 29365 and 29366; DSMZ Nos. 635, 636, 637 and 638), *Desulfurella* (52-57° C.), *Dichotomicrobium* (35-55° C.), *Fervidobacterium* (40-80° C.), *Flexibacter* (18-47° C.), *Isosphaera* (35-55° C.), *Methylococcus* (30-50° C.), *Microscilla* (30-45° C.), *Oscillatoria* (56-60° C.), *Thermodesulfobacterium* (65-70° C.), *Thermoleophilum* (45-70° C.), *Thermomicrobium* (45-80° C.), *Thermomonema* (60-70° C.), *Thermosiphon* (33-77° C.), *Thermotoga* (55-90° C.), *Thermus* (70-75° C.), and *Thiobacillus aquaesulis* (40-50° C.). Examples of Gram-negative extreme halophiles with exemplary NaCl growth ranges include *Halobacteroides* (1.44-2.4 M), *Halomonas* (0.09-3.42 M) and *Marinobacter* (0.08-3.5 M). Examples of Gram-negative extreme alkaliphile and/or extreme acidophile genera with exemplary pH growth ranges include *Acetobacter* (pH 5.4-6.3), *Acidomonas* (pH 2.0-5.5), *Acidiphilium* (pH 2.5-5.9), *Arthrosira* (pH 11.0), *Beijerinckia* (pH 3.0-10.0),

Chitinophaga (pH 4.0-10.0), *Derxia* (pH 5.5-9.0), *Ectothiorhodospira* (pH 7.6-9.5), *Frateruia* (H 3.6), *Gluconobacter* (pH 5.5-6.0), *Herbaspirillum* (pH 5.3-8.0), *Leptospirillum* (pH 1.5-4.0), *Morococcus* (pH 5.5-9.0), *Rhodopila* (pH 4.8-5.0), *Rhodobaca bogoriensis* (pH range 7.5-10; ATCC No. 700920), *Thermoleophilum* (pH 5.8-8.0), *Thermomicrobium* (pH 7.5-8.7), *Thiobacillus* (pH 2.0-8.0), and *Xanthobacter* (pH 5.8-9.0).

[0146] b. Eukaryotic Organisms

[0147] Eukaryotic organisms are generally classified in the Kingdom Animalia ("animals"), the Kingdom Fungi ("fungi"), the Kingdom Plantae ("plants") or the Kingdom Protista ("protists"). Eukaryotic cells are generally of larger cellular size than prokaryotes, with numerous examples of cells and cell sizes described herein. In the practice of the present invention, unicellular and oligocellular eukaryotic organisms are preferred, as it is contemplated that the number of processing steps, and hence cost, will be less. Such eukaryotic cells and organisms are often classified in the Kingdom Protista, though certain fungi are also unicellular and oligocellular fungi are contemplated, and are described herein. Eukaryotic cells and organisms that possess a cell wall or other durable biomolecule material are contemplated, and such cells are usually classified in the Kingdom Protista, the Kingdom Plantae, and the Kingdom Fungi. Eukaryotic cells and organisms that lack a durable cell wall (e.g., the Kingdom Animalia) may be used as a coating or other surface treatment component, but are less preferred for use a cell-based particulate material in the present invention. Examples of preferred eukaryotic cells and organisms for use as a cell-based particulate material of the present invention are described below.

(1) Fungi

[0148] Organisms of the eukaryotic Fungi Kingdom include organisms commonly referred to as molds, morels, mushrooms, puffballs, rusts, smuts, truffles, and yeasts. A fungal organism typically comprises multicellular filaments that grow into a food supply (e.g., carbon based polymers), but may become unicellular spores in nutrient poor conditions. In the practice of the present invention, fungi microorganisms (e.g., filamentous fungi, yeasts) that are unicellular or oligocellular, including those that are unicellular or oligocellular during a stage in the lifecycle (e.g., spores), are preferred. Yeasts are a preferred type of fungi, as they generally live or have a stage of life that is typically unicellular in nature. It is contemplated that culturing such unicellular or oligocellular fungi, and/or producing the cell-based particulate material of the present invention from such fungi, will entail less steps, be more amenable to large scale production, be more economical, or a combination thereof, relative to culturing and processing cell-based particulate material from a multicellular fungi.

[0149] Fungi cell wall components typically include beta-1,4-linked homopolymers of N-acetylglucosamine ("chitin") and a glucan. The glucan is usually an alpha-glucan, such as a polymer comprising an alpha-1,3- and alpha-1,6-linkage (Griffin, 1993). Some Ascomycota species (Ophiostomataceae) comprise cell walls made of cellulose. Certain species of Chytridiomycota (e.g., Coelomomyces) do not possess cell walls, and are less preferred (Alexopoulos et al., 1996).

[0150] Examples of yeast cell's size and shapes are shown at Table 7 below.

TABLE 7

Examples of Yeast Cell's Size and Shape			
Genus	Size	Shape	Number
Aciculoconidium	3.5–8.5 μm \times 4.0–15.0 μm	O, Ep	S, OC, OL
Agaricostilbum	4.0–10.0 μm \times 2.0–4.0 μm	Ep, Fu	S
Ambrosiozyma	2.0–9.0 μm \times 4.0–14.0 μm	Sp, O, Ep	S, P, OC, OL
Arxiozyma	2.9–6.0 μm \times 4.5–7.5 μm	Sp, Ep	S, P, OC
Arxula	2.2–3.6 μm \times 2.4–5.6 μm	O	S
Ascoidea	2.5–4.0 μm \times 3.5–5.5 μm	Gl	S, OL
Babjevia	4.5–7.0 μm \times 5.3–9.0 μm	Sp, O	S
Bensingtonia	6.0–30.0 μm \times 2.0–7.0 μm	O, Ep, Gl, Fu, Cy	S, OC
Blastobotrys	2.5–3.5 μm	O	OL
Botryozyma	8.0–22.5 μm \times 2.0–5.5 μm	Cy	P, OC
Bullera	4.0–35.0 μm \times 2.0–12.0 μm	Ep, O, Cy, Le, Fu	S
Bulleromyces	5.0–11.0 μm \times 3.0–6.0 μm	Ep, O, Gl	S
Candida	1.0–7.0 μm \times 1.5–23.0 μm	El, Gl, O, Sp, Cy, Lu	S, P, OC, OL
Cephalascus	1.5–2.5 μm \times 3.0–5.0 μm	Ep	OC, OL
Chionosphaera	1.5–3.0 μm \times 3.0–6.0 μm	Ep	S, P
Citeromyces	3.0–9.5 μm \times 4.0–10.5 μm	Sp, O	S, P, T
Clavispora	2.0–6.0 μm \times 3.0–16.0 μm	O	S, P, OC
Cryptococcus	1.1–15.0 μm \times 4.0–10.1 μm	Gl, Ep, O, Sp, Le	S, P, OC, OL
Cystofilobasidium	1.0–5.0 μm \times 2.0–14.0 μm	Gl, O, Ep	S, P, OC
Debaryomyces	1.4–8.5 μm \times 2.0–20.0 μm	Sp, El, Ep, Cy	S, P, OL, OC
Dekkera	2.0–7.0 μm \times 3.0–28.0 μm	Sp, O, Ep, Cy	S, P, OL, OC
Dipodascopsis	1.0 μm \times 1.5–2.0 μm	Ep	S, OL
Dipodascus	3.0–4.5 μm \times 3.8–6.0 μm	Ep	S, OL
Endomyces	3.5–4.0 μm \times 4.0–5.5 μm	Gl	S, OL
Eremothecium	1.7–13.9 μm \times 4.2–14.0 μm	Ov, Gl	S, P, OL
Erythrobasidium	3.8–5.8 μm \times 6.3–10.5 μm	O	S, P
Fellomyces	1.0–8.0 μm \times 2.0–11.0 μm	Sp, O, Ep, Ap, Gl	S, O
Filobasidiella	3.0–8.0 μm \times 3.0–5.0 μm	Gl, O	S, OL
Filobasidium	3.0–10.7 μm \times 3.0–17.8 μm	O, Ep, Sp	S, P, OL
Galactomyces	7.0–12.0 μm \times 6.0–9.0 μm	Sp	S, OL
Geotrichum	5.0–7.0 μm \times 7.0–9.0 μm	El	OL
Hanseniaspora	1.5–7.5 μm \times 2.5–18.2 μm	O, Sp	S, P
Hyalodendron	1.5–3.0 μm \times 5.0–15.0 μm	Cy	OL
Issatchenkia	1.3–6.0 μm \times 3.0–14.7 μm	O	S, P
Itersonilia	9.0–40.0 μm \times 3.0–11.0 μm	Cy, El, Fu	OL
Kloeckera	2.0–4.5 μm \times 4.0–9.5 μm	Ap, O, El	S, P
Kluyveromyces	1.0–9.0 μm \times 2.0–11.0 μm	Gl, Ep, O, Cy, Sp	S, P, OL, OC
Kockovaella	1.5–5.9 μm \times 4.0–10.0 μm	Sp, O	OL, OC
Kurtzmanomyces	2.0–7.0 μm \times 4.0–8.0 μm	Sp, O	S
Leucosporidium	1.0–7.0 μm \times 3.0–16.0 μm	O	S, P, OC
Lipomyces	3.2–8.0 μm \times 4.0–12.0 μm	Gl, Ep	s, p
Lodderomyces	2.6–6.3 μm \times 4.0–7.4 μm	Sp, Ep	S, P, OL
Malassezia	1.5–7.5 μm \times 2.0–8.0 μm	O, Ep	S, P, OL
Metschnikowia	2.0–11.0 μm \times 3.0–27.5 μm	O, Ep, Sp, Gl, Cy	S, P, OL, OC
Moniliella	3.0–6.0 μm \times 6.0–19.0 μm	El	OL
Mrakia	2.6–8.0 μm \times 3.0–14.0 μm	O	S, P
Myxozyma	1.9–6.9 μm \times 2.1–6.9 μm	Sp, O, Ep	S, P, OL
Nadsonia	4.2–8.0 μm \times 5.6–16.0 μm	O, Ap, Ep	S, P, OC
Oosporidium	5.0–12.0 μm \times 6.0–12.5 μm	Gl, O, El	OL
Pachysolen	1.5–5.0 μm \times 2.0–7.0 μm	Sp, Ep	S, P
Phaffia	3.5–10.0 μm \times 5.0–13.5 μm	Sp, O	S, P, OC
Pichia	1.0–8.0 μm \times 1.0–25.0 μm	Sp, Ep, O, Sp, Cy	S, P, OC, OL
Protomyces	2.0–5.0 μm \times 2.5–10.0 μm	Ep	S, P, OC
Pseudozyma	5.0–35.0 μm \times 1.5–3.0 μm	Fu, Cy	OL
Reniforma	3.0–6.0 μm \times 2.3–5.0 μm	Ki	S, P, OC
Rhodospiridium	1.0–8.0 μm \times 2.0–20.1 μm	Sp, O, R, Ep	S, P, OC
Rhodotorula	1.0–8.0 μm \times 1.5–24.0 μm	Ep, O, Cy, Gl	S, P, OL, OC
Saccharomycopsis	1.9–11.1 μm \times 3.0–25.0 μm	Sp, Ep, O	S, P
Saccharomyces	2.2–8.0 μm \times 3.0–13.5 μm	Gl, O, Ep, Cy	S, P, OL
Saccharomycodes	4.0–7.0 μm \times 8.0–23.0 μm	Le	S, P, T
Saitoella	2.5–8.0 μm \times 3.0–14.0 μm	O, Ep	S
Saturnispora	2.3–7.0 μm \times 2.5–12.0 μm	Sp, El, O	S, P
Schizoblastosporion	2.5–6.8 μm \times 4.5–20.0 μm	Ep, Cy	S, P
Schizosaccharomyces	3.0–9.0 μm \times 5.0–24.0 μm	Gl, Ep, Cy	S, P, OL
Sporidiobolus	2.0–9.0 μm \times 3.0–27.0 μm	O, E, Sp, Cy	S, P, OL, OC
Sporobolomyces	3.5–25.0 μm \times 4.0–6.5 μm	Ep, Cy, Fu, O	S, OC
Sporopachydermia	2.0–4.0 μm \times 4.0–14.0 μm	Ep	S, P, OL
Stephanosascus	3.0–5.0 μm \times 5.0–8.0 μm	Gl	S, OL, ML

TABLE 7-continued

<u>Examples of Yeast Cell's Size and Shape</u>			
Genus	Size	Shape	Number
Sterigmatomyces	2.0–7.0 $\mu\text{m} \times 3.0\text{--}11.0 \mu\text{m}$	Sp, O	OC
Sterigmatosporidium	1.1–3.7 $\mu\text{m} \times 1.6\text{--}10.1 \mu\text{m}$	O, Cy, Ep	S
Sympodiomyces	1.0–1.3 $\mu\text{m} \times 1.3\text{--}3.4 \mu\text{m}$	O	S
Sympodiomycesopsis	4.0–11.0 $\mu\text{m} \times 2.0\text{--}6.0 \mu\text{m}$	O, Ep	S, P, OC
Tilletiaria	6.0–20.0 $\mu\text{m} \times 5.0\text{--}8.0 \mu\text{m}$	Gl, El	OCL
Tilletiopsis	5.0–20.0 $\mu\text{m} \times 3.0\text{--}7.0 \mu\text{m}$	Fu, Cy, El	OL
Torulasporea	2.1–6.6 $\mu\text{m} \times 3.0\text{--}6.6 \mu\text{m}$	Sp, Ep	S, P
Trichosporon	3.0–4.0 $\mu\text{m} \times 4.0\text{--}15.0 \mu\text{m}$	Fu, Cy	OL
Trichosporonoides	2.0–6.5 $\mu\text{m} \times 4.0\text{--}8.0 \mu\text{m}$	O	S, OC
Trigonopsis	3.5–6.0 $\mu\text{m} \times 2.0\text{--}6.0 \mu\text{m}$	Ep, Tr	S, P
Tsuchiyaea	4.0–14.0 $\mu\text{m} \times 3.0\text{--}9.0 \mu\text{m}$	Gl, Ep	S, P, OC
Wickerhamia	4.0–7.0 $\mu\text{m} \times 8.0\text{--}22.0 \mu\text{m}$	O, Ap	S, P, T
Wickerhamiella	1.2–3.5 $\mu\text{m} \times 1.4\text{--}3.5 \mu\text{m}$	Sp, Ep	S, P, OL
Williopsis	2.4–6.5 $\mu\text{m} \times 3.0\text{--}8.5 \mu\text{m}$	Sp, Ep	S, P, OL
Xanthophyllomyces	3.5–10.0 $\mu\text{m} \times 5.0\text{--}13.5 \mu\text{m}$	Sp, O	S, P, OC
Yarrowia	3.0–5.0 $\mu\text{m} \times 3.3\text{--}15.0 \mu\text{m}$	Sp, El	S, P, OL
Zygoascus	2.0–5.0 $\mu\text{m} \times 4.5\text{--}15.5 \mu\text{m}$	O	S, OL
Zygosaccharomyces	1.8–7.8 $\mu\text{m} \times 2.1\text{--}11.8 \mu\text{m}$	Sp, Ep, Cy, O	S, P, OL
Zygozoma	3.0–7.0 $\mu\text{m} \times 2.0\text{--}6.0 \mu\text{m}$	Gl, Ep	S, P

Shape: Ap = apiculate; R = rod; O = ovoid, oval; Sp = spherical; Gl = globose; Cy = cylindrical; Ep = ellipsoidal; El = elongate; Fu = fusiform; Ki = kidney-shape; Le = lemon-shape; Lu = lunate; Og = ogiva; Tr = triangle.
 Number: S = unicellular; P = cell pairs; T = triad of cells; OC = oligocellular cluster; OL = oligocellular linear.

[0151] Examples of biological culture collection sources for yeasts are shown at Table 8 below.

TABLE 8

<u>Examples of Yeast Culture Sources</u>	
Genus	Examples of Culture Collection Strains
Aciculoconidium	ATCC No. 15540; DSMZ No. 3426; IHEM No. 5757
Agaricostilbum	VKM No. Y-2684
Ambrosiozyma	ATCC Nos. 14627 and 24611; MUCL No. 31903
Arxiozyma	ATCC No. 13603; MUCL No. 31148
Arxula	ATCC Nos. 60136 and 76597; MUCL No. 31910
Ascoidea	ATCC Nos. 16142, 22790, 22852 and 24275
Babjevia	ATCC No. 32435
Bensingtonia	ATCC No. 20919; MUCL Nos. 34517, 34516 and 34518
Blastobotrys	ATCC Nos. 18420, 34215, 34216, 36955 and 42712
Botryozoma	ATCC No. 90048
Bullera	ATCC Nos. 52901, 52901 and 24608
Bulleromyces	ATCC No. 18568; DSMZ No. 10637; MUCL No. 27709
Candida	ATCC Nos. 18805, 22939, 12573, 22983 and 10674
Cephaloascus	ATCC Nos. 12091 and 66658; IHEM No. 3810
Chionosphaera	ATCC No. 52639
Citeromyces	ATCC No. 14080; DSMZ No. 70187; IHEM No. 5815
Clavispora	ATCC Nos. 201083 and 42172; IHEM No. 3979
Cryptococcus	ATCC Nos. 76863, 56686, 64839, 22025 and 36649
Cystofilobasidium	ATCC Nos. 24496, 24500, 16182 and 96307
Debaryomyces	ATCC Nos. 10619, 18106, 20322, 24214 and 66545
Dekkera	ATCC Nos. 10559, 10563, 201304, 22341 and 24195
Dipodascopsis	ATCC Nos. 76902, 76904, 32251 and 7445
Dipodascus	ATCC Nos. 10678, 11647, 12934, 200547 and 22540
Endomyces	DSMZ No. 70554; IHEM No. 4861
Eremothecium	MUCL Nos. 27806 and 31252
Erythrobasidium	ATCC No. 9536; DSMZ No. 7505
Fellomyces	ATCC Nos. 32128, 32821 and 32822
Filobasidiella	ATCC Nos. 10226, 36983, 64866, 24066 and 28958
Filobasidium	ATCC Nos. 22179, 22367 and 24227
Galactomyces	ATCC Nos. 66100 and 66101; IHEM Nos. 5249 and 5248
Geotrichum	ATCC Nos. 10675, 10834, 11247, 18019 and 200558
Hanseniaspora	ATCC Nos. 10630, 10631, 18859 and 204303
Hyalodendron	ATCC Nos. 16172 and 66689
Issatchenkia	ATCC Nos. 201080, 20380, 22306 and 24184

TABLE 8-continued

<u>Examples of Yeast Culture Sources</u>	
Genus	Examples of Culture Collection Strains
Itersonilia	ATCC Nos. 15495 and 36403
Kloeckera	ATCC Nos. 10632, 10634, 10635, 58370 and 10636
Kluyveromyces	ATCC Nos. 10022, 18862, 34711, 200793 and 200968
Kockovaella	ATCC No. 204345; MUCL Nos. 38916 and 38917
Kurtzmanomyces	ATCC Nos. 32127 and 76287; MUCL Nos. 38920 and 38921
Leucosporidium	ATCC Nos. 22177 and 10572; MUCL No. 28629
Lipomyces	ATCC Nos. 12659 and 32372; IHEM No. 5759
Lodderomyces	ATCC No. 11503; DSMZ No. 70320; IHEM No. 5820
Malassezia	ATCC Nos. 14522, 42132 and 44338
Metschnikowia	ATCC Nos. 10570, 22033, 22301, 42520 and 90300
Moniliella	ATCC Nos. 18455 and 18456
Mrakia	ATCC No. 22029; DSMZ No. 4634; MUCL No. 30337
Myxozyma	ATCC Nos. 52275, 76214, 52276, 90526 and 76358
Nadsonia	ATCC Nos. 10644 and 58437; MUCL No. 31251
Oosporidium	ATCC Nos. 10676 and 64138; DSMZ No. 70351
Pachysolen	ATCC No. 32691; DSMZ No. 70352; IHEM No. 5813
Phaffia	MUCL No. 31142; IHEM No. 5758
Pichia	ATCC Nos. 36079, 28319, 24238, 46071 and 36905
Protomyces	ATCC Nos. 16175, 22666, 56196, 64066 and 90575
Pseudozyma	ATCC Nos. 32189, 32657, 64961, 34888 and 64962
Reniforma	ATCC No. 66374
Rhodospiridium	ATCC Nos. 90942, 66477, 90175, 201850 and 10657
Rhodotorula	ATCC Nos. 28266, 18818, 52902, 14023 and 28322
Saccaromycopsis	DSMZ Nos. 70560
Saccharomyces	ATCC Nos. 10601, 10274, 58439, 200343 and 48553
Saccharomycodes	ATCC No. 11313; DSMZ No. 3437; MUCL No. 27836
Saitoella	JCM No. 7358
Saturnispora	JCM Nos. 10726, 1795, 1793 and 1515
Schizoblastosporion	ATCC No. 24615; DSMZ No. 70569; IHEM No. 5819
Schizosaccharomyces	ATCC Nos. 10660 and 14548; MUCL No. 27840
Sporidiobolus	ATCC Nos. 16039, 11386, 18159 and 16406
Sporobolomyces	ATCC Nos. 52908, 24258, MYA-595, 16406 and 18802
Sporopachydermia	ATCC Nos. 22026, 26895 and 56629
Stephanosascus	ATCC Nos. 22873, 64874, 64875, 90780 and 96582
Sterigmatomyces	ATCC Nos. 18893 and 24056; IHEM No. 1083
Sterigmatosporidium	ATCC No. 60340; MUCL No. 31914
Sympodiomyces	ATCC No. 22869; MUCL No. 31913
Sympodiomycopsis	ATCC No. 201321
Taphrina	MUCL Nos. 39262, 39267, 42983, 30956 and 39263
Tilletiaria	ATCC No. 24038
Tilletiopsis	ATCC Nos. 10764, 24343, 24344, 24345 and 36489
Torulasporea	ATCC Nos. 10662 and 18975; IHEM No. 2393
Trichosporon	ATCC Nos. 10266, 10677, 18020, 201110 and 201112
Trichosporonoides	ATCC Nos. 16958 and 76718; MUCL No. 10190
Trigonopsis	ATCC No. 10679; DSMZ No. 70714; MUCL No. 27875
Tsuchiyaea	JCM No. 7368; MUCL No. 34524
Wickerhamia	ATCC No. 20148; DSMZ No. 70715; IHEM No. 5822
Wickerhamiella	ATCC No. 24012; IHEM No. 4439; MUCL No. 31279
Williopsis	ATCC Nos. 10680, 10743 and 22541
Xanthophyllomyces	ATCC No. 24201; DSMZ No. 5626; MUCL No. 31142
Yarrowia	ATCC No. 16617; DSMZ No. 1345; MUCL No. 11523
Zygoascus	ATCC Nos. 18822 and 60200; MUCL Nos. 14475 and 42923
Zygosaccharomyces	ATCC Nos. 10383, 11003, 36238, 200584 and 36242
Zygozoma	ATCC Nos. 66546 and 76359

[0152] Yeasts are often white or near white, light colored or neutral colored (e.g., white, light yellow, pink, gray, brown, tan, etc.). Specific examples of colored yeast species, with exemplary colors, include: *Pichia alni* (cream white; ATCC Nos. 36594 and 36596), *Pichia ciferii* (white; DSMZ No. 70780), *Pichia fluxuum* (yellowish-white; ATCC Nos. 24239 and 60370), *Protomyces gravidus* (pink; ATCC No. 64066), *Protomyces inouyei* (tannish-orange; ATCC No. 16175), *Arxiozyma telluris* (tannish-white; ATCC Nos. 22953 and 24107), *Debaryomyces carsonii* (tannish-white; ATCC Nos. 16050 and 90022), *Debaryomyces* etc. *hellsii* (white; ATCC Nos. 10620 and 20126), *Debaryomyces robertsiae* (tannish-white; ATCC No. 22312, DSMZ No.

70870), *Issatchenkia occidentalis* (cream; ATCC Nos. 22686 and 58065), *Issatchenkia orientalis* (cream; ATCC No. 20380 and 204290), *Issatchenkia scutulata* (tannish-white; ATCC Nos. 24186 and 58067), *Issatchenkia terricola* (tannish-cream; ATCC Nos. 22306 and 58069), *Kluyveromyces aestuarii* (white to ochre; ATCC No. 18862), *Kluyveromyces africanus* (white to cream; ATCC No. 22294, DSMZ No. 70290), *Kluyveromyces bacillisporus* (white; ATCC Nos. 200960 and 90019), *Kluyveromyces blattae* (cream to white; ATCC No. 34711), *Kluyveromyces delphensis* (cream; ATCC No. 24205), *Kluyveromyces dobzhanskii* (cream to pink; ATCC No. 24175), *Kluyveromyces lactis* (cream to pink; ATCC Nos. 12425 and 200795),

Kluyveromyces lodderae (cream; ATCC Nos. 200793 and 24206), *Kluyveromyces marxianus* (cream to brown; ATCC Nos. 10606 and 16045), *Kluyveromyces polysporus* (cream to brown; ATCC No. 22028, DSMZ No. 70294), *Kluyveromyces thermotolerans* (cream; ATCC Nos. 20309 and 28913), *Kluyveromyces waltii* (cream; ATCC No. 56500), *Kluyveromyces wickerhamii* (cream, pink, brown; ATCC Nos. 200968 and 24178), *Kluyveromyces yarrowii* (cream; ATCC Nos. 200791 and 36591), *Lodderomyces elongisporus* (tannish-white; ATCC Nos. 11503 and 22688), *Pachysolen tannophilus* (tannish-white; ATCC Nos. 32691 and 60396), *Williopsis californica* (gray white; DSMZ Nos. 3455 and 70267), *Williopsis mucosa* (tannish-white; ATCC No. 22541), *Bullera armeniaca* (pink to orange; ATCC Nos. 52900 and 52901), *Bullera dendrophila* (cream to gray-brown; ATCC No. 24608, DSMZ No. 70745), *Bullera pseudoalba* (brownish-yellow; MUCL No. 29434), *Sporobolomyces gracilis* (pink to red; ATCC No. 24258), *Sporobolomyces griseoflavus* (yellowish cream to cream to grayish-white; MUCL No. 34514), *Sporobolomyces falcatus* (yellowish cream to cream to grayish-white; ATCC No. 64693), and *Sporobolomyces kluyveri-nielii* (brownish-orange to pinkish-orange, MUCL No. 34523). Additional examples of colored yeast genera, with exemplary colors, include: *Saccaromycopsis* (tannish white), *Saturnispora* (tannish white), *Sporopachydermia* (white to cream), *Torulaspora* (tannish white), *Wickerhamiella* (tannish-white), *Yarrowia* (tannish-white), *Zygosaccharomyces* (tannish-white), *Myxozyma* (tannish-white), *Agaricostilbum* (yellowish cream), *Bulleromyces* (brownish-cream), *Chionosphaera* (cream), *Filobasidium* (gray-white or cream), *Bensingtonia* (grayish cream), *Malassezia* (cream to yellowish), *Cephaloscyus* (cream-white), *Citeromyces* (white), and *Clavispora* (white to cream).

(2) Protista

[0153] Organisms of the Kingdom Protista ("protists") are a heterogeneous set of eukaryotic unicellular, oligocellular and/or multicellular organisms that have not been classified as belonging to the other eukaryotic Kingdoms, though they typically may have features related to the Plant Kingdom (e.g., algae, which are photosynthetic), the Fungi Kingdom (e.g., Oomycota) and/or the Animal Kingdom (e.g., protozoa). Organisms of certain Phyla ("divisions"), particularly those organisms commonly known as "algae," comprise a cell wall, silica based shell or exoskeleton (e.g., a test, a frustule), or other durable material at the cell-external environment interface, and are preferred for use in preparing a cell-based particulate material of the present invention. It is contemplated that most protists cell sizes (e.g., $1.5 \mu\text{m} \times 10.0 \mu\text{m}$) and shapes will be similar to those described for other eukaryotic cells described herein (e.g., fungi). Examples of protists with durable cellular material that are preferred for use in the present invention include those of the Phyla Chlorophyta, Chrysophyta, Bacillariophyta, Euglenophyta, Ciliophora, Oomycota, Pyrrophyta, Rhodophyta, or Xanthophyta (Graham, L. E. and Wilcox, L. W. "Algae," Prentice-Hall, Inc. Upper Saddle River, N.J., U.S.A., 2000).

[0154] Diatoms are unicellular algae that possess a cell wall comprising silicon. Fossilized diatoms are a major component of diatomaceous earth, which is often used as an extender. However, the present invention relates to living or recently living cells (e.g., alive within the past 20 years), as opposed to mineralized fossils. Such fossils typically com-

prise little or no biomolecules from the organism, as processes such as biodegradation, oxidation with the earth's atmosphere, etc., have long since destroyed such molecules. For example, a diatom's frustule is an exoskeleton comprising organic material and silica, and the organic material of such frustule will be removed by time and fossilization. Examples of diatoms include organisms of the phyla Chrysophyta and Bacillariophyta. Chrysophyta ("golden algae," "golden-brown algae") are freshwater diatoms. Chrysophyta generally comprise chlorophyll a and chlorophyll c, as well as a carotenoid and/or a xanthophyll, and are often yellow-brown in color. Genera of Chrysophyta include Chlorobotrys, Chromulina, Chrysamoeba, Chrysocapsa, Dinobryon, Eustigmatos, Heterosigma, Mallomonas, Monodopsis, Nannochloropsis, Ochromonas, Paraphysomonas, Pleurochloris, Polyedriella, Pseudocharaciopsis, Rhizochromulina, Synura, Thaumatomastix, and Vischeria. Bacillariophyta are marine diatoms, and these cells typically comprise chlorophyll a and chlorophyll c and fucoxanthin. Genera of Bacillariophyta include Achnanthes, Asterionella, Chaetoceros, Cocconeis, Cyclotella, Fragilaria, Melosira, Navicula, Nitzschia, Skeletonema, Stauroneis, Stephanodiscus, Synedra and Thalassiosira.

[0155] Xanthophyta ("yellow-green algae") typically comprise chlorophyll c. Xanthophyta are typically yellowish-green in color. Examples of Xanthophyta genera include Botrydiopsis, Botrydium, Botryococcus, Chloridella, Mischococcus, Ophiocytium, Tribonema and Vaucheria.

[0156] Euglenophyta ("euglenoids") generally are unicellular and comprise a pellicle, which is an outer membrane reinforced by proteins, rather than a cell wall. The Euglenophyta typically comprise chlorophyll a and chlorophyll b and a carotene. Genera of Euglenophyta include Astasia, Colacium, Cryptoglena, Distigma, Entosiphon, Euglena, Gyropaigne, Khawkingia, Menoidium, Parmidium, Peranema, Petalomonas, Phacus, Ploetia, Rhabdomonas, Rhynchopus, Scytomonas and Trachelomonas.

[0157] Chlorophyta ("green algae") typically are unicellular to oligocellular clusters, and comprise a cell wall that comprises cellulose. The Chlorophyta typically comprise chlorophyll a and chlorophyll b and a carotene or a xanthophyll, and are often green in color. Genera of Chlorophyta include Volvox, Chlorella, Pleurococcus, Spirogyra, Chlamydomonas, Gonium, Mantoniella, Nephroselmis, Pyramimonas, Tetraselmis, Ulothrix, Enteromorpha, Cephaleuros, Cladophora, Pithophora, Rhizoclonium, Derbesia, Acetabularia, Chlorella, Microthamnion, Prototheca, Stichococcus, Trebouxia, Ankistrodesmus, Bracteacoccus, Bulbochaete, Chaetophora, Characiosiphon, Chlamydomonas, Chlorococcum, Coelastrum, Dictyosphaerium, Draparnaldia, Dunaliella, Dysmorphococcus, Eudorina, Fritschella, Gonium, Haematococcus, Hydrodictyon, Oedogonium, Microspora, Pandorina, Pediastrum, Pleodorina, Scenedesmus, Selenastrum, Sphaerocystis, Stephanosphaera, Stigeoclonium, Tetracystis, Tetradron, Trentepohlia, Uronema, Volvox, Closterium, Cosmarium, Cylindrocystis, Hyalotheca, Mesotaenium, Micrasterias, Mougeotia, Pleurotaenium, Spirogyra, Spondylosium, Staurastrum, Xanthidium and Zygnema.

[0158] Rhodophyta ("red algae") are generally multicellular and comprise a cell wall comprising a sulfated polysaccharide, such as, for example, agar, carrageenan, cellulose,

or a combination thereof. Rhodophyta generally comprise chlorophyll a and are typically red due to the presence of the phycobilin phycoerythrin, though others may be blue-green. Examples of Rhodophyta genera that are unicellular include Chroodactylon, Flintella, Porphyridium, Rhodella and Rhodorus.

[0159] Pyrrophyta (“fire algae,” “dinoflagellate”) are unicellular marine organisms that possess a cell wall comprising cellulose. Pyrrophyta typically comprise chlorophyll a and chlorophyll c and fucoxanthin. Pyrrophyta are typically red, and comprise dinoflagellate genera such as Amphidinium, Ceratium, Gonyaulax, Gymnodinium, Oxyrrhis, Peridinium, and Prorocentrum.

[0160] Ciliophora (“ciliates”) are generally unicellular and comprise a pellicle. Ciliophora are not photosynthetic, and thus not particularly colored (e.g., translucent to whitish). Examples of Ciliophora genera include Anophryoides, Blepharisma, Caenomorpha, Cohnilembus, Coleps, Colpidium,

Colpoda, Cyclidium, Dexiostoma, Didinium, Euplotes, Glaucoma, Mesanophrys, Metopus, Opisthonecta, Paramecium, Paranophrys, Plagiopyla, Platyophrya, Pseudocohnilembus, Spathidium, Spirostomum, Stentor, Tetrahymena, Trimyema, Uronema and Vorticella.

[0161] Oomycota (“oomycetes,” “water molds”) are fungi-like organisms, and are often listed in the fungal sections of biological culture collections. Oomycota are typically unicellular but differ from fungi by possessing a cell wall that comprises cellulose and/or glycan. Oomycota are not photosynthetic, and thus typically not particularly colored (e.g., whitish). Examples of Oomycota genera include Aphanomyces, Brevilegnia, Dictyuchus, Halophytophthora, Lagenidium, Leptolegnia, Peronophythora, Plasmopara, Plectospora, Pythiopsis, Pythium, Saprolegnia and Thraustotheca.

[0162] Examples of biological culture collection sources for Protista are shown at Table 9 below.

TABLE 9

Examples of Protista Culture Sources	
Genus	Examples of Culture Collection Strains
Acetabularia	CCAP No. 702/3
Achnanthes	CCAP No. 1095/1
Amphidinium	CCAP Nos. 1102/1, 1102/2, 1102/7, 1102/3 and 1102/6
Ankistrodesmus	CCAP Nos. 202/11A, 202/2, 202/25, 202/7A and 202/10B
Anophryoides	ATCC Nos. 50204, 50205 and 50279
Aphanomyces	ATCC Nos. 18709, 18713, 204464, 46688 and 46690
Astasia	CCAP Nos. 1204/21, 1204/19, 1204/17J, 1204/8B and 1204/1
Asterionella	CCAP Nos. 1005/5, 1005/8, 1005/9, 1005/12 and 1005/14
Blepharisma	ATCC Nos. 30299; CCAP Nos. 1607/1 and 1607/4
Botrydiopsis	CCAP Nos. 222/1B, 806/2, 806/4 and 806/3
Botrydium	CCAP Nos. 805/1, 805/2, 805/3A, 805/4 and 805/5
Botryococcus	CCAP Nos. 807/1 and 807/2
Bracteacoccus	CCAP Nos. 221/2, 221/3, 221/8, 221/9 and 221/4
Brevilegnia	ATCC No. 11270
Bulbochaete	CCAP No. 555/1
Caenomorpha	CCAP Nos. 1609/1 and 1609/2
Cephaleuros	ATCC Nos. 30913, 30914 and 30915
Ceratium	CCAP Nos. 1110/5 and 1110/4
Chaetoceros	CCAP Nos. 1010/11, 1010/6, 1010/9, 1010/3 and 1085/3
Chaetophora	CCAP Nos. 413/1 and 413/2
Characiosiphon	CCAP Nos. 208/1 and 208/2
Chlamydomonas	ATCC Nos. 12235, 18302, 30401, 30418 and 30423
Chlorella	ATCC Nos. 11466, 11468, 13482, 22521 and 30406
Chloridella	CCAP Nos. 813/2, 813/1 and 813/3
Chlorobotrys	CCAP No. 810/1
Chlorococcum	CCAP Nos. 213/5, 213/11, 213/6, 213/2A and 213/7
Chromulina	CCAP Nos. 909/9, 909/1 and 909/3
Chroodactylon	CCAP Nos. 1364/1 and 1364/2
Chrysamoeba	CCAP No. 921/1
Chrysocapsa	CCAP No. 919/1
Cladophora	CCAP Nos. 505/10, 505/1B, 505/6, 505/9 and 505/11
Closterium	CCAP Nos. 611/7, 611/6, 611/9 and 1017/3
Cocconeis	ATCC No. 50220
Coelastrum	CCAP Nos. 217/1A, 217/4, 217/6, 217/2 and 217/3
Cohnilembus	CCAP No. 1610/1
Colacium	CCAP No. 1211/3
Coleps	CCAP Nos. 1613/1 and 1613/2
Colpidium	CCAP Nos. 1614/1, 1614/3 and 1614/2
Colpoda	ATCC Nos. 30916, 30918, 30919, 30920 and 50128
Cosmarium	CCAP Nos. 612/17, 612/16, 612/7, 612/13 and 612/14B
Cryptoglena	CCAP No. 1212/1
Cyclidium	ATCC No. 30701; CCAP No. 1616/1
Cyclotella	CCAP Nos. 1070/2, 1070/6, 1070/5 and 1070/3
Cylindrocystis	CCAP Nos. 615/1A and 615/3
Derbesia	CCAP No. 706/1
Dexiostoma	ATCC No. 50414
Dictyosphaerium	CCAP Nos. 222/1C, 222/3, 222/1A, 222/2D and 222/4

TABLE 9-continued

<u>Examples of Protista Culture Sources</u>	
Genus	Examples of Culture Collection Strains
Dictyuchus	ATCC Nos. 34931 and 44890
Didinium	ATCC Nos. 30399 and 30599
Dinobryon	CCAP Nos. 917/1 and 917/2
Distigma	CCAP Nos. 1216/1, 1216/2, 1216/3A, 1216/3C and 1216/4
Draparnaldia	CCAP No. 418/1A
Dunaliella	CCAP Nos. 19/35, 19/4, 19/5, 19/9 and 19/7A
Dysmorphococcus	CCAP No. 20/1
Enteromorpha	CCAP No. 320/1
Entosiphon	ATCC No. 50106; CCAP Nos. 1220/1A and 1220/1B
Eudorina	CCAP Nos. 24/1A, 162/2A, 24/1C, 24/6 and 24/9
Euglena	ATCC Nos. 10616, 12716, 50471 and 50490
Euplotes	CCAP Nos. 1624/15, 1624/22, 1624/10, 1624/12 and 1624/13
Eustigmatos	CCAP Nos. 860/2, 860/8, 860/1A, 860/4 and 860/6
Flintella	CCAP No. 1371/1
Fragilaria	ATCC No. 50218; CCAP Nos. 1029/8, 1029/13, 1029/21, 1029/2 and 1029/18
Frittschiella	CCAP No. 428/2
Glaucoma	ATCC Nos. 50601 and 50034
Gonium	CCAP Nos. 32/1C, 32/4 and 32/3
Gonyaulax	CCAP No. 1118/1
Gymnodinium	CCAP Nos. 1117/5, 1117/6, 1117/7, 1117/8 and 1117/3
Gyropaigne	CCAP No. 1233/1
Haematococcus	CCAP Nos. 34/10, 34/2G, 34/1F, 34/6 and 34/8
Halophytophthora	ATCC Nos. 208871, 28291, 28293, 28296 and 48641
Heterosigma	CCAP Nos. 934/1, 934/3 and 934/4
Hyalotheca	CCAP Nos. 637/1
Hydrodictyon	CCAP Nos. 236/2, 236/3, 236/1A, 236/1B and 236/1C
Khawkinia	CCAP Nos. 1204/17H, 1204/20A and 1204/20B
Lagenidium	ATCC Nos. 200318, 200325, 200337, 36492 and 58383
Leptolegnia	ATCC Nos. 36191, 46237, 48818, 58384 and 66223
Mallomonas	CCAP Nos. 929/6 and 929/1
Mantoniella	CCAP Nos. 1965/1 and 1965/5
Melosira	CCAP No. 1048/6
Menoidium	CCAP Nos. 1247/1, 1247/2, 1247/3, 1247/4 and 1247/6
Mesanothrix	ATCC No. 50563
Mesotaenium	ATCC No. 30595; CCAP Nos. 230/1 and 648/1
Metopus	CCAP Nos. 1653/1, 1653/2 and 1653/3
Micrasterias	CCAP Nos. 649/14, 649/17, 649/19, 649/21 and 649/6
Microspora	CCAP No. 348/1
Microthamnion	CCAP Nos. 450/2 and 450/1B
Mischococcus	ATCC No. 30592; CCAP No. 847/1
Monodopsis	CCAP No. 848/1
Mougeotia	CCAP No. 650/1
Nannochloropsis	CCAP Nos. 849/5, 849/1, 849/2, 849/8 and 849/9
Navicula	CCAP Nos. 1050/8, 1050/10, 1050/3C and 1050/9
Nephroselmis	CCAP Nos. 1960/4B, 1960/3 and 1960/1
Nitzschia	CCAP Nos. 1052/13 and 1052/18
Ochromonas	ATCC No. 30004; CCAP Nos. 933/2B, 933/27 and 933/25
Oedogonium	CCAP Nos. 575/1A, 575/1B and 575/2
Ophiocytium	ATCC No. 30601; CCAP No. 855/1
Opisthonecta	ATCC No. 30600; CCAP No. 1655/2
Oxyrrhis	CCAP Nos. 1133/3, 1133/4 and 1133/5
Pandorina	CCAP No. 24/2A, 24/2B, 60/1B and 60/2
Paramecium	CCAP Nos. 1660/3A, 1660/3D, 1660/1B, 1660/2A and 1660/14
Paranophrys	ATCC Nos. 50276 and 50277
Paraphysomonas	ATCC No. 50309; CCAP Nos. 935/13 and 935/14
Parmidium	CCAP No. 1258/1
Pediastrum	CCAP Nos. 261/9, 261/10 and 261/8
Peranema	CCAP No. 1260/1B
Peridinium	CCAP Nos. 1140/1 and 1140/3
Peronophythora	ATCC Nos. 28739, 34595, 56191 and 60172
Petalomonas	CCAP No. 1259/1
Phacus	CCAP Nos. 1261/9, 1261/10, 1261/6, 1261/4B and 1261/8
Pithophora	CCAP No. 530/1
Plagiopyla	CCAP No. 1663/1
Plasmopara	ATCC Nos. 10091, 10922, 10923, 10924 and 10952
Platyophrya	ATCC Nos. 50265 and 50288
Plectospira	ATCC No. 64139
Pleodorina	CCAP No. 68/1
Pleurochloris	ATCC No. 11474; CCAP No. 860/3
Pleurococcus	CCAP No. 464/1
Pleurotaenium	CCAP No. 664/3
Ploetia	CCAP No. 1265/1

TABLE 9-continued

<u>Examples of Protista Culture Sources</u>	
Genus	Examples of Culture Collection Strains
Polyedriella	ATCC No. 30425
Porphyridium	CCAP Nos. 1380/4, 1380/1A, 1380/5, 1380/6 and 1380/7
Procentrum	CCAP Nos. 1136/9, 1136/11, 1136/12 and 1136/15
Prototheca	ATTC Nos. 16523, 16525, 16527, 16528 and 50112
Pseudocharaciopsis	CCAP No. 822/1
Pseudocohnilembus	ATCC Nos. 50208 and PRA-30
Pyramimonas	CCAP Nos. 67/3, 67/8, 4/1, 67/7 and 67/18
Pythiopsis	ATCC No. 26880
Pythium	ATTC Nos. 10392, 10393, 10930, 10951 and 11101
Rhabdomonas	CCAP Nos. 1271/1, 1271/2, 1271/4 and 1271/5
Rhizochromulina	CCAP No. 950/1
Rhizoclonium	CCAP No. 540/1
Rhodella	CCAP No. 1388/2
Rhodorus	CCAP No. 1391/1
Rhynchopus	ATCC Nos. 50226, 50229, 50230, 50231 and 50616
Saprolegnia	ATCC Nos. 10396, 200013, 200018, 28275 and 34563
Scenedesmus	ATCC Nos. 11457, 11460, 11462, 30428 and 30429
Scytomonas	ATCC No. 50341
Selenastrum	CCAP Nos. 278/4 and 278/5
Skeletonema	CCAP Nos. 1077/1B, 1077/4, 1077/5, 1077/7 and 1077/8
Spathidium	ATCC No. 50273
Sphaerocystis	CCAP No. 176/6
Spirogyra	CCAP Nos. 678/2, 678/9, 678/7C, 678/3 and 678/4
Spirostomum	CCAP Nos. 1677/2B and 1677/3
Spondylosium	CCAP No. 680/1
Staurastrum	CCAP Nos. 679/7, 679/10, 679/3, 679/13 and 679/9
Stauroneis	CCAP No. 1078/1
Stentor	CCAP No. 1682/1
Stephanodiscus	CCAP No. 1079/4
Stephanosphaera	CCAP Nos. 78/1B and 78/1D
Stichococcus	CCAP Nos. 379/12, 379/40, 379/3, 379/27 and 379/29
Stigeoclonium	CCAP Nos. 477/10A, 477/1, 477/18, 477/11A and 477/13
Synedra	CCAP Nos. 1080/7, 1080/10, 1080/11 and 1080/4
Synura	CCAP Nos. 960/1C and 960/3
Tetracystis	ATCC No. 30438
Tetraedron	CCAP No. 282/1
Tetrahymena	CCAP Nos. 1630/7A, 1630/5A, 1630/6B, 1630/20 and 1630/21
Tetraselmis	CCAP Nos. 66/15, 66/21A, 66/9, 66/32 and 161/1B
Thalassiosira	CCAP Nos. 1085/5, 1085/6, 1085/8, 1085/12 and 1085/1
Thaumatocystis	ATCC No. 50250
Thraustotheca	ATCC Nos. 14555 and 34112
Trachelomonas	CCAP Nos. 1283/8, 1283/12, 1283/13, 1283/4B and 1283/17
Trebouxia	CCAP Nos. 219/3, 219/1B, 219/1C, 219/5B and 213/1B
Trentepohlia	UTEX No. 429; CCAP No. 483/4
Tribonema	CCAP Nos. 880/1, 880/3, 880/4, 880/2 and 880/6
Trimyema	ATCC No. 50416
Ulothrix	CCAP Nos. 386/2, 384/2, 386/3, 386/1 and 386/5
Uronema	ATCC No. 50282; CCAP Nos. 1686/1 and 1686/2
Vaucheria	CCAP Nos. 745/1C and 745/6
Vischeria	ATCC No. 30441; CCAP Nos. 861/1, 887/1 and 887/2B
Volvox	CCAP Nos. 88/6, 88/7 and 88/3B
Vorticella	ATCC No. 30897; CCAP Nos. 1690/3 and 1690/2
Xanthidium	CCAP Nos. 690/5, 690/1, 690/2, 690/3 and 690/4
Zygnema	CCAP Nos. 698/3B, 698/2, 698/1B and 698/1A

[0163] B. Viruses

[0164] In certain embodiments, a cell-based particulate material of the present invention is prepared from a virus. Though a virus is not a cell, a virus may be used to as a particulate material in a coating or other surface treatment, and due to the biomolecule structure of a virus, the definition of “a cell-based particulate material” used herein includes a virus. A virus does not have a cell wall, but has a proteinaceous outer coat that is sometimes surrounded by a phospholipid membrane (“envelope”). It is contemplated that a cell-based particulate material of the present invention pre-

pared from a virus will typically be of a smaller particle size than that prepared from a cell.

[0165] It is particularly not preferred to use a virus that is pathogenic to and/or able to infect one or more desirable organisms. In some embodiments, it is preferred to use an attenuated virus and/or an inactivated virus. Additionally, it is contemplated that production of genera that infect host cells of desirable organisms will generally be more expensive to produce per virus particle than a virus that infects a microorganism.

[0166] A virus that infects a microorganism (e.g., an Archaea, a bacterium, certain types of fungi, a Protista) is preferred, as a microorganism typically is not a desirable organism, and it is contemplated that the production and processing of such a virus will be relatively inexpensive compared to a virus that is produced in cells of a desirable

organism. A virus that is capable of reproduction in an Archaea and/or Eubacteria cell is known herein as a “bacteriophage,” and is typically a proteinaceous particulate material without a phospholipid membrane.

[0167] Examples of bacteriophages’ size and shape are described at Table 10.

TABLE 10

Examples of Bacteriophage Size and Shape		
Genus	Size	Shape
Inovirus	6–8 nm × 700–2000 nm	Filamentous
Leviviridae	26–28 nm	Isohedral
Microviridae	26–28 nm	Isohedral
Myoviridae	50–111 nm × 78–216 nm	Polyhedral with tail, I with tail, I
Podoviridae	31.5–65 nm × 41.5 nm	Isohedral
Siphoviridae	36–90 nm × 50–340 nm	Isohedral with Tail, Polyhedral with Tail

[0168] Examples of biological culture collection sources for bacteriophages and the host cells typically used for bacteriophage production are shown at Table 11 below.

TABLE 11

Examples of Bacteriophages			
Virus	ATCC No.	Host	ATCC No.
<u>Inoviridae genus</u>			
<u>Inovirus</u>			
If1	27065-B1	<i>Escherichia coli</i>	27065
If2	27065-B2	<i>Escherichia coli</i>	27065
<u>Leviviridae</u>			
ZK/1	25298-B1	<i>Escherichia coli</i>	25298
R 17	25868-B1	<i>Escherichia coli</i>	25868
MS2	15597-B1	<i>Escherichia coli</i>	15597
fr	15767-B1	<i>Escherichia coli</i>	19853
Q-beta	23631-B1	<i>Escherichia coli</i>	23631
<u>Microviridae</u>			
alpha 3	13706-B2	<i>Escherichia coli</i>	13706
phi X174	13706-B1	<i>Escherichia coli</i>	13706
S13	13706-B5	<i>Escherichia coli</i>	13706
phi R	13706-B3	<i>Escherichia coli</i>	13706
<u>Myoviridae</u>			
A-1 (L)	27893-B16	<i>Nostoc</i> sp.	27893
A19	11509-B1	<i>Brochothrix thermosphacta</i>	11509
AN-10	27893-B14	<i>Nostoc</i> sp.	27893
AN-15	29106-B1	<i>Nostoc</i> sp.	29106
D20	12661-B1	<i>Shigella flexneri</i>	12661
E1	13706-B4	<i>Escherichia coli</i>	13706
II	51352-B7	<i>Vibrio cholerae</i>	51352
Mu-1	23724-B9	<i>Escherichia coli</i>	23724
N-1	27893-B15	<i>Nostoc</i> sp.	27893
P1	25404-B1	<i>Escherichia coli</i>	25404
PEa7	29780-B2	<i>Erwinia amylovora</i>	29780
phi 92	35860-B1	<i>Escherichia coli</i>	35860
SP10	23059-B1	<i>Bacillus subtilis</i>	23059
SP8	15563-B1	<i>Bacillus subtilis</i>	15563
V	51352-B10	<i>Vibrio cholerae</i>	51352
Vi I	27870-B1	<i>Salmonella choleraesuis</i> subsp. <i>choleraesuis</i>	27870
wy	27363-B1	<i>Pseudomonas fragi</i>	27363
XP5	10016-B5	<i>Xanthomonas arboricola</i>	10016
Ox6	15593-B1	<i>Escherichia coli</i>	15593

TABLE 11-continued

<u>Examples of Bacteriophages</u>			
Virus	ATCC No.	Host	ATCC No.
T2	11303-B2	<i>Escherichia coli</i>	11303
T6	11303-B6	<i>Escherichia coli</i>	11303
<u>Podoviridae</u>			
10/I	23448-B2	<i>Brucella abortus</i>	23448
212/XV	17385-B1	<i>Brucella abortus</i>	17385
24/II	23448-B3	<i>Brucella abortus</i>	23448
371/XX1X	17385-B2	<i>Brucella abortus</i>	17385
8	12144-B2	<i>Escherichia coli</i>	12144
A-4 (L)	27892-B3	<i>Nostoc</i> sp.	27892
AN-20	27892-B2	<i>Nostoc</i> sp.	27892
AN-22	27892-B1	<i>Nostoc</i> sp.	27892
AN-24	27893-B3	<i>Nostoc</i> sp.	27893
I	51352-B6	<i>Vibrio cholerae</i>	51352
III	51352-B8	<i>Vibrio cholerae</i>	51352
P22 [PLT-22(22)]	19585-B1	<i>Salmonella choleraesuis</i> subsp. <i>choleraesuis</i>	19585
PEa1 (h)	29780-B1	<i>Erwinia amylovora</i>	29780
phi V-1	15597-B2	<i>Escherichia coli</i>	15597
T3	11303-B3	<i>Escherichia coli</i>	11303
ps 1	27362-B1	<i>Pseudomonas fragi</i>	27362
A-41	12518-B10	<i>Azotobacter vinelandii</i>	12518
phi-S1	27663-B1	<i>Pseudomonas fluorescens</i>	27663
<u>Siphoviridae</u>			
S-a	15841-B1	<i>Bacillus subtilis</i>	15841
B40-8	51477-B1	<i>Bacteroides fragilis</i>	51477
P/SW1/a [NCMB 384]	19326-B1	<i>Cytophaga marinoflava</i>	19326
J1	27139-B1	<i>Lactobacillus casei</i>	27139
hp	11602-B1	<i>Lactococcus lactis</i> subsp. <i>cremoris</i>	11602
N1 [N]	4698-B1	<i>Micrococcus luteus</i>	4698
N4 [X-5-A]	4698-B2	<i>Micrococcus luteus</i>	4698
N8 [Horse]	4698-B3	<i>Micrococcus luteus</i>	4698
N3 [Cay]	4698-B4	<i>Micrococcus luteus</i>	4698
Minetti	23052-B1	<i>Mycobacterium fortuitum</i> subsp. <i>fortuitum</i>	23052
BK1	607-B5	<i>Mycobacterium smegmatis</i>	607
Mc-4	607-B7	<i>Mycobacterium smegmatis</i>	607
B5	15483-B1	<i>Mycobacterium vaccae</i>	15483
149	14100-B3	<i>Vibrio cholerae</i>	14100
249	14214-B1	<i>Pseudomonas aeruginosa</i>	14214
IV	51352-B9	<i>Vibrio cholerae</i>	51352
B1	23239-B1	<i>Mycobacterium</i> sp.	23239
F1	8074-B1	<i>Clostridium sporogenes</i>	8074
R-1	607-B1	<i>Mycobacterium smegmatis</i>	607
5	12141-B1	<i>Escherichia coli</i>	12141
MOR-1	29730-B1	<i>Bacillus thuringiensis</i>	29730
VD13	29200-B1	<i>Enterococcus faecalis</i>	29200
F [HER 346]	27505-B1	<i>Bacillus subtilis</i>	27505

[0169] C. Production of Cells and Viruses

[0170] It is contemplated that any technique known to one of ordinary skill in the art may be applied in the isolation, growth and storage of a virus, a cell, a microorganism, and a multicellular organism from which a cell-based particulate material of the present invention may be derived. Such techniques of cell isolation, characterization, genetic manipulation, preservation, small-scale solid medium or liquid medium production growth, growth optimization, large (“industrial”) scale production of a biomolecule (“fermentation”), separation of a biomolecule from a cell or visa versa, etc. for various cell types (e.g., microorganisms, Eubacteria, fungi, protozoa cells, algae cells, extremophile cells, insect cells, plant cells, mammalian cells, recombinantly modified viruses or cells) is well known to those of

ordinary skill of the art [see, for example, in “Manual of Industrial Microbiology and Biotechnology, 2nd Edition (Demain, A. L. and Davies, J. E., Eds.), 1999; “Maintenance of Microorganism and Cultured Cells—A Manual of Laboratory Methods, 2nd Edition” (Kirsop, B. E. and Doyle, A., Eds.), 1991; Walker, G. M. “Yeast Physiology and Biotechnology,” 1998; “Molecular Industrial Mycology Systems and Applications for Filamentous Fungi” (Leong, S. A. and Berka, R. M., Eds.), 1991; “Recombinant Microbes for Industrial and Agricultural Applications” (Murooka, Y. and Imanaka, T., Eds.), 1994; “Handbook of Applied Mycology Fungal Biotechnology Volume 4” (Arora, D. K., Elander, R. P., Mukeiji, K. G., Eds.), 1992; “Genetics and Breeding of Industrial Microorganisms” (Ball, C., Ed.), 1984; “Microbiological Methods Seventh Edition” (Collins, C. H., Lyne,

P. L., Grange, J. M., Eds.), 1995; "Handbook of Microbiological Media" (Parks, L. C., Ed.), 1993; Waites, M. J. et al., "Microbiology—An Introduction," 2001; "Rapid Microbiological Methods in the Pharmaceutical Industry," (Easter, M. C., Ed.), 2003; "Handbook of Microbiological Quality Control Pharmaceuticals and Medical Devices" (Baird, R. M., Hodges, N. A., Denyer, S. P., Eds.), 2000; "Bioreactor System Design" (Asenjo, J. A. and Marchuk, J. C., Eds.), 1995; Endress, R. "Plant Cell Biotechnology," 1994; Slater, A. et al., "Plant Biotechnology—The genetic manipulation of plants," 2003; "Molecular Cloning" (Sambrook, J., and Russell, D. W., Eds.), 3rd Edition, 2001; and "Current Protocols in Molecular Biology" (Chanda, V. B. Ed.), 2002.]. In embodiments wherein a cell or virus is pathogenic (e.g., pathogenic to a desirable organism) may be produced in the practice of the present invention, techniques are well known to those of ordinary skill in the art for handling pathogens, including identification of a pathogen, production of a pathogen, sterilizing a pathogen, attenuating a pathogen, as well as conducting cell preparation to reduce the quantity of a pathogen in non-pathogenic material [see, for example, In "Manual of Commercial Methods in Clinical Microbiology" (Truant, A. L., Ed.), 2002; "Manual of Clinical Microbiology 8th Edition Volume 1" (Murray P. R., Baron, E. J., Jorgensen, J. H., Pfaller, M. A., Tenover, R. C., Eds.), 2003; "Manual of Clinical Microbiology 8th Edition Volume 2" (Murray P. R., Baron, E. J., Jorgensen, J. H., Pfaller, M. A., Tenover, R. C., Eds.), 2003; and "Biological Safety Principles and Practice 3rd Edition" (Fleming, D. O. and Hunt, D. L., Eds.), 2000].

[0171] D. Cell-Based Particulate Material

[0172] After production of a living cell, the cell may be made to undergo one or more processing steps to prepare a cell-based particulate material of the present invention. A preferred embodiment of the cell-based particulate material is a material in the form of a "whole cell material" or "whole cell particulate material," which refers to particulate material resembling an intact living cell upon microscopic examination, in contrast to cell fragments of varying shape and size. Examples of a whole cell particulate material include a living cell, a sterilized cell, an attenuated cell, a permeabilized cell, etc. It is contemplated that a composition of the present invention comprising a whole cell particulate material will provide protection from diffusion of compounds that may damage a desired biomolecule (e.g., a colorant, an enzyme, an antibody, a receptor, a transport protein, structural protein, an ligand, etc.) comprised as part of the whole cell particulate material. As would be known to those of ordinary skill in the art, any preparation of a cell will comprise a certain percentage of cell fragments, which comprise pieces of a cell wall or other durable cell material, pieces of cell membrane, and other cell components. The whole cell particulate material composition of the present invention will comprise 50% to 100%, including all intermediate ranges and combinations thereof of whole cell particulate material. The percentage of whole cell particulate material and cell fragments (e.g., cell wall fragments) may be determined by any applicable technique known to one of ordinary skill in the art such as microscopic examination, centrifugation, chromatography, etc., as well as any technique described herein for determining the properties of a pigment, extender, or other particulate material either alone or comprised in a coating or other surface treatment. It is contemplated that in some aspects, cell fragments may be

used as cell-based particulate material. The cell fragment particulate material of the present invention will comprise 50% to 100%, including all intermediate ranges and combinations thereof of cell fragment material. Such cell fragment particulate material may be prepared to reduce the size and/or alter the shape of the cell-based particulate material to better suit a specific coating or other surface treatment composition.

[0173] In some embodiments, a multicellular organism (e.g., a plant) may undergo a processing step wherein one or more cells are physically, chemically, and/or enzymatically separated to produce a material with desired particulate properties for a coating or other surface treatment formulation. In certain embodiments, cells and/or cell components may be separated using a disrupting step, described herein. As microorganisms are generally unicellular or oligocellular in nature, they are preferred in many embodiments, as it is contemplated that the number of processing steps used to prepare a cell-based particulate material of the present invention from such an organism will be fewer than for a cell from a multicellular organism. For example, a particulate material for a coating or other surface treatment may be selected for properties such as ease of dispersal, particle size, particle shape, etc. It is contemplated that a microorganism may be selected for cell shape, cell size, ease of dispersal, due to poor affinity for other cells relative to a cell embedded in a multicellular organism, or a combination thereof, to produce a cell-based particulate material of the present invention with desired particulate material properties using fewer processing steps and/or with greater ease than a multicellular organism.

[0174] 1. Biomolecule Components

[0175] In certain embodiments, a cell-based particulate material of the present invention may comprise various cellular components (e.g., cell wall material, cell membrane material, nucleic acids, sugars, polysaccharides, peptides, polypeptides, proteins, lipids, etc.). Such cell or virus biomolecule components are known to those of ordinary skill in the art (see, for example, *CRC Handbook of Microbiology*. Volume 1, bacteria; Volume 2, fungi, algae, protozoa, and viruses; Volume 3, microbial compositions: amino acids, proteins, and nucleic acids; Volume 4, microbial compositions: carbohydrates, lipids, and minerals; Volume 5, microbial products; Volume 6, growth and metabolism; Volume 7, microbial transformation; Volume 8, toxins and enzymes; Volume 9, pt. A. antibiotics—Volume 9, pt. B. antimicrobial inhibitors; 1977). In certain embodiments, it is preferred that the cell-based particulate material comprise a cell wall and/or cell membrane material, to enhance the particulate nature of the cell-based particulate material. However, it is particularly preferred that the cell-based particulate material of the present invention comprises cell wall material, as it is contemplated that the cell wall is the dominant cellular component for conferring particulate material properties such as shape, size, and insolubility.

[0176] Depending upon the type of processing used various cell components may be partly or fully removed from the organism to produce a cell-based particulate material. In particular, a processing step wherein a cell is contacted with a liquid (e.g., an organic liquid) is contemplated to dissolve many cell components. Removal of the solvent would thereby remove ("extract") the dissolved cell components

from the particulate matter. However, it is additionally contemplated that a large biomolecule, particularly a polymer that comprises a cell wall, such as peptidoglycan, teichoic acid, lipopolysaccharide or a combination thereof, will be resistant to extraction with a non-aqueous or aqueous solvent, and thus be retained as a component of the particulate matter. In particular embodiments, it is contemplated that a biomolecule of extremely large size, such as greater than 1,000 kDa molecular mass, will be retained in the particulate matter. Further, it is contemplated that in certain embodiments, greater than 50% of the dry weight of such particulate matter will comprise a biomolecule of extremely large size and/or cell wall polymers after processing.

[0177] It is contemplated that a large biomolecule, particularly cell wall polymer, will be at or near the interface of the particulate matter and the external environment. As this interface is primary area of contact between the particulate matter and other coating or other surface treatment components, it is contemplated that a biomolecule will contribute the most to the properties of the particulate matter produced from a cell used in a coating or other surface treatment. Examples of such properties include the size range of particulate matter, the shape of the particulate matter, the solubility of the particulate matter, the permeability and/or impermeability of the particulate matter to a chemical, the chemical reactivity of the particulate matter, or a combination thereof. It is also contemplated that a chemical moiety of the biomolecule at the interface of the particulate matter and the external environment may chemically react with a second coating or other surface treatment component. In certain embodiments, such reactions may be desirable, such as, for example, the chemical crosslinking of a cell-based particulate material to a binder in a thermosetting coating or surface treatment. By participating in such crosslinking reactions, it is contemplated that a cell-based particulate material may be selected for use as a binder in a coating or surface treatment. The chemical nature of various biomolecules typically found at the surface of a cell is further described below to provide guidance in selection of a cell-based particulate material based on potential chemical reactivity with various coating or other surface treatment components (e.g., binders, catalysts, cure agents, etc.) described herein.

[0178] a. Peptidoglycan and Pseudopeptidoglycan

[0179] Peptidoglycan ("mucopeptide," "murein") is a polymer common to Eubacteria cell walls that is contemplated as being an important biomolecule for conferring particulate nature and durability to various cell-based particulate materials of the present invention. Peptidoglycan generally comprises alternating monomers of the amino-sugars N-acetylglucosamine and N-acetylmuramic acid. The N-acetylmuramic acid monomers often further comprise a tetra-peptide of the sequence L-alanine-D-glutamic acid-L-diamino acid-D-alanine covalently bonded to the muramic acid. The attached tetrapeptides of peptidoglycan participate in cross-linking a plurality of polymers to contribute to the cell wall structure. Depending on the species, the tetrapeptides may form the cross-linkages by direct covalent bonds, or one or more amino acids may form the cross-linking bonds between the tetrapeptides. Archaea do not possess peptidoglycan, but many Archaea may contain

pseudopeptidoglycan, which comprises N-acetylta-losaminuronic acid, instead of N-acetylmuramic in peptidoglycan.

[0180] b. Teichoic acid and Teichuronic acid

[0181] A cell wall, particularly of Gram-positive Eubacteria, may comprise up to 50% teichoic acid. Teichoic acid is an acidic polymer comprising monomers of a phosphate and glycerol; phosphate and ribitol; or N-acetylglucosamine and glycerol. A sugar (e.g., glucose) and/or an amino acid (e.g., D-alanine) is usually attached to the glycerol or ribitol of a teichoic acid. In addition to direct association with or integration into a cell wall, a teichoic acid may be associated with a phospholipid bilayer adjacent to a cell wall. Often, a teichoic acid is covalently bonded to a glycolipid of a cell membrane, and is known as a "lipoteichoic acid." Teichoic acids are common in the genera *Staphylococcus*, *Micrococcus*, *Bacillus*, and *Lactobacillus*.

[0182] A cell wall of certain species of Gram-positive Eubacteria may comprise teichuronic acid. Teichuronic acid is a polymer comprising N-acetylglucosamine and glucuronic acid or glucose and amino-mannuronic acid. However, it is thought that acidic conditions damages this cell wall component, as uronic acids such as glucuronic acid, and particularly amino-mannuronic acid, are hydrolyzed in acid. It is contemplated that exposure to acid during processing or in a surface treatment may reduce this component from the particulate matter.

[0183] c. Cellulose

[0184] A cell wall of organisms, primarily of the Kingdom *Plantae*, comprises cellulose. Cellulose is a polysaccharide polymer of glucose monomers. Chemically modified forms of cellulose (e.g., a cellulose ester, a nitrocellulose) have been used as binders in coatings and other surface treatments. However, in the practice of the present invention, it is contemplated that cellulose will be used in particulate material, preferably not chemically modified as a cellulose ester and/or a nitrocellulose, or a combination thereof.

[0185] d. Neutral Polysaccharides

[0186] A cell wall, particularly of Gram-positive Eubacteria, may comprise a neutral polysaccharide, other than those described for a peptidoglycan, teichoic acid, cellulose, or lipopolysaccharide. As used herein, a "neutral polysaccharide" is a polymer comprising a majority of neutral sugars, wherein the neutral sugar is typically a hexose or a pentose, and/or an aminosugar thereof. Examples of neutral sugars found in neutral polysaccharides include arabinose, galactose, 3-O-methyl-D-galactose, mannose, xylose, rhamnose, glucose, fructose, or a combination thereof. Examples of amino sugars found in neutral polysaccharides include glucosamine, galactosamine, or a combination thereof.

[0187] e. Proteinaceous Molecules

[0188] A cell wall may comprise a proteinaceous molecule, such as, for example, a polypeptide, a peptide, a protein, other than those described for a peptidoglycan, teichoic acid, or lipopolysaccharide. As used herein, a "peptide" comprises 3 to 100 amino acids as monomers, while a "polypeptide" is a polymer comprising 101 amino acids or more as monomers. As used herein a "protein" is a proteinaceous molecule comprising a contiguous molecular sequence three amino acids or greater in length, matching

the length of a biologically produced proteinaceous molecule encoded by the genome of an organism. Such proteinaceous materials may dominate the structural integrity that confers particulate material durability to a virus or a cell comprising a pellicle. Additionally, peptide linkages are common throughout peptidoglycan and pseudopeptidoglycan. However, it is contemplated that in most embodiments, a peptide or polypeptide is not the biomolecule component that dominates the overall structural integrity and/or composition of most cell walls.

[0189] f. Lipids

[0190] A cell wall may comprise a lipid, other than those described for a peptidoglycan, teichoic acid, or lipopolysaccharide. As used herein a "lipid" refers to any hydrophobic or amphipathic organic compound extractable with a non-aqueous solvent. Typically, a cell comprises various lipid biomolecules, which generally comprise fatty acids. It is contemplated that in embodiments wherein a processing step comprises contacting the cell with a non-aqueous solvent, most lipids will be removed from the cell and/or cell wall. However, it is contemplated that in embodiments wherein such a processing step does not occur, the lipid components of a cell and/or cell wall remaining in the particulate matter may affect coating or other surface treatment reactions wherein lipid (e.g., fatty acid double bond) cross-linking activity contributes to film-formation. Lipids of particular relevance for such potential cross-linking reactions include those of the outer membrane, which comprise fatty acids, the cell wall, or a combination thereof.

[0191] For example, Gram-negative cells comprise a phospholipid bilayer known as the "outer cell membrane" that surrounds the cell wall. A "phospholipid bilayer" comprises two layers of phospholipid molecules, wherein the fatty acids components of each layer's phospholipids contact each other, thereby creating a hydrophobic inner region, and the head groups of each layer's phospholipids, which are generally hydrophilic, contact the external environment. Examples of a phospholipid include a glycerophospholipid, which comprises two fatty acids and one hydrophilic moiety called a "head group" covalently connected to a trihydroxyl alcohol glycerol. Non-limiting examples of a head group include choline, ethanolamine, serine, inositol, an additional glycerol or a combination thereof. Additionally, a phospholipid bilayer generally comprises a plurality of peptides and polypeptides with hydrophobic regions that are retained in the phospholipid bilayer's hydrophobic inner region.

[0192] Gram-positive Eubacteria cell walls generally 0% to 2% lipid. However, certain categories of Gram-positive Eubacteria can comprise up to 50% or more lipid content as part of the cell wall. Such Eubacteria include different species of *Gordonia*, *Mycobacterium*, *Nocardia*, and *Rhodococcus*. Additionally, the lipids of such Eubacteria generally comprise a branched chain fatty acid, particularly mycolic acids (Barry, C. E. et al., *Prog Lipid Res* 37:143, 1998). It is though that mycolic acids are covalently bound or loosely associated with cell wall sugars. The type of Eubacteria is sometimes used to identify the carbon-backbone length of the mycolic acids. For example, an eumycolic acid is isolated from a *Mycobacterium*, and generally comprises 60 to 90 carbon atoms. A corynomycolic acid is isolated from a *Corynebacterium*, and generally comprises 22 to 36 carbons. A nocardomycolic acid is isolated from a *Nocardia*, and

generally comprises 44 to 60 carbons. A mycolic acid generally comprises a fatty acid branch ("alpha branch") and an aldehyde ("meromycolate branch"). A mycolic acid may further comprise a carbon double bond, an epoxy ester moiety, a cyclopropane ring moiety, a keto moiety, a methoxy moiety or a combination thereof, generally located on meromycolate branch. A mycolic acid may comprise a α -mycolic acid, a methoxymycolic acid, a ketomycolic acid, an epoxymycolic acid, a wax ester or a combination thereof. A α -mycolic acid comprises a cis or trans carbon double bond and/or a cyclopropane, and may further comprise a methyl branch adjacent to such a moiety. A methoxymycolic acid comprises a methoxy moiety and a double bond or a cyclopropane. A ketomycolic acid comprises an α -methyl-branched ketone. An epoxymycolic acid comprises an α -methyl-branch epoxide. A wax ester comprises an internal ester group and a carbon double bond or a cyclopropane ring.

[0193] In certain facets, a cell lipid may comprise a glycolipid, which refers to a glycan covalently attached to a lipid. Non-limiting examples of a glycolipid include a dolichyl phosphoryl glycan, a pyrophosphoryl glycan, an undecaprenyl phosphoryl glycan, a pyrophosphoryl glycan, a retinyl phosphoryl glycan, a glycosphingolipid (e.g., a ceramide, a galactosphingolipid, a glucosphingolipid including a ganglioside), a glycoacylglycerolipid (e.g., a monogalactosyldiacylglycerol), a steroidal glycoside (e.g., ouabain, digoxin, digitonin), a glycosylated phosphoinositide (e.g., a GPI anchor, a lipophosphoglycan, a lipopeptidophosphoglycan, a glycoinositol phospholipid), or a combination thereof.

[0194] The phospholipid bilayers of Archaea are biochemically distinct from the lipids described above, as they comprise branched hydrocarbon chains attached to glycerol by ether linkages instead of fatty acids attached to glycerol by ester linkages.

[0195] g. Additional Biomolecule Components

[0196] In addition to the biomolecules described above that are contemplated as contributing to the particulate nature and/or potential chemical reactivity of a cell-based particulate material of the present invention, such a composition may comprise other desirable biomolecules (e.g., a colorant, an enzyme, an antibody, a receptor, a transport protein, structural protein, an ligand, a prion) that may confer desirable properties to a surface treatment. Such biomolecules may be an endogenously produced cell component, or a product of expression of a recombinant nucleic acid in the virus or cell [see, for example, co-pending U.S. patent application Ser. No. 10/655,345 "Biological Active Coating Components, Coatings, and Coated surfaces, filed Sep. 4, 2003; in "Molecular Cloning," 2001; and "Current Protocols in Molecular Biology," 2002].

[0197] Often colorants produced by living organisms are soluble in a liquids (e.g., organic liquids, aqueous liquids) typically used as liquid component of a coating or other surface treatment. Most of the color producing and/or light absorbing biomolecules of cells described herein are extractable with solvents of lipids. For example, carotenoids and many photosynthetic biomolecules are extractable from cells with solvents of lipids, such as acetone, ethanol or ether. However, as would be known to those of ordinary skill in the art, some cells produce biomolecule colorants that are water-soluble. In particular, the colors of some cells from multicellular plants (e.g., fruit cells, flower cells), and some

algae, are often dominated or influenced by one or more anthocyanins, which are water soluble colored biomolecules. Further, other less well characterized water-soluble biomolecule colorants are found in various cells of bacteria or fungi. Examples of colored cells comprising a water-soluble colorant include *Azotobacter armeniacus* (brown-black and red-violet; DSMZ Nos. 2284), *Azotobacter vine-landii* (yellow-green fluorescent; ATCC Nos. 12518, 13705 and 53800), *Azorhizophilus paspali* (yellow-green fluorescent; DSMZ Nos. 2283, 88, 376, 388, 391 and 400), *Beijerinckia dextrii* (green fluorescent; DSMZ Nos. 2328, 1716 and 2329), *Pseudomonas aeruginosa* (blue-green; DSMZ Nos. 50071, 288, 939 and 1117), *Pseudomonas viridiflava* (blue-green; DSMZ Nos. 11124, 50337 and 50338), *Burkholderia caryophylli* (yellow-green; DSMZ Nos. 11124, 50337 and 50338), *Burkholderia gladioli* (yellow-green; DSMZ Nos. 4285, 8361, 11318), *Ralstonia solanacearum* (brown; DSMZ Nos. 9544, 1993 and 50905), *Brevundimonas vesicularis* (yellow-orange; DSMZ Nos. 7226 and 7233), *Erwinia rhapontici* (pink; DSMZ No. 4484), *Brenneria rubrifaciens* (pink; DSMZ No. 4483), *Aeromonas media* (brown; DSMZ No. 4881), *Lysobacter antibioticus* (brown; DSMZ No. 2044 and 2045), *Lysobacter brunescens* (brown; DSMZ No. 6979), *Amycolatopsis azurea* (blue; DSMZ No. 43854), *Prauserella rugosa* (yellow; ATCC No. 43014), *Actinoplanes italicus* (red; ATCC No. 27366), *Actinoplanes ferrugineus* (brown; ATCC No. 29868), *Actinoplanes auranti-color* (yellow; ATCC No. 15330), *Actinoplanes liguriae* (brown; ATCC No. 31048), *Couchioplanes caeruleus* (yellow-brown; ATCC No. 33937), *Kitasatospora griseola* (pink; DSMZ No. 43859), *Kitasatospora medicidica* (yellow-brown; DSMZ No. 43929), *Kitasatospora phosalacinea* (yellow-brown; DSMZ No. 43860), and *Kitasatospora setae* (yellow-brown; DSMZ No. 43861).

[0198] Due to the solubility of biomolecule colorants in certain liquid components, such colorants may be used as a dye in a coating or other surface treatment upon extraction from a cell-based particulate material of the present invention. The biomolecule dye may be produced by extraction within the coating or other surface treatment by contact with a liquid component that acts as a solvent for the biomolecule colorant. Alternatively, the biomolecule dye may be extracted by a solvent from the cell-based particulate material of the present invention in a processing step of the cell-based particulate material. Extraction of such colored biomolecules in a separate processing step may be done to alter the color of the cell-based particulate material prior to incorporation in a coating or other surface treatment, separate the biomolecule dye for subsequent use as a coating or other surface treatment component (e.g., a dye), or a combination thereof. Of course, selection of processing steps and/or a liquid component of a coating or other surface treatment that does not extract a colored biomolecule may be used to maintain the colored biomolecule within a cell-based particulate material of the present invention, such particulate material is part of or separate from a surface treatment.

[0199] E. Processing of Cells

[0200] Examples of cell processing steps include permeabilizing, extracting, disrupting, sterilizing, attenuating, concentrating, drying, resuspending, encapsulation, or a combination thereof. Various embodiments of a cell-based particulate material of the present invention are contemplated after one or more such processing steps. However, it

is further contemplated that each processing step will increase economic costs and/or reduce total cell-based particulate material yield, so that embodiments comprising fewer steps are preferred. The cell-based particulate material of the present invention, in addition to its usefulness as a particulate material component (e.g., a colorant, an additive) of a coating or surface treatment, may confer a desirable additional characteristic (e.g., enzymatic activity) typically not associated with a particulate material of a coating or surface treatment [see, for example, co-pending U.S. patent application Ser. No. 10/655,345 "Biological Active Coating Components, Coatings, and Coated surfaces, filed Sep. 4, 2003]. It is contemplated that in certain embodiments, particularly wherein the cell-based particulate material comprises a biomolecule (e.g., an enzyme) that may confer an additional desirable property typically not associated with a particulate material of a coating or other surface treatment, a processing step (e.g., attenuation, sterilization, chemical modification, etc.) may reduce or eliminate the desirable property (e.g., reduce biomolecule yield, reduce biomolecule activity, etc.), and thus fewer processing steps are preferred in most such embodiments. It is further contemplated that the order of steps may be varied and still produce a cell-based particulate material of the present invention.

[0201] 1. Sterilization/Attenuation

[0202] A processing step may comprise sterilizing or attenuating a cell-based particulate material of the present invention. Sterilizing ("inactivating") kills living matter (e.g., a cell, a virus), while attenuation reduces the virulence of living matter. A sterilizing and/or attenuating step may be desirable as continued post expression growth of a cell-based particulate material and/or a contaminating organism may detrimentally affect the composition. For example, one or more properties of a coating or other surface treatment may be undesirably altered by the presence of a living organism. Additionally, a cell or virus may be able to infect, and even be pathogenic to a desirable organism. Examples of desirable organisms include humans, mammals, marsupials, birds, fish, amphibians, crustaceans, reptiles, plants or a combination thereof.

[0203] The pathogenicity of a cell or virus may be reduced or eliminated through genetic alteration (e.g., an attenuated virus with reduced pathogenicity, infectivity, etc.), processing techniques such as partial or complete sterilization and/or attenuation using techniques known to those of ordinary skill in the art (e.g., heat treatment, irradiation, contact with chemicals), passage of a virus through cell not typically a host cell for the virus, or a combination thereof, and such a cell or virus is preferred. In most embodiments, it is preferred that the majority (e.g., 50% to 100%, including all intermediate ranges and combinations thereof) of the cell-based particulate material has been sterilized and/or attenuated, with 100% or as close to 100% as is practically accomplishable, preferred. A cell-based particulate material wherein the majority of material by dry or wet weight or volume has been sterilized or attenuated, is known herein as a "sterilized cell-based particulate material" or "attenuated cell-based particulate material," respectively.

[0204] In certain embodiments, it is contemplated that sterilization or attenuation may be accomplished in a surface treatment (e.g., a coating) by contact with biologically detrimental surface treatment components such as solvents

or chemically reactive surface treatment components (e.g., a binder). In further embodiments, sterilizing or attenuation of a cell-based particulate material or a surface treatment comprising such a material may be accomplished by any method known in the art, and are commonly applied in the food, medical, and pharmaceutical arts to sterilize or attenuate pathogenic microorganisms [see, for example, "Food Irradiation: Principles and Applications," 2001; "Manual of Commercial Methods in Clinical Microbiology" (Truant, A. L., Ed.), 2002; "Manual of Clinical Microbiology 8th Edition Volume 1" (Murray P. R., Baron, E. J., Jorgensen, J. H., Pfaller, M. A., Tenover, R. C., Tenover, R. C., Eds.), 2003; "Manual of Clinical Microbiology 8th Edition Volume 2" (Murray P. R., Baron, E. J., Jorgensen, J. H., Pfaller, M. A., Tenover, R. C., Eds.), 2003; and "Biological Safety Principles and Practice 3rd Edition" (Fleming, D. O. and Hunt, D. L., Eds.), 2000]. Examples of sterilizing or attenuating may include contacting the living matter with a toxin, irradiating the living matter, heating the living matter above a temperature suitable for life (e.g., 100° C. in most cases), or a combination thereof. It is preferred that sterilizing or attenuating comprises irradiating the living matter, as radiation generally does not leave a toxic residue, and is not contemplated to detrimentally affect the stability of a desired biomolecule (e.g., a colorant, an enzyme) that might be present in the cell-based particulate material, to the same degree as other sterilizing or attenuating techniques (e.g., heating). Examples of radiation include infrared ("IR") radiation, ionizing radiation, microwave radiation, ultra-violet ("UV") radiation, particle radiation, or a combination thereof. Particle radiation, UV radiation and/or ionizing radiation are preferred, and particle radiation is particularly preferred. Examples of particle radiation include alpha radiation, electron beam/beta radiation, neutron radiation, proton radiation, or a combination thereof.

[0205] However, in alternative embodiments, it is contemplated that partly or non-sterilized or attenuated cell-based particulate material will be suitable for a temporary coating (e.g., a non-film forming coating) or other temporary surface treatment. In particular aspects, the damage produced by living cells or viruses in a coating, film or other surface treatment may make the composition more suitable for use as a temporary coating or other surface treatment. For example, the cell-based particulate material may reduce the durability of the coating, film or other surface treatment over time (e.g., degrade a binder molecule), enhance ease of removal of the coating, film or other surface treatment (e.g., reduce resistance to a solvent), etc.

[0206] 2. Concentration

[0207] A processing step may comprise concentrating a cell-based particulate material of the present invention. As used herein, "concentrating" refers to any process wherein the volume of a composition is reduced. Often, undesired components that comprise the excess volume are removed, the desired composition is localized to a reduced volume, or a combination thereof.

[0208] For example, it is contemplated that a concentrating step may be used to reduce the amount of a growth and/or expression medium component from a composition of the present invention. It is contemplated that nutrients, salts and other chemicals that comprise a biological growth and/or expression medium may be unnecessary and/or

unsuitable in a composition of the present invention, and reducing the amount of such compounds is preferred. A growth medium may promote undesirable microorganism growth in a composition of the present invention, while salts or other chemicals may undesirably alter the formulation of a coating or other surface treatment.

[0209] Concentrating a cell-based particulate material may be by any method known in the art, including, for example, washing, filtrating, a gravitational force, a gravimetric force, or a combination thereof. An example of a gravitational force is normal gravity. An example of a gravimetric force is the force exerted during centrifugation. Often a gravitational or gravimetric force is used to concentrate a cell-based particulate material from undesired components that are retained in the volume of a liquid medium. After cells are localized to the bottom of a centrifugation device, the media may be removed via such techniques as decanting, aspiration, etc.

[0210] 3. Drying

[0211] In additional embodiments, the cell-based particulate material is dried. Such a drying step may remove undesired liquids from the cell-based particulate material. Examples of drying include freeze-drying, lyophilizing, or a combination thereof. In some aspects, a cryoprotectant may be added to the cell-based particulate material during a drying step (e.g., lyophilizing). In certain embodiments, it is contemplated that a drying step may enhance the particulate nature of the material. For example, reduction of a liquid in the cell-based particulate material may reduce the tendency of particles of the material to adhere to each other (e.g., agglomerate, aggregate), or a combination thereof. It is also contemplated that in some aspects, the particulate material may be in a form (e.g., a powder) sufficiently liquid free ("dry") that it is suitable for convenient storage at ambient conditions without need for desiccation.

[0212] 4. Physical Force/Milling

[0213] It is contemplated that an application of physical force (e.g., grinding, milling, shearing) may enhance the particulate nature of the material by converting multicellular material (e.g., a plant) into oligocellular and/or unicellular material, or convert oligocellular material into unicellular material. Such an application of physical force generally will be referred to as "milling" herein, particularly the claims. Further, the average particle size may be reduced to a desired range, including the conversion of cells into disrupted cells and/or cell debris. It is also contemplated that such physical force may produce a powder form of the cell-based particulate material.

[0214] 5. Extraction

[0215] It is contemplated that a biomolecule may be removed by extraction of a cell-based particulate material. In addition to the extraction of colored biomolecules previously described, it is contemplated that a lipid and/or an aqueous component of a cell-based particulate material may be partly or fully removed by extraction with appropriate solvents. Such extraction may be desirable to dry the cell-based particulate material by removal of liquid (e.g., water, lipids), remove of a biotoxin, sterilize/attenuate living material in the composition, disrupt and/or permeabilize a cell, alter the physical and/or chemical characteristics of the cell-external environment interface, or a combination

thereof. For example, lipids such as phospholipids are often present at or within a cell wall and/or membrane, and an extraction step may partly or fully remove those lipids most likely to chemically react with other surface treatment components. Additionally, such an extraction of surface lipids may alter (e.g., increase or decrease) the hydrophobicity or hydrophilicity of a cell-based particulate material to enhance its suitability (e.g., dispersability) for a specific coating or other surface treatment.

[0216] 6. Resuspension

[0217] A processing step may comprise resuspending the composition comprising a cell-based particulate material. It is contemplated that the material to be resuspended will have undergone a prior processing step, such as concentration (e.g., precipitation), drying, extraction, etc., and is resuspended into a form suitable for storage, further processing, and/or addition to a coating or other surface treatment. In certain aspects, the resuspension medium is a liquid component of a coating or other surface treatment described herein, a cryopreservative ("cryoprotector"), a xeroprotectant, or a combination thereof. As would be known to those of ordinary skill in the art, a cryopreservative is a substance, typically a liquid, that reduces the ability of a cell wall or cell membrane to rupture, particularly during a freezing and thawing process, while a xeroprotectant is a substance, typically a liquid, that reduces damage to a composition (e.g., a desirable biomolecule composition), during a drying process (e.g., a drying processing step, physical film formation). In some embodiments, a cryopreservative, a xeroprotectant, or a combination thereof, may be used as an additive to a coating or other surface treatment in the practice of the present invention. Examples of a cryopreservative include glycerol, dimethyl sulfoxide ("DMSO"), a protein (e.g., an animal serum albumin), a sugar of 4 to 10 carbons (e.g., sucrose), or a combination thereof. Examples of a xeroprotectant include glycerol, a glycol such as a polyethylene glycol (e.g., PEG₈₀₀₀), a mineral oil, a bicarbonate (e.g., ammonium bicarbonate), DMSO, a sugar of 4 to 10 carbons (e.g., trehalose), or a combination thereof. Often, a cryopreservative and/or a xeroprotectant is in an aqueous liquid, and may comprise a pH buffer (e.g., a phosphate buffer). As would be recognized by one of ordinary skill in the art, a substance (e.g., a cryopreservative, a xeroprotectant) included as part of a surface treatment with or as part of cell-based particulate material that may alter the physical (e.g., hydrophobicity, hydrophilicity, dispersal of particulate material, etc.) or chemical properties (e.g., reactivity with a surface treatment component) of a surface treatment, and a surface treatment's formulation may be optimized using the techniques described herein or as would be known to one of ordinary skill in the art to account for these additional coating or other surface treatment components. In certain embodiments, the amount of cryopreservative and/or a xeroprotectant will comprise 0.000001% to 80%, including all intermediate ranges and combinations thereof, of a cell-based particulate material of the present invention. In specific facets, a cell-based particulate material, a cryopreservative and/or a xeroprotectant may comprise 0.000001% to 66% a glycerol or a glycol (e.g., a polyethylene glycol), including all intermediate ranges and combinations thereof. In other embodiments, a cell-based particulate material, a cryopreservative and/or a xeroprotectant may comprise 0.000001% to 10% DMSO, including all intermediate ranges and combinations

thereof. In further embodiments, a cell-based particulate material, a surface treatment, a cryopreservative and/or a xeroprotectant may comprise 0.000001 M to 1.5 M bicarbonate, including all intermediate ranges and combinations thereof.

[0218] 7. Temperatures

[0219] It is contemplated that in some embodiments, processing of a cell-based particulate material composition may be conducted at 4° C. to 50° C., including all intermediate ranges and combinations thereof. In preferred embodiments, a processing step may comprise maintaining a cell-based particulate material at a temperature less than the optimum temperature for the activity of a living organism and/or enzyme that may detrimentally affect a cell-based particulate material of the present invention. Temperatures less than 37° C. are preferred, temperatures less than 30° C. are more preferred, temperatures less than 20° C. even more preferred, temperatures less than 10° C. are particularly preferred, and temperatures of 4° C. more preferred.

[0220] 8. Permeabilization/Disruption

[0221] In preferred aspects, a cell-based particulate material of the present invention comprises a cell preparation wherein the cell membrane and/or cell wall has been altered through a permeabilizing process, a disruption process, or a combination thereof. An example of such an altered cell preparation includes disrupted cells, permeabilized cells, or a combination thereof. As used herein, a "disrupted cell" is a cell preparation wherein the cell membrane and/or cell wall has been altered through a disruption process. As used herein, a "permeabilized cell" is a cell preparation wherein the cell membrane and/or cell wall has been altered through a permeabilizing process. Permeabilization and/or disruption may promote the separation of cells, reduce the average particle size of the material, allow greater access to a biomolecule in a cell (e.g., to promote ease of extraction), or a combination thereof.

[0222] A processing step may comprise a permeabilizing step, wherein a cell is contacted with a permeabilizing agent such as DMSO, ethylenediaminetetraacetic acid ("EDTA"), tributyl phosphate, or a combination thereof. A permeabilizing step may increase the mass transport of a substance (e.g., a substrate) into the interior of a cell, where an enzyme localized inside the cell can catalyze a chemical reaction with the substrate. (Martinez, M. B. et al., 1996; Martinez, M. B. et al., 2001; Hung, S.-C. and Liao, J. C., 1996). Cell permeabilizing using EDTA has been described (Leduc, M. et al., 1985).

[0223] In some embodiments, a processing step comprises disrupting a cell. A cell may be disrupted by any method known in the art, including, for example, a chemical method, a mechanical method, a biological method, or a combination thereof. Examples of a chemical cell disruption method include suspension in a solvent for certain cellular components. In specific facets, such a solvent may comprise an organic solvent (e.g., acetone), a volatile solvent, or a combination thereof. In a particular facet, a cell be disrupted by acetone (Wild, J. R. et al., 1986; Albizo, J. M. and White, W. E., 1986). In certain preferred facets, the cells are disrupted in a volatile solvent for ease in evaporation. Examples of a mechanical cell disruption method include pressure (e.g., processing through a French press), sonica-

tion, mechanical shearing, or a combination thereof. An example of a pressure cell disruption method includes processing through a French press. Examples of a biological cell disruption method include contacting the cell with one or more proteins/polypeptides that are known to possess such disrupting activity including porins and enzymes such as a lysozyme, as well as contact/cell infection with a virus that weakens, damages, and/or permeabilizes a cell membrane, cell wall or combination thereof. Cell-based particulate material of the present invention comprising cells and/or cellular components may be homogenized, sheared, undergo one or more freeze thaw cycles, be subjected to enzymatic and/or chemical digestion of cellular materials (e.g., cell walls, sugars, etc.), undergo extraction with organic or aqueous solvents, etc., to weaken interactions between the cellular materials. A processing step may comprise sonicating a composition. Other disrupting and drying will be done by freeze-drying with a reduced or absent cryoprotector.

[0224] 9. Chemical Modification

[0225] In certain embodiments, a cell-based particulate material may be chemically modified for a specific physical (e.g., hydrophobicity, hydrophilicity, dispersal of particulate material, etc.) or chemical properties (e.g., reactivity with a surface treatment component) to enhance suitability in a coating or other surface treatment. It is contemplated that such chemical (e.g., organic chemistry) modification will primarily affect the cell-external environment interface. Such modifications are known to those of ordinary skill in the art [see, Greene, T. W. and Wuts, P. G. M. "Productive Groups in Organic Synthesis," Second Edition, pp. 309-315, John Wiley & Sons, Inc., USA, 1991; and co-pending U.S. patent application Ser. No. 10/655,345 "Biological Active Coating Components, Coatings, and Coated surfaces, filed Sep. 4, 2003; in "Molecular Cloning," 2001; "Current Protocols in Molecular Biology," 2002], and examples include acylation, amination, hydroxylation, phosphorylation, methylation, adding a detectable label such as a fluorescein isothiocyanate, covalent attachment of a poly ethylene glycol, a derivation of an amino acid by a sugar moiety, a lipid, a phosphate, or a farnesyl group; or a combination thereof.

[0226] 10. Encapsulation

[0227] Additionally, it is contemplated that a cell-based particulate material of the present invention may be encapsulated using a microencapsulation technique as would be known to one of ordinary skill in the art. Such encapsulation may enhance or confer the particulate nature of the cell-based particulate material, provide protection to the cell-based particulate material, increase the average particle size to a desired range, allow release of a cellular component (e.g., a biomolecule) from the encapsulating material, alter surface charge, hydrophobicity, hydrophilicity, solubility and/or dispersability of the particulate material, or a combination thereof. Examples of microencapsulation (e.g., microsphere) compositions and techniques are described in Wang, H. T. et al., *J. of Controlled Release* 17:23-25, 1991; and U.S. Pat. Nos. 4,324,683, 4,839,046, 4,988,623, 5,026,650, 5,153,131, 6,485,983, 5,627,021 and 6,020,312.

[0228] F. Combinations of Cell-Based Particulate Material

[0229] It is contemplated that in various embodiments, a composition of the present invention may comprise one or more selected cell-based particulate materials. It is contemplated that a combination of cell-based particulate materials

may be selected for inclusion in the composition, coating and/or paint, to optimize one or more properties of such a composition of the present invention. Thus, a composition of the present invention may comprise 1 to 100 or more different selected cell-based particulate materials of interest, including all intermediate ranges and combinations thereof. For example, as various cells and viruses have differing sizes, colors, opacity, biochemical composition, etc., one may select a combination of cell-based particulate materials to confer a more desirable range of properties to a composition of the present invention. In a specific example, a coating may comprise a plurality of cell-based particulate materials. In an additional specific example, one or more layers of a multicoat system may comprise one or more different cell-based particulate materials to confer differing properties between one layer and at least a second layer of the multicoat system.

[0230] G. Incorporation of a Particulate Material into a Coating

[0231] As would be known to one of ordinary skill in the art, a coating may comprise insoluble particulate material. Particulate material may comprise a primary particle, an agglomerate, an aggregate, or a combination thereof. A primary particle is a single particle not in contact with a second particle. An agglomerate is two or more particles in contact with each other, and generally can be separated by a dispersion technique, a wetting agent, a dispersant, or a combination thereof. An aggregate is two or more particles in contact with each other, which are generally difficult to separate by a dispersion technique, a wetting agent, a dispersant, or a combination thereof.

[0232] Usually, a pigment, an extender, certain types of rheology modifiers, certain types of dispersants, or a combination thereof are the major sources of particulate material in a coating. In the present invention, cell-based particulate material will also be a source of particulate material in a coating. In certain embodiments, a cell-based particulate material of the present invention may be used in combination with and/or as a substitute for a pigment, an extender, a rheology modifier, a dispersant, or a combination thereof. In specific facets, a cell-based particulate material of the present invention may substitute for 0.000001% to 100%, including all intermediate ranges and combinations thereof, of a pigment, an extender, a rheology modifier, a dispersant, or a combination thereof. In certain embodiments, it is contemplated that a coating or other surface treatment wherein the cell-based particulate material of the present invention tends to be at or near the coating/surface treatment-external environment interface. Preparation of such a coating or surface treatment wherein a particulate material is at or near the coating/surface treatment-external environment interface may be accomplished by formulation to enhance the ballooning, blooming, floating, flooding, etc. of the particulate material. It is contemplated that any technique used in the preparation of a coating that comprises a pigment, extender or any other form of particulate material described herein or would be known to one of ordinary skill in the art may be applied in the preparation of a coating comprising the cell-based particulate material of the present invention. Incorporation of particulate materials (e.g., pigments), assays for determining a rheological property and/or a related property (e.g., viscosity, flow, molecular weight,

component concentration, particle size, particle shape, particle surface area, particle spread, dispersion, flocculation, solubility, oil absorption values, CPVC, hiding power, corrosion resistance, wet abrasion resistance, stain resistance, optical properties, porosity, surface tension, volatility, settling, leveling, sagging, slumping, draining, floating, flooding, cratering, foaming, splattering,) of a coating component and/or a coating (e.g., pigment, binder, vehicle, surfactant, dispersant, paint) and procedures for determining such properties, as well as procedures for large scale (e.g., industrial) coating preparation (e.g., wetting, pigment dispersion into a vehicle, milling, letdown) are described in, for example, in Patton, T. C. "Paint Flow and Pigment Dispersion, A Rheological Approach to Coating and Ink Technology," 1979.

[0233] In many embodiments, dispersion of the particulate material is promoted by application of physical force (e.g., impact, shear) to the composition. Techniques such as grinding and/or milling are typically used to apply physical force for dispersion of particulate matter. Though it is contemplated that such application of physical force may be used in the dispersal of the cell-based particulate material of the present invention, such force may damage the structural integrity of the cell wall and/or cell membrane that confers size and shape to the material. The average particle size and shape will be altered by the degree of damage to the cell wall and/or cell membrane, which may alter a physical property, a chemical property, an optical property, or a combination thereof, of a cell-based particulate material of the present invention. Examples of a physical property that may be altered by cell fragmentation include a rheological property, such as the contribution to viscosity, flow, etc., the tendency to form a primary particle, an agglomerate, an aggregate, etc. An example of a chemical property that may be altered includes allowing greater contact between amine and hydroxyl moieties of internally located biomolecules (e.g., a proteinaceous molecule) with a coating component, which may undergo a chemical reaction (e.g., crosslinking) with a binder. An example of an optical property that may be altered includes an alteration in the gloss characteristic of a coating and/or film by a reduction in particle size due to cell fragmentation.

[0234] For example, during typical preparation of a water-borne and/or solvent-borne coating comprising particulate material such as a pigment and/or extender, the particulate material is dispersed into a paste known as a "grind" or "millbase." A combination of a binder and a liquid component known as a "vehicle" is used to disperse the particulate material into the grind. Often, a wetting additive is included to promoted dispersion of the particulate material. Additional vehicle and/or additives are admixed with the grind in a stage referred to as the "letdown" to produce a coating of a desired composition and/or properties. These techniques and others for coating preparation are well known to those of ordinary skill in the art [see, for example, in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D6619-00, 2002; in "Paint and Surface Coatings, Theory and Practice, Second Edition," (Lambourne, R. and Strivens, T. A., Eds.), pp. 286-329, 1999; and in "Paints, Coatings and Solvents, Second, Completely Revised Edition," (Stoye, D. and Freitag, W., Eds.) pp. 178-193, 1998.] It is specifically contemplated that these techniques may be used in preparing a coating comprising the cell-based particulate material of the present invention, wherein the cell-based particulate

material of the present invention is treated as a pigment, extender, or other such particulate material dispersed into a coating.

[0235] In another example, the effectiveness of the conversion of agglomerates and/or an aggregates into primary particles in the grind (e.g., pigments, pigment-vehicle combinations, pastes), and latter stages (e.g., lacquer, paint) are typically measured to insure quality, using techniques such as, for example, those described in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D1210-96, 2002; "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D2338-02, D1316-93 and D2067-97, 2002; and in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D185-84, 2002. It is specifically contemplated that these techniques for the preparation of coatings comprising a pigment, extender, or other particulate material may be used in the practice of the present invention in the preparation of a coating comprising a cell-based particulate material of the present invention.

[0236] In a further example, a cell-based particulate material of the present invention may be adapted for use in standard coating formulation techniques to optimize a coating composition for desired properties. As is known to those of ordinary skill in the art, the pigment volume concentration is the volume of pigment in the total volume solids of a dry film. The volume solids is the fractional volume of binder and pigment in the total volume of a coating. It is contemplated that in calculating the PVC, the content of a cell-based particulate material of the present invention would be included in this or related calculations as a pigment or extender. A related calculation to the PVC that is specifically contemplated is the critical pigment volume concentration ("CPVC") is the formulation of pigment and binder wherein the coating comprises the minimum amount of binder to fill the voids between the pigment particles. A pigment to binder concentration that exceeds the CPVC threshold produces a coating with empty spaces wherein gas (e.g., air, evaporated liquid component), may be trapped. Various properties rapidly change above the CPVC. For example, corrosion resistance, abrasion (e.g., scrub) resistance, stain resistance, opacity, moisture resistance, rigidity, gloss, or a combination thereof, are more rapidly reduced above the CPVC, while reflectance is often increased. However, in certain embodiments, coating may be formulated above the CPVC and still produce a film suitable for given use upon a surface. Standard procedures for determining CPVC are known to those of ordinary skill in the art [see, for example, in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D1483-95, D281-95 and D6336-98, 2002; and in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp. 252-258, 1995].

[0237] The physical and/or optical properties of a coating are affected by the size of particulate material comprised within the coating. For example, inclusion of a physically hard particulate material, such as a silica extender, may increase the abrasion resistance of a film. In another example, gloss is reduced when particulate material of a larger average particle size increases the roughness of the surface of a coating and/or film. Standard procedures for

determining particle properties (e.g., size, shape) are known to those of ordinary skill in the art (see, for example, "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D1366-86 and D3360-96, 2002; and in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp. 305-332, 1995).

[0238] It is also contemplated that a cell-based particulate material of the present invention may be incorporated into a powder coating. Specific procedures for determining the properties (e.g., particle size, surface coverage, optical properties) of a powder coating and/or film have been described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D3451-01, D2967-02a, D4242-02, D5382-02 and D5861-95, 2002.

[0239] In some embodiments, the dispersion of particulate material ("fineness of grind") in a coating is, in Hegman units ("Hu"), 0.0 Hu to 8.0 Hu, including all intermediate ranges and combinations thereof. The dispersion of particulate material content of a coating can be empirically determined, for example, as described in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D1210-96, 2002. The size of particulate matter in a coating can affect gloss, with smaller particle size generally more conducive for a higher gloss property of a coating and/or film. It is contemplated that a whole cell particulate material of the present invention will possess similar size and shape as the organism from which it was derived. For example, *E. coli* is about 2 μm in length and 0.8 μm in diameter, maize cells vary more in size, but a size of about 65 μm in diameter may be found in some cell types, and *Saccaromyces cerevisia* is about 10 μm in diameter. Of course, processing and purifying techniques may reduce the particle size by fragmentation of the cell wall and membrane, and it is contemplated that a cell-based particulate material of the present invention may be prepared to an average particle size for a specific purpose (e.g., gloss). In certain facets, a visibly coarse and/or low gloss coating (e.g., a low gloss finish, a flat latex paint) has a dispersion of particulate material of 2.0 Hu to 4.0 Hu. A particle size of 100 μm to 50 μm is associated with a dispersion of 0.0 Hu to 4.0 Hu. In some aspects, a semi-gloss or gloss coating has a dispersion of particulate material of 5.0 Hu to 7.5 Hu. A particle size of 50 μm to 40 μm , 40 μm to 26 μm , 26 μm to 13 μm , and 13 μm to 6 μm is associated with a dispersion of 4.0 Hu to 5.0 Hu, 5.0 Hu to 6.0 Hu, 6.0 Hu to 7.0 Hu, and 7.0 Hu to 7.5 Hu, respectively. In other aspects, a high gloss coating has a dispersion of particulate material of 7.5 Hu to 8.0 Hu. A particle size of 6 μm to 3 μm and 3 μm to 0.1 μm is associated with a dispersion of 7.5 Hu to 7.75 Hu and 7.75 Hu to 8.0 Hu, respectively. In embodiments wherein a coating comprises a combination of particulate materials, wherein the different particulate materials such as a combination of a cell-based particulate material of the present invention and one or more of different pigments, with each type of particulate material possessing a different average particle size, it is contemplated that the gloss will be affected most by the particle size of the largest type of particulate material added. However, gloss can also be empirically determined for a coating and/or film, as described herein or as would be known to one of ordinary skill in the art in light of the present disclosures.

[0240] H. Coatings

[0241] A coating ("coat," "surface coat," "surface coating") is "a liquid, liquefiable or mastic composition that is converted to a solid protective, decorative, or functional adherent film after application as a thin layer" ("Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook" (Koleske, J. V. Ed.), p. 696, 1995; and in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D16-00, 2002). Additionally, a thin layer is 5 μm to 5000 μm thick, including all intermediate ranges and combinations thereof. However, in most embodiments, it is contemplated that a coating will form a thin layer 15 μm to 150 μm thick, including all intermediate ranges and combinations thereof. Examples of a coating of the present invention include a clear coating or a paint.

[0242] A surface is the outer layer of any solid object. As would be known to those of ordinary skill in the art, the term "substrate," in the context of a coating, is synonymous with the term "surface." However, as "substrate" has a different meaning to those of skill in coating arts and biological arts, the term "surface" will be preferentially used herein for clarity. A surface wherein a coating has been applied, whether or not film formation has occurred, is known herein as a "coated surface."

[0243] As is known to those of ordinary skill in the art, a coating generally comprises one or more materials that contribute to the properties of the coating, the ability of a coating to be applied to a surface, the ability of the coating to undergo film formation, and/or the properties of the produced film. Examples of such coating components include a binder, a liquid component, a colorizing agent, an additive, or a combination thereof, and such materials are contemplated for used in a coating of the present invention. A coating typically comprises a material often referred to as a "binder," which is the primary material in a coating capable of film formation. Often the binder is the coating component that dominates conferring a physical and/or chemical property to a coating and/or film. Examples of properties of a binder typically affects include chemical reactivity, minimum film formation temperature, minimum T_g , volume fraction solids, a Theological property (e.g., viscosity), film moisture resistance, film UV resistance, film heat resistance, film weathering resistance, adherence, film hardness, film flexibility, or a combination thereof. Consequently, different categories of coatings may be identified herein by the binder used in the coating. For example, a binder may be an oil, a chlorinated rubber, or an acrylic, and examples of a coating comprising such binders include an oil coating, a chlorinated rubber-topcoat, an acrylic-lacquer, etc. In certain embodiments, a cell-based particulate material of the present invention may function as a binder, particularly in aspects wherein the coating comprises another thermosetting binder that may crosslink to the chemical moieties (e.g., hydroxyl moieties, amine moieties, polyols, carboxyl moieties, fatty acids, double bonds, etc.) typically found in cells.

[0244] In most embodiments, a coating will comprise a liquid component (e.g., a solvent, a diluent, a thinner), which often confers and/or alters the coating's rheological properties (e.g., viscosity) to ease the application of the coating to a surface. In some embodiments, a coating will comprise a

colorizing agent (e.g., a pigment), which usually functions to alter an optical property of a coating and/or film. In certain preferred embodiments, a cell-based particulate material of the present invention is a colorizing agent. In particularly preferred embodiments, a colorizing agent comprising a cell-based particulate material of the present invention is an extender, a pigment, or a combination thereof. In other preferred embodiments, a coating comprises a colorizing agent that comprises a cell-based particulate material of the present invention. A coating will often comprise an additive which is a composition incorporated into a coating to reduce and/or prevent the development of a physical, chemical, and/or aesthetic defect in the coating and/or film; confer some addition desired property to a coating and/or film; or a combination thereof. Examples of an additive include an accelerator, an adhesion promoter, an antioxidant, an anti-skinning agent, a coalescing agent, a defoamer, a dispersant, a drier, an emulsifier, a fire retardant, a flow control agent, a gloss aid, a leveling agent, a marproofing agent, a slip agent, a thickener, a UV stabilizer, a viscosity control agent, a wetting agent, or a combination thereof. In certain preferred embodiments, a cell-based particulate material of the present invention is an additive. In particularly preferred embodiments, an additive comprising a cell-based particulate material of the present invention comprises a viscosity control agent, a dispersant, or a combination thereof. In other preferred embodiments, a coating comprises an additive that comprises a cell-based particulate material of the present invention. A contaminant is a material that is unintentionally added to a coating, and may be volatile and/or non-volatile component of a coating and/or film. As would be known to those of ordinary skill in the art, a coating component may be categorized as possessing more than one defining characteristic, and thereby simultaneously functioning in a coating composition as a combination of a binder, a liquid component, a colorizing agent, and/or additive. Different coating compositions are described herein as examples of coatings with varying sets of properties.

[0245] In certain embodiments, a coating may be stored in a container ("pot") prior to application. In certain aspects, the coating is a multi-pack coating, which is a coating wherein different components are stored in a plurality of containers. Typically, this is done to reduce film formation during storage for certain types of coatings. The components are admixed prior to and/or during application. However, in certain embodiments, it is specifically contemplated that a coating comprising a cell-based particulate material of the present invention is a multi-pack coating. In specific aspects, the coating is a two-pack coating, three-pack coating, four-pack coating, five-pack coating, or more wherein the coating components are stored in separate containers. In certain aspects, 0.000001% to 100%, including all intermediate ranges and combinations thereof, of the cell-based particulate material is stored in a separate container from a coating component. It is contemplated that separate storage may reduce undesirable microorganism growth in the coating and/or coating component, damage to the cell-based particulate material of the present invention by the coating component, increase the storage life ("pot life") of a coating, reduce the amount of a preservative in a coating, or a combination thereof. In certain facets, it is contemplated that the coating components of a container holding the cell-based particulate material of the present invention may further include a coating component such as a preservative, a

wetting agent, a dispersing agent, a liquid component, a rheological modifier, or a combination thereof. It is contemplated that a preservative may reduce undesirable growth of a microorganism, whether the microorganism is derived from a microorganism-based particulate material of the present invention or a contaminating microorganism. It is contemplated that a wetting agent, a dispersing agent, a liquid component, a rheological modifier, or a combination thereof, may promote ease of admixing of coating components in a multi-pack coating. In certain aspects, a three-pack coating or four-pack coating may be used, wherein the first container and the second container contain coating components separated to reduced film formation during storage, and a third container comprises 0.000001% to 100%, including all intermediate ranges and combinations thereof, of the cell-based particulate material. In certain facets, a multi-pack coating may be used to separate two or more preparations of the cell-based particulate material of the present invention such as, for example, to reduce damage by microorganisms used in the preparation of a cell-based particulate material to a second preparation of cell-based particulate material during storage.

[0246] A coating may be applied to a surface using any technique known in the art. In the context of a coating, "application," "apply," or "applying" is the process of transferring of a coating to a surface to produce a layer of coating upon the surface. As known herein, an "applicator" is a device that is used to apply the coating to a surface. Examples of an applicator include a brush, a roller, a pad, a rag, a spray applicator, etc. Application techniques that are contemplated as suitable for a user of the present invention of little or no particular skill include, for example, dipping, pouring, siphoning, brushing, rolling, padding, ragging, spraying, etc. Certain types of coatings may be applied using techniques contemplated as more suitable for a skilled artisan such as anodizing, electroplating, and/or laminating of a polymer film onto a surface.

[0247] In certain embodiments, the layer of coating undergoes film formation ("curing," "cure"), which is the physical and/or chemical change of a coating to a solid that is a preferred solid when in the form of a layer upon the surface. In certain aspects, a coating may be prepared, applied and cured at an ambient condition, a baking condition, or a combination thereof. An ambient condition is a temperature range between -10° C. to 40° C., including all intermediate ranges and combinations thereof. As used herein, a "baking condition" or "baking" is contacting a coating with a temperature above 40° C. and/or raising the temperature of a coating above 40° C., typically to promote film formation. Examples of baking the coating include contacting a coating and/or raising the temperature of coating to 40° C. to 300° C., or more, including all intermediate ranges and combinations thereof. Various coatings described herein or as would be known to one of ordinary skill in the art may be applied and/or cured at ambient conditions, baking conditions, or a combination thereof.

[0248] It is contemplated that in general embodiments, a coating comprising a cell-based particulate material of the present invention may be prepared, applied and cured at any temperature range described herein or would be known to one of ordinary skill in the art in light of the present disclosures. An example of such a temperature range is -100° C. to 300° C., or more, including all intermediate

ranges and combinations thereof. However, a cell-based particulate material may further comprise a desired biomolecule (e.g., a colorant, an enzyme), whether endogenously or recombinantly produced, that may have a reduced tolerance to temperature. It is contemplated that the preferred temperature that can be tolerated by a biomolecule will vary depending on the specific biomolecule used in a coating, and will generally be within the range of temperatures tolerated by the living organism from which the biomolecule was derived. For example, it is preferred for a coating comprising a cell-based particulate material of the present invention that the coating is prepared, applied and cured at -100°C . to 110°C ., including all intermediate ranges and combinations thereof. For example, it is contemplated that a temperature of -100°C . to 40°C . including all intermediate ranges and combinations thereof, will be suitable for many biomolecules derived from an eukaryote, while temperatures up to, for example -100°C . to 50°C . including all intermediate ranges and combinations thereof, may be tolerated by biomolecules derived from many prokaryotes.

[0249] The type of film formation that a coating may undergo depends upon the coating components. A coating may comprise, for example, volatile coating components, non-volatile coating components, or a combination thereof. In certain aspects, the physical process of film formation comprises loss of 1% to 100%, including all intermediate ranges and combinations thereof, of a volatile coating component. In general embodiments, a volatile component is lost by evaporation. In certain aspects, loss of a volatile coating component during film formation reaction is promoted by baking the coating. Examples of volatile coating components include a coalescing agent, a solvent, a thinner, a diluent, or a combination thereof. A non-volatile component of the coating remains upon the surface. In specific aspects, the non-volatile component forms a film. Examples of non-volatile coating components include a binder, a colorizing agent, a plasticizer, a coating additive, or a combination thereof. It is contemplated that a cell-based particulate material of the present invention will be a non-volatile coating component. In specific aspects, a coating component may undergo a chemical change to form a film. In general embodiments, a binder undergoes a cross-linking (e.g., polymerization) reaction to produce a film. In general embodiments, a chemical film formation reaction occurs spontaneously under ambient conditions. In other aspects, a chemical film formation reaction is promoted by irradiating the coating, heating the coat, or a combination thereof. In some embodiments, irradiating the coating comprises exposing the coating to electromagnetic radiation, particle radiation, or a combination thereof. Examples of electromagnetic radiation used to irradiate a coating include UV radiation, infrared radiation, or a combination thereof. Examples of particle radiation used to irradiate a coating include electron-beam radiation. Often irradiating the coating induces an oxidative and/or free radical chemical reaction that cross-links of one or more coating components.

[0250] However, in some alternate embodiments, it is contemplated that a coating undergoes a reduced amount of film formation than such a solid film is not produced, or does not undergo film formation to a measurable extent during the period of time it is used on a surface. Such a coating is referred to herein as a "non-film forming coating." Such a non-film forming coating may be prepared, for example, by increasing the non-volatile component in a thermoplastic

coating (e.g., increasing plasticizer content in a liquid component), reducing the amount of a coating component that contributes to the film formation chemical reaction (e.g., a binder, a catalyst), increasing the concentration of a component that inhibits film formation (e.g., an antioxidant/radical scavenger in an oxidation/radical cured thermosetting coating), reducing the contact with an external curing agent (e.g., radiation, baking), selection of a non-film formation binder produced from components that lack crosslinking moieties, selection of a non-film formation binder that lack sufficient size to undergo thermoplastic film formation, or a combination thereof. As used herein, a "non-film formation binder" refers to a molecule that is chemically similar to a binder, but lacks sufficient size and/or crosslinking moiety to undergo film formation. For example, a coating may be prepared by selection of an oil-based binder that lacks sufficient double bonds to undergo sufficient crosslinking reactions to produce a film. In another example, a non-film formation binder may be selected that lacks sufficient crosslinking moieties such as an epoxide, an isocyanate, a hydroxyl, a carboxyl, an amine, an amide, a silicon moiety, etc., to produce a film by thermosetting. Such a non-film formation binder may be prepared by chemical modification of a binder, such as, for example, a crosslinking reaction with a small molecule (e.g., less than 1 kDa) that comprises a moiety capable of reaction with a binder's crosslinking moiety, to produce a chemically blocked binder moiety that is inert to a further crosslinking reaction. In another example, a thermoplastic binder typically comprises a molecule 29 kDa to 1000 kDa or more in size, though more specific, preferred ranges for different binders (e.g., acrylics, polyvinyls, etc.) are described herein. Film formation may be reduced or prevented by selection of a like molecule that is too small to effectively undergo thermoplastic film formation. An example would be selection of a non-film formation binder molecule between 1 kDa to 29 kDa in molecular weight, including all intermediate ranges and combinations thereof.

[0251] In other alternative embodiments, a coating may undergo film formation, but produce a film whose properties makes it more suited for a temporary use. Such a temporary film will generally possess a poor and/or low rating for a property that would confer longevity in use. For example, a film with a poor abrasion (e.g., scrub) resistance, a poor solvent resistance, a poor water resistance, a poor weathering property (e.g., UV resistance), a poor adhesion property, a poor microorganism/biological resistance, or a combination thereof, may be selected as a temporary film. Such a "poor" or "low" property would be known to one of ordinary skill in the art, and often the detection of the coating property (e.g., a change in the coating's color, gloss, loss of coating material) and/or is a rating in the half of a standard test rating scale and/or a detectable that is associated with a reduced longevity of use. In one aspect, a film may have poor adhesion for a surface, allowing ease of removal by stripping and/or peeling. In certain aspects, a poor or low adhesion rating on a scale of 0 (lowest adhesion) to 5 is denoted 2A, 1A, 0A, 2B, 1B, 0B, including all intermediate ranges and combinations thereof, as described in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D3359-97, 2002. Other examples of standard adhesion assays that may be used to determine a poor or low adhesion property rating include "ASTM Book of Standards, Volume 06.01, Paint—

Tests for Chemical, Physical, and Optical Properties; Appearance,” D5179-98 and D2197-98, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D4541-02, D3730-98, D4145-83, D4146-96, and D6677-01, 2002; and “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D5064-01, 2002. In other aspects, a poor or low abrasion rating for a coating is denoted as a detectable gloss, color and/or material erosion, such as an increase (“I”), large increase (“LI”), decrease (“D”), or large decrease (“LD”) gloss change, a slightly darker (“SD”), considerably darker (“CD”), slightly lighter (“SL”) or considerably lighter (“CL”) color change, a slight (“S”) or moderate (“M”) erosion change, including all intermediate ranges and combinations thereof for gloss, color and/or erosion, as described in “ASTM Book of Standards, and Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D4828-94, 2002. Additional examples of standard abrasion tests that may be used to determine a poor or low abrasion resistance property rating include those described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D968-93 and D4060-01, 2002; and “ASTM Book of Standards, and Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D3170-01, D4213-96, D2486-00, D3450-00, D6736-01, and D6279-99e1, 2002. Weathering resistance is described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D4141-01, D1729-96, D660-93, D661-93, D662-93, D772-86, D4214-98, D3274-95, D714-02, D1654-92, D2244-02, D523-89, D1006-01, D1014-95, and D1186-01, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D3719-00, D610-01, D1641-97, D2830-96, and D6763-02, 2002; and “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D822-01, D4587-01, D5031-01, D6631-01, D6695-01, D5894-96, and D4141-01, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D5722-95, D3361-01 and D3424-01, 2002. Examples of poor weathering resistance includes a blistering rating of dense (“D”), medium dense (“MD”), medium (“M”) blistering, a failure at scribe, which is a measure of corrosion and paint loss at the site of contact with a tool known as a scribe, in the range of 0 to 5, a rating of the unscribed areas of 0 to 5, a rust grade rating of a coated steel surface of 0 to 5, a general appearance rating of 0 to 5, a cracking rating of 0 to 5, a checking rating of 0 to 5, a dulling rating of 0 to 5, and/or a discoloration rating of 0 to 5, including all intermediate ranges and combinations thereof, respectively, as described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D714-02 and D1654-92, 2002; and “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D610-01 and D1641-97, 2002. In additional aspects, a poor or low solvent resistance rating for a coating is denoted as a solvent resistance rating of 0 to 2, a coating removal efficiency rating of 3 to 5, an effect of coating removal on the condition of the surface of 0 to 2, including all intermediate ranges and combinations thereof, respectively, as described in “ASTM

Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D4752-98, 2002; and “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D6189-97, 2002. An additional example of a standard solvent resistance assay is described in “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D5402-93, 2002. In further aspects, a poor or low water resistance rating for a coating is denoted as a discernable change in a coating’s color, blistering, adhesion, softening, and/or embrittlement upon conducting an assay as described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D2247-02 and D4585-99, 2002. Further assays for water resistance are described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D870-02, D1653-93, D17 35-02, 2002; and “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D2065-96, D2921-98, D3459-98, and D6665-01, 2002.

[0252] In particular aspects, growth of cells, particularly microorganisms, may produce a coating or film with reduced stability, film formation capability, durability, etc. Such a non-film forming film and/or temporary film may be prepared by the inclusion of the cell-based particulate material of the present invention, particularly in embodiments wherein the cell-based particulate material is not a sterilized cell-based particulate material, the coating has a reduced concentration of biocide (e.g., 0% to 99.9999%, including all intermediate ranges and combinations thereof, a typically used concentration for a coating comprising the cell-based particulate material), the coating comprises a nutrient (e.g., a cell-based particulate material of the present invention, other digestible material, vitamins, trace minerals, etc.) as a coating component (e.g., an additive) that promotes cell growth, or a combination thereof.

[0253] In additional aspects, a poor or low microorganism/biological resistance rating for a coating is denoted as a colony recovery/growth rating of 2 to 4, a discoloration/disfigurement rating of 0 to 5, a fouling resistance (“F.R.”) or antifouling film (“A.F.”) rating of 0 to 70, and observed growth (e.g., fungal growth) on specimens of 2 to 4, including all intermediate ranges and combinations thereof, respectively, as described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D3274-95, D2574-00, D3273-00, D5589-97 and D5590-00, 2002; and in “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D3623-78a, 2002. An additional example of a standard microorganism/biological resistance assay is described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D4610-98 and D3456-86, 2002; in “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D4938-89, D4939-89, D5108-90, D5479-94, D6442-99, D6632-01, D4940-98 and D5618-94, 2002; and “ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles,” D912-81 and D964-65, 2002.

[0254] In another example, a film may have a poor resistance to an environmental factor, and subsequently fail (e.g., crack, peel, chalk, etc.) to remain a viable film upon the surface. For example, a film that undergoes chalking is specifically contemplated. Chalking is the erosion a coating, typically by degradation of the binder due to various environmental forces (e.g., UV irradiation). It is contemplated that in some embodiments, chalking may be desirable, to expose remove a contaminant from the surface of a film and/or expose a component of the film (e.g., a cell-based particulate material of the present invention) to the surface of the coating. In some aspects, a chalking coating has a chalking rating on a "Wet Finger Method" of visible or severe and/or a chalk reflectance rating of 0 to 5, including all intermediate ranges and combinations thereof, as described in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D4214-98, 2002. A self-cleaning coating is a film with a desirable high chalking property. It is further contemplated that in many aspects the layer of non-film forming coating, a temporary film and/or a self-cleaning film may be removed from a surface with ease. In such embodiments, a non-film forming coating, a temporary film, a self-cleaning film, or a combination thereof would be more suitable for a temporary use upon a surface, due to the ability to be applied as a layer and easily removed when its presence is no longer desired. In these embodiments, it is contemplated that the non-film forming coating, the temporary film, the self-cleaning film, or a combination thereof, is desired for a use upon a surface that lasts a temporary period of time, such as, for example, 1 to 60 seconds, 1 to 24 hours, 1 to 7 days, 1 to 10 weeks, 1 to 6 months, including all intermediate ranges and combinations thereof, respectively.

[0255] In some embodiments, a plurality of coating layers, known herein as a "multicoat system" ("multicoating system"), may be applied upon a surface. The coating selected for use in a specific layer may differ from an additional layer of the multicoat system. This selection of coatings with differing components and/or properties is typically done to sequentially confer, in a desired pattern, the properties of differing coatings to a coated surface and/or multicoat system. Examples of a coating that may be selected for use, either alone or in a multicoat system, includes a sealer, a water repellent, a primer, an undercoat, a topcoat, or a combination thereof. A sealer is coating applied to a surface to reduce or prevent absorption by the surface of a subsequent coating layer and/or a coating component thereof, and/or to prevent damage to the subsequent coating layer by the surface. A water repellent is a coating applied to a surface to repel water. A primer is a coating that is applied to increase adhesion between the surface and a subsequent layer. In typical embodiments a primer-coating, a sealer-coating, a water repellent-coating, or a combination thereof is applied to porous surface. Examples of a porous surface include drywall, wood, plaster, masonry, damaged and/or degraded film, corroded metal, or a combination thereof. In certain aspects, the porous surface is not coated or lacks a film prior to application of a primer, a sealer, a water repellent, or combination thereof. An undercoat is a coating applied to surface to provide a smooth surface for a subsequent coat. A topcoat ("finish") is a coating applied to a surface for a protective and/or decorative purpose. Of course, a sealer, water repellent, primer, undercoat, and/or topcoat may possess additional protective, decorative, and/or

functional properties. Additionally, the surface a sealer, water repellent, primer, undercoat, and/or topcoat are applied to may be a coated surface such as a coating and/or film of a layer of the a multicoat system. In certain embodiments, a multicoat system may comprise any combination of a sealer, water repellent, primer, undercoat, and/or topcoat. For example, a multicoat system may comprise any of the following combinations: a sealer, a primer and a topcoat; a primer and topcoat; a water repellent, a primer, undercoat, and topcoat; an undercoat and topcoat; a sealer, an undercoat, and a topcoat; a sealer and topcoat; a water repellent and topcoat, etc. In particular aspects, a coating layer may comprise properties that would be a combination of those associated with different coating types such as a sealer, water repellent, primer, undercoat, and/or topcoat. In such instances, such a combination coating and/or film is designated by a backslash "/" separating the individual coating designations encompassed by the layer. Examples of such a coating layer comprising a plurality of functions include a sealer/primer coating, a sealer/primer/undercoat coating, a sealer/undercoat coating, a primer/undercoat coating, a water repellent/primer coating, an undercoat/topcoat coating, a primer/topcoat coating, a primer/undercoat/topcoat coating, etc. In embodiments wherein the coated surface comprises a particular type of coating, then the coated surface may be known herein by the type of coating such as a "painted surface," a "clear coated surface," a "lacquered surface," a "varnished surface," a "water repellent/primered surface," an "primer/undercoat-topcoated surface," etc.

[0256] In specific aspects, a multicoat system may comprise a plurality of layers of the same type, such as, for example, 1 to 10 layers, including all intermediate ranges and combinations thereof, of a sealer, water repellent, primer, undercoat, topcoat, or any combination thereof. In specific facets, a multicoat system comprises a plurality of layers of the same coating type, such as, for example, 1 to 10 layers, including all intermediate ranges and combinations thereof, of a sealer, water repellent, primer, undercoat, or topcoat. In embodiment where a coating does not comprise a multicoat system, but a single layer of coating applied to a surface, such a layer, regardless of typical function in a multicoat system, is regarded herein as a topcoat.

[0257] 1. Paints

[0258] A paint is a "pigmented liquid, liquefiable or mastic composition designed for application to a substrate in a thin layer which is converted to an opaque solid film after application. Used for protection, decoration or identification, or to serve some functional purpose such as the filling or concealing of surface irregularities, the modification of light and heat radiation characteristics, etc." ["Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook" (Koleske, J. V. Ed.), p. 696, 1995]. However, as certain coatings disclosed herein are non-film forming coatings, this definition is modified herein to encompass a coating with the same properties of a film forming paint, with the exception that it does not produce a solid film. In particular embodiments, a non-film forming paint possesses a hiding power sufficient to concealing surface feature comparable to an opaque film.

[0259] Hiding power is the ability of a coating and/or film to prevent light from being reflected from a surface, par-

ticularly to convey the surface's visual pattern. Opacity is the hiding power of a film. An example of hiding power would be the ability of a paint-coating to visually block the appearance of grain and color of a wooden surface, as opposed to a clear varnish-coating allowing the relatively unobstructed appearance of wood to pass through the coating. Standard techniques for determining the hiding power of a coating and/or film (e.g., paint, a powder coating) are described, for example, in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," E284-02b, D344-97, D2805-96a, D2745-00 and D6762-02a 2002; "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D5007-99, D5150-92 and D6441-99, 2002; and "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook" (Koleske, J. V. Ed.), pp. 481-506, 1995.

[0260] 2. Clear-Coatings

[0261] A clear-coating is a coating that is not opaque and/or does not produce an opaque solid film after application. A clear-coating and/or film may be transparent or semi-transparent (e.g., translucent). A clear-coating may be colored or non-colored. In certain embodiments, reducing the content of a pigment in a paint composition may produce a clear-coating. Additionally, a clear-coating may comprise a lacquer, a varnish, a shellac, a stain, a water repellent coating, or a combination thereof. Though some opaque coatings are referred to in the art as a lacquer, a varnish, a shellac, or a water repellent coating, all such opaque coatings are considered as paints herein (e.g., a lacquer-paint, a varnish-paint, a shellac-paint, a water repellent paint).

[0262] a. Varnishes

[0263] A varnish is a thermosetting coating that converts to a transparent or translucent solid film after application. In general embodiments, a varnish is a wood-coating. A varnish comprises an oil and a dissolved binder. In general embodiments, the oil comprises a drying oil, wherein the drying oil functions as an additional binder. In other embodiments, the binder is solid at ambient conditions prior to dissolving into the oil and/or an additional liquid component of the varnish. Examples of a dissolvable binder include resins obtained from a natural source (e.g., a Congo resin, a copal resin, a damar resin, a kauri resin), a synthetic resin, or a combination thereof. In specific aspects, the additional liquid component comprises a solvent such as a hydrocarbon solvent. In some facets, the solvent is added to reduce viscosity of the varnish. A varnish may further comprise a coloring agent, including a pigment, for such purposes as conferring or altering a color, gloss, sheen, or a combination thereof. A varnish undergoes thermosetting film formation by oxidative cross-linking. In certain aspects, a varnish may additionally undergo film-formation by evaporation of a volatile component. The dissolved binder generally functions to shorten the time to film-formation relative to certain measures (e.g., dryness, hardness), though the final cross-linking reaction time may not be significantly or measurably shortened. Standards for determining a varnish-coating and/or film's properties are described in, for example, "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D154-85, 2002.

[0264] b. Lacquers

[0265] A lacquer is a thermoplastic, solvent-borne coating that converts to a transparent or translucent solid film after application. In general embodiments, a lacquer is a wood-coating. A lacquer-coating comprises a thermoplastic binder dissolved in a liquid component comprising an active solvent. Examples of a thermoplastic binder include a cellulosic binder (e.g., nitrocellulose, cellulose acetate), a synthetic resin (e.g., an acrylic), or a combination thereof. In certain aspects, a liquid component comprises an active solvent, a latent solvent, diluent, a thinner, or a combination thereof. In certain embodiments, a lacquer is nonaqueous dispersion ("NAD") lacquer, wherein the content of solvent is not sufficient to fully dissolve the thermoplastic binder. In certain aspects, a lacquer may comprise an additional binder (e.g., an alkyd), a colorant, a plasticizer, or a combination thereof. Film formation of a lacquer occurs by loss of the volatile components, typically through evaporation.

[0266] Standards for a lacquer-coating and/or film's composition (e.g., a lacquer, a pigmented-lacquer, a nitrocellulose lacquer, a nitrocellulose-alkyd lacquer), physical and/or chemical properties (e.g., heat and cold resistance, hardness, film-formation time, stain resistance, particulate material dispersion), and procedures for testing a lacquer's composition/properties, are described in, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D333-01, D2337-01, D3133-01, D365-01, D2091-96, D2198-02, D2199-82, D2571-95 and D2338-02, 2002.

[0267] c. Shellacs

[0268] A shellac is similar to a lacquer, but the binder does not comprise a nitrocellulose binder, and the binder is soluble in alcohol, and the binder is obtained from a natural source. A preferred binder comprises *Lacifer lacca* beetle secretion. In general embodiments, a shellac comprises a liquid component (e.g., alcohol). In specific aspects, the additional liquid component comprises a solvent. In some facets, the liquid component is added to reduce viscosity of the varnish. In other embodiments, a shellac undergoes rapid film formation. Standards for a shellac-coating and/or film's composition and properties are described in, for example, "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D29-98 and D360-89, 2002.

[0269] d. Stains

[0270] A stain is a clear or semitransparent coating formulated to change the color of surface. In general embodiments, a stain is a wood-coating designed to color or protect a wood surface but not conceal the grain pattern or texture. A stain comprises a binder such as an oil, an alkyd, or a combination thereof. Often a stain comprises a low solid content. A low solids content for a wood stain is less than 20% volume of solids. The low solid content of a stain promotes the ability of the coating to penetrate the material of the wooden surface. This property is often used to, for example, to promote the incorporation of a fungicide that may be comprised within the stain into the wood. In certain alternative aspects, a stain comprises a high solids content stain, wherein the solid content is 20% or greater, may be used on a surface to produce a film possessing the property of little or no flaking. In other alternative aspects, a water-borne stain may be used such as a stain comprising a water-borne alkyd. A stain typically further comprises a

liquid component (e.g., a solvent), a fungicide, a pigment, or a combination thereof. In other aspects, a stain comprises a water repellent hydrophobic compound so it functions as a water repellent-coating (“stain/water repellent-coating”). Examples of a water repellent hydrophobic compound a stain may comprise include a silicone oil, a wax, or a combination thereof. Examples of a fungicide include a copper soap, a zinc soap, or a combination thereof. Examples of a pigment include a pigment that is similar in color to wood. Examples of such pigments include a red pigment (e.g., a red iron oxide) a yellow pigment (e.g., a yellow iron oxide), or a combination thereof. Standards procedures for testing a stain’s (e.g., an exterior stain) properties, are described in, for example, in “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D6763-02, 2002.

[0271] e. Water Repellent-Coatings

[0272] A water repellent-coating is a coating that comprises hydrophobic compounds that repel water. A water repellent-coating is typically applied to a surface susceptible to water damage, such as metal, masonry, wood, or a combination thereof. A water repellent-coating typically comprises a hydrophobic compound and a liquid component. In specific embodiments, a water repellent-coating comprises 1% to 65% hydrophobic compound, including all intermediate ranges and combinations thereof. Examples of a hydrophobic compound that may be selected include an acrylic, a silicate, a metal-searate, a silane, a siloxane, a paraffinic wax, or a combination thereof. A water repellent may be a water-borne coating, or a solvent-borne coating. A solvent-borne water repellent-coating typically comprises a solvent that dissolves the hydrophobic compound. Examples of solvents include an aliphatic, an aromatic, a chlorinated solvent, or a combination thereof.

[0273] In certain embodiments, a water repellent-coating, undergoes film formation, penetrates pores, or a combination thereof. In certain aspects, an acrylic-coating, a silicone-coating, or a combination thereof, undergoes film formation. In other aspects, a metal-searate, a silane, a siloxane, a paraffinic wax, or a combination thereof, penetrates pores in a surface. In some facets, a water repellent-coating (e.g., a silane, a siloxane) covalently bonds to a surface and/or pore (e.g., masonry). Standards for a water repellent-coating and/or film’s composition and properties are described in, for example, “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D2921-98, 2002; and in “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 748-750, 1995. Alternatively, standards for a sealer-coating (e.g., a floor sealer) and/or film’s composition and properties are described in, for example, “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D1546-96, 2002.

[0274] 3. Coating Categories by Use

[0275] In light of the present disclosures, one of ordinary skill in the art may prepare and apply a coating of the present invention to any surface. However, it is preferred that the coating components and methods described herein are selected for a particular application to provide a coating and/or film with properties best suited for a particular use.

For example, a coating used in an external environment would preferably comprise a coating component of superior UV resistance than a coating used in interior environment. In another example, a film used upon a surface of a washing machine would preferably comprise a component that confers superior moisture resistance than a component of a film for use upon a ceiling surface. In a further example, a coating applied to the surface of an assembly line manufactured product would preferably comprise components suitable for application by a spray applicator. Various properties of coating components are described herein to provide guidance to the selection of specific coating compositions with a suitable set of properties for a particular use.

[0276] A coating of the present invention may be classified by its preferred end use, including, for example, as an architectural coating, an industrial coating, a specification coating, or a combination thereof. An architectural coating is “an organic coating intended for on-site application to interior or exterior surfaces of residential, commercial, institutional, or industrial buildings, in contrast to industrial coatings. They are protective and decorative finishes applied at ambient conditions”[“Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook” (Koleske, J. V. Ed.), p. 686, 1995)]. An industrial coating is a coating applied in a factory setting, typically for a protective and/or aesthetic purpose. A specification coating (“specification finish coating”) is a coating formulated to a “precise statement of a set of requirements to be satisfied by a material, produce, system, or service that indicates the procedures for determining whether each of the requirements are satisfied”[“Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook” (Koleske, J. V. Ed.), p. 891, 1995]. Often, a coating may be categorized as a combination of an architectural coating, an industrial coating, and/or a specification coating. For example, a coating for the metal surfaces of ships may be classified as specification coating, as specific criteria of water resistance and corrosion resistance are required in the film, but typically such a coating can be classified as an industrial coating, since it would typically be applied in a factory. Various examples of an architectural coating, an industrial coating and/or a specification coating and coating components are described herein. Additionally, architectural coatings, industrial coatings, specification coatings are known to those of ordinary skill in the art, and are described, for example, in “Paint and Surface Coatings: Theory and Practice” 2nd Edition, pp. 190-192, 1999; in “Paints, Coatings and Solvents” 2nd Edition, pp. 330-410, 1998; in “Organic Coatings: Science and Technology, Volume 1: Film Formation, Components, and Appearance” 2nd Edition, pp. 138 and 317-318.

[0277] a. Architectural Coatings

[0278] An architectural coating (“trade sale coating,” “building coating,” “decorative coating,” “house coating”) is a coating suitable to coat surface materials commonly found as part of buildings and/or associated objects (e.g., furniture). Examples of a surface an architectural coating is typically applied to include, a plaster surface, a wood surface, a metal surface, a composite particle board surface, a plastic surface, a coated surface (e.g., a painted surface), a masonry surface, a floor, a wall, a ceiling, a roof, or a combination thereof. Additionally, an architectural coating may be applied to an interior surface, an exterior surface, or

a combination thereof. An interior coating generally possesses properties such as minimal odor (e.g., no odor, very low VOC), good blocking resistance, print resistance, good washability (e.g., wet abrasion resistance), or a combination thereof. An exterior coating typically is selected to possess good weathering properties. Examples of coating type commonly used as an architectural coating include an acrylic-coating, an alkyd-coating, a vinyl-coating, a urethane-coating, or a combination thereof. In certain aspects, a urethane-coating is applied to a piece of furniture. In other facets, an epoxy-coating, a urethane-coating, or a combination thereof, is applied to a floor. In some embodiments, an architectural coating is a multicoat system. In certain aspects, an architectural coating is a high performance architectural coating ("HIPAC"). A HIPAC is architectural coatings that produce a film with a combination of good abrasion resistance, staining resistance, chemical resistance, detergent resistance, and mildew resistance. Examples of binders suitable for producing a HIPAC include a two-pack epoxide or urethane, or a moisture cured urethane. In general embodiments, an architectural coating comprises a liquid component, an additive, or a combination thereof. In certain aspects, an architectural coating is a water-borne coating or a solvent-borne coating. In other aspects, an architectural coating comprises a pigment. In preferred aspects, such an architectural coating is formulated to comprise a reduced amount or lack a toxic coating component. Examples of a toxic coating component include a heavy metal (e.g., lead), formaldehyde, a nonyl phenol ethoxylate surfactant, a crystalline silicate, or a combination thereof.

[0279] In certain embodiments, a water-borne coating has a density of 1.20 kg/L to 1.50 kg/L, including all intermediate ranges and combinations thereof. In other embodiments, a solvent-borne coating has a density of 0.90 kg/L to 1.2 kg/L, including all intermediate ranges and combinations thereof. The density of a coating can be empirically determined, for example, as described in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D1475-98, 2002. In certain embodiments, the coarse particle content of an architectural coating, by weight, is 0.5% or less. The coarse particle (e.g., coarse contaminants, pigment agglomerates) content of a coating can be empirically determined, for example, as described in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D185-84, 2002. In some embodiments, the viscosity for an architectural coating at relatively low shear rates used during typical application, in Krebs Units ("Ku"), is 72 Ku to 95 Ku, including all intermediate ranges and combinations thereof.

[0280] In typical use, an architectural coating is often stored in a container for months or even years prior to first use, and/or between different uses. In many embodiments, it will be preferred that a building coating will retain a desirable set properties of a coating, film formation, film, or a combination thereof, for a period of 12 months or greater in a container at ambient conditions. Properties that are preferred for storage include settling resistance, skinning resistance, coagulation resistance, viscosity alteration resistance, or a combination thereof. Storage properties can be empirically determined for a coating (e.g., an architectural coating) as described, for example, in "ASTM Book of

Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D869-85 and D1849-95, 2002.

[0281] It is preferred that application and/or film formation of an architectural coating occurs at ambient conditions to provide ease of use to a casual user of the coating, as well as reduce potential damage to the target surface and the surrounding environment (e.g., unprotected people and objects). In general embodiments, it is preferred that an architectural coating does not undergo film formation by a temperature greater than 40° C. to reduce possible heat and fire damage. In other embodiments, it is preferred that an architectural coating is suitable to be applied by using hand-held applicator. Hand-held applicators are generally can be used without difficulty by most users of a coating, and examples include a brush, a roller, a sprayer (e.g., a spray can), or a combination thereof.

[0282] Specific procedures for determining the suitability of a coating and/or film for use as an architectural coating (e.g., a water-borne coating, a solvent-borne coating, an interior coating, an exterior paint, a latex paint), and specific assays for properties typically desired in an architectural coating (e.g., blocking resistance, hiding power, print resistance, washability, weatherability, corrosion resistance) have been described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D5324-98, D5146-98, D3730-98, D1848-88, D5150-92, D2064-91, D4946-89, D6583-00, D3258-00, and D3450-00, 2000; "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D660-93, D4214-98, D772-86, D662-93, and D661-93, 2002; and in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook" (Koleske, J. V. Ed.), pp. 696-705, 1995.

(1) Wood Coatings

[0283] As is well known to those of ordinary skill in the art, a wood coating is often selected to protect the wood from damage, as well as aesthetic purposes. For example, wood is susceptible to damage from bacteria and fungi. Examples of fungi that damage wood include *Aureobasidium pullulans*, and Ascomycotina, Deutermycotina, Basidiomycetes, *Coniophora puteana*, *Serpula lacrymans*, and *Dacrymyces stillatus*. It is preferred that a wooden surface is impregnated with a preservative such as a fungicide, prior to application of a coating of the present invention. However, most wood that is contemplated as a surface for a coating of the present invention is provided this way from wood suppliers. Specific procedures for determining the presence of a preservative and/or water repellent in wood have been described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D2921-98, 2002.

[0284] Typically, wood surfaces are coated with a paint, a varnish, a stain, or a combination thereof. Often, the choice of coating is based on the ability of a coating to protect the wood from damage by moisture. Generally, a paint, a varnish, and a stain generally have progressively greater permeability to moisture, and moisture penetration of a wooden surface can which can lead to undesirable alterations in wood structure (e.g., splitting); undesirable alter-

ation in piece of wood's dimension ("dimensional movement") such as shrinking, swelling, and/or warping; promote the growth of a microorganism such as fungi (e.g., wet rot, dry rot); or a combination thereof. Additionally, UV light irradiation damages a wood surface by depolymerizing lignin comprised in the wood. It is preferred that in embodiments wherein a wood surface is irradiated by UV light (e.g., sunlight), the wood coating comprises a UV protective agent such as a pigment that absorbs UV light. An example of a UV absorbing pigment includes a transparent iron oxide.

[0285] A preferred paint for use on a wood surface comprises an oil-paint, an alkyd-paint, or a combination thereof. A preferred alkyd-paint for use on a wood surface comprises a solvent-borne paint. A preferred paint system comprises a combination of a primer, an undercoat, and a topcoat. A film produced by a paint is often moisture impermeable. A film produced by paint upon a wooden surface may crack, flake, trap moisture that can encourage wood decay, be expensive to repair, or a combination thereof.

(2) Masonry Coatings

[0286] Masonry coatings refer to coatings used on a masonry surface, such as, for example, stone, brick, tile, cement-based materials (e.g., concrete, mortar), or a combination thereof. In general embodiments, a masonry coating is selected to confer resistance to water (e.g., salt water), resistance to acid conditions, alteration of appearance (e.g., color, brightness), or a combination thereof. Typically, a masonry coating comprises a multicoat system. In specific embodiments, a masonry multicoat system comprises a primer, a topcoat, or a combination thereof. Examples of a masonry primer include a rubber primer (e.g., a styrene-butadiene copolymer primer). In certain embodiments, a topcoat comprises a water-borne coating or a solvent borne coating. Examples of a water-borne coating that may be selected for a masonry topcoat include a latex coating, a water reducible polyvinyl acetate-coating, or a combination thereof. In certain aspects, a solvent-borne topcoat comprises a thermoplastic coating, a thermosetting coating, or a combination thereof. Examples of a thermosetting coating include an oil, an alkyd, a urethane, an epoxy, or a combination thereof. In certain aspects, a thermosetting coating is a multi-pack coating, such as, for example, an epoxy, a urethane, or a combination thereof. In specific aspects, a thermosetting coating undergoes film formation at ambient conditions. In other aspects, a thermosetting coating undergoes film formation at film formation at an elevated temperature such as a baking alkyd, a baking acrylic, a baking urethane, or a combination thereof. Examples of a thermoplastic coating include an acrylic, cellulosic, a rubber-derivative, a vinyl, or a combination thereof. In specific aspects, a thermoplastic coating is a lacquer.

[0287] A masonry surface that is basic in pH, such as, for example, cement-based material and/or a calcareous stone (e.g., marble, limestone) may be damaging to certain coatings. Specific procedures for determining the pH of a masonry surface have been described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D4262, 2002. Due to porosity and/or contact with an external environment, a masonry surface often accumulates dirt and other loose surface contaminants, which are preferably removed prior to application of a coating. Specific proce-

dures for preparative cleaning (e.g., abrading, acid etc. hing) of a masonry surface (e.g., sandstone, clay brick, concrete) have been described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D4259-88, D4260-88D, 5107-90, D5703-95, D4261-83 and D4258-83, 2002. In certain embodiments, moisture at or near a masonry surface may be undesirable during application of a coating (e.g., a solvent-borne coating). Specific procedures for determining the presence of such moisture upon a masonry surface have been described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D4263-83, 2002. Specific procedures for determining the suitability of a coating and/or film, particularly in conferring water resistance to a masonry surface, have been described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D6237-98, D4787-93, D5860-95, D6489-99, D6490-99 and D6532-00, 2002. Additional procedures for determining the suitability of a coating and/or film for use as a masonry coating have been described, for example, in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp. 725-730, 1995.

(3) Artist's Coatings

[0288] Artist coatings refer to a coating used by artists for a decorative purpose. Often, an artist's coating (e.g., paint) is selected for durability for decades or centuries at ambient conditions, usually indoors. Coatings such as an alkyd coating, an oil coating, an oleoresinous coating, an emulsion (e.g., acrylic emulsion) coating, or a combination thereof, are typically selected for use as an artist's coating. Specific standards for physical properties, chemical properties, and/or procedures for determining the suitability (e.g., lightfastness) of a coating and/or film for use as an artist's coating have been described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D4236-94, D5724-99, D4302-99, D4303-99, D4941-89, D5067-99, D5098-99, D5383-02, D5398-97, D5517-00 and D6801-02a, 2002; and in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp. 706-710, 1995.

[0289] b. Industrial Coatings

[0290] An industrial coating is a coating applied to a surface of a manufactured product in a factory setting. An industrial coating typically undergoes film formation to produce a film with a protective and/or aesthetic purpose. Industrial coatings share some similarities to an architectural coating, such as comprising similar coating components, being applied to the same material types of surfaces, being applied to an interior surface, being applied to an exterior surface, or a combination thereof. Examples of coating types that are commonly used for an industrial coating include an epoxy-coating, a urethane-coating, alkyd-coating, a vinyl-coating, chlorinated rubber-coating, or a combination thereof. Examples of a surface commonly coated by an industrial coating include metal (e.g., aluminum, zinc, copper, an alloy, etc.); glass; plastic; cement; wood; paper; or a combination thereof. An industrial coating may be storage stable for 12 months or more, applied at ambient conditions,

applied using a hand-held applicator, undergo film formation at ambient conditions, or a combination thereof.

[0291] However, an industrial coating often does not meet one or more of these characteristics previously described as preferred for an architectural coating. For example, an industrial coating may have a storage stability of only days, weeks, or months, as due to a more rapid use rate in coating factory prepared items. An industrial coating may be applied and/or undergo film formation at baking conditions. An industrial coating may be applied using techniques such as, for example, spraying by a robot, anodizing, electroplating, and/or laminating of a coating and/or film onto a surface. In some embodiments, an industrial coating undergoes film formation by irradiating the coating with non-visible light electromagnetic radiation and/or particle radiation such as UV radiation, infrared radiation, electron-beam radiation, or a combination thereof.

[0292] In certain embodiments, an industrial coating comprises an industrial maintenance coating, which is a coating that produces a protective film with excellent heat resistance (e.g., 121° C. or greater), solvent resistance (e.g., an industrial solvent, an industrial cleanser), water resistance (e.g., salt water, acidic water, alkali water), corrosion resistance, abrasion resistance (e.g., mechanical produced wear), or a combination thereof. An example of an industrial maintenance coating includes a high-temperature industrial maintenance coating, which is applied to a surface intermittently or continuously contacted with a temperature of 204° C. or greater. An additional example of an industrial maintenance coating is an industrial maintenance anti-graffiti coating, which is a two-pack clear coating applied to an exterior surface that is intermittently contacted with a solvent and abrasion. Examples of coating types that are commonly used for an industrial maintenance coating include an epoxy-coating, a urethane-coating, alkyd-coating, a vinyl-coating, chlorinated rubber-coating, or a combination thereof.

[0293] Industrial coatings (e.g., coil coatings) and their use are well known to those of ordinary skill in the art (see, for example, in "Paint and Surface Coatings: Theory and Practice," 2nd Edition, pp. 502-528, 1999; in "Paints, Coatings and Solvents," 2nd Edition, pp. 330-410, 1998; in "Organic Coatings: Science and Technology, Volume 1: Film Formation, Components, and Appearance," 2nd Edition, pp. 138, 317-318). Standard procedures for determining the properties of an industrial coating (e.g., an industrial wood coating, an industrial water-reducible coating) have been described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D4712-87a, D6577-00a, D2336-99, D3023-98, D3794-00, D4147-99 and D5795-95, 2002.

(1) Automotive Coatings

[0294] Automotive coatings refer to coatings used on automotive vehicles, particularly those for civilian use. The manufacturers of a vehicle typically require that a coating conform to specific properties of weatherability (e.g., UV resistance) and/or appearance. Typically, an automotive coating comprises a multicoat system. In specific embodiments, an automotive multicoat system comprises a primer, a topcoat, or a combination thereof. Examples of an automotive primer include a nonweatherable primer, which lack

sufficient UV resistance for single layer use, or a weatherable primer, which possesses sufficient UV resistance to be used without an additional layer. Examples of a topcoat include an interior topcoat, an exterior topcoat, or a combination thereof.

[0295] Examples of a nonweatherable automotive primer include a primer applied by electrodeposition, a conductive ("electrostatic") primer, or a nonconductive primer. In certain embodiments, a primer is applied by electrodeposition, wherein a metal surface is immersed in a primer, and electrical current promotes application of a primer component (e.g., a binder) to the surface. An example of a metal primer suitable for electrodeposition application includes a primer comprising an epoxy binder comprising an amino moiety, a blocked isocyanate urethane binder, and a 75% to 95% aqueous liquid component. In other embodiments, a primer is a conductive primer, which allows additional coating layers to be applied using electrostatic techniques. A conductive primer typically is applied to a plastic surface, including a flexible plastic surface or a nonflexible plastic surface. Such primers vary in their respective flexibility property to better suit use upon the surface. An example of a flexible plastic conductive primer includes a primer comprising polyester binder, a melamine binder and a conductive carbon black pigment. An example of a nonflexible plastic primer includes a primer that comprises an epoxy ester binder and/or an alkyd binder, a melamine binder and conductive carbon black pigment. In certain embodiments, a melamine binder may be partly or fully replaced with an aromatic isocyanate urethane binder, wherein the coating is a two-pack coating. A nonconductive primer is similar to a conductive primer, except the carbon-black pigment is absent or reduced in content. In certain embodiments, a nonconductive primer is a metal primer, a plastic primer, or a combination thereof. In specific aspects, the nonconductive primer comprises a pigment for colorizing purposes.

[0296] Examples of a weatherable automotive primer include a primer/topcoat or a conductive primer. An example of a primer/topcoat includes a flexible plastic primer, with suitable weathering properties (e.g., UV resistance) to function as a single layer topcoat. Examples of a flexible plastic primer include a primer comprising an acrylic and/or polyester binder and a melamine binder. In certain embodiments, a melamine binder may be partly or fully replaced with an aliphatic isocyanate urethane binder, wherein the coating is a two-pack coating. A weatherable conductive primer typically is similar to a weatherable primer/topcoat, including a conductive pigment. In specific aspects, a weatherable automotive primer comprises a pigment for colorizing purposes.

[0297] An interior automotive topcoat typically is applied to a metal surface, a plastic surface, a wood surface, or a combination thereof. In certain aspects, an interior automotive topcoat is part of a multicoat system further comprising a primer. Examples of an interior automotive topcoat include a coating comprising a urethane binder, an acrylic binder, or a combination thereof.

[0298] An exterior automotive topcoat is typically applied to a metal surface, a plastic surface, or a combination thereof. In certain aspects, an exterior automotive topcoat is part of a multicoat system further comprising a primer, a sealer, an undercoat, or a combination thereof. In certain embodiments, an exterior automotive topcoat comprises a

lead peroxide), an adhesion promoter, an extender pigment, and a light stabilizer. A silicone sealant typically comprises a polydimethylsiloxane and a methyltriacetoxysilane, a methyltrimethoxysilane, a methyltricyclorhexylaminosilane, or a combination thereof. A water-borne acrylic latex sealant typically comprises a thermoplastic acrylic, a filler, a surfactant, a thixotrope, an additive, and a liquid component. Procedures for determining the suitability of a coating and/or film for use as an sealant coating have been described, for example, in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp. 735-740, 1995.

(4) Marine Coatings

[0303] A marine coating is a coating used on a surface that contacts water, or a surface that is part of a structure continually near water (e.g., a ship, a dock, an drilling platform for fossil fuels, etc.). Typically, such surfaces comprise metal, such as aluminum, high tensile steel, mild steel, or a combination thereof. For embodiments wherein a surface contacts water, the type of marine coating is selected to resist fouling, corrosion, or a combination thereof. Fouling is an accumulation of aquatic organisms, including microorganisms, upon a marine surface. Fouling can damage a film, and as many marine coatings are formulated with a preservative, an anti-corrosion property (e.g., an anticorrosion pigment), or a combination thereof, as such damage often leads to corrosion of metal surfaces. Additionally, a marine coating may be selected to resist fire, such as a coating applied to a surface of a ship. Further properties that are often desirable for a marine coating include chemical resistance, impact resistance, abrasion resistance, friction resistance, acoustic camouflage, electromagnetic camouflage, or a combination thereof.

[0304] To achieve the various properties of a marine coating, often a multicoat system is used. For metal surfaces, a primer known as a blast primer is typically applied to the surface within seconds of blast cleaning. Examples of a blast primer include a polyvinyl butyral ("PVB") and phenolic resin coating, a two-pack epoxy coating, or a two-pack zinc and ethyl silicate coating. A marine metal surface undercoat or topcoat typically comprises an alkyd coating, a bitumen coating, a polyvinyl coating, or a combination thereof. Marine coatings and their use are well known to those of ordinary skill in the art (see, for example, in "Paint and Surface Coatings: Theory and Practice," 2nd Edition, pp. 529-549, 1999; in "Paints, Coatings and Solvents," 2nd Edition, pp. 252-258, 1998; in "Organic Coatings: Science and Technology, Volume 1: Film Formation, Components, and Appearance," 2nd Edition, pp. 138, 317-318). Specific procedures for determining the purity/properties of a marine coating, anti-fouling coating, or coating component thereof (e.g., cuprous oxide, copper powder, organotin) under marine conditions (e.g., submergence, water based erosion, seawater biofouling resistance, barnacle adhesion resistance) and/or film have been described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D3623-78a, D4938-89, D4939-89, D5108-90, D5479-94, D6442-99, D6632-01, D4940-98 and D5618-94, 2002; and "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D912-81 and D964-65, 2002.

[0305] c. Specification Coatings

[0306] It is contemplated that, in light of the present disclosures, a specification coating may be formulated by selection of coating components one of ordinary skill in the art to fulfill a set of requirements prescribed by a consumer. Examples a specification finish coating include a military specified coating, a Federal agency specified coating (e.g., Department of Transportation), a state specified coating, or a combination thereof. A specification coating such as a CARC, a camouflage coating, or a combination thereof would be preferred in certain embodiments for incorporation of a microorganism-based particulate material of the present invention. A camouflage coating is a coating that is formulated with materials (e.g., pigments) that reduce the visible differences between the appearances of a coated surface from the surrounding environment. Often, as would be known to one of ordinary skill in the art, a camouflage coating is formulated to reduce the detection of a coated surface by devise that measures nonvisible light (e.g., infrared radiation). Various sources of specification coating requirements are described in, for example, "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp. 891-893, 1995).

(1) Pipeline Coatings

[0307] An example of a specification coating is a pipeline (e.g., a metal pipeline) coating used to convey a fossil fuel. A pipeline coating must possess corrosion resistance, and an example of a pipeline coating includes a coal tar-coating, a polyethylene-coating, an epoxy powder-coating, or a combination thereof. A coal tar-coating may comprise, for example, a coal tar mastic-coating, a coal tar epoxide-coating, a coal tar urethane-coating, a coal tar enamel-coating, or a combination thereof. A coal tar mastic-coating typically comprises an extender, a vicosifier, or a combination thereof. In general aspects, a coal tar mastic-coating layer is 127 mm to 160 mm thick, including all intermediate ranges and combinations thereof. In embodiments wherein superior water resistance is desired, a coal tar epoxide-coating may be selected. In embodiments wherein rapid film formation is desired (e.g., pipeline repair), a coal tar urethane-coating may be selected. In embodiments wherein good water resistance, heat resistance up to 82° C., bacterial resistance, poor UV resistance, or a combination thereof, is suitable, a coal tar enamel may be selected. In embodiments wherein cathodic protection, physical durability, or a combination thereof is desired, an epoxide powder-coating may be selected. In certain embodiments, an electrostatic spray applicator may be used to apply the powder coating. In certain embodiments, a pipeline coating comprises a multicoat system. In specific aspects, a pipeline multicoat system comprises an epoxy powder primer, a two-pack epoxy primer, a chlorinated rubber primer, or a combination thereof and a polyethylene topcoat. Specific procedures for determining the suitability of a coating and/or film for use as a pipeline coating, including coating storage stability (e.g., settling) and film properties (e.g., abrasion resistance, water resistance, flexibility, weathering, film thickness, impact resistance, chemical resistance, cathodic disbonding resistance, heat resistance) have been described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," G6-88, G9-87, G10-83, G11-88, G12-83, G13-89, G20-88, G70-81, G8-96, G17-88, G18-88, G19-88, G42-96, G55-88,

G62-87, G80-88, G95-87 and D6676-01e1, 2002; and in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp. 731-734, 1995.

(2) Traffic Marker Coatings

[0308] A traffic marker coating is a coating (e.g., a paint) used to very visibly convey information on a surface usually subjected to weathering and abrasion (e.g., a pavement). A traffic marker coating may be a solvent-borne coating or a water-borne coating. Examples of a solvent-borne traffic marker coating include an alkyd, a chlorinated rubber, or a combination thereof. In certain aspects, a solvent-borne coating is applied by spray application. In some embodiments, a traffic marker coating is a two-pack coating, such as, for example, an epoxy-coating, a polyester-coating, or a combination thereof. In other embodiments, a traffic marker coating comprises a thermoplastic coating, a thermosetting coating, or a combination thereof. Examples of a combination thermoplastic/thermosetting coating include a solvent-borne alkyd and/or solvent-borne chlorinated rubber-coating. Examples of a thermoplastic coating include a maleic-modified glycerol ester-coating, a hydrocarbon-coating, or a combination thereof. In certain aspects, a thermoplastic coating comprises a liquid component, wherein the liquid component comprises a plasticizer, a pigment, and an additive (e.g., a glass bead).

[0309] Specific procedures for determining the suitability of a coating and/or film for use as a traffic marker paint, including coating storage stability (e.g., settling), glass bead properties (e.g., reflectance), film durability (e.g., adhesion, pigment retention, solvent resistance, fuel resistance) and particularly relevant film visual properties (e.g., retroreflectance, fluorescence) have been described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D713-90, D868-85, D969-85, D1309-93, D2205-85, D2743-68, D2792-69, D4796-88, D4797-88, D1155-89, D1214-89 and D4960-89, 2002; in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," F923-00, E1501-99e1, E1696-02, E1709-00e1, E1710-97, E1743-96, E2176-01, E808-01, E809-02, E810-01, E811-95, D4061-94, E2177-01, E991-98 and E1247-92, 2002; and in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp. 741-747, 1995.

(3) Aircraft Coatings

[0310] An aircraft coating protects and/or decorates a surface (e.g., metal, plastic) of an aircraft. Typically, an aircraft coating is selected for excellent weathering properties, excellent heat and cold resistance (e.g., -54° C. to 177° C.), or a combination thereof. Specific procedures for determining the suitability of a coating and/or film for use as aircraft coating, are described in, for example, in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp. 683-695, 1995.

(4) Nuclear Power Plant Coatings

[0311] An additional example of a specification coating is a coating for a nuclear power plant, which generally must possess particular properties (e.g., gamma radiation resis-

tance, chemical resistance), as described in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D5962-96, D5163-91, D5139-90, D5144-00, D4286-90, D3843-00, D3911-95, D3912-95, D4082-02, D4537-91, D5498-01 and D4538-95, 2002.

[0312] I. Coating Components

[0313] In addition to the disclosures herein, the preparation and/or chemical syntheses of coating components, other than the cell-based particulate material of the present invention disclosed herein, are well known to those ordinary skill in the art [see, for example, "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V., Ed.) (1995); "Paint and Surface Coatings: Theory and Practice, Second Edition," (Lambourne, R. and Strivens, T. A., Eds.) (1999); Wicks, Jr., Z. W., Jones, F. N., Pappas, S. P. "Organic Coatings, Science and Technology, Volume 1: Film Formation, Components, and Appearance," (1992); Wicks, Jr., Z. W., Jones, F. N., Pappas, S. P. "Organic Coatings, Science and Technology, Volume 2: Applications, Properties and Performance," (1992); "Paints, Coatings and Solvents, Second, Completely Revised Edition," (Stoye, D. and Freitag, W., Eds.) (1998); "Handbook of Coatings Additives," 1987; In "Waterborne Coatings and Additives" 1995; "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," (2002); "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," (2002); "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," (2002); and "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons," (2002)].

[0314] However, as would be known to one of ordinary skill in the art, coating components are typically obtained from commercial vendors, which is a preferred method of obtaining a coating component due to ease and reduced cost. As would be known to one of ordinary skill in the art, texts as, for example, Flick, E. W. "Handbook of Paint Raw Materials, Second Edition," 1989, describes over 4,000 coating components (e.g., an antifoamer, an antiskinning agent, a bactericide, a binder, a defoamer, a dispersant, a drier, an extender, a filler, a flame/fire retardant, a flattening agent, a fungicide, a latex emulsion, an oil, a pigment, a preservative, a resin, a rheological/viscosity control agent, a silicone additive, a surfactant, a titanium dioxide, etc.) provided by commercial vendors; and Ash, M. and Ash, I. "Handbook of Paint and Coating Raw Materials, Second Edition," 1996, which describes over 18,000 coating components (e.g., an accelerator, an adhesion promoter, an antioxidant, an antiskinning agent, a binder, a coalescing agent, a defoamer, a diluent, a dispersant, a drier, an emulsifier, a fire retardant, a flow control agent, a gloss aid, a leveling agent, a marproofing agent, a pigment, a slip agent, a thickener, a UV stabilizer, viscosity control agent, a wetting agent, etc.) provided by commercial vendors.

[0315] Specific commercial vendors are referred to herein as examples, and include Acima™ AG, Im Ochensand, CH-9470 Buchs/SG; Air Products and Chemicals, Inc., 7201 Hamilton Boulevard, Allentown, Pa. 18195-1501; Arch Chemicals, Inc., 350 Knotter Drive, Cheshire, Conn., 06410

U.S.A.; Avecia Inc., 1405 Foulk Road, PO Box 15457, Wilmington, Del. 19850-5457, U.S.A.; Bayer Corporation, 100 Bayer Rd., Pittsburgh, Pa. 15205-9741, U.S.A.; Buckman Laboratories, Inc., 1256 North McLean Blvd., Memphis, Tenn. 38108-0305, U.S.A.; BYK-Chemie GmbH, Abelstrasse 45, P.O. Box 100245, D-46462 Wesel, Germany; Ciba Specialty Chemicals, 540 White Plains Road, P.O. Box 2005, Tarrytown, N.Y. 10591-9005, U.S.A.; Clariant LSM (America) Inc., 200 Rodney Building, 3411 Silverside Road, Wilmington, Del. 19810 U.S.A.; Cognis Corporation, 5051 Estecreek Drive, Cincinnati, Ohio 45232-1446, U.S.A.; Condea Servo LLC., 4081 B Hadley Road, South Plainfield, N.J. 07080-1114, U.S.A.; Cray Valley Limited, Waterloo Works, Machen, Caerphilly CF83 8YN United Kingdom; Dexter Chemical L.L.C., 845 Edgewater Road Bronx, N.Y. 10474, U.S.A.; Dow Chemical Company, 2030 Dow Center, Midland, Mich. 48674 U.S.A.; Elementis Specialties, Inc., PO Box 700, 329 Wyckoffs Mill Road, Hightstown, N.J. 08520 U.S.A.; Goldschmidt Chemical Corp., 914 East Randolph Road PO Box 1299 Hopewell, Va. 23860 U.S.A.; Hercules Incorporated, 1313 North Market Street, Wilmington, DE 19894-0001, U.S.A.; International Specialty Products, 1361 Alps Road, Wayne, N.J. 07470, U.S.A.; Octel-Starreon LLC USA, North American Headquarters, 8375 South Willow Street, Littleton, Colo. 80124, U.S.A.; Rohm and Haas Company, 100 Independence Mall West, Philadelphia, Pa. 19106-2399, U.S.A.; Solvay Advanced Functional Minerals, Via Varesina 2-4, I-21021 Angera (VA); Troy Corporation, 8 Vreeland Road, PO Box 955, Florham Park, N.J., 07932 U.S.A.; R. T. Vanderbilt Company, Inc., 30 Winfield Street, Norwalk, Conn. 06855, U.S.A.; Union Carbide Chemicals and Plastics Co., Inc., 39 Old Ridgebury Road, Danbury, Conn. 06817-0001, U.S.A.

[0316] 1. Binders

[0317] A binder ("polymer," "resin," "film former") is a molecule capable of film formation. Film formation is a physical and/or chemical change of a binder in a coating, wherein the change converts the coating into a film. Often, a binder converts into a film through a polymerization reaction, wherein a first binder molecule covalently bonds with at least a second binder molecule to form a larger molecule, known as a "polymer." 38 As this process is repeated a plurality of times, the composition converts from a coating comprising a binder into a film comprising a polymer.

[0318] A binder may comprise a monomer, an oligomer, a polymer, or a combination thereof. A monomer is a single unit of a chemical species that can undergo a polymerization reaction. However, a binder itself is often a polymer, as such larger binder molecules are more suitable for formulation into a coating capable of both being easily applied to a surface and undergoing an additional polymerization reaction to produce a film. An oligomer comprises 2 to 25 polymerized monomers, including all intermediate ranges and combinations thereof.

[0319] A homopolymer is a polymer that comprises monomers of the same chemical species. A copolymer is a polymer that comprises monomers of at least two different chemical species. A linear polymer is an unbranched chain of monomers. A branched polymer is a branched ("forked") chain of monomers. A network ("cross-linked") polymer is

a branched polymer wherein at least one branch forms an interconnecting covalent bond with at least one additional polymer molecule.

[0320] A thermoplastic binder and/or coating reversibly softens and/or liquefies when heated. Film formation for a thermoplastic coating generally comprises a physical process, typically the loss of the volatile (e.g., liquid) component from a coating. As a volatile component is removed, a solid film may be produced through entanglement of the binder molecules. In many aspects, a thermoplastic binder is generally a higher molecular mass than a comparable thermosetting binder. In many aspects, a thermoplastic film is often susceptible to damage by a volatile component that can be absorbed by the film, which can soften and/or physically expand the film. In certain facets, a thermoplastic film may be removed from a surface by use of a volatile component. However, in many aspects, damage to a thermoplastic film may be repaired by application of a thermoplastic coating into the damaged areas and subsequent film formation.

[0321] A thermosetting binder undergoes film formation by a chemical process, typically the cross-linking of a binder into a network polymer. In certain embodiments, a thermosetting binder does not possess significant thermoplastic properties.

[0322] The glass transition temperature is the temperature wherein the rate of increase of the volume of a binder or a film changes. Binders and films often do not convert from solid to liquid ("melt") at a specific temperature (" T_m "), but rather possess a specific glass transition temperature wherein there is an increase in the rate of volume expansion with increasing temperature. At temperatures above the glass transition temperature, a binder or film becomes increasingly rubbery in texture until it becomes a viscous liquid. In certain embodiments described herein, a binder, particularly a thermoplastic binder, may be selected by its glass transition temperature, which provides guidance to the temperature range of film formation, as well as thermal and/or heat resistance of a film. The lower the T_g , the "softer" the resin, and generally, the film produced from such a resin. A softer film typically possesses greater flexibility (e.g., crack resistance) and/or poorer resistance to dirt accumulation than a harder film.

[0323] In certain embodiments, a coating comprises a low molecular weight polymer, a high molecular weight polymer, or a combination thereof. Examples of a low molecular weight polymer include an alkyd, an amino resin, a chlorinated rubber, an epoxide resin, an oleoresinous binder, a phenolic resin, a urethane, a polyester, an urethane oil, or a combination thereof. Examples of a high molecular weight polymer include a latex, a nitrocellulose, a non-aqueous dispersion polymer ("NAS"), a solution acrylic, a solution vinyl, or a combination thereof. Examples of a latex include an acrylic, a polyvinyl acetate ("PVA"), a styrene/butadiene, or a combination thereof.

[0324] In addition to the disclosures herein, a binder, methods of binder preparation, commercial vendors of binder, and techniques for using a binder in a coating known to those of ordinary skill in the art may be applied in the practice of the present invention [see, for example, Flick, E. W. "Handbook of Paint Raw Materials, Second Edition," pp. 287-805 and 879-998, 1989; in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward

Handbook," (Koleske, J. V. Ed.), pp. 23-29, 39-67, 74-84, 87, 268-285, 410, 539-540, 732, 735-736, 741, 770, 806-807, 845-849 and 859-861, 1995; in "Paint and Surface Coatings: Theory and Practice, Second Edition," (Lambourne, R. and Strivens, T. A., Eds.), pp. 2-3, 7-10, 21, 24-40, 40-54, 60-71, 76, 81-86, 352, 358, 381-394, 396, 398, 405, 433-448, 494-497, 500, 537-540, 700-702 and 734, 1999; Wicks, Jr., Z. W., Jones, F. N., Pappas, S. P. "Organic Coatings, Science and Technology, Volume 1: Film Formation, Components, and Appearance," pp. 39, 49-57, 62, 65-67, 67, 76-80, 83, 91, 104-118, 155, 168, 178, 182-183, 200, 202-203, 209, 214-216, 220 and 250, 162-186, 215-216 and 232, 59-60, 183-184, 133-143, 39, 144-161, 203, 219-220 and 239, 23, 110, 120-132, 122-130, 198, 202-203, 209 and 220, 60-62, 83-103, 164-167, 173, 177-178, 184-187, 195, 206 and 216-219, 1992; Wicks, Jr., Z. W., Jones, F. N., Pappas, S. P. "Organic Coatings, Science and Technology, Volume 2: Applications, Properties and Performance," pp. 13-14, 18-19, 26, 33-34, 36, 41, 57, 77, 92, 95, 116-119, 143-145, 156, 161-165, 179-180, 191-193, 197-203, 210-211, 213-214, 216, 219-222, 230-239, 260-263, 269-271, 276-284, 288-293, 301-307, 310, 315-316, 319-321 and 325-346, 1992; and in "Paints, Coatings and Solvents, Second, Completely Revised Edition," (Stoye, D. and Freitag, W., Eds.) pp. 5, 11-22, 37-50, 54-55, 72, 80-87, 96-98, 108, 126 and 136, 1998].

[0325] a. Oil-Based Binders

[0326] Certain binders, such as, for example, an oil (e.g., a drying oil), an alkyd, an oleoresinous binder, a fatty acid epoxide ester, or a combination thereof, are prepared and/or synthesized from an oil and/or a fatty acid, and undergo film formation by thermosetting oxidative cross-linking of fatty acids, and will be referred to herein as an "oil-based binder." These types of binders often possess similar properties (e.g., solubility, viscosity). An oil-based binder coating often further comprises a drier, an antiskinning agent, an alkyphenolic resin, a pigment, an extender, a liquid component (e.g., a solvent), or a combination thereof. A drier, such as a primary drier, secondary drier, or a combination thereof, may be selected to promote film formation. In certain facets, an oil-based binder coating may comprise an anti-skinning agent, which is typically used to control undesirable film-formation caused by a primary drier and/or oxidation. A liquid component may be selected, for example, to alter a Theological property (e.g., flow), wetting and/or dispersion of particulate material, or a combination thereof. In certain embodiments, a liquid component comprises a hydrocarbon. In particular embodiments, the hydrocarbon comprises an aliphatic hydrocarbon, an aromatic hydrocarbon (e.g., toluene, xylene), or a combination thereof. In some facets, the liquid component comprises, by weight, 5% to 20% of an oil-based binder coating, including all intermediate ranges and combinations thereof.

[0327] In alternative embodiments, an oil-based temporary coating (e.g., a non-film forming coating) may be produced, for example, by inclusion of an antioxidant, reduction of the amount of a drier, selection of a oil-based binder that comprises fewer or no double bonds, or a combination thereof.

[0328] An oil-based binder coating may be selected for embodiments wherein a relatively low viscosity is desired, such as, for example, application to a corroded metal sur-

face, a porous surface (e.g., wood), or a combination thereof, due to the penetration power of a low viscosity coating. In certain facets, it is preferred that application of an oil-binder coating produces a layer is less than 25 μm on vertical surfaces and 40 μm on horizontal surfaces to reduce shrinkage, wrinkling. Additionally, in aspects wherein the profile of the wood surface is to be retained, a such a thin film thickness is preferred. In specific aspects, an oil-binder coating may be selected as a wood stains, a topcoat, or a combination thereof. In particular facets, a wood stain comprises an oil (e.g., linseed oil) coating, an alkyd, or a combination thereof. Often, wood coating comprises a light-stabilizer (e.g., UV absorber).

(1) Oils

[0329] An oil is a polyol esterified to at least one fatty acid. A polyol ("polyalcohol," "polyhydric alcohol") is an alcohol comprising more than one hydroxyl moiety per molecule. In certain embodiments, an oil comprises an acylglycerol esterified to one fatty acid ("monacylglycerol"), two fatty acids ("diacylglycerol"), or three fatty acids ("triacylglycerol," "triglyceride"). Typically, however, an oil will comprise a triacylglycerol. A fatty acid is an organic compound comprising a hydrocarbon chain that includes a terminal carboxyl moiety. A fatty acid may be unsaturated, monounsaturated, and polyunsaturated referring to whether the hydrocarbon chain possess no carbon double bonds, one carbon double bond, or a plurality of carbon double bonds (e.g., 2, 3, 4, 5, 6, 7, or 8 double bonds), respectively.

[0330] In typical use in a coating, a plurality of fatty acids forms covalent cross-linking bonds to produce a film in coatings comprising oil binders and/or other binders comprising a fatty acid. Usually oxidation through contact with atmospheric oxygen is used to promote film formation. Exposure to light also enhances film formation. The ability of an oil to undergo film formation by chemical cross-linking is related to the content of chemically reactive double bonds available in its fatty acids. Oils are generally a mixture of chemical species, comprising different combinations of fatty acids esterified to glycerol. The overall types and percentages of particular fatty acids that are comprised in oils affect the ability of the oil to be used as a binder. Oils can be classified as a drying oil, a semi-drying oil, or a non-drying oil depending upon the ability of the oil to cross-link into a dry film without additives (e.g., driers) at ambient conditions and atmospheric oxygen. A drying oil forms a dry film to touch upon cross-linking, a semi-drying oil forms a sticky ("tacky") film to touch upon cross-linking, while a non-drying oil does not produce a tacky or dry film upon cross-linking. In certain facets, it is contemplated that film-formation of a non-chemically modified oil-binder coating will typically take from 12 hours to 24 hours at ambient conditions, air, and lighting. Procedures for selection and testing of drying oils for a coating are described in, for example, "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D555-84, 2002.

[0331] Drying oils comprise at least one polyunsaturated fatty acid to promote cross-linking. Polyunsaturated fatty acids ("polyenoic fatty acids") include, but are not limited to, 7,10,13-hexadecatrienoic ("16:3 n-3"); linoleic ["9,12-octadecadienoic," "18:2(n-6)"]; γ -linolenic ["6,9,12-octadecatrienoic," "18:3(n-6)"]; a trienoic 20:3(n-9); dihomom-

linolenic ["8,11,14-eicosatrienoic," "20:3(n-6)"]; arachidonic ["5,8,11,14-eicosatetraenoic," "20:4(n-6)"]; a licanic, ("4-oxo 9c11t13t-18:3"); 7,10,13,16-docosatetraenoic ["22:4(n-6)"]; 4,7,10,13,16-docosapentaenoic ["22:5(n-6)"]; α -linolenic ["9,12,15-octadecatrienoic," "18:3(n-3)"]; stearidonic ["6,9,12,15-octadecatetraenoic," "18:4(n-3)"]; 8,11,14,17-eicosatetraenoic ["20:4(n-3)"]; 5,8,11,14,17-eicosapentaenoic ["EPA," "20:5(n-3)"]; 7,10,13,16,19-docosapentaenoic ["DPA," "22:5(n-3)"]; 4,7,10,13,16,19-docosahexaenoic ["DHA," "22:6(n-3)"]; 5,8,11-eicosatrienoic ["Mead acid," "20:3(n-9)"]; taxoleic ("all-cis-5,9-18:2"); pinolenic ("all-cis-5,9,12-18:3"); sciadonic ("all-cis-5,11,14-20:3"); dihomotaxoleic ("7,11-20:2"); cis-9, cis-15 octadecadienoic ("9,15-18:2"); retinoic; or a combination thereof.

[0332] Drying oils can be further characterized as non-conjugated or conjugated drying oils depending upon whether their most abundant fatty acid comprises a polymethylene-interrupted double bond or a conjugated double bond, respectively. A polymethylene-interrupted double bond is two double bonds separated by two or more methylene moieties. A polymethylene-interrupted fatty acid is a fatty acid comprising such a configuration of double bonds. Examples of polymethylene-interrupted fatty acids include taxoleic, pinolenic, sciadonic, dihomotaxoleic, cis-9, cis-15 octadecadienoic, retinoic, or a combination thereof.

[0333] A conjugated double bond is a moiety wherein a single methylene moiety connects pair of carbon chain double bonds. A conjugated fatty acid is a fatty acid comprising such a pair of double bonds. A conjugated double bond is more prone to cross-linking reactions than non-conjugated double bonds. A conjugated diene fatty acid, a conjugated triene fatty acid or a conjugated tetraene fatty acid, possesses only two, three or four conjugated double bonds, respectively. An example of a common conjugated diene fatty acid is a conjugated linoleic. Examples of a conjugated triene fatty acid include an octadecatrienoic, a licanic, or a combination thereof. Examples of an octadecatrienoic acid include an α -eleostearic comprising the 9c,11t,13t isomer, a calendic comprising a 8t,10t,12c isomer, a catalpic comprising the 9c,11t,13c isomer, or a combination thereof. An example of a conjugated tetraene fatty acid is α -parinaric comprising the 9c,11t,13t,15c isomer, and β -parinaric comprising the 9t,11t,13t,15t isomer, or a combination thereof.

[0334] Oils for use in coatings are generally obtained from renewable biological sources, such as plants, fish or a combination thereof. Examples of plant oils commonly used in coatings or coating components include cottonseed oil, linseed oil, oiticica oil, safflower oil, soybean oil, sunflower oil, tall oil, rosin, tung oil, or a combination thereof. An example of a fish oil commonly used in coatings or coating components include castor oil. A colder environment generally promotes a higher polyunsaturated fatty acid content in an organism (e.g., sunflowers). Cottonseed oil comprises about 36% saturated fatty acids, 24% oleic, and 40% linoleic. Castor oil comprises about 3% saturated fatty acids, 7% oleic, 3% linoleic, and 87% ricinoleic ("12-hydroxy-9-octadecenoic"). Linseed oil comprises about 10% saturated fatty acids, 20% to 24% oleic ("cis-9-octadecenoic"), 14% to 19% linoleic, and 48% to 54% linolenic. Oiticica oil comprises about 16% saturated fatty acids, 6% oleic, and 78% licanic. Safflower oil comprises about 11% saturated

fatty acids, 13% oleic, 75% linoleic, and 1% linolenic. Soybean oil comprises about 14% to 15% saturated fatty acids, 22% to 28% oleic, 52% to 55% linoleic, and 5% to 9% linolenic. Tall oil, which is a product of paper production and generally is not in the form of a triglyceride, often comprises about 3% saturated fatty acids, 30% to 35% oleic, 35% to 40% linoleic, 2% to 5% linolenic, and 10% to 15% of a combination of pinolenic and conjugated linoleic. Rosin is a combination of acidic compounds isolated during paper production, such as, for example, abietic acid, neoabietic acid, dihydroabietic acid, tetraabietic acid, isodextropimaric acid, dextropimaric acid, dehydroabietic acid, and levopimaric acid. Tung oil comprises about 5% saturated fatty acids, 8% oleic, 4% linoleic, 3% linolenic, and 80% α -eleostearic. Standards for physical properties, chemical properties, and/or procedures for testing the purity/properties of various oils (e.g., castor, linseed, oiticica, safflower, soybean, sunflower, tall, tung, rosin, dehydrated castor, boiled linseed, a drying oil, a fish oil, a heat-bodied drying oil) for use in a coating are described, for example in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D555-84, D960-02a, D961-86, D234-82, D601-87, D1392-92, D1392-92, D1462-62, D12-88, D1981-02, D5768-95, D3169-89, D260-86, D124-88, D803-02, D1541-97, D1358-86, D1950-86, D1951-86, D1952-86, D1954-86, D1958-86, D464-95, D465-01, D1959-97, D1960-86, D1962-85, D1964-85, D1965-87, D1966-69, D1967-86, D3725-78, D1466-86, D890-98, D1957-86, D1963-85, D5974-00, D1131-97, D1240-02, D889-99, D509-98, D269-97, D1065-96, and D804-02, 2002.

[0335] In certain embodiments, an oil comprises a chemically modified oil, which is an oil altered by a reaction thought to promote limited cross-linking. Generally, such a modified oil possesses an altered property, such as a higher viscosity, which may be more suitable for a particular coating application. Examples of a chemically modified oil include a bodied oil, a blown oil, a dimer acid, or a combination thereof. A bodied oil ("heat bodied oil," "stand oil") is produced, for example, by heating a nonconjugated oil (e.g., 320° C.) or a conjugated oil (e.g., 240° C.) in an chemically unreactive atmosphere to promote limited cross-linking. A blown oil is produced, for example, by passing air through a drying oil at, for example, 150° C. A dimer acid is produced, for example, by acid catalyzed dimerization or oligomerization of a polyunsaturated acid.

[0336] In certain embodiments, an oil comprises a synthetic conjugated oil, which is an oil altered by a reaction thought to produce a conjugated double bond in a fatty acid of the oil. Conjugated fatty acids have been produced from nonconjugated fatty acids by alkaline hydroxide catalyzed reactions. However, a synthetic conjugated oil is generally semi-drying in air catalyzed film formation at ambient conditions and a coating comprising such an oil is typically cured by baking. Additionally richinoleic acid, which is prevalent in castor oil, can be dehydrogenated to produce a mixture of conjugated and non-conjugated fatty acids. Dehydrogenated castor oil comprises about 2% to 4% saturated fatty acids, 6% to 8% oleic, 48% to 50% linoleic, and 40% to 42% conjugated linoleic.

[0337] Certain other compounds comprising a fatty acid and polyol are classified herein as an oil for use as a binder

such as a high ester oil, a maleated oil, or a combination thereof. A high ester oil comprises a polyol capable of comprising greater than three fatty acid esters per molecule and at least one fatty acid ester. However, a high ester oil comprising four or more fatty acid esters per molecule is preferred. Examples of such a polyol include a pentaerythritol, a dipentaerythritol, a tripentaerythritol, or a styrene/allyl alcohol copolymer. These high ester oils generally form films more rapidly than acylglycerol based oil, as the opportunity for cross-linking reactions between fatty acids increases with the number of fatty acids attached to a single polyol. A maleated oil is an oil modified by a chemical reaction with maleic anhydride. Maleic acid and an unsaturated or polyunsaturated fatty acid react to produce a fatty acid with additional acid moieties. A maleated oil generally is more hydrophilic and/or has a faster film formation time than a comparative non-maleated oil.

(2) Alkyd Resins

[0338] In certain embodiments, a binder can comprise an alkyd resin. In general embodiments, an alkyd-coating may be selected as an architectural coating, a metal coating, a plastic coating, a wood coating, or a combination thereof. In certain aspects, an alkyd coating may be selected for use as a primer, an undercoat, a topcoat, or a combination thereof. In particular aspects, an alkyd coating comprises a pigment, an additive, or a combination thereof.

[0339] An alkyd resin comprises a polyester prepared from a polyol, a fatty acid, and a polybasic ("polyfunctional") organic acid or acid anhydride. An alkyd resin is generally produced by first preparing monoacylpolyol, which is a polyol esterified to one fatty acid. The monoacylpolyol is polymerized by ester linkages with a polybasic acid to produce an alkyd resin of desired viscosity in a solvent. Examples of a polyol include 1,3-butylene glycol; diethylene glycol; dipentaerythritol; ethylene glycol; glycerol; hexylene glycol; methyl glucoside; neopentyl glycol; pentaerythritol; pentanediol; propylene glycol; sorbitol; triethylene glycol; trimethylol ethane; trimethylol propane; trimethylpentanediol; or a combination thereof. In certain aspects, a polyol comprises ethylene glycol; glycerol; neopentyl glycol; pentaerythritol; trimethylpentanediol; or a combination thereof. Examples of a polybasic acid or an acid anhydride include adipic acid, azelaic acid, chlorendic anhydride, citric acid, fumaric acid, isophthalic acid, maleic anhydride, phthalic anhydride, sebacic acid, succinic acid, trimellitic anhydride, or a combination thereof. In certain aspects, a polybasic acid or an acid anhydride comprises isophthalic acid, maleic anhydride, phthalic anhydride, trimellitic anhydride, or a combination thereof. Examples of a fatty acid include abiatic, benzoic, caproic, caprylic, lauric, linoleic, linolenic, oleic, a tertiary-butyl benzoic acid, a fatty acid from an oil/fat (e.g., castor, coconut, cottonseed, tall, tallow), or a combination thereof. In certain aspects, a fatty acid comprises benzoic, a fatty acid from tall oil, or a combination thereof. In specific aspects, an oil is used in the reaction directly as a source of a fatty acid and/or a polyol. Examples of an oil include castor oil, coconut oil, corn oil, cottonseed oil, dehydrated castor oil, linseed oil, safflower oil, soybean oil, tung oil, walnut oil, sunflower oil, menhaden oil, palm oil, or a combination thereof. In some aspects, an oil comprises coconut oil, linseed oil, soybean oil, or a combination thereof.

[0340] In addition to the standards and analysis techniques previously described for an oil, standards for physical properties, chemical properties, and/or procedures for testing the purity/properties of various fatty acids (e.g., coconut, corn, cottonseed, dehydrated castor, linseed, soybean, tall oil fatty acids, rosin fatty acids) and a polyol (e.g., pentaerythritol, hexylene glycol, ethylene glycol, diethylene glycol, propylene glycol, dipropylene glycol) and acid anhydrides (e.g., phthalic anhydride, maleic anhydride) for use in an alkyd or other coating components are described, for example, in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D1537-60, D1538-60, D1539-60, D1841-63, D1842-63, D1843-63, D5768-95, D1981-02, D1982-85, D1980-87, D804-02, D1957-86, D464-95, D465-01, D1963-85, D5974-00, D1466-86, D2800-92, D1585-96, D1467-89, and D1983-90, 2002; and in "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons," D2403-96, D3504-96, D2930-94, D3366-95, D3438-99, D2195-00, D2636-01, D2693-02, D2694-91, D5164-91, D1257-90, and D1258-95, 2002. Further, the composition, properties and/or purity of an alkyd resin and/or a solution comprising an alkyd resin selected for use in a coating such as phthalic anhydride content, isophthalic acid content, unsaponifiable matter content, fatty acid content/identification, polyhydric alcohol content/identification, glycerol, ethylene glycol and/or pentaerythritol content, and silicon content can be empirically determined by procedures known to those of ordinary skill in the art (see, for example, "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D2689-88, D563-88, D2690-98, D2998-89, D1306-88, D1397-93, D1398-93, D2455-89, D1639-90, D1615-60, and D2456-91, 2002).

(i) Oil Length Alkyd Binders

[0341] In specific embodiments, an alkyd resin may be selected based on the materials used in its preparation, which typically affect the alkyd's properties. In general aspects, an alkyd resin is often classified and/or selected for use in a particular application by its oil content, as the oil content affects the alkyd resin properties. Oil content is the amount of oil relative to the solvent-free alkyd resin. Based on oil content, an alkyd resin may be classified as a very long oil alkyd resin, a long oil alkyd resin, a medium oil alkyd resin, or a short oil alkyd resin. Generally, the greater the oil content classification of an alkyd resin that is comprised in a coating, the greater the ease of brush application, the slower the rate of film formation, the greater the film's flexibility, the poorer the chemical resistance of the film, the poorer the retention of gloss in exterior environments, or a combination thereof. A short oil alkyd, a medium oil alkyd, a long oil alkyd, and a very long oil alkyd has an oil content range of 1% to 40%, 40% to 60%, 60% to 70%, and 70% to 85%, respectively, including all intermediate ranges and combinations thereof, respectively. In typical embodiments, a short oil alkyd, a medium oil alkyd, a long oil alkyd, and a very long oil alkyd resin and/or coating comprise 50%, 45% to 50%, 60% to 70%, or 85% to 100% nonvolatile component, respectively.

[0342] In certain embodiments, a short oil alkyd coating may be selected as an industrial coating. In certain aspects, a short oil alkyd is synthesized from an oil, wherein the oil

comprises castor, dehydrated castor, coconut, linseed, soybean, tall, or a combination thereof. In some aspects, the oil of a short oil alkyd comprises a saturated fatty acid. Examples of a saturated fatty acid include, but are not limited to, caproic ("hexanoic," "6:0"); caprylic ("octanoic," "8:0"); lauric ("dodecanoic," "12:0"); or a combination thereof. In particular facets, a short oil alkyd coating comprises a solvent, wherein the solvent comprises an aromatic hydrocarbon, isobutanol, VMP naphtha, xylene, or a combination thereof. In other facets, the aromatic solvent comprises a high boiling aromatic solvent. In some aspects, a short oil alkyd is insoluble or poorly soluble in an aliphatic hydrocarbon. In further embodiments, a short oil alkyd coating undergoes film formation by baking.

[0343] In certain embodiments, a medium oil alkyd coating may be selected as a farm implement coating, a railway equipment coating, a maintenance coating, or a combination thereof. In certain aspects, a medium oil alkyd is synthesized from an oil, wherein the oil comprises linseed, safflower, soybean, sunflower, tall, or a combination thereof. In some aspects, the oil of a medium oil alkyd comprises a monounsaturated fatty acid (e.g., oleic acid). In particular facets, a medium oil alkyd coating comprises a solvent, wherein the solvent comprises an aliphatic hydrocarbon, an aromatic hydrocarbon, or a combination thereof.

[0344] In certain embodiments, a tall oil alkyd coating may be selected as an architectural coating, a maintenance coating, a primer, a topcoat, or a combination thereof. In certain aspects, a tall oil alkyd is synthesized from an oil, wherein the oil comprises linseed, safflower, soybean, sunflower, tall, or a combination thereof. In some aspects, the oil of a long oil alkyd comprises a polyunsaturated fatty acid. In particular facets, a tall oil alkyd coating comprises a solvent, wherein the solvent comprises an aliphatic hydrocarbon.

[0345] In certain embodiments, a very long oil alkyd coating may be selected as a latex architectural coating, a wood stain, or a combination thereof. In certain aspects, a very long oil alkyd is synthesized from an oil, wherein the oil comprises linseed, soybean, tall, or a combination thereof. In some aspects, the oil of a long oil alkyd comprises a polyunsaturated fatty acid. In particular facets, a very long oil alkyd coating comprises a solvent, wherein the solvent comprises an aliphatic hydrocarbon.

(ii) High Solid Alkyd Coatings

[0346] A high solid alkyd possesses a reduced viscosity, a lower average molecular weight, or a combination thereof. A high solid alkyd may be selected for embodiments wherein a reduced quantity liquid content (e.g., solvent) of a coating is desired. In some embodiments, a high solid alkyd coating comprises an enamel coating. In other aspects, a high solid long or very long oil alkyd coating comprises an architectural coating. In further aspects, a high solid medium oil alkyd coating comprises a transportation coating. In further aspects, a high solid short oil alkyd coating comprises an industrial coating. Additional, various chemical moieties may be incorporated in an alkyd to modify a property. Examples of such moieties include an acrylic, a benzoic acid, an epoxide, an isocyanate, a phenolic, a polyamide, a rosin, a silicon, a styrene (e.g., a paramethyl styrene), a vinyl toluene, or a combination thereof. In certain embodiments, a benzoic acid modified high solid alkyd

coating comprises a coating for a tool. In other embodiments, a phenolic modified high solid alkyd coating comprises a primer. A silicone modified alkyd coating may be selected for improved weather resistance, heat resistance, or a combination thereof. In specific aspects, a silicone modified alkyd coating may comprise an additional binder capable of cross-linking with the silicone moiety (e.g., a melamine formaldehyde resin). In specific facets, a silicone modified alkyd coating may be selected as a coil coating, an architectural coating, a metal coating, an exterior coating, or a combination thereof. In certain facets, a high solid silicon-modified alkyd coating may substitute an oxygenated compound (e.g., a ketone, an ester) for an aromatic hydrocarbon liquid component. However, a high solid silicon-modified alkyd coating, to achieve cross-linking during film-formation, should comprise an additional binder capable of cross-linking. In further embodiments, a silicone modified high solid alkyd coating comprises a maintenance coating, a topcoat, or a combination thereof.

(iii) Uralkyd Coatings

[0347] An uralkyd binder ("uralkyd," "urethane alkyd," "urethane oil," "urethane modified alkyd") is an alkyd binder, with the modification that compound comprising plurality of diisocyanate moieties partly or fully replacing the dibasic acid (e.g., phthalic anhydride) in the synthesis reactions. Examples of an isocyanate comprising compounds include a 1,6-hexamethylene diisocyanate ("HDI"), a toluene diisocyanate ("TDI"), or a combination thereof. An uralkyd binder may be selected for embodiments wherein a superior abrasion resistance, superior resistance to hydrolysis, or a combination thereof, relative to an alkyd, is desired in a film. However, an uralkyd binder prepared using TDI often has greater viscosity in a coating, inferior color retention in a film, or a combination thereof, relative to an alkyd binder. Additionally, an uralkyd binder prepared using an aliphatic isocyanate generally possesses superior color retention to an uralkyd prepared from TDI. An uralkyd coating tends to undergo film formation faster than a comparable alkyd binder, due to a generally greater number of available conjugated double bonds, an increased T_g in an uralkyd binder prepared using an aromatic isocyanate, or a combination thereof. A film comprising an uralkyd binder tends to develop a yellow to brown color. An uralkyd binder is often used in preparation of an architectural coating such as a varnish, an automotive refinish coating, or a combination thereof. Examples of a surface where an uralkyd coating may be applied include a furniture surface, a wood surface, or a floor surface.

(iv) Water-Borne Alkyd Coatings

[0348] In general embodiments, an alkyd coating is a solvent-borne coating. However, an alkyd (e.g., a chemically modified alkyd) may be combined with a coupling solvent and water to produce a water-borne alkyd coating. Examples of a coupling solvent that may confer water reducibility to an alkyd resin includes ethylene glycol monobutyl ether, propylene glycol monoethylether, propylene glycol monopropylether, an alcohol whose carbon content is four carbon atoms (e.g., s-butanol), or a combination thereof. In certain embodiments, a water-borne long oil alkyd coating may be selected as a stain, an enamel, or a combination thereof. In other embodiments, a water-borne medium oil alkyd coating

may be selected as an enamel, an industrial coating, or a combination thereof. In further facets, a water-borne medium oil alkyd coating may undergo film formation by air oxidation. In other embodiments, a water-borne short oil alkyd coating may be selected as an enamel, an industrial coating, or a combination thereof. In further facets, a water-borne short oil alkyd coating may undergo film formation by baking.

(3) Oleoresinous Binders

[0349] An oleoresinous binder is a type of binder prepared from heating a resin and an oil. Examples of a resin typically used in the preparation of an oleoresinous binder include resins obtained from a biological source (e.g., a wood resin, a bitumen resin); a fossil source (e.g., copal resin, a Kauri gum resin, a rosin resin, a shellac resin); a synthetic source (e.g., a rosin derivative resin, a phenolic resin, an epoxy resin); or a combination thereof. An example of an oil typically used in the preparation of an oleoresinous binder includes a vegetable oil, particularly an oil that comprises a polyunsaturated fatty acid such as tung, linseed, or a combination thereof. The type of resin and oil used can identify an oleoresinous binder such as a copal-tung oleoresinous binder, a rosin-linseed oleoresinous binder, etc. An oleoresinous binder generally are used in clear varnishes such as a lacquer, as well as in applications as a primer, an undercoat, a marine coating, or a combination thereof. In addition to the standards and analysis techniques previously described for an oil, standards for physical properties, chemical properties, and/or procedures for testing the purity/properties (e.g., glass transition temperature, molecular weight, color stability) of a hydrocarbon resin (e.g., a synthetic source resin) for use in an oleoresinous binder or other coating component are described, for example, in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," E28-99, D6090-99, D6440-01, D6493-99, D6579-00, D6604-00, and D6605-00, 2002.

[0350] Similar to alkyd resins, oleoresinous binders can be categorized by oil length as a short oil or long oil oleoresinous binder, depending whether oil length is 1% to 67% or 67% to 99% oil, including all intermediate ranges and combinations thereof, respectively. Short oil oleoresinous binders generally dry fast and form relatively harder, less flexible films, and are used, for example, for floor varnishes. Long oil oleoresinous binders generally dry slower and form relatively more flexible films, and are used, for example, as an undercoat, exterior varnish, or combination thereof.

(4) Fatty Acid Epoxy Esters

[0351] In certain facets, an epoxy coating may be cured by fatty acid oxidation rather than epoxide moiety or hydroxyl moiety cross-linking reactions. A fatty acid epoxide ester resin is an ester of an epoxide resin and a fatty acid, which can be used to produce an ambient cure coating that undergoes film formation by oxidative reactions as an oil-based coating. In certain embodiments, an epoxy resin may be selected with an epoxy equivalent weight of 800 to 1000, including all intermediate ranges and combinations thereof. Short, medium, and long oil epoxide ester resins comprise 30% to 50%, 50% to 70%, or 70% to 90% fatty acid esterification, including all intermediate ranges and combinations thereof, respectively, with similar, though sometimes

superior, properties relative to an analogous alkyd. An epoxide ester resin is inferior in chemical resistance than a film produced by an epoxy and a curing agent comprising an amine. An epoxy ester resin may be selected as a substitute for an alkyd, a marine coating, an industrial maintenance coating, a floor topcoat, or a combination thereof.

[0352] b. Polyester Resins

[0353] A polyester resin ("polyester," "oil-free alkyd") is a polyester chemical, other than an alkyd resin, capable as use as a binder. A polyester resin is chemically very similar to an alkyd, though the oil content is 0%. Consequently, a polyester-coating does not form cross-linking bonds by fatty acids oxidation during thermosetting film formation, but rather is combined with an additional binder to form a cross-linked film. The selection of a polyester and additional binder combination is generally determined by the polyester's crosslinkable moieties. For example, a hydroxy-terminated polyester is a polyester produced by an esterification reaction comprising a molar excess of a polyol, and may be crosslinked with a urethane, an amino resin, or a combination thereof. A hydroxy-terminated polyester's hydroxyl moiety may react with a urethane's isocyanate moiety such as at ambient conditions or low-bake conditions, while such a polyester generally undergoes film formation at baking temperatures with an amino resin. In another example, a "carboxylic acid-terminated polyester" is a polyester produced by an esterification reaction comprising an molar excess of a polycarboxylic acid, and may be crosslinked with a urethane, an amino resin, a 2-hydroxylalkylamide, or a combination thereof.

[0354] In general embodiments, a polyester-coating possesses superior color retention, flexibility, hardness, weathering, or a combination thereof, relative to an alkyd-coating. In some embodiments, a polyester resin may be selected to produce a coating for a metal surface. Generally, a polyester-coating possesses a superior adhesion property on a metal surface than a thermosetting acrylic-coating. Often, a polyester-coating is a thermosetting coating, particularly in embodiments for use upon a metal surface. However, a polyester-coating generally comprises an ester linkage that is susceptible to hydrolysis, therefore, applications wherein such a polyester-coating contacts water is less preferred.

[0355] A polyester resin is generally prepared by an acid catalyzed esterification of a polyacid (e.g., a polycarboxylic acid, an aromatic polyacid) and a polyalcohol. A "polyacid" ("polybasic acid") is a chemical comprising more than one acid moiety. Typically, a polyacid used in the preparation of a polyester comprise two acidic moieties, such as, for example, an aromatic dibasic acid, an anhydride of an aromatic dibasic acid, an aliphatic dibasic acid, or a combination thereof. Usually, a polyester resin comprises a plurality of polycarboxylic acids and/or polyalcohols, and such a polyester resin is known herein as a "copolyester resin." Examples of polycarboxylic acids commonly used to prepare a polyester resin includes adipic acid ("AA"); azelic acid ("AZA"); dimerized fatty acid; dodecanoic acid; hexahydrophthalic anhydride ("HHPA"); isophthalic acid ("IPA"); phthalic anhydride ("PA"); sebacic acid; terephthalic acid; trimellitic anhydride; or a combination thereof. Examples of a polyalcohol commonly used to prepare a polyester resin include 1,2-propanediol; 1,4-butanediol; 1,4-cyclohexanedimethanol ("CHDM"); 1,6-hexanediol

("HD"); diethylene glycol; ethylene glycol; glycerol; neopentyl glycol ("NPG"); pentaerythritol ("PE"); trimethylolpropane ("TMP"); or a combination thereof. In certain embodiments, a polyester may be selected that has been synthesized by an acid catalyzed esterification reaction between a plurality of polyalcohols comprising two hydroxy moieties (a "diol"), a polyalcohol comprising three hydroxy moieties (a "triol"), and a dibasic acid. An example of a diol includes 1,4-cyclohexanedimethanol; 1,6-hexanediol; neopentyl glycol; or a combination thereof. An example of a triol includes trimethylolpropane. An example of a polyol comprising four hydroxy moieties (a "tetraol") includes pentaerythritol. In addition to the standards and analysis techniques previously described for an oil, an alkyd, a polyol, an acid anhydride standards for physical properties, chemical properties, and/or procedures for testing the purity/properties of an polyester are described, for example, in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D2690-98 and D3733-93, 2002.

[0356] The selection of a polyacid and/or a polyalcohol often affects a property of the polyester resin, such as the resistance of the polyester resin to hydrolysis, and similarly the water resistance of a coating and/or film comprising such a polyester resin. In embodiments wherein a polyester-coating is desired with a superior water resistance property relative to other types of polyester-coatings, it is preferred that the coating comprises a polyester prepared with a polyol that is more difficult to esterify, and thus generally more difficult to hydrolyze. Examples of such polyols include neopentyl glycol, trimethylolpropane, 1,4-cyclohexanedimethanol, or a combination thereof.

[0357] In general embodiments, a polyester-coating is a solvent-borne coating. However, a polyester suitable for a water-borne coating is known to one of ordinary skill in the art. A water-borne polyester-coating generally comprises a polyester resin, wherein the acid number of the polyester resin is 40 to 60 including all intermediate ranges and combinations thereof, and wherein the acid moieties have been neutralized by an amine, and wherein the coating comprises liquid component that comprises a co-solvent. An additional water-borne binder (e.g., an amino resin) may be used to produce thermosetting film formation. In specific aspects, a water-borne polyester-coating produces a film of excellent hardness, gloss, flexibility, or a combination thereof.

[0358] In alternative embodiments, a polyester temporary coating (e.g., a non-film forming coating) may be produced, for example, by selection of a polyester that comprises fewer or no crosslinkable moieties, selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the polyester or additional binder, or a combination thereof.

[0359] c. Modified Cellulose Binders

[0360] In some embodiments, a chemically modified cellulose molecule ("modified cellulose," "cellulosic") may be used as a coating component (e.g., a binder). Cellulose is a polymer of anhydroglucose monomers that is insoluble in water and organic solvents. Various chemically modified forms of cellulose with enhanced solubility have been used as a coating component. Examples of chemically modified

cellulose ("modified cellulose," "cellulosic") include a cellulose ester, a nitrocellulose, or a combination thereof. Examples of a cellulose ester include cellulose acetate ("CA"), cellulose butyrate, cellulose acetate butyrate ("CAB"), cellulose acetate propionate ("CAP"), a hydroxy ethyl cellulose, a carboxy methyl cellulose, cellulose aceto-butylate, ethyl cellulose, or a combination thereof. A cellulose ester coating typically produces films with excellent flame resistance, toughness, clarity, or a combination thereof. In certain embodiments, a cellulose ester coating is selected as a topcoat, a clear coating, a lacquer, or a combination thereof. A cellulose ester is often selected for embodiments wherein the coating comprises an automotive coating, a furniture coating, a wood surface coating, cable coating, or a combination thereof. A cellulose ester coating may be a thermoplastic coating, a thermosetting coating, or a combination thereof.

[0361] A cellulose ester may be selected by the properties associated with the degree and/or type of esterification. Typically, solubility in a liquid component and/or combinability with an addition binder is increased by partial esterification of an anhydroglucose's hydroxy moieties. For example, for a cellulose acetate butyrate, properties such as compatibility, diluent tolerance, flexibility (e.g., lower T_g), moisture resistance, solubility, or a combination thereof, increases with greater butyrate esterification. However, decreased hydroxyl content alters properties in a cellulose ester. For example, a cellulose acetate butyrate comprising a hydroxy content of 1% or below has limited solubility in most solvents, while a hydroxy content of 5% or greater allows solubility in many alcohols, and the increased number of hydroxy moieties allows a greater degree of cross-linking reactions with binders such as, for example, an amino binder, an acrylic binder, urethane binder, or a combination thereof. A cellulose acetate butyrate acrylic-coating may be selected as lacquers, an automotive coating, a coating comprising a metallic pigment (e.g., aluminum), or a combination thereof. A cellulose acetate butyrate acrylic-coating may comprise a liquid component that comprises greater amounts of an aromatic hydrocarbon solvent with the selection of a CAB with greater butyrate ester content. Though not a cellulosic, sucrose esters may be similarly used as cellulose ester, particularly CAB.

[0362] In some embodiments, in a cellulose ester comprising an acetyl ester (e.g., comprises cellulose acetate, cellulose acetate butyrate, cellulose acetate propionate), the acetyl content will range from 0.1% to 40.5% acetate, including all intermediate ranges and combinations thereof. In certain aspects, the acetyl content of a cellulose acetate, a cellulose acetate butyrate, or a cellulose acetate propionate will range from 39.0% to 40.5%, 1.0% to 30.0%, or 0.3% to 3.0%, respectively, including all intermediate ranges and combinations thereof, respectively. In many aspects, in a cellulose ester comprising a butyryl ester (e.g., cellulose acetate butyrate), the butyryl content will range from 15.0% to 55.0% butyryl, including all intermediate ranges and combinations thereof. In other aspects, in a cellulose ester comprising a propionyl ester (e.g., cellulose acetate propionate), the propionyl content will range from 40.0% to 47.0% propionyl, including all intermediate ranges and combinations thereof. In other embodiments, the hydroxyl content of a cellulose acetate, a cellulose acetate butyrate, or a cellulose acetate propionate will range from 0% to 5.0%, including all intermediate ranges and combinations thereof.

[0363] A nitrocellulose ("cellulose nitrate") resin comprises a cellulose molecule wherein a hydroxyl moiety has been nitrated. A nitrocellulose for use in a coating typically comprises an average of 2.15 to 2.25 nitrates per anhydroglucose monomer, and is soluble in an ester, a ketone, or a combination thereof. Additionally, nitrocellulose is soluble in a combination of a ketone, an ester, and an alcohol and/or hydrocarbon. A nitrocellulose may be selected as a lacquer, an automotive primer, automotive topcoat, a wood topcoat, or a combination thereof. Nitrocellulose coatings are typically a thermoplastic coating.

[0364] Standard procedures for determining physical and/or chemical properties (e.g., acetyl content, ash, apparent acetyl content, butyryl content, carbohydrate content, carboxyl content, color and haze, combined acetyl, free acidity, heat stability, hydroxyl content, intrinsic viscosity, solution viscosity, moisture content, propionyl content, sulfur content, sulfate content, metal content), of a cellulose and/or a modified cellulose (e.g., cellulose acetate, cellulose acetate propionate, cellulose acetate butyrate, methylcellulose, sodium carboxymethylcellulose, ethylcellulose, hydroxypropyl methylcellulose, hydroxyethylcellulose, hydroxypropylcellulose) have been described, for example, in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D1695-96 D817-96, D871-96, D1347-72, D1439-97, D914-00, D2363-79, D2364-01, D5400-93, D1343-95, D1795-96, D2929-89, D3971-89, D4085-93, D1926-00, D4794-94, D3876-96, D3516-89, D5897-96, D5896-96, D6188-97, D1348-94, and D1696-95, 2000. Specific procedures for determining purity/properties of a nitrocellulose (e.g., nitrogen content) have been described, for example, in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D301-95 and D4795-94, 2002.

[0365] In alternative embodiments, a modified cellulose temporary coating (e.g., a non-film forming coating) may be produced, for example, by selection of a modified cellulose that comprises fewer or no crosslinkable moieties, selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the modified cellulose or additional binder, or a combination thereof.

[0366] d. Polyamide and Amidoamine Binders

[0367] A polyamide ("fatty nitrogen compound," "fatty nitrogen product") is a reaction product of a polyamine and a dimerized and/or trimerized fatty acid. In typical embodiments, a polyamide is an oligomer. An amide resin comprises a terminal amine moiety capable of cross-linking with an epoxy moiety, and it is particularly preferred that a polyamide binder is combined with an epoxide binder. In other aspects, a polyamide may be considered an additive (e.g., a curing agent, a hardening agent, a coreactant) of an epoxide coating. A polyamine-epoxy coating may be used as an industrial coating (e.g., an industrial maintenance coating), a marine coating, or a combination thereof. A polyamide-epoxide coating may be applied to a surface such as, for example, wood, masonry, metal (e.g., steel), or a combination thereof. However, it is preferred that any surface is thoroughly cleaned prior to application to promote adhesion. Such surface preparation are well known to those of ordi-

nary skill in the art, and include, for example, removal of rust, degraded film, grease, etc. A polyamide-epoxy coating typically is a solvent-borne coating. Examples of solvents for a polyamide include an alcohol, an aromatic hydrocarbon, a glycol ether, a ketone, or a combination thereof. In certain embodiments, a polyamide-epoxy coating may comprise a two-pack coating, wherein coating component(s) comprising the polyamide resin are stored in one container, and coating components comprising the epoxy resin are stored in a second container. Such a two-pack coating is admixed immediately before application, as the stoichiometric mix ratio of resin is formulated to promote a rapid cure. However, in other embodiments, a polyamide-epoxy coating may be a single container coating. Such a solvent-borne polyamine-epoxy coating may be formulated for a storage life of a year or more. An aluminum and/or stainless steel container is suitable, though a carbon steel container may alter coating and/or film color. However, such a coating typically undergoes film formation in stages, wherein the liquid component is physically lost by evaporation while thermosetting produces a physically durable film in about 8 to 10 hours, a chemically resistant film in three to four days, and final cross-linking completed in about three weeks. In some embodiments, a polyamine-epoxy coating may undergo chalking upon exterior weathering.

[0368] Though a polyamide is prepared from a fatty acid, it is not classified as an oil-based binder herein due to the chemistry of film formation for polyamide binder. The dimerized ("dibasic") or trimerized fatty acid generally comprises a polyunsaturated fatty acid, a monounsaturated fatty acid, or a combination thereof. In certain aspects, the fatty acid is a linseed oil fatty acid, soybean oil fatty acid, tall oil fatty acid, or a combination thereof. In specific facets, the fatty acid is an 18-carbon fatty acid. However, to reduce the volatile organic compounds of solvent-borne coating, a polyamide binder may be partly or fully substituted, such as 0% to 100% substitution, including all intermediate ranges and combinations thereof, with an amidoamine binder. An amidoamine binder differs from a polyamide binder by the use of a fatty acid rather than a dimerized fatty acid in the synthesis of the resin. The selection of the polyamine in the preparation of a polyamide can affect the properties of the polyamide. The polyamine may be linear (e.g., diethylenetriamine), branched or cyclic (e.g., aminoethylpiperazine). Standards for physical properties, chemical properties, and/or procedures for testing the purity/properties (e.g., amine value) of a polyamide and/or an amidoamine are described, for example, in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D2071-87, D2073-92, D2082-92, D2072-92, D2074-92, D2075-92, D2076-92, D2077-92, D2078-86, D2079-92, D2080-92, D2081-92, and D2083-92, 2002.

[0369] In general embodiments, a polyamine comprises a polyethylene amine. A polyamide produced from diethylenetriamine can be prepared to comprise a varying amount, typically 35% to 85%, including all intermediate ranges and combinations thereof, of an imidazoline moiety. In other embodiments, the amount of amine moiety capable of cross-linking with an epoxy moiety may vary from 100 to 400 amine value, including all intermediate ranges and combinations thereof. However, the amine value is converted into units known as "active hydrogen equivalent weight," which varies from 550 to 140, including all intermediate ranges and

combinations thereof, for comparison to the epoxy resins epoxide equivalent weight for determining the stoichiometric mix ratio of a polyamide-epoxy combination. The stoichiometric mix ratio affects coating and film properties. As the polyamide to epoxy stoichiometric mix ratio increases from a ratio of less than one to a ratio of greater than one, properties such as excellent impact resistance, excellent chemical resistance, or a combination thereof, decrease while film flexibility increases. Examples of polyamide to epoxy stoichiometric mix ratio include 2:1 to 1:2, including all intermediate ranges and combinations thereof.

[0370] In alternative embodiments, a polyamide and/or amidoamine temporary coating (e.g., a non-film forming coating) may be produced, for example, by selection of a polyamide and/or amidoamine that comprises fewer or no crosslinkable moieties, selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the polyamide and/or amidoamine or additional binder, selection of a stoichiometric ratio that is less suitable for crosslinking reactions, or a combination thereof.

[0371] e. Amino Resins

[0372] An amino resin ("amino binder," "aminoplast," "nitrogen resin") is a reaction product of formaldehyde, an alcohol and a nitrogen compound such as, for example, urea, melamine ("1:3:5 triamino triazine"), benzoguanamine, glycoluril, or a combination thereof. An amino resin may be used to a thermosetting coating. An amino resin comprises an alkoxymethyl moiety capable of cross-linking with a hydroxyl moiety of an additional binder such as an acrylic binder, an alkyd resin, a polyester binder, or a combination thereof, and it is preferred that an amino resin is combined with a binder that comprises a hydroxyl moiety in a coating. In aspects wherein the coating comprises an amino resin and an alkyd resin, it is preferred that the amino:alkyd resin ratio is 1:1 to 1:5, including all intermediate ranges and combinations thereof. An amino resin coating typically is a solvent-borne coating. Examples of solvents for an amino resin include an alcohol (e.g., butanol, isobutanol, methanol, isopropanol), a ketone, hydroxyl functional glycol ether, or a combination thereof. Additionally, an amino resin generally possesses limited solubility in a hydrocarbon (e.g., xylene), which may be added to a solvent-borne coating's liquid component. In certain aspects, an amino resin coating may be a water-borne coating, wherein water is a solvent for an amino resin comprising a plurality of methylol moieties. In other embodiments, a water-borne amino resin coating may comprise a water-reducible coating, particularly wherein the liquid component comprises a glycol ether, an alcohol, or a combination thereof. In certain embodiments, an amino coating comprises an acid catalyst.

[0373] An amino resin coating generally is cured by baking at a temperature of 82° C. and 204° C., including all intermediate ranges and combinations thereof. Baking generally promotes reactions between amino resins, though it does improve the reaction rate between an amino resin and an additional binder. It is preferred that in embodiments wherein the coating comprises an additional binder, the additional resin comprises less hydroxyl moieties and/or the amino resin is polar amino resin (e.g., a conventional amino resin) when cured by baking than embodiments wherein an acid catalyst is used. An amino resin coating undergoes rapid

film formation, typically lasting 30 seconds and 30 minutes, wherein a higher temperature and/or acid catalyst shortens film formation time. An amino resin prepared from urea is generally undergoes film formation faster than an amino resin prepared from melamine. However, an amino resin coating generally produces an alcohol (e.g., methanol, butanol) and formaldehyde during film formation as byproducts.

[0374] An amino resin for use in a coating may be classified by content of a liquid component (e.g., a solvent) as a high solids amino resin or a conventional amino resin. The liquid component is generally used to reduce the viscosity of the resin for coating preparation. A high solids amino resin comprises 80% to 100%, by weight, an amino resin, with the balance a liquid component. A high solids amino resin is relatively less polar, less polymeric, lower in viscosity, or a combination thereof, relative to a conventional amino resin. The lower viscosity allows the use of little or no liquid component. Additionally, a high solids amino resin may be water-soluble and/or water reducible. A conventional amino resin comprises less than 80% amino resin, by weight, with the balance a liquid component. Properties of a high solids or conventional amino resin selected for use in a coating such as the amount of amino resin and liquid component, the amount of unreacted formaldehyde in the resin preparation, the viscosity of the resin, the ability of the resin to accept additional liquid component as a solvent, can be empirically determined by procedures known to those of ordinary skill in the art (see, for example, "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D4277-83, D1545-98, D1979-97, and D1198-93, 2002; and "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D2369-01e1, 2002).

[0375] In embodiments wherein an amino resin coating comprise an amino resin prepared from urea, the coating may be used as wood coating (e.g., furniture coating), an industrial coating (e.g., an appliance coating), an automotive primer, a clear coating, or a combination thereof. However, an amino resin film, wherein the resin was prepared from urea, generally produces a film with poor resistance to moisture, and is preferred as an internal coating and/or as part of a multicoat system. In certain embodiments, an amino resin prepared from melamine, generally produces films with good resistance to moisture, temperature, UV irradiation, or a combination thereof. A melamine-based amino coating may be applied to a metal surface. In specific aspects, such a melamine amino resin coating may be an automotive coating, a coil coating, a metal container coating, or a combination thereof. In embodiments wherein an amino resin coating comprise an amino resin prepared from benzoguanamine, the film produced generally possesses poor weathering resistance, good corrosion resistance, water resistance, detergent resistance, flexibility, hardness, or a combination thereof. A benzoguanamine amino resin may be used as an industrial coating, particularly for indoor applications (e.g., an appliance coating). In embodiments wherein an amino resin coating comprise an amino resin prepared from, glycoluril, a higher baking temperature and/or acid catalyst may be used during film formation, but less byproducts may be released. A glycoluril-based amino-coating typically produces a film with excellent corrosion resistance,

humidity resistance, or a combination thereof. A glycoluril-based amino-coating may be selected as a metal coating.

[0376] In alternative embodiments, an amino resin temporary coating (e.g., a non-film forming coating) may be produced, for example, by selection of an amino resin that comprises fewer or no crosslinkable moieties, selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the amino resin and/or additional binder, selection of a binder ratio that is less suitable for crosslinking reactions, using a bake cured amino resin coating at temperatures less than is needed for curing (e.g., ambient conditions) or a combination thereof.

[0377] f. Urethane Binders

[0378] A urethane binder ("polyurethane binder," "urethane," "polyurethane") is a binder comprising prepared from compounds that comprise an isocyanate moiety. The urethane binder's urethane moiety can form intermolecular hydrogen bonds between urethane binder polymers, and these non-covalent bonds confer useful properties in a coating or film comprising an urethane binder. The hydrogen bonds can be broken by mechanical stress, but will reform, thereby conferring a property of abrasion resistance. Additionally, a urethane binder can form some hydrogen bonds with water, conferring a plasticizing property to the coating. In certain embodiments, a urethane binder comprises an isocyanate moiety. The isocyanate moiety is highly reactive (e.g., crosslinkable) with a moiety comprising a chemically reactive hydrogen. Examples of a chemically reactive hydrogen moiety include a hydroxyl moiety, an amine moiety, or a combination thereof. Examples of an additional binder include a polyol, an amine, an epoxide, silicone, vinyl, phenolic, or a combination thereof. In certain embodiments, a urethane coating is a thermosetting coating. In specific aspects, a urethane coating comprises a catalyst (e.g., dibutyltin dilaurate, stannous octoate, zinc octoate). In specific facets, the coating comprises 10 to 100 parts per million catalyst, including all intermediate ranges and combinations thereof. In some embodiments, such a coating will undergo film formation at ambient conditions or slightly greater temperatures. A binder comprising an isocyanate moiety is often selected to produce a coating with durability in an external environment. A urethane coating typically possesses good flexibility, toughness, abrasion resistance, chemical resistance, water resistance, or a combination thereof. An aliphatic urethane coating may be selected for the additional property of good lightfastness.

[0379] In general embodiments, a urethane binder may be selected based on the materials used in its preparation, which typically affect the urethane binder's properties. An example of a urethane binder includes an aromatic isocyanate urethane binder, an aliphatic isocyanate urethane binder, or a combination thereof. Aliphatic isocyanate urethane binders are often selected for embodiments wherein a superior exterior durability, color stability, good lightfastness, or a combination thereof relative to an aromatic isocyanate binder is desired. Examples of an aliphatic isocyanate urethane binder includes a hydrogenated bis(4-isocyanatophenyl)methane ("4,4'-dicyclohexylmethane diisocyanate," "HMDI"), HDI, a combination of 2,2,4-trimethyl hexamethylene diisocyanate and 2,4,4-trimethyl hexamethylene diisocyanate ("TMHDI"), 1,4-cyclohexane diisocyanate ("CHDI"), isophorone diisocyanate ("3-isocyanatom-

ethyl-3,5,5-trimethylcyclohexyl isocyanate," "IPDI"), or a combination thereof. In certain aspects, a HDI derived binder is prepared from excess HDI reacted with water, known as "HDI biuret." In certain aspects, a HDI derived binder may be prepared from a 1,6-hexamethylene diisocyanate isocyanurate, wherein such a HDI derived binder produces a coating with generally superior heat resistance and/or exterior durability is desired relative to other HDI derived binders. As would be known to one of ordinary skill in the art, standards for physical properties, chemical properties, and/or procedures for testing the purity/properties of urethane precursor components (e.g., toluene) and urethane resins (e.g., isocyanate moieties) for use in a coating are described, for example in "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons," D5606-01, 2002; and "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D3432-89 and D2572-97, 2002.

[0380] In certain embodiments, a urethane coating comprises a urethane binder capable of a self-crosslinking reaction. An example is a moisture-cure urethane, which comprises an isocyanate moiety. Contact between an isocyanate moiety and a water molecule produces an amine moiety capable of bonding with an isocyanate moiety of another urethane binder molecule in a linear polymerization reaction. In certain aspects, a moisture cure urethane coating is baked at 100° C. to 140° C., including all intermediate ranges and combinations thereof, to promote crosslinking reactions between the linear polymers. In certain embodiments, a moisture-cure urethane coating is a solvent-borne coating. In specific aspects, a moisture-cure urethane coating comprises a dehydrator. In general aspects, moisture-cure urethane coating typically is a one-pack coating, prepared for storage of the coating in anhydrous conditions.

[0381] In certain embodiments, an urethane coating comprises a blocked isocyanate urethane binder, wherein the isocyanate moiety has been chemically modified by a hydrogen donor to be inert until contacted with a baking temperature. Such a blocked isocyanate urethane coating typically is a one-pack coating, as it is designed for stability at ambient conditions. Additionally, a blocked isocyanate urethane coating may be a powder coating.

[0382] In certain embodiments, a urethane coating comprises an additional binder. In certain embodiments, a urethane may be combined with a binder such as an amine, an epoxide, silicone, vinyl, phenolic, a polyol, or a combination thereof, wherein the binder comprises a reactive hydrogen moiety. In specific embodiments, selection of a second binder to crosslink with the urethane binder affects coating and/or film properties. In certain aspects, a coating comprising a urethane and an epoxide, vinyl, phenolic, or a combination thereof produces a film with good chemical resistance. In other aspects, a coating comprising a urethane and a silicone produces a coating with good thermal resistance. In some aspects, a coating comprises a urethane and a polyol. A primary hydroxyl moiety, secondary hydroxyl moiety, and tertiary hydroxyl moiety of a polyol are respectively the fastest, moderate, and slowest to react with a urethane. Steric hindrance from a neighboring moiety may slow the reaction with a hydroxyl moiety. In an additional example, use of a polyol may increase flexibility of a urethane coating. Often, a selected polyol has a molecular

weight from 200 Da to 3000 Da, including all intermediate ranges and combinations thereof. Generally, a lower molecular weight polyol increases the hardness property, lowers the flexibility property, or a combination thereof, of a urethane polyol film. Examples of a polyol include a glycol, a triol (e.g., 1,4-butane-diol, diethylene glycol, trimethylolpropane), a tetraol, a polyester polyol, a polyether polyol, an acrylic polyol, a polylactone polyol, or a combination thereof. Examples of a polyether polyol include a poly (propylene oxide) homopolymer polyol, a poly (propylene oxide) and ethylene oxide copolymer polyol, or a combination thereof.

[0383] In certain embodiments, a urethane binder comprises a thermoplastic urethane binder. Typically, a thermoplastic urethane binder is from 40 kDa to 100 kDa, including all intermediate ranges and combinations thereof. In particular aspects, a thermoplastic urethane binder comprises little or no isocyanate moieties. In general aspects, a thermoplastic urethane coating is a solvent borne coating. In specific facets, a thermoplastic urethane coating is a lacquer, a high gloss coating, or a combination thereof.

[0384] In certain embodiments, a urethane binder is an urethane acrylate ("acrylated urethane") binder. An urethane acrylate binder generally comprises an acrylate moiety at an end of the polymeric binder. The acrylate moiety is typically part of an acrylate monomer, wherein the monomer comprises a hydroxyl moiety (e.g., a 2-hydroxy-ethyl acrylate). An urethane acrylate coating generally comprises another binder for crosslinking reactions. Examples of a suitable binder include a triacrylate (e.g., trimethylolpropane). A urethane acrylate coating generally also comprises a viscosifier, wherein the viscosifier reduces viscosity. Examples of such a viscosifier include an acrylate monomer, a N-vinyl pyrrolidone, or a combination thereof. A urethane acrylate coating is cured by irradiation. Examples of irradiation include UV light, electron beam, or a combination thereof. In embodiments wherein UV light is a curing agent, a urethane acrylate coating typically comprises a photoinitiator. Examples of a suitable initiator include 2,2-diethoxyacetophenone, a combination of benzophenone and an amine synergist, or a combination thereof. In specific facets, an urethane acrylate coating is applied to a plastic surface. In other facets, an urethane acrylate coating floor coating, an electronic circuit board coating, or a combination thereof.

[0385] In alternative embodiments, a urethane temporary coating (e.g., a non-film forming coating) may be produced, for example, by selection of a urethane resin that that comprises fewer or no crosslinkable moieties, selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the a urethane resin and/or additional binder, using a bake cured a urethane resin coating at temperatures less than is needed for curing (e.g., ambient conditions), selection of size range for a thermoplastic urethane resin coating that is less suitable for film formation (e.g., 1 kDa to 40 kDa), or a combination thereof.

(1) Water-Borne Urethanes

[0386] The previous discussion of urethane coatings focused on solvent-borne urethane coating. A water-borne urethane coating typically is comprises a water-dispersible urethane binder such as a cationic modified urethane binder and/or anionic modified urethane binder. A cationic modified

urethane binder is a urethane binder chemically modified by an diol comprising an amine, such as, for example, diethanolamine, methyl diethanolamine, N,N-bis(hydroxyethyl)- α -aminopyridine, lysine, N-hydroxyethylpiperidine, or a combination thereof. An anionic modified urethane binder is a urethane binder chemically modified by an diol comprising a carboxylic acid such as dimethylolpropionic acid (2,2-bis(hydroxymethyl) propionic acid), dihydroxybenzoic acid, and/or a sulfonic acid (e.g., 2-hydroxymethyl-3-hydroxypropanesulfonic acid), or a combination thereof.

(2) Urethane Powder Coatings

[0387] A urethane powder coating refers to a polyester and/or acrylic coating, wherein the binder has been modified to comprise a urethane moiety. Such a coating is typically a thermosetting, bake cured coating, an industrial coating (e.g., an appliance coating), or a combination thereof.

[0388] g. Phenolic Resins

[0389] A phenolic resin ("phenolic binder," "phenolic") is reaction product of a phenolic compound and an aldehyde. A preferred aldehyde is formaldehyde, and such a phenolic resin is known as a "phenolic formaldehyde resin" ("PF resin"). The properties of a phenolic resin are affected by the phenolic compound and reaction conditions used during synthesis. A resole resin ("resole phenolic") is prepared by a reaction of a molar excess of a phenolic compound with formaldehyde under alkaline conditions. A novolac resin ("novolac phenolic") is prepared by a reaction of a molar excess of formaldehyde with a phenolic compound under acidic conditions. Examples of phenolic compounds used in preparing a phenolic resin include phenol; orthocresol ("o-cresol"); metacresol, paracresol ("p-cresol"); a xylenol (e.g., 4-xylenol); bisphenol-A ["2,2-bis (4-hydroxyphenyl) propane"; "diphenylol propane"]; p-phenylphenol; p-tert-butylphenol; p-tert-amylphenol; p-tert-octyl phenol; p-nonylphenol; or a combination thereof. As would be known to one of ordinary skill in the art, standards for physical properties, chemical properties, and/or procedures for testing the purity/properties of various compounds used in phenolic resins (e.g., bisphenol A, a phenol, a cresol, formaldehyde) for use in a coating are described, for example in "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons," D6143-97, D3852-99, D4789-94, D2194-02, D2087-97, D2378-02, D2379-99, D2380-99, D1631-99, D6142-97, D4493-94, D4297-99, and D4961-99, 2002. As would be known to one of ordinary skill in the art, standards for physical properties, chemical properties, and/or procedures for testing the purity/properties of phenolic resins for use in a coating are described, for example in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D1312-93, D4639-86, D4706-93, D4613-86 and D4640-86, 2002.

[0390] In alternative embodiments, a phenolic resin temporary coating (e.g., a non-film forming coating) may be produced, for example, by selection of a phenolic resin that that comprises fewer or no crosslinkable moieties, selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the a phenolic resin and/or additional binder, using a bake cured a phenolic resin coating at temperatures less than is needed for curing (e.g., ambient conditions), or a combination thereof.

(1) Resole

[0391] A resole resin is the more commonly used PF resin. A solvent-borne phenolic formaldehyde coating typically comprises an alcohol, an ester, a glycol ether, a ketone, or a combination thereof, as a PF solvent. However, a phenolic resin prepared from phenolic compound comprising an alkyd moiety, such as, for example, p-tert-butylphenol p-tert-amylphenol p-tert-octyl phenol, or a combination thereof, typically has solubility in an aromatic compound and/or able to tolerate an aliphatic diluent. Often, a phenolic-resin coating comprises an additional binder such as an alkyd resin, an amino resin, a blown oil, an epoxy resin, a polyamide, a polyvinyl resin [e.g., poly(vinyl butyral)], or a combination thereof. An example of a phenolic-resin coating includes a varnish, an industrial coating, or a combination thereof. A phenolic resin-coating may be selected for embodiments wherein a film possessing solvent resistance, corrosion resistant, of a combination thereof, is desired. Examples of surfaces wherein such properties are often desirable include a surface of a metallic container (e.g., a can, a pipeline, a drum, a tank), a coil coating, or a combination thereof. In specific aspects, a phenolic coating produces a film 0.2 to 1.0 mil thick, including all intermediate ranges and combinations thereof. In specific aspects, coating comprising a phenolic-binder and additional binder undergoes thermosetting cross-linking reactions between the binders during film formation. In certain embodiments, a phenolic-resin coating undergoes cure by baking, such as, for example, 135° C. to 204° C., including all intermediate ranges and combinations thereof. In specific aspects, a baking cure time is one minute to four hours, with shorter cure times at high temperatures. A phenolic-resin film generally possesses excellent hardness property (e.g., glass-like), excellent resistance to solvents, water, acids, salt, electricity, heat resistance, as well as thermal resistance up to 370° C. for a period of minutes.

[0392] However, a phenolic-resin film is poorly resistant to alkali unless made from a coating that also comprised an epoxy binder. In certain embodiments, a phenolic-epoxy coating comprises a binder ratio of 15:85 to 50:50 phenolic binder:epoxy binder, including all intermediate ranges and combinations thereof. In certain aspects, a phenolic-epoxy coating possesses superior flexibility, toughness, or a combination thereof relative to a phenolic coating. In specific facets, a phenolic-epoxy coating is cured at 200° C. for 10 to 12 minutes.

[0393] In other aspects, a phenolic coating comprises a blown oil, an alkyd, or a combination thereof. In some aspects, such a coating comprises a phenolic resin prepared from p-tert-butylphenol p-tert-amylphenol p-tert-octyl phenol, or a combination thereof. In specific aspects, such a coating is applied to electrical coil, electrical equipment, or a combination thereof.

(2) Novolak

[0394] In other aspects, wherein a film is desired, it novolak coating may be used. However, a novolak resin is generally a non-film forming resin. It is particularly preferred that the coating comprise an epoxy resin. It is also preferred that the coating comprise a basic catalyst. A film produced from such a novolak-epoxy coating typically possesses good resistance to chemicals, water, heat, or a com-

bination thereof. In specific facets, a novolak-epoxy coating may be a high solids coating, a powder coating, a pipeline coating, or a combination thereof.

[0395] A novolak resin prepared from phenolic compound comprising an alkyd moiety such as p-tert-butylphenol p-tert-amylphenol p-tert-octyl phenol, or a combination thereof, typically has solubility in an oil. Additionally, a PF resin may be modified by reaction with an oil to produce an oil modified PF resin, which is also oil soluble. An alkyd phenol-formaldehyde resin, an oil modified phenol-formaldehyde resin, is generally a non-film forming resin. A coating capable of producing a film may be formulated by combining such a resin with a drying oil, an alkyd, or a combination thereof. In specific aspects, an alkyd phenol-formaldehyde resin, an oil modified phenol-formaldehyde resin undergoes cross-linking with an oil and/or an alkyd. Such a coating may further comprise a liquid component (e.g., a solvent), a drier, a UV absorber, an anti-skinning agent, or a combination thereof. In certain facets, such a coating undergoes film formation under ambient conditions or by baking. In particular aspects, such a coating comprises a varnish, a wood coating, or a combination thereof. In specific facets, such a coating comprises a pigment.

[0396] h. Epoxy Resins

[0397] An epoxy resin ("epoxy binder," "epoxy") is a compound comprising an epoxide ("oxirane") moiety. An epoxide resin may be used in a thermosetting coating, thermoplastic coating, or a combination thereof. An epoxide coating typically is a solvent borne coating, though examples of a water-borne and powder epoxy coating are described herein. An epoxide coating generally possesses excellent properties of adhesion, corrosion resistance, chemical resistance, or a combination thereof. An epoxide coating may be selected for various surfaces, particularly a metal surface.

[0398] An epoxide resin (e.g., a bisphenol A epoxy resin) generally comprises one or two epoxide moieties per resin molecule. An epoxide resin may additionally comprise a monomer, oligomer, or polymer of repeating chemical units, each generally lacking an epoxide moiety, but comprising a hydroxy moiety. The number of monomer(s) present is expressed "n" value, wherein an average increase of one monomer per epoxide resin molecule increase the n value by one. The chemical and/or physical properties of an epoxide resin are affected by the n value. For example, as the n value increases, the chemical reactions selected for film formation in a thermosetting coating may become more dominated by reactions with the increasing numbers of hydroxyl moieties, and less dominated by the epoxide moieties. Often, an epoxide resin is classified by an epoxide equivalent weight, which is the grams of resin required to provide 1 M epoxide moiety equivalent. In certain embodiments, the epoxide equivalent weight is 182 to 3050, including all intermediate ranges and combinations thereof. Additionally, an epoxide resin may be used in a thermoplastic coating, particularly wherein the n value is greater than 25. In certain embodiments, an epoxide resin may possess an n value of 0 to 250, including all intermediate ranges and combinations thereof. As would be known to one of ordinary skill in the art, standards for physical properties, chemical properties, and/or procedures for testing the purity/properties of epoxy resins (e.g., epoxy moiety content) for use in a coating are

described, for example in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D4142-89, D1652-97, D1726-90, D1847-93, and D4301-84, 2002.

[0399] An epoxide moiety is chemically reactive with a variety of other moieties, such as, for example, an amine, a carboxyl, a hydroxyl or a phenol. An epoxide coating may comprise an additional binder capable of undergoing a cross-linking reaction with the epoxide during film formation. Various such additional binders are known to those of ordinary skill in the art, and are often referred to as a "curing agent" or "hardener." The selection of a curing agent and/or an epoxide can affect whether the coating undergoes film formation at ambient conditions or by baking.

[0400] In alternative embodiments, an epoxide resin temporary coating (e.g., a non-film forming coating) may be produced, for example, by selection of an epoxide resin that comprises fewer or no crosslinkable moieties, selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the an epoxide resin and/or additional binder, using a bake cured an epoxide resin at temperatures less than is needed for curing (e.g., ambient conditions), not irradiating the coating, or a combination thereof.

(1) Ambient Condition Curing Epoxies

[0401] In certain embodiments, a curing agent suitable for curing at ambient conditions comprises an amine moiety such as a polyamine adduct, which is an epoxy resin modified to comprise an amine moiety, a polyamide, a ketimine, an aliphatic amine, or a combination thereof. Examples of an aliphatic amine include ethylene diamine ("EDA"), diethylene triamine ("DETA"), triethylene tetraamine ("TETA"), or a combination thereof. Selection of a polyamine adduct generally produces a film with excellent solvent resistance, corrosion resistance, acid resistance, flexibility, impact resistance, or a combination thereof. Selection of a polyamide generally produces a film with superior adhesion, particularly to a moist or poorly prepared surface, good solvent resistance, excellent corrosion resistance, good acid resistance, superior flexibility retention, superior impact resistance retention, or a combination thereof. A ketimine is a reaction product of a primary amine and a ketone, and produces a coating and/or film with similar properties as a polyamine or amine adduct. However, the pot life is longer with a ketimine, and moisture (e.g., atmospheric humidity) activates this cure agent. Examples of an epoxide selected for curing at ambient conditions includes a low mass epoxide resins with an n value from 0 to 2.0, including all intermediate ranges and combinations thereof. In certain embodiments, an epoxy resin may be selected with an epoxy equivalent weight of 182 to 1750, including all intermediate ranges and combinations thereof. In specific aspects, the greater the n value of an epoxide resin, the longer the pot life in a two-pack coating, the greater the coating leveling property, the lower the film solvent resistance, the lower the film chemical resistance, the greater the film flexibility, or a combination thereof. In certain aspects, an ambient curing epoxide coating is a two-pack coating, wherein the epoxide resin is in one container and the curing agent in a second container. In typical aspects, the pot life upon admixing the coating components is two hours to two

days. An ambient cure epoxide may be selected for an industrial coating (e.g., industrial maintenance coating), a marine coating, an aircraft primer, a pipeline coating, a HIPAC, or a combination thereof.

(2) Bake Curing Epoxies

[0402] In other embodiments, a curing agent suitable for curing by baking includes an amino resin (e.g., a urea or melamine-based amino resin), a phenolic resin, or a combination thereof. Since baking is generally needed to promote film formation, an epoxy coating comprising such a curing agent typically is a one-pack coating. In certain embodiments, an epoxy resin may be selected with an epoxy equivalent weight of 1750 to 3050, including all intermediate ranges and combinations thereof. An epoxy resin coating that comprises an amino resin cure agent typically is selected for a lower cure temperature. Such a coating may be selected as a can coating, a metal coating, an industrial coating (e.g., equipment, appliances), or a combination thereof. An epoxy coating comprises an phenolic resin cure agent typically possesses greater chemical resistance and/or solvent resistance, and is typically selected for a can coating, a pipeline coating, a wire coating, an industrial primer, or a combination thereof. Examples of an epoxide selected for curing by baking includes a higher mass epoxide resins with an n value from 9.0 to 12.0, including all intermediate ranges and combinations thereof. In certain embodiments, a heat-cured epoxy coating is a water-borne coating. Such a water-borne coating comprises a higher mass epoxide resin modified to comprise a terpolymer that comprises monomers of styrene, methacrylic, acrylate, or a combination thereof, and an amino resin, a phenolic resin, or a combination thereof. Such a water-borne coating is typically selected as a can coating.

(3) Electrodeposition Epoxies

[0403] Another example of a water-borne epoxide coating is an electrodeposition epoxy coating. In certain embodiments, an epoxy resin may be selected with an epoxy equivalent weight of 500 to 1500, including all intermediate ranges and combinations thereof. An anionic and/or cationic epoxy resin is electrically attracted to a surface for application. The surface removed from the coating bath, and the coating is baked cured into a film upon the surface. Such a water-borne coating may be selected for an automotive primer, described elsewhere herein.

(4) Powder Coating Epoxies

[0404] An epoxy coating may be a powder coating, wherein the various nonvolatile coating components are admixed. Examples of typical admixed components include an epoxy resin, a curing agent, and a pigment, an additive, or a combination thereof. In certain embodiments, an epoxy resin may be selected with an epoxy equivalent weight of 550 to 750, including all intermediate ranges and combinations thereof. The mixture is then melted, cooled, and powderized. The powder coating is typically applied by attraction to an electrostatic charge of a surface. The thermosetting coating is cured by baking. An epoxy powder coating may be selected as a pipe coating, an electrical device coating, an industrial coating (e.g., appliance coating, automotive coating, furniture coating), or a combination thereof.

(5) Cycloaliphatic Epoxies

[0405] A cycloaliphatic epoxy binder possesses a ring structure, rather than the linear structure for the epoxy embodiments described above. Examples of a cycloaliphatic epoxide is ERL-4221 (“3,4-epoxycyclohexylmethyl 3,4-epoxycyclohexane carboxylate”), which has an epoxy equivalent weight of 131 to 143, bis(3,4-epoxycyclohexylmethyl) adipate, which has an epoxy equivalent weight of 190 to 210, 2-(3,4-epoxycyclohexyl-5,5-spiro-3,4-epoxy)cyclohexane-m-dioxane, which has an epoxy equivalent weight of 133-154, 1-vinyl-epoxy-3,4-epoxycyclohexane, which has an epoxy equivalent weight of 70 to 74, or a combination thereof. Usually, a cycloaliphatic epoxy coating is combined with another binder, such as a polyol, a polyol modified to comprise a carboxyl moiety, or a combination thereof. An acid may be used to initiate crosslinking, particularly with a polyol. A cycloaliphatic epoxy polyol coating may comprise a triflic acid salt (e.g., diethylammonium triflate) to produce a one-pack coating with a pot life of up to eight months. In certain embodiments, a cycloaliphatic epoxy coating is a UV radiation cured coating, wherein the coating comprises a compound that converts to a strong acid upon UV irradiation (e.g., an onium salt). In certain aspects, a UV radiation cured cycloaliphatic epoxy coating is a one-pack coating. A UV radiation cured cycloaliphatic epoxy coating generally possesses excellent flame resistance, water resistance, or a combination thereof, and may be selected as a can coating or an electrical equipment coating. A compound comprising a carboxyl moiety (e.g., a carboxyl modified polyol) readily crosslinks with a cycloaliphatic epoxy binder. However, such a cycloaliphatic epoxy coating comprising such an additional binder generally has a short pot life (e.g., less than eight hours). In certain aspects, a cycloaliphatic epoxy carboxylic acid binder coating is a two-pack coating. A cycloaliphatic epoxy carboxylic acid polyol coating generally possesses excellent adhesion, toughness, gloss, hardness, solvent resistance, or a combination thereof.

[0406] i. Polyhydroxyether Binders

[0407] A polyhydroxyether binder (“polyhydroxyether resin,” “phenoxy binder,” “phenoxy”) chemically resembles a bisphenol A epoxy resin, though a polyhydroxyether binder lacks an epoxide moiety, and about 30 kDa in size. A polyhydroxyether coating is typically a thermoplastic coating. The polyhydroxyether binder comprises a hydroxyl moiety, and can be cross-linked with an additional binder such as an epoxide, a polyurethane comprising an isocyanate moiety, an amino resin, or a combination thereof. A thermosetting polyhydroxyether coating typically possesses excellent physical resistance properties, excellent chemical resistance, modest solvent resistance, or a combination thereof. In alternative embodiments, a polyhydroxyether binder temporary coating (e.g., a non-film forming coating) may be produced, for example, by selection of a polyhydroxyether binder that comprises fewer or no crosslinkable moieties, selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the a polyhydroxyether binder and/or additional binder, or a combination thereof.

[0408] j. Acrylic Resins

[0409] An acrylic resin (“acrylic polymer,” “acrylic binder,” “acrylic”) is a binder comprising a polymer of an acrylate ester monomer, a methacrylate ester monomer, or combina-

tion thereof. An acrylic-coating generally possesses a superior property of water resistance and/or exterior use durability than a polyester-coating. Other properties that an acrylic-coating typically possesses include color stability, chemical resistance, resistance to a UV light, or a combination thereof. An acrylic resin may further comprise an additional monomer to confer a desirable property to the resin, coating and/or film. For example, a styrene, a vinyl-toluene, or a combination thereof, generally improve alkali resistance. Examples of such properties include the acrylic resin's chemical reactivity (e.g., cross-linkability), acidity, alkalinity, hydrophobicity, hydrophilicity, glass transition temperature, or a combination thereof. However, a thermoplastic acrylic film generally possesses poor solvent (e.g., acetone, toluene) resistance. Like other thermoplastic films, a thermoplastic acrylic film is generally easy to repair by application of additional acrylic coating to an area of solvent damage. An acrylic-coating is often suitable for various surfaces (e.g., metal), and examples of such coatings include an aerosol lacquer, an automotive coating, an architectural coating, a clear coating, a coating for external environment, an industrial coating, or a combination thereof. An acrylic resin may be used to prepare a thermoplastic coating, a thermosetting coating, or a combination thereof. In certain aspects, an acrylic-coating is selected for use as a thermosetting coating, particularly in embodiments for use upon a metal surface. Acrylic resins generally are soluble in a solvent with a similar solubility parameter. Examples of solvents typically used to dissolve an acrylic resin include an aromatic hydrocarbon (e.g., toluene, a xylene); a ketone (e.g., methyl ethyl ketone), an ester, or a combination thereof.

[0410] The thermoplastic and/or thermosetting properties of an acrylic resin are related to the monomers that are comprised in the selected resin. Examples of an acrylate ester monomer include a butylacrylate, an ethylacrylate (“EA”), ethylhexylacrylate (“EHA”), or a combination thereof. Examples of a methacrylate ester monomer include a butylmethacrylate (“BMA”), an ethylmethacrylate, a methylmethacrylate (“MMA”), or a combination thereof. Standards for physical properties, chemical properties, and/or procedures for empirically determining the purity/properties of various acrylic monomers (e.g., acrylate esters, 2-ethylhexyl acrylate, n-butyl acrylate, ethyl acrylate, methacrylic acid, acrylic acid, methyl acrylate) are known to those of ordinary skill in the art (see, for example, “ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons,” D3362-93, D3125-97, D4415-91, D3541-91, D3547-91, D3548-99, D3845-96, D4416-89, and D4709-02, 2002).

[0411] In alternative embodiments, an acrylic resin temporary coating (e.g., a non-film forming coating) may be produced, for example, by selection of an acrylic resin that comprises fewer or no crosslinkable moieties, selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the an acrylic resin and/or additional binder, using a bake cured an acrylic resin coating at temperatures less than is needed for curing (e.g., ambient conditions), selection of size range for a thermoplastic acrylic resin coating that is less suitable for film formation (e.g., 1 kDa to 75 kDa), selection of a thermoplastic acrylic resin with T_g that is lower than the temperature ranges herein and/or 20° C. lower than the temperature range of use, or a combination thereof.

(1) Thermoplastic Acrylic Resins

[0412] A strait acrylic resin ("strait acrylic polymer," "strait acrylic binder") is a homopolymer or copolymer comprising an acrylate ester monomer and/or a methacrylate ester monomer. A strait acrylic resin may be used to formulate a thermoplastic coating, as cross-linking reactions are absent or limited without additional reactive moieties in the monomers. Generally, a thermoplastic film produced from an acrylic resin-coating will possess a lower elongation, an increased hardness, an increased tensile strength, greater UV resistance (e.g., chalk resistance), color retention, a greater T_g , or a combination thereof, with increasing methacrylate ester monomer content in the acrylic resin. However, the ester of a monomer may comprise various alcohol moieties, and an alcohol moiety of larger size generally reduces the T_g . Examples a T_g value for a homopolymer strait acrylic resins with the include -100°C ., poly(octadecyl methacrylate); -72°C ., poly(tetradecyl methacrylate); -65°C ., poly(lauryl methacrylate); -60°C ., poly(heptyl acrylate); -60°C ., poly(n-decyl methacrylate); -55°C ., poly(n-butyl acrylate); -50°C ., poly(2-ethoxyethyl acrylate); -50°C ., poly(2-ethylbutyl acrylate); -50°C ., poly(2-ethylhexyl acrylate); -45°C ., poly(propyl acrylate); -43°C ., poly(isobutyl acrylate); -38°C ., poly(2-heptyl acrylate); -24°C ., poly(ethyl acrylate); -20°C ., poly(n-octyl methacrylate); -20°C ., poly(sec-butyl acrylate); -20°C ., poly(ethylthioethyl methacrylate); -10°C ., poly(2-ethylhexyl methacrylate); -5°C ., poly(n-hexyl methacrylate); -3°C ., poly(isopropyl acrylate); 6°C ., poly(methyl acrylate); 11°C ., poly(2-ethylbutyl methacrylate); 16°C ., poly(cyclohexyl acrylate); 20°C ., poly(n-butyl methacrylate); 35°C ., poly(hexadecyl acrylate); 35°C ., poly(n-propyl methacrylate); 43°C ., poly(t-butyl acrylate); 53°C ., poly(isobutyl methacrylate); 54°C ., poly(benzyl methacrylate); 60°C ., poly(sec-butyl methacrylate); 65°C ., poly(ethyl methacrylate); 79°C ., poly(3,3,5-trimethylcyclohexylmethacrylate); 81°C ., poly(isopropyl methacrylate); 94°C ., poly(isobornyl acrylate); 104°C ., poly(cyclohexyl methacrylate); 105°C ., poly(methyl methacrylate); 107°C ., poly(t-butyl methacrylate); and 110°C ., poly(phenyl methacrylate). Additionally, an estimated T_g of a copolymer comprising one or more monomers of an acrylate and/or methacrylate monomer can be made by using the following equation: $1/T_g = W_1/T_{g1} + W_2/T_{g2}$, wherein W_1 and W_2 are the molecular weight ratios of the first and second monomer, respectively; and wherein T_{g1} and T_{g2} are glass transition temperatures of the first and second monomer, respectively (Fox, T. G., 1956). For many embodiments (e.g., solvent-borne coatings), it is contemplated that a T_g of 40°C . to 60°C ., including all intermediate ranges and combinations thereof, will be suitable.

[0413] The thermoplastic properties of an acrylic resin are also related to the molecular mass of the selected resin. Increasing the polymer size of an acrylic resin promotes physical polymer entanglement during film formation. Typically, a thermoplastic film produced from an acrylic-coating will possess a lower flexibility, an increased exterior durability, an increased hardness, an increased solvent resistance, an increased tensile strength, a greater T_g , or a combination thereof, with increasing polymer size of the acrylic resin. However, increasing polymer size of an acrylic resin generally increases viscosity of a solution comprising a dissolved acrylic resin, which may make application to a surface more difficult, such as cobwebbing of coating during

spray application and the changes of film properties generally will reach a plateau at 100 kDa. In most embodiments, it is contemplated that an acrylic resin will range in mass from 75 kDa to 100 kDa, including all intermediate ranges and combinations thereof.

[0414] Examples of such a thermoplastic acrylic-coating include a lacquer. In specific facets, the lacquer possesses a good, high, or spectacular gloss. In specific aspects, such a thermoplastic acrylic-coating further comprises a pigment. In specific aspects, a wetting agent is less preferred in a coating comprising an acrylic resin and a pigment, due to the ease of dispersion of a pigment with an acrylic resin. In certain aspects, a thermoplastic acrylic-coating may be selected to coat a metal surface, a plastic surface, or a combination thereof. However, in particular aspects, a thermoplastic acrylic coating is an automotive coating. Such an automotive coating may comprise an acrylic binder with a high temperature T_g to produce a film of sufficient durability (e.g., hardness) for external use and contact with heated surfaces. In certain aspects, a thermoplastic acrylic coating comprises a binder with a T_g to 90°C . to 110°C ., including all intermediate ranges and combinations thereof. In additional aspects, an automotive coating comprises a plasticizer, a metallic pigment, or a combination thereof. In specific aspects, a binder for an automotive coating comprises a methylmethacrylate ester monomer. In specific facets, an automotive coating comprises poly(methyl methacrylate).

(2) Water-Borne Thermoplastic Acrylic Coatings

[0415] The thermoplastic acrylic coatings described above are solvent-borne coatings. In other embodiments, a thermoplastic acrylic resin may be a waterborne coating. A water-borne acrylic ("acrylic latex") typically is an emulsion, wherein the acrylic binder is dispersed in the liquid component. In general embodiments, an emulsifier (e.g., a surfactant) promotes dispersion. In certain embodiments, an acrylic latex coating comprises 0% to 20% coalescent per weight of binder. In most embodiments, it is contemplated that a water-borne acrylic resin will range in mass from 100 kDa to 1000 kDa, including all intermediate ranges and combinations thereof. In certain embodiments, a water-borne acrylic coating comprises an associative thickener ("rheology modifier"), which may enhance flow, brushability, splatter resistance, film build, or a combination thereof. A water-borne acrylic may be selected as an architectural coating. An associative thickener forms a network with acrylic resin latex particles by hydrophobic interactions. Hydroxyethyl cellulose ("HEC") changes the coating rheology by promoting flocculation, which tends to reduce gloss, flow, or a combination thereof. Selection of an acrylic resin with smaller size, greater hydrophobicity, or a combination thereof, and an associative thickener may produce higher gloss, better flow, lower roller splatter, or a combination thereof.

(i) Architectural Coatings

[0416] A flat interior coating typically comprises a vinyl acetate and a lesser amount of acrylate (e.g., butyl acrylate) monomers, which generally produces a film with suitable scrub resistance. A copolymer of acrylate and methacrylate may be selected for a semigloss or gloss coating. In certain embodiments, the acrylate resin has a T_g to 20°C . to 50°C .,

including all intermediate ranges and combinations thereof. In some aspects, such a coating generally possesses good block resistance good print resistance, or a combination thereof. An acrylic resin that comprises a monomer that comprises a ureide moiety may be selected for enhanced film adhesion (e.g., to a coated surface), blistering resistance, or a combination thereof. An acrylic resin that comprises a styrene monomer may be selected for enhanced film water resistance.

[0417] An exterior latex coating typically produces a film with greater flexibility than an interior latex due to temperature changes and/or dimensional movement of a substrate (e.g., wood). In certain embodiments, the acrylic resin has a T_g to 10° C. to 35° C., including all intermediate ranges and combinations thereof. The selection of a T_g may be influenced by the selection of the amount particulate material (e.g., pigment) in the coating to achieve a particular visual appearance. For example, a higher the pigment volume content ("PVC") that is typically selected to reduce gloss. However, to retain properties such as flexibility, a binder with a lower a T_g may be selected for combination with the higher PVC. For example, flat exterior latex a coating generally possesses a pigment volume content of 40% to 60% and a T_g of 10° C. to 15° C., including all intermediate ranges and combinations thereof, respectively. In another example, a semigloss or gloss exterior latex binder of a coating generally possesses a T_g of 20° C. to 35° C., including all intermediate ranges and combinations thereof, respectively. In other embodiments, the exterior latex binder particle size is selected to be relatively small such as 90 nm to 110 nm, including all intermediate ranges and combinations thereof. In certain facets, a smaller latex particle size promotes adhesion of the coating and/or film, particularly to a surface that comprises a degraded (e.g., chalking) film. In certain other embodiments, a larger latex particle size may be selected to increase the coating and/or film's build (e.g., thickness). In certain aspects, a larger latex particle size ranges from, for example 325 nm to 375 nm, including all intermediate ranges and combinations thereof.

(ii) Industrial Coatings

[0418] A water-borne thermoplastic acrylic latex industrial coating typically comprises a binder with a T_g of 30° C. to 70° C., including all intermediate ranges and combinations thereof. Such a coating typically is applied to a metal surface, and thus often further comprises a surfactant, an additive, or a combination thereof to improve an anti-corrosion property. In specific aspects, the industrial coating comprises an anti-corrosion pigments, anti-corrosion pigment enhancers, or a combination thereof. In contrast, a water-borne acrylic latex industrial maintenance coating typically is similar to an exterior flat architectural coating in selection of binders, though they preferably comprise anti-corrosion pigments, anti-corrosion pigment enhancers, and other anti-corrosion components for use on a metal surface.

(3) Thermosetting Acrylic Resins

[0419] Unless otherwise noted, the following thermosetting acrylic resins and/or coatings are preferably solvent-borne coatings. In certain embodiments an acrylic coating comprises a thermosetting acrylic resin. A thermosetting acrylic coating typically possesses superior hardness, superior toughness, superior temperature resistance, superior

resistance to a solvent, superior resistance to a stain, superior resistance to a detergent, higher application of solids, relative to a thermoplastic acrylic coating. The average size of a thermosetting acrylic resin is typically less than a thermoplastic acrylic resin, which promotes a relatively lower viscosity and/or higher application of solids in a solution comprising a thermosetting acrylic resin. In certain embodiments, a thermosetting acrylic resin is from 10 kDa to 50 kDa, including all intermediate ranges and combinations thereof.

[0420] A thermosetting acrylic resin comprises a moiety capable of undergoing a cross-linking reaction. A monomer may comprise the moiety, and be incorporated into the polymer structure of an acrylic resin during resin synthesis (e.g., a styrene, a vinyltoluene), and/or the acrylic resin may be chemically modified after polymerization to comprise a chemical moiety. In additional embodiments, an acrylic resin may be selected to comprise chemical moieties, such as an amine, a carboxyl, an epoxy, a hydroxyl, an isocyanate, or a combination thereof, to confer a desirable property to the acrylic resin produced. Examples of such properties include the acrylic resin's chemical reactivity (e.g., crosslinkability), acidity, alkalinity, hydrophobicity, hydrophilicity, glass transition temperature, or a combination thereof. In general embodiments, an acrylic resin comprising a carboxyl moiety, a hydroxyl moiety, or a combination thereof, promotes a crosslinking reaction with another binder. In other embodiments, an acrylic resin may be chemically modified to comprise a methylol and/or methylol ether group, which is a resin capable of self-crosslinking.

(i) Acrylic-Epoxy Combinations

[0421] In certain embodiments, a thermosetting acrylic resin may be combined with an epoxide resin. In general embodiments, an acrylic resin comprising a carboxyl moiety may be selected for cross-linking with an epoxy resin. In specific aspects, an acrylic resin comprises 5% to 20% including all intermediate ranges and combinations thereof, of a monomer that comprises a carboxyl moiety, such as of an acrylic acid monomer, a methacrylic acid monomer, or a combination thereof. The carboxyl moiety may undergo a cross-linking reaction with an epoxide resin (e.g., a bisphenol A/epichlorohydrin epoxide resin) during film formation. In certain aspects, an epoxide resin cross-linked with an acrylic resin generally produces a film with good hardness, good alkali resistance, greater solvent resistance to a film, poorer UV resistance, or a combination thereof.

[0422] A thermosetting acrylic-epoxy coating may be selected for application to a metal surface. Examples of surfaces that an acrylic-epoxy coating is selected for use include an indoor surface, an indoor metal surface (e.g., an appliance), or a combination thereof. In certain aspects, an epoxide resin cross-linked with an acrylic resin generally produces a film with good hardness, good alkali resistance, greater solvent resistance to a film, poorer UV resistance, or a combination thereof. In some facets, an acrylic resin may be combined with an aliphatic epoxide resin to produce a film with relatively superior UV resistance than a bisphenol A/epichlorohydrin based epoxide resin. In another facet, an acrylic resin polymerized with an allyl glycidyl ether monomer, a glycidyl acrylate monomer, a glycidyl methacrylate monomer, or a combination thereof, may undergo a cross-linking reaction with an epoxide resin during film formation.

In specific facets, a film produced from cross-linking an epoxide other than a bisphenol A/epichlorohydrin epoxide resin and an acrylic resin comprising an allyl glycidyl ether monomer, a glycidyl acrylate monomer, a glycidyl methacrylate monomer, or a combination thereof possesses a relatively superior UV resistance.

[0423] In certain embodiments, an acrylic epoxy coating comprises a catalyst to promote cross-linking during film formation. In specific aspects, the catalyst is a base such as a dodecyl trimethyl ammonium chloride, a tri(dimethylaminomethyl) phenol, a melamine-formaldehyde resin, or a combination thereof. In other embodiments, an acrylic epoxy coating is cured by baking at 150° C. to 190° C., including all intermediate ranges and combinations thereof. In particular aspects, film formation time of an acrylic epoxy coating is from 15 minutes to 30 minutes, including all intermediate ranges and combinations thereof. In certain embodiments, a thermosetting coating comprises an acrylic epoxide melamine-formaldehyde coating, wherein an acrylic resin, an epoxide resin and a melamine-formaldehyde resin undergo cross-linking during film formation.

(ii) Acrylic-Amino Combinations

[0424] In other embodiments, a thermosetting acrylic resin may be combined with an amino resin. In general embodiments, an acrylic resin comprising an acid (e.g., carboxyl) moiety, a hydroxyl moiety, or a combination thereof, may be selected for cross-linking with an amino resin. An acrylic amino coating, wherein the acrylic resin comprises an acid moiety, may be cured by baking at, for example 150° C. for 30 minutes. However, an acid moiety acrylic amino coating is typically undergoes a greater degree of reactions between amino resins, which reduces properties such as toughness. In specific aspects, an acrylic resin comprises a monomer that comprises a hydroxyl moiety such as a hydroxyethyl acrylate ("HEA"), a hydroxyethyl methacrylate ("HEMA"), or a combination thereof. An acrylic amino coating, wherein the acrylic resin comprises a hydroxyl moiety, typically comprises an acid catalyst to promote curing by baking at, for example 125° C. for 30 minutes. An acrylic amino coating, wherein the amino resin was prepared from urea, generally produces a film with lower gloss, less chemical resistance, or a combination thereof, than an amino resin prepared from another nitrogen compound. Selection of a melamine and/or benzoguanamine based amino coating generally produces a film with excellent weathering resistance, excellent solvent resistance, good hardness, good mar resistance, or a combination thereof, and such an acrylic amino coating may be selected for an automotive topcoat.

(iii) Acrylic-Urethane Combinations

[0425] In other embodiments, a thermosetting acrylic resin may be combined with an urethane resin. In general embodiments, an acrylic resin comprising an acid moiety, a hydroxyl moiety, or a combination thereof, may be selected for crosslinking with an urethane resin. In specific embodiments, an acrylic resin comprises a hydroxyl moiety, such as, for example, a moiety provided by a HEA monomer, a HEMA monomer, or a combination thereof. Selection of an aliphatic isocyanate urethane (e.g., hexamethylene diisocyanate based) generally produces a film with superior color, weathering, or a combination thereof relative to other urethanes. An acrylic urethane coating may comprise a catalyst,

such as, for example, triethylene diamine, zinc naphthenate, dibutyl tin-di-laurate, or a combination thereof. An acrylic urethane coating cures at ambient conditions. However, an acrylic urethane coating typically is a two-pack coating to separate the reactive binders until application. An acrylic urethane coating generally produces a film with good weathering, good hardness, good toughness, good chemical resistance, or a combination thereof. An acrylic urethane coating may be selected an aircraft coating, an automotive coating, an industrial coating (e.g., an industrial maintenance coating), or a combination thereof.

(iv) Water-Borne Thermosetting Acrylics

[0426] In other embodiments, a thermosetting acrylic coating may be a waterborne coating (e.g., a latex coating). Typically, such a thermosetting acrylic coating comprises an acrylic resin with a hydroxyl moiety, an acid moiety, or a combination thereof. An acrylic resin may further comprise an additional monomer such as a styrene, a vinyltoluene, or a combination thereof. The acrylic resin typically is combined in a coating with an amino resin, an epoxy resin, or a combination thereof as previously described. A film produced from a water-borne thermosetting acrylic coating is similar in properties as a solvent-borne counterpart. Such a coating may be selected for surfaces such as masonry, wood, metal, or a combination thereof.

[0427] k. Polyvinyl binders

[0428] A polyvinyl binder ("polyvinyl," "vinyl binder," "vinyl") is a binder comprising a polymer of a vinyl chloride monomer, a vinyl acetate monomer, or combination thereof. A solvent-borne polyvinyl coating may comprise a ketone, ester, chlorinated hydrocarbon, nitroparaffin, or a combination thereof, as a solvent. A solvent-borne polyvinyl coating may comprise a hydrocarbon (e.g., aromatic, aliphatic) as a diluent. A polyvinyl binder is generally insoluble in an alcohol, however, in embodiments wherein a solvent-borne polyvinyl coating that comprises an additional alcohol soluble binder, alcohol may comprise 0% to 20% of the liquid component. In embodiments wherein solvent-borne polyvinyl coating is cured by baking, a glycol ether and/or glycol ester may be used in the liquid component to enhance a rheological property. In other embodiments, the liquid component of a polyvinyl coating may comprise a plasticizer (e.g., a phthalate, a phosphate, a glycol ester), wherein the plasticizer is 1 to 25 parts per hundred parts polyvinyl binder, including all intermediate ranges and combinations thereof, for a non-plastisol or non-organosol coating. A polyvinyl-coating may be used to prepare a thermoplastic coating, a thermosetting coating, or a combination thereof. In specific aspects, a thermoplastic polyvinyl binder coating possesses a T_g of 50° C. to 85° C., including all intermediate ranges and combinations thereof. However, in some aspects, a polyvinyl-coating/film possesses moderate resistance to heat, UV irradiation, or a combination thereof. In specific aspects, a polyvinyl-coating comprises a light stabilizer, a pigment, or a combination thereof. In particular facets, the light stabilizer, the pigment (e.g., titanium dioxide), or the combination thereof, improves the polyvinyl-coating and/or film's resistance to heat, UV irradiation, or a combination thereof.

[0429] In embodiments wherein a polyvinyl coating comprises a solvent-borne coating, it is contemplated that a

polyvinyl resin will range in mass from 2 kDa to 45 kDa, including all intermediate ranges and combinations thereof. A typical solvent-borne polyvinyl coating comprises a polyvinyl resin, a liquid component wherein the liquid component comprises a solvent, and a plasticizer. A solvent-borne polyvinyl coating may additionally comprise a colorizing agent (e.g., a pigment), a light stabilizer, an additional binder, a cross-linker, or a combination thereof.

[0430] A polyvinyl binder typically possesses excellent adhesion for a plastic surface, an acrylic and/or acrylic coated surface, paper, or a combination thereof. A thermoplastic polyvinyl coating may be selected as a lacquer, a topcoat of a can coating (e.g., can interior surface), or a combination thereof. In some embodiments, a polyvinyl-coating may be selected to produce a film with such properties, for example, as excellent water resistance, excellent resistance to various solvents (e.g., an aliphatic hydrocarbon, an alcohol, an oil), excellent resistance to acid pH, excellent resistance to basic pH, inertness relative to food, or a combination thereof.

[0431] In many aspects, a polyvinyl resin is a copolymer that comprises a combination of a vinyl chloride monomer and vinyl acetate monomer. Often during resin synthesis (e.g., polymerization), a polyvinyl resin is prepared to further comprise monomers with specific chemical moieties to confer a property such as solubility in water, solubility in a solvent, compatibility with another coating component (e.g., a binder), or a combination thereof. In certain embodiments, a polyvinyl resin comprises a monomer comprising carboxyl moiety, a hydroxyl moiety (e.g., a hydroxyalkyl acrylate monomer), a monomer comprising an epoxy moiety, a monomer comprising a maleic acid, or a combination thereof. A carboxyl moiety may confer an increased adhesion property (e.g., excellent adhesion to metal). However, a polyvinyl resin comprising a carboxyl moiety is generally not compatible with a basic pigment. A thermosetting polyvinyl coating comprising a polyvinyl binder that comprises a carboxyl moiety and a polyvinyl binder that comprises an epoxy moiety generally possesses one or more excellent physical properties (e.g., flexibility), and may be selected as a coil coating. A hydroxyl moiety may confer cross-linkability, compatibility with another coating component, an increased adhesion property (e.g., good adhesion to aluminum), or a combination thereof. Additionally, after polymer synthesis, a polyvinyl resin can be chemically modified to comprise such a specific chemical moiety. In some embodiments, a polyvinyl resin is chemically modified to comprise a secondary hydroxyl moiety, an epoxy moiety, a carboxyl moiety, or a combination thereof. A polyvinyl resin comprising a secondary hydroxyl moiety may be combined with another binder such as an alkyd, an urethane, an amino-formaldehyde, or a combination thereof. A thermosetting polyvinyl amino-formaldehyde coating comprising a polyvinyl binder that comprises a hydroxyl moiety generally possesses good corrosion resistance, water resistance, solvent resistance, chemical resistance, and may be selected as a can coating, a coating for an interior wood surface, or a combination thereof. Standards for physical properties, chemical properties, and/or procedures for testing the purity/properties of various polyvinyl monomers (e.g., vinyl acetate) and polyvinyl resins (e.g., polymer components, polymer mass, shear viscosity for a higher mass resin, chlorine content) are described, for example, in "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aro-

matic Hydrocarbons," D2190-97, D2086-02, D2191-97, and D2193-97, 2002; "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D4368-89, D3680-89, and D1396-92, 2002; and in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D2621-87, 2002.

[0432] In alternative embodiments, a polyvinyl resin temporary coating (e.g., a non-film forming coating) may be produced, for example, by selection of a polyvinyl resin that that comprises fewer or no crosslinkable moieties, selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the a polyvinyl resin and/or additional binder, using a bake cured a polyvinyl resin coating at temperatures less than is needed for curing (e.g., ambient conditions), selection of size range for a plastisol or organisol polyvinyl resin coating that is less suitable for film formation (e.g., 1 kDa to 60 kDa), selection of a polyvinyl resin with T_g that is lower than the temperature ranges herein and/or 20° C. lower than the temperature range of use, or a combination thereof.

(1) Plastisols and Organisols

[0433] A polyvinyl resin of 60 kDa to 110 kDa, including all intermediate ranges and combinations thereof, may be selected for use as an organosol or a plastisol. A plastisol is coating comprising a vinyl homopolymer binder and a liquid component, wherein the liquid component comprises a plasticizer comprising a minimum of 55 parts or more of plasticizer per hundred parts of homopolymer binder in the coating. In certain embodiments, a plastisol comprises, by weight, 0% to 10% including all intermediate ranges and combinations thereof, of a thinner (e.g., an aliphatic hydrocarbon). A plastisol coating typically comprises an additional vinyl binder. A plastisol may comprise a pigment, however, a low oil absorption pigment is preferred to avoid undesirable increase in coating viscosity given the liquid component used for a plastisol.

[0434] An organosol is similar to a plastisol, except the less than 55 parts of plasticizer per hundred parts of homopolymer binder is used in the coating. In typical embodiments, the liquid component of comprises a weak solvent that may act as a dispersant and a thinner (e.g., a hydrocarbon). In typical aspects, the reduced content of plasticizer produced a film with a superior hardness property relative to a plastisol. In additional embodiments, the non-volatile component of an organisol is 50% to 55%, including all intermediate ranges and combinations thereof. An organosol coating typically comprises a second binder. In specific aspects, the second binder is a vinyl copolymer, an acrylic, or a combination thereof. In certain aspects, the second binder comprises a carboxyl moiety, a hydroxyl moiety, or a combination thereof. In further aspects, an organisol may comprise a third binder. In specific facets, the third binder comprises an amino resin, a phenolic resin prepared from formaldehyde, or a combination thereof. In additional facets, a second binder that comprises a hydroxyl moiety may undergo a thermosetting cross-linking reaction with a third binder. An organisol may comprise a pigment suitable for general polyvinyl coatings.

[0435] A plastisol or organisol typically is cured by baking. In general embodiments, baking is at a temperature of

175° C. to 180° C., including all intermediate ranges and combinations thereof. In general embodiments, a plastisol or organisol comprises a heat stabilizer. The heat stabilizer may protect a vinyl binder during baking. Examples of a suitable heat stabilizer include a combination of a metal salt of an organic acid and an epoxidized oil or a liquid epoxide binder. However, in an embodiment wherein the plastisol or organisol comprises a binder that comprises a carboxyl moiety, a metal salt is less preferred due to possible gelation of the coating, and may be substituted with a merapto tin and/or tin ester compound.

[0436] In embodiments wherein a plastisol or organisol comprise a binder with good adhesion properties for a surface such as a binder comprising carboxy moiety, the plastisol or organisol may be used as a single layer coating. For example, such an organisol may be selected to coat the end of a can. However, a plastisol or organisol typically is part of a multicoat system that comprises a primer to promote adhesion. In specific aspects, the primer comprises a vinyl resin comprising a carboxy moiety. In specific facets, the primer further comprises a thermosetting binder such as an amino-formaldehyde, phenolic, or a combination thereof, to enhance solvent resistance. In certain facets, it is preferred that a primer or other coat layer of a multicoat system possesses good solvent resistance to the plasticizers of the organosol and/or plastisol coat layer.

(2) Powder Coatings

[0437] A polyvinyl binder may be selected as a powder coating. Typically, coating components such as a polyvinyl binder and a plasticizer, colorizing agent, additive, or a combination thereof, admixed to prepare a powder coating. Such a powder coating is usually applied by a fluidized bed applicator, a spray applicator, or a combination thereof. In some aspects, the coating components are melted then ground into a powder. Such a powder coating is usually applied by an electrostatic spray applicator. The coating is cured by baking. A polyvinyl powder coating may be selected to coat a metal surface.

(3) Water-Borne Coatings

[0438] The previous discussions of polyvinyl coatings focused upon solvent-borne and powder coatings. A polyvinyl binder with a T_g of 75° C. to 85° C., including all intermediate ranges and combinations thereof, may be selected for use in a dispersion waterborne coating. The liquid component may comprise a cosolvent such as a glycol ether, a plasticizer, or a combination thereof. Examples of a cosolvent include ethylene glycol monobutyl ether. The dispersion water-borne polyvinyl coating may be used as described for a solvent-borne polyvinyl coating. In another example, an organisol may be prepared with a plasticizer as a latex coating. Such a latex is suitable for selection as a primer coating. The latex coating is cured by baking.

[0439] 1. Rubber Resins

[0440] In certain embodiments, a coating may comprise a rubber resin as a binder. A rubber may be either obtained from a biological source ("natural rubber"), synthesized from petroleum ("synthetic rubber"), or a combination thereof. Examples of synthetic rubber include polymers of styrene monomers, butadiene monomers, or a combination thereof. In alternative embodiments, a rubber temporary

coating (e.g., a non-film forming coating) may be produced, for example, by selection of rubber resin that comprises fewer or no crosslinkable moieties, selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the a rubber resin and/or additional binder, or a combination thereof.

(1) Chlorinated Rubber Resins

[0441] In general embodiments, a rubber resin comprises a chlorinated rubber resin, wherein a rubber isolated from a biological source has been chemically modified by reaction with chlorine to produce a resin comprising 65% to 68% chlorine by weight, including all intermediate ranges and combinations thereof. A chlorinated rubber resins generally are in a molecular weight range of 3.5 kDa to 20 kDa, including all intermediate ranges and combinations thereof. A chlorinated rubber coating may comprise another binder, such as, for example, an acrylic resin, an alkyd resin, a bituminous resin, or a combination thereof. In specific aspects, a chlorinated rubber resin comprises 10% to 50%, by weight, including all intermediate ranges and combinations thereof, of the binder when in combination with an acrylic resin, an alkyd resin, or a combination thereof. In general embodiments, a chlorinated rubber coating is a solvent-borne coating. In certain aspects, a chlorinated rubber coating comprises a liquid component, such as, for example, a solvent, a diluent, a thinner, a plasticizer, or a combination thereof. A chlorinated rubber coating may be a thermoplastic coating. To reduce the T_g of a film produced from a chlorinated rubber resin, the liquid component generally comprises a plasticizer. In certain aspects, a chlorinated rubber coating comprises 30% to 40%, by weight, including all intermediate ranges and combinations thereof, of plasticizer. In certain facets, a plasticizer is selected for water resistance (e.g., hydrolysis resistance) such as a bisphenoxyethylformal. In certain facets, a chlorinated rubber coating comprises light stabilizer, an epoxy resin, an epoxy plasticizer (e.g., epoxidized soybean oil), or combination thereof, to chemically stabilize a chlorinated resin, coating and/or film. In other embodiments, a chlorinated rubber coating comprises a pigment, an extender, or a combination thereof. In particular aspects, the pigment is a corrosion resistant pigment. A chlorinated rubber film are generally has good chemical resistance (e.g., acid resistance, alkali resistance), water resistance, or a combination thereof. Coatings comprising chlorinated rubber resins may be used, for example, on surfaces that contact gaseous, liquid and/or solid external environments. Examples of such uses include a coating for an architectural coating (e.g., a masonry coating), a traffic marker coating, a marine coating (e.g., a marine vehicle, a swimming pool), a metal primer, a metal topcoat, or a combination thereof.

(2) Synthetic Rubber Resins

[0442] Examples of synthetic rubber include polymers comprising a styrene monomer, a methylstyrene (e.g., α -methylstyrene) monomer, or a combination thereof. A polystyrene and/or polymethylstyrene coating may be a solvent-borne coating. Examples of a solvent include an aliphatic hydrocarbon, an aromatic hydrocarbon, a ketone, an ester, or a combination thereof. A polystyrene and/or polymethylstyrene coating may possess good water resistance, good chemical resistance, or a combination thereof. A polystyrene

and/or polymethylstyrene coating may be selected as a primer, a lacquer, a masonry coating, or a combination thereof. A polystyrene homopolymer has a T_g of 100° C., and in certain embodiments, a polystyrene coating is baked cured. Standards for physical properties, chemical properties, and/or procedures for testing the purity/properties of a styrene monomer, a methylstyrene monomer, (e.g., a-methylstyrene), a resin comprising a styrene and/or methylstyrene monomer, are described, for example, in "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons," D2827-00, D6367-99, D6144-97, D4590-00, D2119-96, D2121-00, and D2340-96, 2002.

[0443] Similar to the variability of T_g previously described for a thermoplastic acrylic resin, a styrene copolymer with a lower a T_g than polystyrene or other altered properties can be produced from polymerization with other monomers such as a butadiene monomer, an acrylic monomer, a maleate ester, an acrylonitrile, an allyl alcohol, a vinyltoluene, or a combination thereof. For example, a butadiene monomer decreases lightfastness, but confers self-crosslinkability to the resin. In another example, an acrylic resin increases the resin's solubility in an alcohol. In a further example, an allyl alcohol monomer confers crosslinkability in combination with a polyol. In certain embodiments, a styrene-butadiene copolymer resin may be selected. In certain aspects, a styrene-butadiene resin comprises a carboxyl moiety to improve an adhesion property, dispersibility in a liquid component, or a combination thereof. In particular facets, a styrene-butadiene coating comprises an emulsifier to increase dispersion in a liquid component, a light stabilizer, or a combination thereof. A styrene-butadiene coating may be a thermosetting coating, due to oxidative crosslinking of a butadiene double bond moiety. However, styrene-butadiene film may have poor chalking resistance, poor color stability, poor UV resistance, or a combination thereof. A styrene-butadiene coating may be selected as a corrosion resistant primer, a wood primer, or a combination thereof. A styrene-vinyltoluene-acrylate copolymer coating may be selected for an exterior coating, a traffic marker paint, a metal coating (e.g., a metal lacquer), a masonry coating, or a combination thereof.

[0444] m. Bituminous Binders

[0445] A bituminous binder ("bituminous") is a binder comprising a hydrocarbon soluble in carbon disulfide, is black or dark colored, and is obtained from a bitumen deposit and/or as a product of petroleum processing. A bituminous binder typically is used in asphalt, tar, and other construction materials. However, in certain embodiments, a bituminous binder may be used in a coating of the present invention, particularly in embodiments wherein good resistance to a chemical such as a petroleum based solvent, an oil, water, or a combination thereof, is desired. Examples of a bituminous binder include a coal tar, a petroleum asphalt, a pitch, an asphaltite, or a combination thereof. In certain embodiments, a coal tar and/or pitch is combined with an epoxy resin to form a thermosetting coating. Such a coating may be selected as a pipeline coating. In other embodiments, an asphaltite and/or petroleum asphalt may be selected for use as an automotive coating (e.g., an underbody part coating). An asphaltite and/or petroleum asphalt coating may further comprise an additional binder such as an epoxy. In certain aspects, an asphaltite and/or petroleum asphalt coating is a solvent-borne coating. In specific aspects, an

asphaltite and/or petroleum asphalt coating comprises a plasticizer. In further aspects, an asphaltite and/or petroleum asphalt coating comprises a wax to increase abrasion resistance.

[0446] In further embodiments, bituminous coating may be selected as a roof coating. Typically, a bituminous roof coating comprises an extender, a thixotrope, or a combination thereof. Examples of a thixotrope additive include asbestos, a silicon extender, a cellulosic, a glass fiber, or a combination thereof. In some aspects, a bituminous roof coating comprises a solvent-borne coating or a water-borne coating. Examples of solvents that may be selected include a mineral spirit, an aliphatic hydrocarbon (e.g., a naphtha, a mineral spirit), an aromatic solvent (e.g., xylene, toluene) or a combination thereof. A bituminous roof coating may be selected as a primer, a topcoat, or a combination thereof. A bituminous roof topcoat typically further comprises a metallic pigment.

[0447] In certain aspects, a solvent-borne or water-borne bituminous coating is an emulsion comprising water and a bituminous binder. In specific facets, the emulsion further comprises a solvent, an extender (e.g., a silica), an emulsifier (e.g., a surfactant), or a combination thereof. The extender typically functions to stabilize the emulsion. In particular facets, the emulsion bituminous coating is a roof coating, a road coating, a sealer, a primer, a topcoat, or a combination thereof. In facets wherein an emulsion bituminous coating is selected as a sealer, an additional binder may be added to increase solvent resistance.

[0448] In alternative embodiments, a bituminous temporary coating (e.g., a non-film forming coating) may be produced, for example, by selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the a bituminous resin and/or additional binder, or a combination thereof.

[0449] n. Polysulfide Binders

[0450] A polysulfide binder is a polymer produced from a reaction of sodium polysulfide, bis(2-chlorethyl)formal and 1,2,3-trichloropropane. Typically, a polysulfide binder is 1 kDa to 8 kDa, including all intermediate ranges and combinations thereof. A polysulfide binder comprises a thiol ("mercaptan") moiety capable of crosslinking with an additional binder. A polysulfide may undergo crosslinking by an oxidative reaction with an additional binder comprising a peroxide (e.g., dicumen hydroperoxide), a manganese dioxide, p-quinonedioxime, or a combination thereof. A polysulfide binder may be crosslinked with a glycidyl epoxide, though a tertiary amine is preferably part of the coating to promote this reaction. A polysulfide may undergo crosslinking with a binder comprising an isocyanate moiety, though it is preferred that the binder comprises a plurality of isocyanates. A polysulfide film typically possesses excellent UV resistance, good general weatherability properties, good chemical resistance, or a combination thereof.

[0451] In alternative embodiments, a polysulfide temporary coating (e.g., a non-film forming coating) may be produced, for example, by selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the a bituminous resin and/or additional binder, or a combination thereof.

[0452] o. Silicone Binders

[0453] The previous described binders are molecules based on carbon, and are considered herein as “organic binders.” A silicone binder (“silicone”) is a binder molecule based on silicone. Examples of a silicone binder include a polydimethylsiloxane and a methyltriacetoxysilane, a methyltrimethoxysilane, a methyltricyclorhexylaminosilane, a fluorosilicone, a trifluoropropyl methyl polysiloxane, or a combination thereof. In general embodiments, a silicone binder comprises a crossreactive silicon moiety, examples of which are described below. A silicone coating may be selected for excellent resistance to irradiation (e.g., UV, infrared, gamma), excellent weatherability, excellent biodegradation resistance, flame resistance, excellent dielectric property, which is poor electrical conductivity with little detrimental effect on an electrostatic field, or a combination thereof. In specific aspects, a silicon coating is an industrial coating. In particular facets, a silicon coating is applied to an appliance part, a furnace part, a jet engine part, an incinerator part, or a missile part. In other embodiments, a silicon coating comprises an organic binder. In particular aspects, a silicon organic binder coating possesses superior heat resistance to an organic binder coating. In other aspects, the greater the silicon binder to organic binder ratio, the greater the crosslinking reactions, greater film hardness, reduced flexibility, or a combination thereof.

[0454] In general embodiments, a silicone coating is a thermosetting coating. Often, a silicon coating is a multi-pack coating due to a limited pot life one the coating components are admixed. The crosslinking reaction depends upon the binder's specific silicon moiety. A plurality of binders may be used, each comprising one or more crosslinking moieties. A binder comprising crosslinking SiOH and HOSi moieties generally comprises a cure agent such as a lead octoate, a zinc octoate, or a combination thereof. In general aspects, the thermosetting SiOH and HOSi silicon coating is bake cured (e.g., 250° C. for one hour). A binder comprising crosslinking SiOH and HSi moieties typically comprises a tin catalyst. A binder comprising crosslinking SiOH and ROSi moieties, wherein RO is an alkoxy moiety, also typically comprises a tin catalyst. A coating prepared using SiOH and ROSi silicon binder typically further comprises an iron oxide, a glass microballoon, or a combination thereof to improve heat resistance. This type of silicon may be selected for rocket and jet engine parts. A binder comprising crosslinking SiOH and CH₃COOSi moieties is moisture cured, and typically comprises a tin catalyst (e.g., an organotin compound). A binder comprising crosslinking SiOH and R₂NOSi moieties, wherein R₂NO is an oxime moiety, is also moisture cured, and typically comprises a tin catalyst. The moisture cured silicon coatings may be selected for one-pack silicon coatings, though film formation is generally slower than other types of silicon thermosetting coatings. A binder comprising crosslinking SiCH=CH₂ and R₂NOSi moieties, wherein R₂NO is an oxime moiety, typically comprises a platinum catalyst, and may be bake cured. A film produced by a SiCH=CH₂ and R₂NOSi silicon coating possesses excellent toughness, flame resistance, or a combination thereof. Such a coating may be selected for a rocket part. However, coating components such as a rubber, a tin compound (e.g., an organotin), or a combination thereof, may inhibit platinum catalyzed film formation in this silicon coating.

[0455] In certain embodiments, a silicone coating is a solvent-borne coating. Examples of liquid components that may function as a silicon solvent include a chlorinated hydrocarbon (e.g., 1,1,1-trichloroethane), an aromatic hydrocarbon (e.g., a VMP naphtha, xylene), an aliphatic hydrocarbon, or a combination thereof. A silicone binder typically is insoluble or poorly soluble in an oxygenated compound such as an alcohol, a ketone, or a combination thereof, of relatively low molecular weight (e.g., ethanol, isopropanol, acetone). However, a fluorosilicone, which is a silicone binder that comprises a fluoride moiety, may be combined with a liquid component comprising a ketone such as methyl ethyl ketone, methyl isobutyl ketone, or a combination thereof. A fluorosilicone binder may be selected for producing a film with excellent solvent resistance. A silicon coating often comprises a pigment. In specific embodiments, a pigment comprises zinc oxide, titanium dioxide, zinc orthotitanate, or a combination thereof, which may improve a film's resistance to extreme temperature variations, such as those of outerspace. In specific embodiments, a silicon coating may comprise a silica extender (e.g., fumed silica), which often increases durability.

[0456] In certain embodiments, a silicon binder comprises a trifluoropropyl methyl polysiloxane binder. In certain aspects, a trifluoropropyl methyl polysiloxane binder may be selected for producing a film with excellent resistance to petroleum products (e.g., automotive fuel, aircraft fuel), but poor resistance to an acid or an alkali, particularly at baking conditions.

[0457] In alternative embodiments, a silicon temporary coating (e.g., a non-film forming coating) may be produced, for example, by selection of an addition binder that comprises fewer or no crosslinkable moieties, reducing the concentration of the a silicon resin and/or additional binder, using a bake-cured silicon coating at non-baking conditions, inclusion of a rubber, a tin compound (e.g., an organotin), or a combination thereof.

[0458] 2. Liquid Components

[0459] A liquid component is a chemical composition that is in a liquid state while comprised in a coating and/or film. A liquid component is typically added to a coating composition, for example, to improve a rheological property for ease of application, alter the period of time that thermoplastic film formation occurs, alter an optical property (e.g., color, gloss) of a film, alter a physical property of a coating (e.g., reduce flammability) and/or film (e.g., increase flexibility), or a combination thereof.

[0460] As would be known to those of ordinary skill in the art, often a liquid component comprises a volatile liquid that is partly or fully removed (e.g., evaporated) from the coating during film formation. Examples of a volatile liquid include a volatile organic compound (“VOC”), water, or a combination thereof. In many embodiments, 0% to 100%, including all intermediate ranges and combinations thereof, of the liquid component is lost during film formation. Various environmental laws and regulations have encouraged the reduction of volatile organic compound use in coatings [see “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 3-12, 1995]. As a consequence, a coating may comprise a solvent-borne coating, which typically comprises a VOC and was the coating usually selected prior to enactment of

the environmental laws, a high solids coating, which is generally a solvent-borne coating formulated with a minimum amount of a VOC, a water-borne coating, which comprises water and typically even less VOC, or a powder coating, which comprises little or no VOC.

[0461] In many embodiments, a liquid component may comprise a liquid composition classified based upon function such as a solvent, a thinner, a diluent, a plasticizer, or a combination thereof. A solvent is a liquid component used to dissolve one or more coating components. A thinner is a liquid component used to reduce the viscosity of a coating, and often additionally confers one or more properties to the coating, such as, for example, dissolving a coating component (e.g., a binder), wetting a colorizing agent, acting as an antisetling agent, stabilizing a coating in storage, acting as an antifoaming agent, or a combination thereof. A diluent is a liquid component that does not dissolve a binder.

[0462] Liquid components can be classified, based on their chemical composition, as an organic compound, an inorganic compound, or a combination thereof. Preferred organic compounds include a hydrocarbon, an oxygenated compound, a chlorinated hydrocarbon, a nitrated hydrocarbon, a miscellaneous organic liquid component, or a combination thereof. A hydrocarbon consists of or consists essentially of one or more carbon and/or hydrogen atoms. Examples of a hydrocarbon include an aliphatic hydrocarbon, an aromatic hydrocarbon, a naphthene, a terpene, or a combination thereof. An oxygenated compound comprises of one or more carbon, hydrogen and/or oxygen atoms. Examples of an oxygenated compound include an alcohol, an ether, an ester, a glycol ester, a ketone, or a combination thereof. A chlorinated hydrocarbon comprises one or more carbon, hydrogen and/or chlorine atoms, but does not comprise an oxygen atom. A nitrated hydrocarbon comprises one or more carbon, hydrogen and/or nitrogen atoms, but does not comprise an oxygen atom. A miscellaneous organic liquid component is a liquid other than a chlorinated hydrocarbon and/or a nitrated hydrocarbon that comprises one or more carbon, hydrogen and/or other atoms. In certain aspects, a miscellaneous organic liquid component does not comprise an oxygen atom. Preferred inorganic compounds include ammonia, hydrogen cyanide, hydrogen fluoride, hydrogen cyanide, sulfur dioxide, or a combination thereof. However, an inorganic compound generally is used at temperatures less than ambient conditions, and at pressures greater than atmospheric pressure.

[0463] In certain embodiments, a liquid component may comprise an azeotrope. An azeotrope ("azeotropic mixture") is a solution of two or more liquid components at concentrations that produces a constant boiling point for the solution. An azeotrope BP ("A-BP") is the boiling point of an azeotrope. Often, the boiling point ("BP") of the majority component of an azeotrope is higher than the A-BP, and in some embodiments, such an azeotrope evaporates from a coating faster than a similar coating that does not comprise the azeotrope. However, in some aspects, a coating comprising an azeotrope with a superior evaporation property may possess a lower flash point temperature, a lower explosion limit, a reduced coating flow, greater surface defect formation, or a combination thereof, relative to a similar coating that does not comprise the azeotrope. Alternatively, an azeotrope may be selected for embodiments wherein a component's BP is increased. In specific aspects, a coating

comprising such an azeotrope may have a relatively slower evaporation rate than a similar coating that does not comprise the azeotrope. It is contemplated that the greater the percentage of liquid component is an azeotrope, the greater the conference of an azeotrope's property to a coating. Thus, a specific range of 50% to 100%, 90% to 100%, or 95% to 100%, including all intermediate ranges and combinations thereof, is sequentially more preferred in embodiments wherein an azeotrope's property is desired as a property of a coating.

[0464] In some embodiments, a chemically non-reactive ("inert") liquid component may be selected. Typically, a liquid component is selected that is inert relative to a particular chemical reaction to prevent an undesirable chemical reaction with other coating components. An example of such an undesirable chemical reaction is a binder-liquid component reaction that is inhibitory to a desired binder-binder film-formation reaction. Examples of a liquid component that are generally inert in an acetal formation reaction include benzene, hexane, or a combination thereof. An example of a liquid component that is generally inert in a decarboxylation reaction includes quinoline. Examples of a liquid component that are generally inert in a dehydration reaction include benzene, toluene, xylene, or a combination thereof. An example of a liquid component that is generally inert in a dehydrohalogenation reaction includes quinoline. Examples of a liquid component that are generally inert in a diazonium compound coupling reaction include ethanol, glacial acetic acid, methanol, pyridine, or a combination thereof. Examples of a liquid component that are generally inert in a diazotization reaction include benzene, dimethylformamide, ethanol, glacial acetic acid, or a combination thereof. Examples of a liquid component that are generally inert in an esterification reaction include benzene, dibutyl ether, toluene, xylene, or a combination thereof. Examples of a liquid component that are generally inert in a Grignard reaction include diethyl ether. Examples of a liquid component that are generally inert in a halogenation reaction include dichlorobenzene, glacial acetic acid, nitrobenzene, tetrachloroethane, tetrachloromethane, or a combination thereof. Examples of a liquid component that are generally inert in a hydrogenation reaction include an alcohol, dioxane, a hydrocarbon, glacial acetic acid, or a combination thereof. Examples of a liquid component that are generally inert in a ketene condensation reaction include acetone, benzene, diethyl ether, xylene, or a combination thereof. Examples of a liquid component that are generally inert in a nitration reaction include dichlorobenzene, glacial acetic acid, nitrobenzene, or a combination thereof. Examples of a liquid component that are generally inert in an oxidation reaction include glacial acetic acid, nitrobenzene, pyridine, or a combination thereof. Examples of a liquid component that are generally inert in a sulfonation reaction include dioxane, nitrobenzene, or a combination thereof.

[0465] A solvent-borne coating is a coating wherein 50% to 100%, including all intermediate ranges and combinations thereof, of a coating's liquid component is not water. Generally, the liquid component of a solvent-borne coating comprises an organic compound, an inorganic compound, or

a combination thereof. The liquid component of a solvent-borne coating may function as a solvent, a thinner, a diluent, a plasticizer, or a combination thereof. In certain embodiments, a solvent-borne coating may comprise water. In specific aspects, the water may function as a solvent, a thinner, a diluent, or a combination thereof. The water component of a solvent-borne coating may comprise 0% to 49.999%, the including all intermediate ranges and combinations thereof, of the liquid component. In certain embodiments, the water component of a water-borne coating may be fully or partly miscible in the non-aqueous liquid component. Examples of the percent of water that is miscible, by weight at 20° C., in various liquids typically used in solvent-borne coatings include 0.01% water in tetrachloroethylene; 0.02% water in ethylbenzene; 0.02% water in p-xylene; 0.02% water in trichloroethylene; 0.05% water in 1,1,1-trichloroethane; 0.05% water in toluene; 0.1% water in hexane; 0.16% water in methylene chloride; 0.2% water in dibutyl ether; 0.2% water in tetrahydronaphthalene; 0.42% water in diisobutyl ketone; 0.5% water in cyclohexyl acetate; 0.5% water in nitropropane; 0.6% water in 2-nitropropane; 0.62% water in butyl acetate; 0.72% water in dipentene; 0.9% water in nitroethane; 1.2% water in diethyl ether; 1.3% water in methyl tert-butyl ether; 1.4% water in trimethylcyclohexanone; 1.65% water in isobutyl acetate; 1.7% water in butyl glycol acetate; 1.9% water in isopropyl acetate; 2.4% water in methyl isobutyl ketone; 3.3% water in ethyl acetate; 3.6% water in cyclohexanol; 4.0% water in trimethylcyclohexanol; 4.3% water in isophorone; 5.8% water in methylbenzyl alcohol; 6.5% water in ethyl glycol acetate; 7.2% water in hexanol; 7.5% water in propylene carbonate; 8.0% water in methyl acetate; 8.0% water in cyclohexanone; 12.0% water in methyl ethyl ketone; 16.2% water in isobutanol; 19.7% water in butanol; 25.0% water in butyl glycolate; or 44.1% water in 2-butanol.

[0466] Various examples of such liquid components are described herein, including properties often used to select a chemical composition for use as a liquid component for a particular coating composition. Additionally, standards for physical properties, chemical properties, and/or procedures for testing purity/properties, are described for various types of liquid components (e.g., hydrocarbons, cycloaliphatic hydrocarbons, aromatic hydrocarbons, alcohols, ketones, esters, glycol ethers, mineral spirits, miscellaneous solvents, plasticizers) in, for example, "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons," D4790-99, D268-01, D3437-99, D1493-97, D235-02, D1836-02, D3735-02, D3054-98, D5309-02, D4734-98, D2359-02, D4492-98, D4077-00, D3760-02, D6526-00, D841-02, D843-97, D5211-01, D5471-97, D5871-98, D5713-00, D852-02, D1685-00, D4735-02, D3797-00, D3798-00, D5135-02, D5316-00, D5060-95, D3193-96, D3734-01, D1152-97, D770-95, D3622-95, D1007-00, D1719-95, D304-95, D319-95, D2635-01, D1969-01, D2306-00, D1612-95, D5008-01, D268-01, D1078-01, D329-02, D1363-94, D740-94, D2804-02, D1153-94, D3329-99, D2917-02, D3893-99, D4360-90, D2627-02, D2916-88, D2192-96, D4614-95, D3545-02, D3131-02, D3130-95, D1718-98, D4615-95, D3540-90, D1617-90, D2634-02, D5137-01, D3728-99, D4835-93, D4773-02, D3128-02, D331-95, D330-93, D4837-02, D4773-02, D4836-95, D5776-99, D5808-95, D5917-02, D6069-01, D6212-99, D6313-99, D6366-99, D6428-99, D6621-00, D6809-02, D5399-95, D6229-01, D6563-00, D6269-98,

D3257-01, D847-96, D1613-02, D848-02, D1614-95, D4367-02, D4534-99, D2360-00, D1353-02, D1492-02, D849-02, D3961-98, D1364-02, D3160-96, D1476-02, and D1722-98, D853-97, D5194-96, D363-90, D1399-95, D1468-93, D3620-98, D3546-90, and D1721-97, 2002.

[0467] a. Solvents, Thinners, and Diluents

[0468] A coating may comprise a liquid component that may function as a solvent, a thinner, a diluent or a combination thereof. In one embodiment of a coating, a particular liquid component may function as a solvent, while in another coating composition comprising, for example, a different binder the same liquid component may function as a thinner and/or a diluent. Whether a liquid component functions primarily as a solvent, a thinner, or a diluent depends considerably upon the particular solvent and/or rheological property the liquid component confers to a specific coating composition. For example, the ability of the liquid component to function as a solvent, or lack thereof of such ability, relative to the other coating components generally differentiates a solvent from a diluent. A thinner is primarily included into a coating composition in combination with a solvent and/or diluent to alter a rheological property such as to reduce viscosity, enhance flow, enhance leveling, or a combination thereof. In addition to the ability of one of ordinary skill in the art to discern such differences of use for a specific liquid composition in a coating, examples of differing solubility properties for specific categories of liquid components, and empirical techniques for determining the solubility properties of a specific liquid component, relative to another coating component, are described herein.

[0469] A solute is a coating component dissolved by a solvent liquid component. A solute may be in solid, liquid or gas from prior to being dissolved. Solvency ("solvent power") is the ability of a solvent to dissolve a solute, maintain a solute in solution upon addition of a diluent, and reduce the viscosity of a solution. A solvent is typically used to produce a solvent-borne coating, wherein the coating possesses desirable a rheological property for application to a surface and/or creation of a film of a desirable thickness. Additionally, a solvent may contribute to an appearance property, a physical property, a chemical property, or a combination thereof, of a coating and/or film. In most embodiments, a solvent is a volatile component of a coating, wherein 50% to 100%, including all intermediate ranges and combinations thereof, of the solvent is lost (e.g., evaporates) during film formation. In certain aspects, the rate of solvent loss slows during application and/or film formation. Such a change in solvent loss rate may promote a desirable rheologically related property during application and/or initial film formation, such as ease of application, minimum sag, reduce excessive flow, or a combination thereof, while still promoting a desirable rheologically related property post-application, such as a desirable leveling property, a desirable adhesion property, or a combination thereof.

[0470] Depending upon the ability of a liquid component to dissolve, partly dissolve, or unsuccessfully dissolve a coating component, a coating may comprise, a real solution, a colloidal solution or a dispersion, respectively. Often the ability of a liquid component to dissolve a coating component is detrimentally affected by increasing particulate matter size (e.g., pigment size, cell-based particulate material

size, etc.) and/or molecular mass of the coating component. For example, a real solution comprises a clear and/or homogenous liquid solution. In typical embodiments, a real solution is produced when a potential solute of 1.0 nm or less in diameter is combined with a solvent. A colloidal solution comprises a physically non-homogenous solution, which may be a clear to opalescent in appearance. Often, a colloidal solution is produced when a potential solute of between 1.0 nm to 100 nm ("0.1 μm ") in diameter is combined with a solvent. A dispersion is a composition comprising two liquid and/or solid phases, which is typically turbid to milky in appearance. Generally, a dispersion is produced when a potential solute of greater than 0.1 μm in diameter is combined with a solvent. In many aspects, a coating composition may comprise a combination of a real solution, a colloidal solution and/or a dispersion, depending upon the various solubility's of coating components and liquid components. For example, a paint may comprise a real solution of a binder and a liquid component, and a dispersion of a pigment within the liquid component.

[0471] Depending upon other coating components, a liquid component may function as an active solvent or a latent solvent. An active solvent is capable of dissolving a solute. Additionally, an active solvent often reduces viscosity of a coating composition. In certain embodiments, an ester, a glycol ether, a ketone, or a combination thereof may be selected for use as an active solvent. A latent solvent, in pure form, does not demonstrate solute dissolving ability. However, the latent solvent may demonstrate the ability to dissolve a solute in a combination of an active solvent and the latent solvent; confer a synergistic improvement in the dissolving ability of an active solvent when combined with the active solvent, or a combination thereof. In certain embodiments, an alcohol may be selected for use as a latent solvent. In certain embodiments, a latent solvent is a thinner. A diluent, whether in pure form or in combination with an active solvent and/or a latent solvent, does not demonstrate solute dissolving ability, but may be combined with an active solvent and/or latent solvent to produce a liquid component with a suitable ability to dissolve a coating component. In certain embodiments, hydrocarbon may be selected for use as a diluent. In particular aspects, a hydrocarbon diluent comprises an aromatic hydrocarbon, an aliphatic hydrocarbon, or a combination thereof. In particular facets, an aromatic hydrocarbon diluent may be selected, due to a generally greater tolerance by a many solvents relative to an aliphatic hydrocarbon. In certain aspects, a diluent is used to alter a rheological property (e.g., reduce viscosity) of a coating composition, reduce cost of a coating composition, or a combination thereof.

[0472] The ability of a solvent to dissolve a potential solute is related to the intermolecular interactions between the solvent molecules, between the potential solute molecules, between the solvent and the potential solute, as well as the molecular size of the potential solute. Examples of intermolecular interactions include, for example, ionic ("Coulomb"), dipole-dipole ("directional"), ionic-dipole, induction ("permanent dipole/induced dipole"), dispersion ("nonpolar," "atomic dipole," "London-Van der Waals"), hydrogen bond, or a combination thereof. As is known to those of ordinary skill in the art, the sum of intramolecular interactions for a compound, relevant for the preparation of a solution, is the solubility parameter (" δ "). The solubility parameter is a measure of the total energy needed to separate

molecules of a liquid. Such a separation of molecules of a solvent occurs during the incorporation of the molecules of a solute during the dissolving process. The solubility parameter is the square root of the molar energy of vaporization of a liquid divided by the molar volume of a liquid, measured at 25° C. Additionally, the solubility parameter can also be expressed as the square root of the sum of the squares of the dispersion (" δ_d "), polar (" δ_p ") and hydrogen bond (" δ_h ") solubility parameters.

[0473] Often, preparation of a coating composition may be aided by comparing the solubility parameter of a potential solvent and a potential solute (e.g., a binder) to ascertain the theoretical ability of a coating composition comprising a solution to be created. In many embodiments, coating components, wherein at least one coating component comprises a liquid, with a solubility parameter that is less than an absolute value of 6 are able to form a solution. The closer this value is to 0, the greater the general ability to form a solution. Additionally, the lower the individual absolute difference (e.g., six or less) between the dispersion solubility parameters of coating components, the polar solubility parameter of coating components, and/or the hydrogen bond solubility parameter of coating components, the generally greater ability to form a solution. The solubility parameter, dispersion solubility parameter, polar solubility parameter, and hydrogen bond solubility parameter, and methods for determining such values, and additional methods for determining the theoretical ability of coating components to form a solution have been described (see, for example, in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D3132-84, 2002).

[0474] However, due to exceptions to the ability of certain liquid components and potential solute coating components to form solutions, empirically determining the ability of a solute to dissolve in a solvent may be desirable in certain embodiments. Standard techniques for determining the ability of a liquid component comprising one or more liquids to function as an active solvent, a latent solvent, a diluent, or a combination thereof, relative to one or more potential solutes are known to those of ordinary skill in the art. For example, the solvency of a liquid component comprising an active solvent (e.g., an oxygenated compound), a latent solvent, a diluent (e.g., a hydrocarbon), or a combination thereof, particularly for use in a lacquer coating, may be determined as described in "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons," D1720-96, 2002. In an additional example, the solvency for a liquid component that primarily comprises a hydrocarbon, and comprises little or lacks an oxygenated compound, may be determined as described in "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons," D1133-02, 2002. In a further example, the solvency of a solution comprising liquid component and an additional coating component (e.g., a binder) may be used to determine, as described in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D1545-98, D1725-62, D5661-95, D5180-93, D6038-96, D5165-93, and D5166-97, 2002. In a supplemental example, the dilutability of a solution comprising liquid component (e.g., a solvent and diluent) and an additional coating component (e.g., a binder) may be used to determine, as described in "ASTM Book of Standards, Volume 06.03, Paint—Pig-

ments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles,” D5062-96, 2002.

[0475] In certain embodiments, a liquid component may be selected on the basis of evaporation rate. The evaporation rate of a coating directly affects a physical aspect of film formation caused by loss of a liquid component, as well as the pot life of a coating, such as after a coating container is opened. Though the evaporation rate is known for various pure chemicals, one of ordinary skill in the art can empirically determine the evaporation rate of a liquid component and/or a coating, in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D3539-87, 2002. Additionally, the boiling point range of a liquid component often is useful in estimating whether the liquid component will evaporate faster or slower relative to another liquid component. Examples of methods for measuring a boiling point for a liquid component (e.g., a hydrocarbon, a chlorinated hydrocarbon) are described in “ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons,” D1078-01 and D850-02e1, 2002. The evaporation rate is also related to the flash point of a liquid component and/or coating. In certain embodiments, a liquid component may be selected on the basis of flash point and/or fire point, which is a measure of the danger of use of a flammable coating composition in, for example, storage, application in an indoor environment, etc. A flash point is the “lowest temperature at which the liquid gives off enough vapor to form an ignitable mixture with air to produce a flame when a source of ignition is brought close to the surface of the liquid under specified conditions of test at standard barometric pressure (760 mmHG, 101.3 kPa),” and a fire point is “the lowest temperature at which sustained burning of the sample takes place for at least 5 seconds” [“Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook” (Koleske, J. V. Ed.), pp. 140 and 142, 1995]. Examples of methods for measuring the flash point and/or fire point for a liquid component and/or a coating are described in and “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D1310-01, D3934-90, D3941-90, and D3278-96e 1, 2002.

[0476] Though it is contemplated that most or all liquid component will be lost from a coating composition during film formation, a liquid component may still contribute to the visual properties of a coating and/or film. In embodiments wherein a liquid component is selected as a coloring agent, the color and/or darkness of the liquid may be empirically measured (see, for example, “ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons,” D1209-00, D1686-96, and D5386-93b, 2002); and “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D1544-98, 2002. In some embodiments, a liquid component and/or coating may be selected on the basis of odor (e.g., faint odor, pleasant odor, etc.). A coating or coating component can be evaluated for suitability in a particular application based on odor using, for example, techniques described in “ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons,” D1296-01, 2002; and “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D6165-97, 2002.

(1) Hydrocarbons

[0477] A hydrocarbon is typically obtained as a petroleum product, a vegetable product, or a combination thereof. As a consequence of imperfect purification (e.g., distillation) from these sources, a hydrocarbon is often a mixture of chemical components. A hydrocarbon may be selected as an active solvent to dissolve an oil (e.g., a drying oil), an alkyd, an asphalt, a rosin, a petroleum product, or a combination thereof. A hydrocarbon is more suitable as a latent solvent or diluent in embodiments wherein an acrylic resin, an epoxide resin, a nitrocellulose resin, an urethane resin, or a combination thereof is to be dissolved. However, a hydrocarbon generally is immiscible in water.

(i) Aliphatic Hydrocarbons

[0478] In general embodiments, an aliphatic hydrocarbon may be selected as an active solvent for an alkyd, an oil, wax, a polyisobutene, a polyethylene, a poly(butyl acrylate), a poly(butyl methacrylate), a poly(vinyl ethers), or a combination thereof. In other embodiments, an aliphatic hydrocarbon may be selected as a diluent in combination with an additional liquid component. In alternative embodiments wherein an aliphatic hydrocarbon is selected as a non-solvent liquid component, a composition comprising a polar binder, a cellulose derivative, or a combination thereof, is usually insoluble. An aliphatic hydrocarbon is often selected as a liquid component in embodiments wherein a chemically inert liquid component is desired. Examples of an aliphatic hydrocarbon include, a petroleum ether, pentane (CAS No. 109-66-0), hexane (CAS No. 110-54-3), heptane (CAS No. 142-82-5), isododecane (CAS No. 13475-82-6), a kerosene, a mineral spirit, a VMP naphthas or a combination thereof. A hexane, a heptane, or a combination thereof, may be selected for a coating wherein rapid evaporation of such a liquid component is desired (e.g., a fast drying lacquer). An example of an azeotrope comprising an aliphatic hydrocarbon includes an azeotrope comprising hexane. Examples of an azeotrope comprising a majority of hexane (BP 65° C. to 70° C.) include those comprising 2.5% isobutanol (azeotrope BP 68.3° C.); 5.6% water (A-BP 61.6° C.); 21% ethanol (A-BP 58.7° C.); 22% isopropyl alcohol (A-BP 61.0C.); 26.9% methanol (A-BP 50.0° C.); 37% methyl ethyl ketone (A-BP 64.2° C.); or 42% ethyl acetate (A-BP 65.0° C.).

[0479] As would be known to one of ordinary skill in the art, an aliphatic hydrocarbon can comprise a petroleum distillation product of heterogeneous chemical composition. Such an aliphatic hydrocarbon may be classified by a physical and/or chemical property (e.g., boiling point range, flash point, evaporation rate) (see, for example, “ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons,” D235-02 and D3735, 2002). In certain embodiments, such a petroleum distillation product aliphatic hydrocarbon may be classified, for example, as a mineral spirit, a VMP naphthas or a kerosene (e.g., deodorized kerosene). A mineral spirit (“white spirit,” “petroleum spirit”) is a petroleum distillation fraction with a boiling point between 149° C. to 204° C., including all intermediate ranges and combinations thereof, and a flash point of 38° C. or greater. A mineral spirit may further be classified as a regular mineral spirit, which possesses the properties previously described for a mineral spirit; a high flash mineral spirit, which possesses a higher minimum flash point (e.g.,

55° C. or greater); a low dry point mineral spirit ("Stoddard solvent"), which typically evaporates 50% faster than a regular mineral spirit; or an odorless mineral spirit, which generally possesses less odor than a regular mineral spirit, but may also possess relatively weaker solvency property. A mineral spirit may be selected for embodiments wherein a solvent and/or diluent is desired for an alkyd coating, a chlorinated rubber coating, an oil-coating, a vinyl chloride copolymer coating, or a combination thereof. A VMP naphtha possess a similar solvency property as a mineral spirit, but evaporates faster with a BP of 121° C. to 149° C., including all intermediate ranges and combinations thereof, and typically has a flash point of 4° C. or greater. A VMP naphtha may further be classified as a regular VMP naphtha, which possesses the properties previously described for a VMP naphtha; a high flash VMP naphtha, which possesses a higher minimum flash point (e.g., 34° C. or greater); or an odorless VMP naphtha, which generally possesses less odor than a regular mineral spirit. A VMP naphtha may be selected for a coating that is spray applied, an industrial coating, or a combination thereof. A petroleum ether is a petroleum distillation fraction with a boiling point between 35° C. to 80° C., including all intermediate ranges and combinations thereof, with a low flash point (e.g., -46° C.), and may be used in embodiments wherein rapid evaporation is desired.

(ii) Cycloaliphatic Hydrocarbons

[0480] In embodiments wherein a cycloaliphatic hydrocarbon is selected as a solvent, a composition comprising an oil, alkyd, bitumen, rubber, or a combination thereof, usually can be dissolved. In alternative embodiments wherein a cycloaliphatic hydrocarbon is selected as a non-solvent liquid component, a composition comprising a polar binder such as a urea-formaldehyde binder, a melamine-formaldehyde binder, a phenol-formaldehyde binder; a cellulose derivative, such as, a cellulose ester binder; or a combination thereof, is usually insoluble. A cycloaliphatic hydrocarbon is generally soluble in other organic solvents, but not soluble in water. Examples of a cycloaliphatic hydrocarbon include cyclohexane (CAS No. 110-82-7); methylcyclohexane (CAS No. 108-87-2); ethylcyclohexane (CAS No. 1678-91-7); tetrahydronaphthalene (CAS No. 119-64-2); decahydronaphthalene (CAS No. 91-17-8); or a combination thereof. Tetrahydronaphthalene is often selected for coatings wherein oxidation of a binder is preferable during film formation; a high gloss is preferable in a film, smooth surface is preferable in a film, or a combination thereof. An example of an azeotrope comprising a cycloaliphatic hydrocarbon includes an azeotrope comprising cyclohexane. Examples of an azeotrope comprising a majority of cyclohexane (BP 80.5° C. to 81.5° C.) include those comprising 8.5% water (A-BP 69.8° C.); 10% butanol (A-BP 79.8° C.); 14% isobutanol (A-BP 78.1° C.); 20% propanol (A-BP 74.3° C.); 37% methanol (A-BP 54.2° C.); or 40% methyl ethyl ketone (A-BP 72.0° C.).

(iii) Terpene Hydrocarbons

[0481] A terpene typically possesses a superior solvency property, stronger odor, or a combination thereof, relative to an aliphatic hydrocarbon. Examples of a terpene include wood turpentine oil (CAS No. 8008-64-2); pine oil (CAS No. 8000-41-7); α -pinene (CAS No. 80-56-8); β -pinene;

dipentene (CAS No. 138-86-3); D-limonene (CAS No. 5989-27-5); or a combination thereof. Dipentene may be selected for embodiments wherein a superior solvency property, a slower evaporation rate, or a combination thereof, relative to a turpentine, is desired. Pine oil may be classified as an oxygenated compound, but is described under hydrocarbons due to convention by those of skill in the art. Pine oil generally comprises a terpene alcohol. Pine oil may be selected for embodiments wherein a greater range of solvency for solutes, a slow evaporation rate, or a combination thereof, is desired. An example of an azeotrope comprising a terpene includes an azeotrope comprising α -pinene. An example of an azeotrope comprising a majority of α -pinene (BP 154.0° C. to 156.0° C.) includes an azeotrope comprising 35.5% cyclohexanol (A-BP 149.9° C.).

[0482] As would be known to one of ordinary skill in the art, a terpene hydrocarbon ("terpene") can comprise a by-product from pines tree and/or citrus processing of heterogeneous chemical composition. Such a terpene hydrocarbon (e.g., a turpentine) may be classified by a physical and/or chemical property (see, for example, "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D804-02, D13-02, D233-02, D801-02, D802-02, and D6387-99, 2002). Examples of a turpentine include a gum turpentine, a steam-distilled wood turpentine, a sulfate wood turpentine, a destructively distilled wood turpentine, or a combination thereof. Both a gum turpentine and a sulfate wood turpentine generally comprise a combination of α -pinene and a lesser quantity of β -pinene. A steam-distilled wood turpentine generally comprises α -pinene and a lesser component of dipentene and one or more other terpenes. Destructively distilled wood turpentine generally comprises various aromatic hydrocarbons and a lesser quantity of one or more terpenes.

(iv) Aromatic Hydrocarbons

[0483] An aromatic hydrocarbon typically possesses a greater solvency property and/or odor relative to other hydrocarbon types. Examples of an aromatic hydrocarbon include benzene (CAS No. 71-43-2); toluene (CAS No. 108-88-3; "methylbenzene"); ethylbenzene (CAS No. 100-41-4); xylene (CAS No. 1330-20-7); cumene ("isopropylbenzene"; CAS No. 98-82-8); a type I high flash aromatic naphthas; a type II high flash aromatic naphthas; mesitylene (CAS No. 108-67-8); pseudocumene (CAS No. 95-63-6); cymol (CAS No. 99-87-6); styrene (CAS No. 100-42-5); or a combination thereof. Xylene typically comprises o-xylene (CAS No. 56004-61-6); m-xylene (CAS No. 108-38-3); p-xylene (CAS No. 41051-88-1); and trace ethylbenzene. Toluene may be selected for embodiments wherein rapid evaporation is desired. In specific aspects, toluene may be selected for a spray applied coating, an industrial coating, or a combination thereof. Xylene may be selected for embodiments wherein a moderate evaporation rate is desired. In specific aspects, xylene may be selected for an industrial coating. As would be known to one of ordinary skill in the art, an aromatic hydrocarbon may comprise a petroleum-processing product of heterogeneous chemical composition such as a high flash aromatic naphtha (e.g., type I, type II). A type I high flash aromatic naphtha and type II high flash aromatic naphtha possess a minimum flash point of 38° C. and 60° C., respectively. Standards for the characteristic chemical and/or physical property of an aromatic naphtha are

known to those of ordinary skill in the art (see, for example, "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons," D3734, 2002). A high flash naphtha typically has a slow evaporation rate. In specific embodiments, a high flash aromatic naphtha may be used in an industrial coating, a coating that is baked, or a combination thereof. An example of a high flash aromatic is Solvesso 100 (CAS No. 64742-95-6). Examples of an azeotrope comprising an aromatic hydrocarbon include an azeotrope comprising toluene or m-xylene. Examples of an azeotrope comprising a majority of toluene (BP 110° C. to 111° C.) include those comprising 27% butanol (A-BP 105.6° C.); or 44.5% isobutanol (A-BP 100.9° C.). Examples of an azeotrope comprising a majority of m-xylene (BP 137.0° C. to 142.0° C.) include those comprising 14% cyclohexanol (A-BP 143.0° C.); or 40% water (A-BP 94.5° C.).

(2) Oxygenated Compounds

[0484] An oxygenated compound ("oxygenated liquid compound") is typically chemically synthesized by standard chemical manufacturing techniques. As a consequence, an individual oxygenated compound is typically an extremely homogenous chemical composition, with singular, rather than a range of, chemical and physical properties. The oxygen moiety of an oxygenated compound generally enhances the strength and breadth of solvency for potential solutes relative to a hydrocarbon. Additionally, an oxygenated compound typically has some or complete miscibility with water. Examples of an oxygenated compound include an alcohol, an ester, a glycol ether, a ketone, or a combination thereof. As would be known to one of ordinary skill in the art, a liquid component often comprises a combination of an alcohol, an ester, a glycol ether, a ketone and/or an addition liquid to produce suitable chemical and/or physical properties for a coating and/or film.

(i) Alcohols

[0485] An alcohol comprises an alcohol moiety. However, a preferred "alcohol" comprises a single hydroxyl moiety. The alcohol moiety confers miscibility with water. Consequentially, increasing molecular size of an alcohol comprising a single alcohol moiety generally reduces miscibility with water. Alcohols typically possess a mild and/or pleasant odor. An alcohol is typically a poor primary solvent, though ethanol is an exception relative to a solute comprising a phenolic and/or polyvinyl resin. An alcohol may be selected as a latent solvent, co-solvent, a coupling solvent, a diluent, or combination thereof such as with solute comprising a nitrocellulose lacquer, melamine-formaldehyde, urea formaldehyde, alkyd, or combination thereof. Examples of an alcohol include methanol (CAS No. 67-56-1); ethanol (CAS No. 64-17-5); propanol (CAS No. 71-23-8); isopropanol (CAS No. 67-63-0); 1-butanol (CAS No. 71-36-3); isobutanol (CAS No. 78-83-1); 2-butanol (CAS No. 78-92-2); tert-butanol (CAS No. 75-65-0); amyl alcohol (CAS No. 71-41-0); isoamyl alcohol (123-51-3); hexanol (25917-35-5); methylisobutylcarbinol (CAS No. 108-11-2); 2-ethylbutanol (CAS No. 97-95-0); isooctyl alcohol (CAS No. 26952-21-6); 2-ethylhexanol (CAS No. 104-76-7); isodecanol (CAS No. 25339-17-7); cyclohexanol (CAS No. 108-93-0); methylcyclohexanol (CAS No. 583-59-5); trimethylcyclohexanol; benzyl alcohol (CAS No. 100-51-6); methylbenzyl alcohol (CAS No. 98-85-1); furfuryl alcohol (CAS No.

98-00-0); tetrahydrofurfuryl alcohol (CAS No. 97-99-4); diacetone alcohol (CAS No. 123-42-2); trimethylcyclohexanol (116-02-9); or a combination thereof. Furfuryl alcohol and tetrahydrofurfuryl alcohol may be selected as a primary solvent for a polyvinyl binder. Examples of an azeotrope comprising an alcohol include an azeotrope comprising butanol, ethanol, isobutanol, or methanol. Examples of an azeotrope comprising a majority of butanol (BP 117.7° C.) include those comprising 97% butanol and 3% hexane (A-BP 67° C.); 32% p-xylene (A-BP 115.7° C.); 32.8% butyl acetate (A-BP 117.6° C.); 44.5% water (A-BP 93° C.); or 50% isobutyl acetate (A-BP 114.5° C.). Examples of an azeotrope comprising a majority of ethanol (BP 78.3° C.) include those comprising 4.4% water (A-BP 78.2° C.); or 32% toluene (A-BP 76.7° C.). Examples of an azeotrope comprising a majority of isobutanol (BP 107.7° C.) include those comprising 2.5% hexane (A-BP 68.3° C.); 5% isobutyl acetate (A-BP 107.6° C.); 17% p-xylene (A-BP 107.5° C.); 33.2% water (A-BP 89.9° C.); or 48% butyl acetate (A-BP 80.1° C.). An example of an azeotrope comprising a majority of methanol (BP 64.6° C.) includes an azeotrope comprising 30% methyl ethyl ketone (A-BP 63.5° C.).

(ii) Ketones

[0486] A ketone comprises a ketone moiety. However, a preferred ketone comprises a single ketone moiety. A ketone generally possesses some miscibility with water, and a strong odor. In general embodiments, a ketone may be selected as a primary solvent, thinner, or combination thereof. Examples of a ketone include acetone (CAS No. 67-64-1); methyl ethyl ketone (CAS No. 78-93-3); methyl propyl ketone (CAS No. 107-87-9); methyl isopropyl ketone (CAS No. 563-80-4); methyl butyl ketone (CAS No. 591-78-6); methyl isobutyl ketone (CAS No. 108-10-1); methyl amyl ketone (CAS No. 110-43-0); methyl isoamyl ketone (CAS No. 110-12-3); diethyl ketone (CAS No. 96-22-0); ethyl amyl ketone (CAS No. 541-85-5); dipropyl ketone (CAS No. 110-43-0); diisopropyl ketone (CAS No. 565-80-0); cyclohexanone (CAS No. 108-94-1); methylcyclohexanone (CAS No. 1331-22-2); trimethylcyclohexanone (CAS No. 873-94-9); mesityl oxide (CAS No. 141-79-7); diisobutyl ketone (CAS No. 108-83-8); isophorone (CAS No. 78-59-1); or a combination thereof. Acetone may be selected for complete miscibility in water, fast evaporation, or a combination thereof. In certain embodiments, acetone may be used as a liquid component in an aerosol, a spray-applied coating, or a combination thereof. In specific aspects, acetone may be used as a thinner. In other aspects, acetone may be used in a coating wherein nitrocellulose, an acrylic, or a combination thereof, is dissolved. Methyl ethyl ketone, methyl isobutyl ketone, and isophorone may be selected in embodiments wherein a fast evaporation rate, moderate evaporation rate, or slow evaporation rate, respectively, is desired. In specific facets, isophorone may be selected for a baked coating, an industrial coating, or a combination thereof. Examples of an azeotrope comprising a ketone include an azeotrope comprising acetone, methyl ethyl ketone or methyl isobutyl ketone. Examples of an azeotrope comprising a majority of acetone (BP 56.2° C.) include those comprising 12% methanol (A-BP 55.7° C.); or 41% hexane (A-BP 49.8° C.). Examples of an azeotrope comprising a majority of methyl ethyl ketone (BP 79.6° C.) include those comprising 11% water (A-BP 73.5° C.); 32% isopropyl alcohol (A-BP 77.5° C.); or 34% ethanol (A-BP 74.8° C.).

Examples of an azeotrope comprising a majority of methyl isobutyl ketone (BP 114° C to 117° C.) include those comprising 24.3% water (A-BP 87.9° C.); or 30% butanol (A-BP 114.35° C.).

(iii) Esters

[0487] An ester may comprise an alkyl acetate, an alkyl propionate, a glycol ether acetate, or a combination thereof. An ester generally possesses a pleasant odor. In general embodiments, an ester possesses a solubility property that decreases with increasing molecular weight. A glycol ester acetate typically possesses a slow evaporation rate. In specific aspects, a glycol ester acetate may be selected as a retarder solvent, a coalescent, or a combination thereof. Examples of an ester include methyl formate (CAS No. 107-31-3); ethyl formate (CAS No. 109-94-4); butyl formate (CAS No. 592-84-7); isobutyl formate (CAS No. 542-55-2); methyl acetate (CAS No. 79-20-9); ethyl acetate (CAS No. 141-78-6); propyl acetate (CAS No. 109-60-4); isopropyl acetate (CAS No. 108-21-4); butyl acetate (CAS No. CAS-No. 123-86-4); isobutyl acetate (CAS No. 110-19-0); sec-butyl acetate (CAS No. 105-46-4); amyl acetate (CAS No. 628-63-7); isoamyl acetate (CAS No. 123-92-2); hexyl acetate (CAS No. 142-92-7); cyclohexyl acetate (CAS No. 622-45-7); benzyl acetate (CAS No. 140-11-4); methyl glycol acetate (CAS No. 110-49-6); ethyl glycol acetate (CAS No. 111-15-9); butyl glycol acetate (CAS No. 112-07-2); ethyl diglycol acetate (CAS No. 111-90-0); butyl diglycol acetate (CAS No. 124-17-4); 1-methoxypropyl acetate (CAS No. 108-65-6); ethoxypropyl acetate (CAS No. 54839-24-6); 3-methoxybutyl acetate (CAS No. 4435-53-4); ethyl 3-ethoxypropionate (CAS No. 763-69-9); isobutyl isobutyrate (CAS No. 97-85-8); ethyl lactate (CAS No. 97-64-3); butyl lactate (CAS No. 138-22-7); butyl glycolate (CAS No. 7397-62-8); dimethyl adipate (CAS No. 627-93-0); glutarate (CAS No. 119-40-0); succinate (CAS No. 106-65-0); ethylene carbonate (CAS No. 96-49-1); propylene carbonate (CAS No. 108-32-7); butyrolactone (CAS No. 96-48-0); or a combination thereof. Ethylene carbonate and propylene carbonate generally possess a high flash point, a slow evaporation rate, a weak odor, or a combination thereof. Ethylene carbonate is preferred for use in coatings at temperatures greater than 25° C. Examples of an azeotrope comprising an ester include an azeotrope comprising butyl acetate, ethyl acetate or methyl acetate. Examples of an azeotrope comprising a majority of butyl acetate (BP 124° C. to 128° C.) include those comprising 27% water (A-BP 90.7° C.) or 35.7% ethyl glycol (A-BP 125.8° C.). Examples of an azeotrope comprising a majority of ethyl acetate (BP 76° C. to 77° C.) include those comprising 5% cyclohexanol (A-BP 153.8° C.); 8.2% water (A-BP 70.4° C.); 22% methyl ethyl ketone (A-BP 76.7° C.); 23% isopropyl alcohol (A-BP 74.8° C.); or 31% ethanol (A-BP 71.8° C.). An example of an azeotrope comprising a majority of methyl acetate (BP 55.0° C.-57.0° C.) includes an azeotrope comprising 19% methanol (A-BP 54° C.).

(iv) Glycol Ethers

[0488] A glycol ether comprises an alcohol moiety and an ether moiety. The glycol ether generally possesses good solvency, high flash point, slow evaporation rate, mild odor, miscibility with water, or a combination thereof. In some embodiments, a glycol ether may be selected as a coupling

solvent, a thinner, or a combination thereof. In particular aspects, a glycol ether may be selected as a liquid component of a lacquer. Examples of a glycol ether include methyl glycol (CAS No. 109-86-4); ethyl glycol (CAS No. 110-80-5); propyl glycol (CAS No. 2807-30-9); isopropyl glycol (CAS No. 109-59-1); butyl glycol (CAS No. 111-76-2); methyl diglycol (111-77-3); ethyl diglycol (CAS No. 111-90-0); butyl diglycol (CAS No. 112-34-5); ethyl triglycol (CAS No. 112-50-5); butyl triglycol (CAS No. 143-22-6); diethylene glycol dimethyl ether (CAS No. 111-96-6); methoxypropanol (CAS No. 107-98-2); isobutoxypropanol (CAS No. 23436-19-3); isobutyl glycol (CAS No. 4439-24-1); propylene glycol monoethyl ether (CAS No. 52125-53-8); 1-isopropoxy-2-propanol (CAS No. 3944-36-3); propylene glycol mono-n-propyl ether (CAS No. 30136-13-1); propylene glycol n-butyl ether (CAS No. 5131-66-8); methyl dipropylene glycol (CAS No. 34590-94-8); methoxybutanol (CAS No. 30677-36-2); or a combination thereof. An example of an azeotrope comprising a glycol ether includes an azeotrope comprising ethyl glycol. An example of an azeotrope comprising a majority of ethyl glycol (BP 134° C. to 137° C.) includes an azeotrope comprising 50% dibutyl ether (A-BP 127° C.).

(v) Ethers

[0489] Examples of an ether include diethyl ether (CAS No. 60-29-7); diisopropyl ether (CAS No. 108-20-3); dibutyl ether (CAS No. 142-96-1); di-sec-butyl ether (CAS No. 6863-58-7); methyl tert-butyl ether (CAS No. 1634-04-4); tetrahydrofuran (CAS No. 109-99-9); 1,4-dioxane (CAS No. 123-91-1); metadioxane (CAS No. 505-22-6); or a combination thereof. Tetrahydrofuran may be selected as a primary solvent for a polyvinyl binder. An example of an azeotrope comprising an ether includes an azeotrope comprising tetrahydrofuran. An example of an azeotrope comprising a majority of tetrahydrofuran (BP 66° C.) includes an azeotrope comprising 5.3% water (A-BP 64.0° C.).

(3) Chlorinated Hydrocarbons

[0490] A chlorinated hydrocarbon generally comprises a hydrocarbon, wherein the hydrocarbon comprises a chloride atom moiety. A chlorinated hydrocarbon generally possesses a very high degree of non-flammability, and consequently lacks a flash point. A chlorinated hydrocarbon may be selected for embodiments where high flash point is desired. In particular facets, a chlorinated hydrocarbon may be added to a liquid component to reduce the liquid component's flash point. In certain facets, it is less preferred that a chlorinated hydrocarbon be combined with a mineral spirit, methylene chloride, or a combination thereof, wherein reduction of the flash point is desired. In particular aspects, a chlorinated hydrocarbon (e.g., methylene chloride, trichloroethylene) may be selected as a solvent for removal of hydrophobic material from a surface (e.g., grease, an undesired coating and/or film). However, a chlorinated hydrocarbon may be less preferred due to an environmental regulation or law. Examples of a chlorinated hydrocarbon include methylene chloride (CAS No. 75-09-2; "dichloromethane"); trichloromethane (CAS No. 67-66-3); tetrachloromethane (CAS No. 56-23-5); ethyl chloride (CAS No. 75-00-3); isopropyl chloride (CAS No. 75-29-6); 1,2-dichloroethane (CAS No. 107-06-2); 1,1,1-trichloroethane (CAS No. 71-55-6; "methylchloroform"); trichloroethylene (CAS No. 79-01-6); 1,1,

2,2-tetrachlorethane (CAS No. 79-55-6); 1,2-dichloroethylene (CAS No. 75-35-4); perchloroethylene (CAS No. 127-18-4); 1,2-dichloropropane (CAS No. 78-87-5); chlorobenzene (CAS No. 108-90-7); or a combination thereof. Methylene chloride may be selected for embodiments wherein a fast evaporation rate is desired. 1,1,1-trichloroethane may be selected for embodiments wherein a photochemically inert liquid component is desired. Additionally, methylene chloride may be selected as a coating remover. Examples of an azeotrope comprising a chlorinated hydrocarbon include an azeotrope comprising methylene chloride, trichloroethylene or 1,1,1-trichloroethane. Examples of an azeotrope comprising a majority of methylene chloride (BP 40.2° C.) include those comprising 1.5% water (A-BP 38.1° C.); 3.5% ethanol (A-BP 41.0° C.); or 8% methanol (A-BP 39.2° C.). Examples of an azeotrope comprising a majority of trichloroethylene (BP 86.7° C.) include those comprising 6.6% water (A-BP 72.9° C.); 27% ethanol (A-BP 70.9° C.); or 36% methanol (A-BP 60.2° C.). An example of an azeotrope comprising a majority of 1,1,1-trichloroethane (BP 74.0° C.) includes an azeotrope comprising 4.3% water (A-BP 65.0° C.).

(4) Nitrated Hydrocarbons

[0491] A nitrated hydrocarbon comprises a hydrocarbon, wherein the hydrocarbon comprises a nitrogen atom moiety. Examples of a nitrated hydrocarbon include a nitroparaffin, N-methyl-2-pyrrolidone ("NMP"), or a combination thereof. Examples of a nitroparaffin include nitroethane, nitromethane, nitropropane, 2-nitropropane ("2NP"), or a combination thereof. 2-nitropropane may be selected for embodiments as a substitute for butyl acetate relative to a solvent property, but wherein a greater evaporation rate is desired. N-methyl-2-pyrrolidone may be selected for embodiments wherein a strong solvent property, miscibility with water, high flash point, biodegradability, low toxicity, or a combination thereof is desired. In certain aspects, N-methyl-2-pyrrolidone may be used in a water-borne coating, a coating remover, or a combination thereof.

(5) Miscellaneous Organic Liquids

[0492] A miscellaneous organic liquid is a liquid comprising carbon that are useful as a liquid component for a coating, but are not readily classified as a hydrocarbon, an oxygenated compound, a chlorinated hydrocarbon, a nitrated hydrocarbon, or a combination thereof. Examples of a miscellaneous organic liquid include carbon dioxide; acetic acid, methylal (CAS No. 109-87-5); dimethylacetel (CAS No. 534-15-6); N,N-dimethylformamide (CAS No. 68-12-2); N,N-dimethylacetamide (CAS No. 127-19-5); dimethylsulfoxide (CAS No. 67-68-5); tetramethylene sulfone (CAS No. 126-33-0); carbon disulfide (CAS No. 75-15-0); 2-nitropropane (CAS No. 79-46-9); N-methylpyrrolidone (CAS No. 872-50-4); hexamethylphosphoric triamide (CAS No. 680-31-9); 1,3-dimethyl-2-imidazolidinone (CAS No. 80-73-9); or a combination thereof. As would be known to one of ordinary skill in the art, carbon dioxide may function as a liquid component when prepared under pressure and temperature conditions to form a supercritical liquid. A supercritical liquid has properties between that of a liquid and a gas, and can be used in spray application of a coating wherein the appropriate pressure conditions can be maintained. Supercritical carbon dioxide may be formulated with

a coating using the tradename technique Unicarb™ (Union Carbide Chemicals and Plastics Co., Inc.). Supercritical carbon dioxide may be selected as a substitute for a hydrocarbon diluent in embodiments wherein chemical inertness, non-flammability, rapid evaporation, or a combination thereof, is desirable. In certain aspects, 0% to 30%, including all intermediate ranges and combinations thereof, of a hydrocarbon liquid component may be replaced with supercritical carbon dioxide.

[0493] b. Plasticizers

[0494] In certain embodiments, a coating may comprise a plasticizer. A plasticizer may be selected for embodiments wherein the resin possesses an unsuitable brittleness and/or low flexibility property upon film formation. Properties a plasticizer typically confers to a coating and/or film include, for example, enhancing a flow property of a coating, lowering a film-forming temperature range, enhancing the adhesion property of a coating and/or film, enhancing the flexibility property of a film, lowering the T_g , improving film toughness, enhancing film heat resistance, enhancing film impact resistance, enhancing UV resistance, or a combination thereof. Since a function of a plasticizer typically is to alter a film's properties, most plasticizer's possess a high (e.g., baking temperature) boiling point, as such a compound is generally less volatile, with increasing boiling point temperature. In certain aspects, a plasticizer may function as a solvent, thinner, diluent, plasticizer, or combination thereof, for a coating composition and/or film at a temperature greater than ambient conditions.

[0495] A plasticizer is thought to interact with a binder by a polar interaction, but is chemically inert relative to the binder. A plasticizer typically will lower the T_g of a binder below the temperature a coating comprising the binder will be applied to a surface. In many embodiments, a plasticizer have a vapor pressure less than 3 mm at 200° C., a mass of 200 Da to 800 Da, a specific gravity of 0.75 to 1.35, a viscosity of 50 cSt to 450 cSt, a flash point temperature greater than 120° C., or a combination thereof. Preferred plasticizers comprise an organic liquid (e.g., an ester). Standards for physical properties, chemical properties, and/or procedures for testing purity/properties, are described for plasticizers (e.g., undesired acidity, color, undesired copper corrosion, boiling point, ester content, odor, undesirable water contamination) in, for example, "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons," D1613-02, D1209-00, D849-02, D1078-01, D1617-90, D1296-01, D608-90, and D1364-02, 2002; and "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D1544-98, 2002. Compatibility of a plasticizer with a binder and/or a solvent has been described (see, for example, Riley, H. E., "Plasticizers," *Paint Testing Manual*, American Society for Testing Materials, 1972). Additionally, techniques previously described for estimating solubility for liquid and an additional coating component may be applied for a plasticizer.

[0496] Various plasticizers comprise an ester of a monoalcohol and an acid (e.g., a dicarboxylic acid). In many embodiments, the monoalcohol comprises 4 to 13 carbons. In specific aspects, the monoalcohol comprises butanol, 2-ethylhexanol, isononanol, isooctyl, isodecyl, or a combination thereof. Examples of an acid include an azelaic acid,

a phthalic acid, a sebacic acid, a trimellitic acid, an adipic acid, or a combination thereof. Examples of such plasticizers include di(2-ethylhexyl) azelate ("DOZ"); di(butyl) sebacate ("DBS"); di(2-ethylhexyl) phthalate ("DOP"); di(isononyl) phthalate ("DINP"); dibutyl phthalate ("DBP"); butyl benzyl phthalate ("BBP"); di(isooctyl) phthalate ("DIOP"); di(idodecyl) phthalate ("DIDP"); tris(2-ethylhexyl) trimellitate ("TOTM"); tris(isononyl) trimellitate ("TINTM"); di(2-ethylhexyl) adipate ("DOA"); di(isononyl) adipate ("DINA"); or a combination thereof.

[0497] A plasticizer may be classified by a moiety, such as, for example, as an adipate (e.g., DOA, DINA), an azelate (e.g., DOZ), a citrate, a chlorinated plasticizer, an epoxide, a phosphate, a sebacate (e.g., DBS), a phthalate (e.g., DOP, DINP, DIOP, DIDP), a polyester, or a trimellitate (e.g., TOTM, TINTM). An example of a citrate plasticizer includes acetyl tri-n-butyl citrate. Examples of an epoxide plasticizer include an epoxy modified soybean oil ("ESO"), 2-ethylhexyl epoxytallate ("2EH tallate"), or a combination thereof. Examples of a phosphate plasticizer include isodecyl diphenyl phosphate, tricresyl phosphate ("TPC"), isodecyl diphenyl phosphate, tri-2-ethylhexyl phosphate ("TOP"), or a combination thereof. Tricresyl phosphate may function as a plastizer, confer flame resistance, confer fungi resistance, or a combination thereof to a coating. Examples of a polyester plasticizer include an adipic acid polyester, an azelaic acid polyester, or a combination thereof. In certain aspects, a plasticizer is selected for water resistance (e.g., hydrolysis resistance, inertness toward water) such as a bisphenoxyethylformal.

[0498] C. Water-Borne Coatings

[0499] A water-borne coating ("water reducible coating") refers to a coating wherein components such as a pigment, a binder, an additive, or a combination thereof are dispersed in water. Often, an additional solvent, surfactant, emulsifier, wetting agent, dispersant, or a combination thereof promotes dispersion of a coating component. A latex coating refers to a water-borne coating wherein the binder is dispersed in water. Typically, a binder of a latex coating comprises a high molecular weight binder. Often a latex coating (e.g., a paint, a lacquer) is a thermoplastic coating. Film formation occurs by loss of the liquid component, typically through evaporation, and fusion of dispersed thermoplastic binder particles. Often, a latex coating further comprises a coalescing solvent (e.g., diethylene glycol monobutyl ether) that promotes fusion of the binder particles. In some embodiments, a film produced from a latex coating is more porous, possesses a lower moisture resistance property, is less compact (e.g., thicker), or a combination thereof, relative to a solvent-borne coating comprising similar non-volatile components. Specific procedures for determining the purity/properties of a latex coating, coating component (e.g., solids content, nonvolatile content, vehicles), and/or film have been described, for example, in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D4747-02 and D4827-93, 2002; "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D3793-00, 2002; and "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D5097-90 D4758-92, and D4143-89, 2002.

[0500] In certain embodiments, a water-borne coating is a coating wherein 50% to 100%, the including all intermediate ranges and combinations thereof, of a coating's liquid component is water. In general embodiments, the water component of a water-borne coating may function as a solvent, a thinner, a diluent, or a combination thereof. In certain embodiments, a water-borne coating may comprise an additional non-aqueous liquid component. In specific aspects, such an additional liquid component may function as a solvent, a thinner, a diluent, a plasticizer, or a combination thereof. An additional liquid component of a water-borne coating may comprise 0% to 49.999%, the including all intermediate ranges and combinations thereof, of the liquid component. Examples of additional liquid components in a water-borne coating include a glycol ether, an alcohol, or a combination thereof.

[0501] In certain embodiments, an additional liquid component of a water-borne coating may be fully or partly miscible in water. Examples of a liquid that is completely miscible in water, and visa versa, include methanol, ethanol, propanol, isopropyl alcohol, tert-butanol, ethylene glycol, methyl glycol, ethyl glycol, propyl glycol, butyl glycol, ethyl diglycol, methoxypropanol, methylpropylene glycol, dioxane, tetrahydrofuran, acetone, diacetone alcohol, dimethylformamide or dimethyl sulfoxide. Examples of a liquid that is partly miscible in water, by weight at 20° C., include 0.02% ethylbenzene; 0.02% tetrachloroethylene; 0.02% p-xylene; 0.035% toluene; 0.04% diisobutyl ketone; 0.1% trichloroethylene; 0.19% trimethylcyclohexanol; 0.2% cyclohexyl acetate; 0.3% dibutyl ether; 0.3% trimethylcyclohexanone; 0.44% 1,1,1-trichloroethane; 0.53% hexane; 0.58% hexanol; 0.67% isobutyl acetate; 0.83% butyl acetate; 1.2% isophorone; 1.4% nitropropane; 1.5% butyl glycol acetate; 1.7% 2-nitropropane; 2.0% methylene chloride; 2.0% methyl isobutyl ketone; 2.3% cyclohexanone; 2.9% isopropyl acetate; 2.9% methylbenzyl alcohol; 3.6% cyclohexanol; 4.5% nitroethane; 4.8% methyl tert-butyl ether; 6.1% ethyl acetate; 6.9% diethyl ether; 7.5% butanol; 7.5% butyl glycolate; 8.4% isobutanol; 12.5% 2-butanol; 21.4% propylene carbonate; 23.5% ethyl glycol acetate; 24% methyl acetate; or 26.0% methyl ethyl ketone. Examples of an azeotrope comprising a majority of water (BP 100° C.) include those comprising 16.1% isophorone (A-BP 99.5° C.); 20% 2-ethylhexanol (A-BP 99.1° C.); 20% cyclohexanol (A-BP 97.8° C.); 20.8% butyl glycol (A-BP 98.8° C.); or 28.8% ethyl glycol (A-BP 99.4° C.).

[0502] 3. Colorants

[0503] A colorant ("colorizing agent") is a composition that confers a desirable optical property to a coating. Examples of desirable optical properties, depending upon the application of the present invention, include a reflection property, a light absorption property, a light scattering property, or a combination thereof. A colorant that increases the reflection of light may increase gloss. A colorant that increased light scattering may increase the opacity and/or confer a color to a coating and/or film. Light scattering of a broad spectrum of wavelengths can confer a white color to a coating and/or film. Scattering of a certain wavelength may confer a color associated with the wavelength to a coating and/or film. Light absorption also affects opacity and/or color. Light absorption over a broad spectrum confers a black color to a coating and/or film. Absorbance of a certain wavelength may eliminate the color associated with the

wavelength from the appearance of a coating and/or film. Examples of colorants include pigments, dyes, extenders, or a combination thereof. Colorants (e.g., pigments, dyes) and procedures for determining the optical properties and physical properties (e.g., hiding power, transparency, light absorption, light scattering, tinting strength, color, particle size, particle dispersion, pigment content, color matching) of a colorant, coating component, coating and/or film are described in, for example, (in "Industrial Color Testing, Fundamentals and Techniques, Second, Completely Revised Edition," 1995; "Colorants for Non-Textile Applications," 2000). Various colorants are well known to those of ordinary skill in the art, and are often identified by their Colour Index ("CI") number (see, for example, "Colour Index International," 1971; and "Colour Index International," 1997). In some cases, a common name for a colorant encompasses several related colorants, which can be differentiated by CI number.

[0504] a. Pigments

[0505] A pigment is a composition that is insoluble in the other components of a coating, and further confers a desirable optical properties, confers a property affecting the application of the coating (e.g., a theological property), confers a performance property to a coating, reduces the cost of the coating, or a combination thereof. In certain embodiment, a pigment confers a performance property to a coating such as a desirable corrosion resistance property, magnetic property, or a combination thereof. Examples of a pigment include an inorganic pigment, an organic pigment, or a combination thereof.

[0506] Pigments possess a variety of properties in addition to color that aid in the selection of a particular pigment for a specific application. Examples of such properties include a tinctorial property, an insolubility property, a corrosion resistance property, a durability property, a heat resistance property, an opacity property, a transparency property, or a combination thereof. A tinctorial property is the ability of a composition to produce a color, wherein a greater tinctorial strength indicating less of the composition is needed to achieve the color. An insolubility property is the ability of a composition to remain in a solid form upon contact with another coating component (e.g., a liquid component), even during a curing process involving chemical reactions (e.g., thermosetting, baking, irradiation). A corrosion resistance property is the ability of a composition to reduce the damage of a chemical (e.g., water, acid) that contacts metal.

[0507] Pigments (e.g., extenders, titanium pigments, inorganic pigments, surface modified pigments, bismuth vanadates, cadmium pigments, cerium pigment, complex inorganic color pigments, metallic pigments, benzimidazolone pigments, diketopyrrolopyrrole pigments, dioxazine violet pigments, disazocondensation pigments, isoindoline pigments, isoindolinone pigments, perylene pigments, phthalocyanine pigments, quinacridone pigments, quinophthalone pigments, thiazine pigments, oxazine pigments, zinc sulfide pigments, zinc oxide pigments, iron oxide pigments, chromium oxide pigments, cadmium pigments, cadmium sulfide, cadmium yellow, cadmium sulfoselenide, cadmium mercury sulfide, bismuth pigments, chromate pigments, chrome yellow, molybdate red, molybdate orange, chrome orange, chrome green, fast chrome green, ultramarine pigments, iron blue pigments, black pigments, carbon black, specialty

pigments, magnetic pigments, cobalt-containing iron oxide pigments, chromium dioxide pigments, metallic iron pigments, barium ferrite pigments, anti-corrosive pigments, phosphate pigments, zinc phosphate, aluminum phosphate, chromium phosphate, metal phosphates, multiphase phosphate pigments, borosilicate pigments, borate pigments, chromate pigments, molybdate pigments, lead cyanamide pigments, zinc cyanamide pigments, iron-exchange pigments, metal oxide pigments, red lead pigment, red lead, calcium plumbate, zinc ferrite pigments, calcium ferrite pigments, zinc oxide pigments, powdered metal pigments, zinc dust, lead powder, flake pigments, nacreous pigments, interference pigments, natural pearl essence pigment, basic lead carbonate pigment, bismuth oxychloride pigment, metal oxide-mica pigments, metal effect pigments, transparent pigments, transparent iron oxide pigments, transparent iron blue pigment, transparent cobalt blue pigment, transparent cobalt green pigment, transparent iron oxide, transparent zinc oxide, luminescent pigments, inorganic phosphor pigments, sulfide pigments, selenide pigments, oxysulfide pigments, oxygen dominant phosphor pigments, halide phosphor pigments, azo pigments, monoazo yellow pigments, monoazo orange pigment, disazo pigments, β -naphthol pigments, naphthol AS pigments, salt-type azo pigments, benzimidazolone pigments, disazo condensation pigments, metal complex pigments, isoindolinone pigments, isoindoline pigments, polycyclic pigments, phthalocyanine pigments, quinacridone pigments, perylene pigments, perinone pigments, diketopyrrolo pyrrole pigments, thioindigo pigments, anthrapyrimidine pigments, flavanthrone pigments, pyranthrone pigments, anthanthrone pigments, dioxazine pigments, triarylcarbonium pigments, quinophthalone pigments) and their chemical properties, physical properties and/or optical properties (e.g., color, tinting strength, lightening power, scattering power, hiding power, transparency, light stability, weathering resistance, heat stability, chemical fastness, interactions with a binder), in coating component, coating and/or film, and techniques for determining such properties, are known to one of ordinary skill in the art (see, for example, Solomon, D. H. and Hawthorne, D. G., "Chemistry of Pigments and Fillers," 1983; "High Performance Pigments," 2002; "Industrial Inorganic Pigments," 1998; "Industrial Organic Pigments, Second, Completely Revised Edition," 1993).

[0508] As would be known to one of ordinary skill in the art, specific standards for physical properties, chemical properties, purity, and/or procedures for testing the purity/properties of various pigments (e.g., lead chromate, chromium oxide, phthalocyanine green, a phthalocyanine blue, molybdate orange, white zinc, zinc oxide, calcium carbonate, barium sulfate, aluminum silicate, diatomaceous silica, magnesium silicate, mica, calcium borosilicate, zinc hydroxy phosphite, aluminum powder, micaceous iron oxide, zinc phosphate, basic lead silicochromate, strontium chromate, ochre, lampblack, orange shellac, raw umber, burnt umber, raw sienna, burnt sienna, bone black, carbon black, red iron oxide, brown iron oxide, basic carbonate, white lead, white titanium dioxide, iron blue, ultramarine blue, chrome yellow, chrome orange, hydrated yellow iron oxide, zinc chromate yellow, red lead, para red toner, toluidine red toner, chrome oxide green, zinc dust, cuprous oxide, mercuric oxide, iron oxide, anhydrous aluminum silicate, black synthetic iron oxide, gold bronze powder, aluminum powder, strontium chromate pigment, basic lead

silicochromate) for use in a coating are described, for example in "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D280-01, D2448-85, D126-87, D305-84, D3021-01, D3256-86, D2218-67, D3280-85, D50-90, D79-86, D1199-86, D602-81, D715-86, D603-66, D718-86, D604-81, D719-91, D605-82, D717-86, D607-82, D716-86, D4288-02, D4487-90, D4462-02, D4450-85, D962-81, D5532-94, D6280-98, D1648-86, D1649-01, D85-87, D209-81, D237-57, D763-01, D765-87, D210-81, D561-82, D3722-82, D3724-01, D34-91, D81-87, D1301-91, D1394-76, D261-75, D262-81, D1135-86, D211-67, D768-01, D444-88, D3872-86, D478-02, D1208-96, D83-84, D49-83, D3926-80, D475-67, D656-87, D970-86, D3721-83, D263-75, D520-00, D521-02, D283-84, D284-88, D3720-90, D3619-77, D769-01, D476-00, D267-82, D480-88, D1845-86, D1844-86, and D279-02, 2002; and in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D5381-93 and D6131-97 2002.

(1) Corrosion Resistance Pigments

[0509] Addition of certain pigments may improve the corrosion resistance of a coating and/or film, or specifically, the protection of a metal surface coated with a coating and/or film from corrosion. Often, a primer comprises such pigments. Examples of corrosion resistance pigments include aluminum flake, aluminum triphosphate, aluminum zinc phosphate, ammonium chromate, barium borosilicate, barium chromate, barium metaborate, basic calcium zinc molybdate, basic carbonate white lead, basic lead silicate, basic lead silicochromate, basic lead silicosulfate, basic zinc molybdate, basic zinc molybdate-phosphate, basic zinc molybdenum phosphate, basic zinc phosphate hydrate, bronze flake, calcium barium phosphosilicate, calcium borosilicate, calcium chromate, calcium plumbate (CI Pigment Brown 10), calcium strontium phosphosilicate, calcium strontium zinc phosphosilicate, dibasic lead phosphite, lead chromosilicate, lead cyanamide, lead suboxide, lead sulfate, mica, micaceous iron oxide, red lead (CI Pigment Red 105), steel flake, strontium borosilicate, strontium chromate (CI Pigment Yellow 32), tribasic lead phosphosilicate, zinc borate, zinc borosilicate, zinc chromate (CI Pigment Yellow 36), zinc dust (CI Pigment Metal 6), zinc hydroxy phosphite, zinc molybdate, zinc oxide, zinc phosphate (CI Pigment White 32), zinc potassium chromate, zinc silicophosphate hydrate, zinc tetraoxylchromate, or a combination thereof.

[0510] The selection of a corrosion resistant pigment may be made based on the mechanism of corrosion resistance it confers to a coating and/or film. Corrosion often occurs as a cathodic process wherein a metal surface acts as a cathode and passes electrons to an electron acceptor moiety of a corrosive chemical, such as, for example, hydrogen, oxygen, or a combination thereof. Corrosion can also occur as an anodic process wherein ionized metal atoms then enter solution. Pigments such as, for example, mica, micaceous iron oxide, metallic flake pigments (e.g., aluminum, bronze, steel), or a combination thereof confer corrosion resistance to a coating and/or film by acting as a physical barrier between a metal surface and corrosive chemicals. However, a chemically reactive pigment such as a metal flake pigment be used in an environment at or near neutral pH (e.g., pH 6 to pH 8). Micaceous iron oxide can be selected for a primer, a topcoat, or a combination thereof, and can also function as

a UV absorber. Aluminum flake may be selected for an industrial coating, an automotive coating, an architectural coating, a primer, or a combination thereof. Aluminum flake may additionally confer heat resistance, moisture resistance, UV resistance, or a combination thereof to a coating and/or film. Aluminum flake may also be stearate modified for use in a topcoat. However, aluminum flake may produce gas in a coating comprising more than 0.15% water. A metallic zinc pigment (e.g., zinc flake, zinc dust) acts by functioning as an anode instead of the metal surface (e.g., steel). However, the effectiveness of a coating's corrosion resistance fades as the zinc pigment is used up in protective reactions. A metallic zinc primer may be selected for a primer, particularly in combination with an epoxy topcoat, a urethane topcoat, or a combination thereof.

[0511] Red lead and/or basic lead silicochromate can confer an orange color, and may be selected for combination with an oil-based coating (e.g., a primer), as the pigment chemically reacts with an oil-based binder to produce a corrosion resistant lead soap in the coating and/or film. Red lead and/or basic lead is typically selected for a primer in an industrial steel coating.

[0512] A barium metaborate pigment acts by retarding an anodic process. A barium metaborate pigment is usually chemically modified by combination with silica to reduce solubility. A zinc borate combined with a zinc phosphate, a modified barium metaborate, or combination thereof demonstrates synergistic enhancement of corrosion resistance, as well as flame retardancy.

[0513] Zinc potassium chromate may confer a yellow color as well as an anticorrosive property. Zinc tetraoxylchromate can also confer a yellow color, and is typically selected for use in a two pack poly(vinyl butyryl) primer. Zinc oxide may be selected for an oleoresinous coating, a water-borne coating, a primer, or a combination thereof, and may be combined with a zinc chromate and/or calcium borosilicate, and additionally may improve thermosetting crosslinking density and/or act as a UV absorber. Strontium chromate may confer a yellow color, and may be selected for an aluminum surface, an aircraft primer, or a combination thereof. Strontium chromate may be combined with a zinc chromate in a water-borne coating, though it is preferred that total chromate content is less than 0.001% to 2%. Ammonium chromate, barium chromate and calcium chromate may be selected as a corrosion inhibitor, particularly as a flash rust inhibitor.

[0514] A zinc molybdate, zinc phosphate, zinc hydroxy phosphite, or a combination thereof may confer a white color. These zinc pigments function by reducing an anodic process, though zinc hydroxy phosphite may form corrosion resistant soap in an oleoresinous-coating. Basic zinc molybdate typically is selected for an alkyl-coating, an epoxide-coating, an epoxy ester-coating, a polyester-coating, a solvent-borne coating, or a combination thereof. Basic zinc molybdate-phosphate is similar to basic zinc molybdate, though it may provide superior corrosion resistance for a rusted steel surface. Basic calcium zinc molybdate may be selected for a water-borne coating, a two-pack polyurethane coating, a two-pack epoxy coating, or a combination thereof. A combination of basic calcium zinc molybdate and zinc phosphate may confer a superior adhesion property to a surface comprising iron, and may be selected for a water-

borne coating or a solvent-borne coating. A zinc phosphate may be selected for an alkyd coating, a water-reducible coating, a coating cured by an acid and baking, or a combination thereof. A zinc phosphate is less preferred for a marine coating for salt water embodiments. A modified zinc phosphate, such as, for example, aluminum zinc phosphate, basic zinc phosphate hydrate, zinc silicophosphate hydrate, basic zinc molybdenum phosphate, or a combination thereof may confer improved corrosion resistance for a salt water embodiment. Zinc hydroxy phosphite may be selected for a solvent-borne coating.

[0515] An aluminum triphosphate typically confers a white color, acts by chelating iron ions, and is preferred for a surface that comprises iron. A grade I aluminum triphosphate is modified with zinc and silicate, and may be selected for an alkyd-coating, an epoxy coating, a solvent-borne coating, a primer, or a combination thereof. A grade II aluminum triphosphate is modified with zinc and silicate, and may be selected for a water-borne coating or a solvent-borne coating. A grade III aluminum triphosphate is modified with zinc, and may be selected for a water-borne coating or a solvent-borne coating.

[0516] A silicate pigment such as barium borosilicate, calcium borosilicate, strontium borosilicate, zinc borosilicate, a calcium barium phosphosilicate, a calcium strontium phosphosilicate, a calcium strontium zinc phosphosilicate, or a combination thereof, typically acts through inhibiting an anodic or cathodic process, as well as forming a corrosion resistant soap in an oleoresinous-coating. A grade I and/or III calcium borosilicate may be selected for a medium oil alkyd-coating, a long oil alkyd, an epoxy ester-coating, a solvent-borne coating, an architectural coating, an industrial coating, or a combination thereof, but is less preferred for a marine coating, an epoxide-coating, a water-borne coating, or a combination thereof. Calcium barium phosphosilicate grade I pigment may be selected for a solvent-borne epoxy-coating, to confer an antisetling property to a primer comprising zinc, or a combination thereof. Calcium barium phosphosilicate grade II pigment may be selected for a water-borne coating, an alkyd-coating, or a combination thereof. Calcium strontium phosphosilicate may be selected for a water-borne acrylic lacquer, a water-borne sealant, or a combination thereof. In aspects wherein a water-borne acrylic lacquer comprises calcium strontium phosphosilicate, it is preferred that a 1:1 ratio of zinc phosphate pigment is included. Calcium strontium zinc phosphosilicate may be selected for an alkyd-coating, an epoxide coating, a coating cured by a catalyst and baking, a water-borne coating, or a combination thereof.

(2) Camouflage Pigments

[0517] A camouflage pigment refers to a pigment typically selected to camouflage a surface (e.g., a military surface) from visual and, more preferred, infrared detection. Examples of a camouflage pigment include an anthraquinone black, a chromium oxide green, or a combination thereof. A chromium oxide green may be selected for embodiments wherein good chemical resistance, dull color, good heat stability, good infrared reflectance, good light fastness, good opacity, good solvent resistance, low tinctorial strength, or a combination thereof, is suitable. Anthraquinone black (CI Pigment Black 20) may be selected

for good light fastness and moderate solvent resistance, and is often selected for camouflage coatings, due to its infrared absorption property.

(3) Color Property Pigments

[0518] A color property is the ability of a composition to confer a visual color and/or metallic appearance to a coating and/or a coated surface. Color pigments are often categorized by a common name recognized within the art, which often encompasses several specific color pigments, each identified by a CI number.

(i) Black Pigments

[0519] A black pigment is a pigment that confers a black color to a coating. Examples of black pigments, identified by common name with examples of specific pigments in parentheses, include aniline black; anthraquinone black; carbon black; copper carbonate; graphite; iron oxide; micaceous iron oxide; manganese dioxide; or a combination thereof.

[0520] Aniline black (e.g., CI Pigment Black 1); may be selected for a deep black color (e.g., strong light absorption, low light scattering) and/or fastness. Coatings comprising aniline black typically comprise relatively higher concentrations of binder, and thus often possesses a matt property.

[0521] Anthraquinone black (e.g., CI Pigment Black 20) may be selected for good light fastness and moderate solvent resistance.

[0522] Carbon black (e.g., CI Pigment Black 6, CI Pigment Black 7, CI Pigment Black 8) generally possesses properties such as chemical stability, good light fastness, good solvent resistance, heat stability, or a combination thereof. Carbon black is often categorized into separate grades, based on the intensity of black color ("jetness"). To reduce flocculation in preparing a coating comprising a carbon black pigment, such pigments may be incrementally added to a coating during preparation, chemically modified by surface oxidation, chemically modified by an organic compound (e.g., a carboxylic acid), or a combination thereof. Additionally, a carbon black pigment may absorb certain other coating components such as a metal soap drier. Typically, increasing the concentration of the susceptible component by, for example, two-fold will reduce this effect. A high jet channel black pigment is often selected for use in an automotive coating wherein a high jetness is desired. The other grades of carbon black pigments are often selected for architectural coatings.

[0523] Graphite (e.g., CI Pigment Black 10) may be selected for properties such as relative chemical inertness, low in color intensity, low in tinctorial strength, an anti-corrosive property, an increase in coating spreading rate, or a combination thereof.

[0524] Iron oxide (e.g., CI Pigment Black 11) may be selected for properties such as good chemical resistance, relative inertness, good solvent resistance, limited heat resistance, low tinctorial strength, or a combination thereof. Iron oxide possesses superior floating resistance than carbon black, particularly in combination with titanium dioxide.

[0525] Micaceous iron oxide may be selected for properties such as relative inertness, grayish appearance, shiny appearance, function as a UV absorber, function as an

anti-corrosive pigment due to resistance to oxygen and moisture passage. However, over-dispersal of a micaceous iron oxide during coating preparation may damage the pigment.

(ii) Brown Pigments

[0526] A brown pigment is a pigment that confers a brown color to a coating. Examples of a brown pigment include azo condensation (CI Pigment Brown 23, CI Pigment Brown 41, CI Pigment Brown 42); benzimidazolone (CI Pigment Brown 25); iron oxide; metal complex brown; or a combination thereof. A synthetically produced iron oxide brown (CI Pigment Brown 6, CI Pigment Brown 7) may be selected for embodiments wherein a rich brown color, good light-fastness, or a combination thereof is suitable. A metal complex brown (CI Pigment Brown 33) may be selected for embodiments wherein high heat stability, good fastness, or a combination thereof is suitable. A metal complex brown may be used, for example, in a coil coating, a coating for a ceramic surface, or a combination thereof.

(iii) White Pigments

[0527] A white pigment is a pigment that confers a white color to a coating. Examples of a white pigment include antimony oxide; basic lead carbonate (CI Pigment White 25); lithopone; titanium dioxide; white lead; zinc oxide; zinc sulphide (CI Pigment White 7); or a combination thereof.

[0528] Antimony oxide (CI Pigment White 11) is chemically inert, and used in fire resistant coatings. In some embodiments, antimony oxide may be combined with titanium dioxide, particularly in a coating where chalking is undesirable and a white color in the coating is desired.

[0529] Titanium dioxide (CI Pigment White 6) is resistant to heat, many chemicals, and organic solvents, allowing use in many different applications where such properties are desirable. Titanium dioxide may be in the form of a crystal, such as an anatase crystal, a rutile crystal, or a combination thereof. Rutile is more opaque than anatase. Anatase has a greater ability to chalk and is whiter in color than rutile. In aspects wherein chalking is undesirable, a titanium dioxide crystal may be reacted with an inorganic oxide to enhance chalking resistance. Examples of such inorganic oxides include aluminum oxide, silicon oxide, zinc oxide, or a combination thereof.

[0530] White lead (CI Pigment White 1) is chemically reactive with acidic binders to form strong films with elastic properties, but also chemically reacts with sulphur to become black in color. It is less preferred in certain coatings due to the toxic nature of lead.

[0531] Zinc oxide (CI Pigment White 4) confers desirable properties such as resistance to mildew, as well as chemically reacting with oleoresin binders in film formation to enhance resistance to abrasion, to enhance resistance to moisture, to enhance hardness, and/or reduce chalking. However, these reactions may undesirably occur during storage. In some embodiments, it may be combined with titanium dioxide, particularly in a coating comprising an oleoresin binder when chalking is undesirable and a white color in the coating is desired.

[0532] Zinc sulfide (CI Pigment White 7) is chemically inert, and confers a strong chalking property. In certain

embodiments, a zinc sulfide comprises a lithopone. A lithopone (CI Pigment White 5) comprises a mixture of ZnS and barium sulphate (BaSO_4), usually from 30% to 60% ZnS and 70% to 40% BaSO_4 .

(iv) Pearlescent Pigments

[0533] A pearlescent pigment is a pigment that confers a pearl-like appearance to a coating. Examples of a white pigment include titanium dioxide and ferric oxide covered mica, bismuth oxychloride crystal, or a combination thereof.

(v) Violet Pigments

[0534] A violet pigment is a pigment that confers a violet color to a coating. However, a violet pigment is often used in combination with a red pigment or a blue pigment to produce a desirable color of an intermediate hue between red and blue. Additionally, a violet pigment is often combined with titanium dioxide to balance the slight yellow color of that white pigment. An example of a violet pigment includes dioxanine violet (CI Pigment Violet 23; CI Pigment Violet 37). A dioxazine violet may be selected for embodiments wherein high heat stability, good light fastness, good solvent fastness, or a combination thereof is suitable. CI Pigment Violet 23 ("carbazole violet") is relatively transparent and bluer than CI Pigment 37, and is typically used in a metallic coating. A dioxazine violet is susceptible to flocculation, loss in a powder coating, or a combination thereof, due to small particle size.

(vi) Blue Pigments

[0535] A blue pigment is a pigment that confers a blue color to a coating. Examples of a blue pigment include carbazol Blue; carbazole Blue; cobalt blue; copper phthalocyanine; dioxanine Blue; indanthrone; phthalocyanin blue; Prussian blue; ultramarine; or a combination thereof.

[0536] A cobalt blue (CI Pigment Blue 36) may be selected for embodiments wherein good chemical resistance, good lightfastness, good solvent fastness, or a combination thereof, is suitable. An indanthrone (CI Pigment Blue 60) may be selected for embodiments wherein a reddish-blue hue, good chemical resistance, good heat resistance, good solvent fastness, transparency, superior resistance to flocculation relative to a copper phthalocyanine, or a combination thereof, is suitable.

[0537] A copper phthalocyanine (CI Pigment Blue 15, CI Pigment Blue 15:1, CI Pigment Blue 15:2, CI Pigment Blue 15:3, CI Pigment Blue 15:4, CI Pigment Blue 15:6, CI Pigment Blue 16) may be selected for embodiments wherein good color strength, good tinctorial strength, good heat stability, good lightfastness, good solvent resistance, transparency, or a combination thereof, is suitable. CI Pigment Blue 15 is reddish in hue, but is chemically unstable upon contact with an aromatic hydrocarbon, and converts to a greenish blue compound. CI Pigment Blue 15:1 is form of CI Pigment Blue 15 chemically stabilized by chlorination, greener, and tinctorially weaker than CI Pigment Blue 15. CI Pigment Blue 15:2 is modified form of CI Pigment Blue 15 that is resistant to flocculation. CI Pigment Blue 15:3 is greenish-blue, while CI Pigment Blue 15:4 is modified form of CI Pigment Blue 15:3 that is resistant to flocculation. CI Pigment Blue 16 is relatively transparent. Examples of coatings wherein copper phthalocyanine are used include a

metallic automotive coating. However, as described above, a copper phthalocyanine may be susceptible to flocculation due to small primary particle size, and various modified forms are known wherein flocculation is reduced. Examples of modifications used to reduce flocculation adding a sulfonic acid moiety; a sulfonic acid moiety and a long chain amine moiety; an aluminum benzoate; an acidic binder (e.g., a rosin); a chloromethyl moiety; or a combination thereof, to the phthalocyanine. A modified phthalocyanine may be selected for embodiments wherein superior color shade, dispersibility, gloss, or a combination thereof is suitable.

[0538] A Prussian blue (CI Pigment Blue 27) may be selected for embodiments wherein a strong color, good heat stability, good solvent fastness, or a combination thereof is suitable. However, a Prussian blue is chemically unstable in alkali conditions. An ultramarine (CI Pigment Blue 29) may be selected wherein a strong color, good heat stability, good light fastness, good solvent resistance, or a combination thereof is suitable. However, an ultramarine is chemically unstable in acidic conditions.

(vii) Green Pigments

[0539] A green pigment is a pigment that confers a green color to a coating. However, often a "green pigment" comprises a mixture of a yellow pigment and a blue pigment, with the properties of each component pigment generally retained. Examples of a green pigment include chrome green; chromium oxide green; halogenated copper phthalocyanine; hydrated chromium oxide; phthalocyanine green; or a combination thereof.

[0540] A chrome green ("Brunswick green," CI Pigment Green 15) comprises a combination of a Prussian blue and/or a copper phthalocyanine blue and a chrome yellow. A coating comprising a chrome green may be susceptible to floating and flooding defects. A chromium oxide green (CI Pigment Green 17) may be selected for embodiments wherein good chemical resistance, dull color, good heat stability, good infrared reflectance, good light fastness, good opacity, good solvent resistance, low tinctorial strength, or a combination thereof is suitable. A hydrated chromium oxide (CI Pigment Green 18) is similar to chromium oxide, and may be selected for embodiments wherein good light fastness, relatively brighter appearance, relatively greater transparency, relatively less heat stability, relatively less acid stability, or a combination thereof, is suitable. A phthalocyanine green (CI Pigment Green 7, CI Pigment Green 36) may be selected for embodiments wherein good chemical resistance, good heat stability, good light fastness, good solvent resistance, good tinctorial strength, color transparency, or a combination thereof is suitable. CI Pigment Green 7 may be selected for a bluish green color, while CI Pigment Green 36 may be selected for a yellower-greenish color. A phthalocyanine green is often selected for an automotive coating (e.g., a metallic coating), an industrial coating, an architectural coating, a powder coating, or a combination thereof.

(viii) Yellow Pigments

[0541] In certain embodiments, a coating may comprise a yellow pigment. A "yellow pigment" is a pigment that confers a yellow color to a coating. Examples of a yellow pigment include anthrapyrimidine; arylamide yellow;

barium chromate; benzimidazolone yellow; bismuth vanadate (CI Pigment Yellow 184); cadmium sulfide yellow (CI Pigment Yellow 37); complex inorganic color pigment; diarylide yellow; disazo condensation; flavanthrone; isoindoline; isoindolinone; lead chromate; nickel azo yellow; organic metal complex; quinophthalone; yellow iron oxide; yellow oxide; zinc chromate; or a combination thereof.

[0542] An anthrapyrimidine pigment (CI Pigment Yellow 108) may be selected for embodiments wherein, moderate light fastness, moderate solvent resistance, a dull color, transparency, or a combination thereof is suitable.

[0543] An arylamide yellow ("Hansa® yellow," CI Pigment Yellow 1, CI Pigment Yellow 3, CI Pigment Yellow 65, CI Pigment Yellow 73, CI Pigment Yellow 74, CI Pigment Yellow 75, CI Pigment Yellow 97, CI Pigment Yellow 111) may be selected for embodiments wherein, poor heat stability, good light fastness, poor solvent resistance, moderate tinctorial strength, or a combination thereof is suitable. CI Pigment 1 and CI Pigment 74 are mid-yellow in hue. CI Pigment Yellow 3 is greenish in hue. CI Pigment Yellow 73 is mid-yellow in hue, and resistant to recrystallization during dispersion. CI Pigment 97 possesses superior solvent fastness than other arylamide yellow pigments, and has been used in a stoving enamel, an automotive coating, or a combination thereof. Other arylamide yellow pigments may be used in a water-borne coating, a coating comprising a white spirit liquid component, or a combination thereof.

[0544] A benzimidazolone yellow (CI Pigment Yellow 120, CI Pigment Yellow 151, CI Pigment Yellow 154, CI Pigment Yellow 175, CI Pigment Yellow 181, CI Pigment Yellow 194) may be selected for embodiments wherein, good chemical resistance, good heat stability, good light fastness, good solvent resistance, or a combination thereof is suitable. A benzimidazolone with larger particle size been used in an automotive coating, a powder coating, or a combination thereof.

[0545] A cadmium sulfide yellow (CI Pigment Yellow 37) may be selected for embodiments wherein good stability in basic pH, good heat stability, good light fastness, good opacity, good solvent fastness, or a combination thereof is suitable. However, a cadmium yellow comprises cadmium, which may limit suitability relative to an environmental law or regulation.

[0546] A complex inorganic color pigment ("mixed phase metal oxide," CI Pigment Yellow 53, CI Pigment Yellow 119, CI Pigment Yellow 164); may be selected for embodiments wherein, good chemical stability, good heat resistance, good light fastness, good opacity, good solvent fastness, or a combination thereof is suitable. However, a complex inorganic color pigment generally produces a pale color, and is often combined with an additional pigment (e.g., an organic pigment). A complex inorganic color pigment is often selected for an automotive coating, a coil coating, or a combination thereof. A bismuth vanadate is similar to a complex inorganic pigment, but possesses superior color of green-yellow hue, poorer light fastness, and greater use in a powder coating. A bismuth vanadate is often combined with a light stabilizer.

[0547] A diarylide yellow (CI Pigment Yellow 12, CI Pigment Yellow 13, CI Pigment Yellow 14, CI Pigment Yellow 17, CI Pigment Yellow 81, CI Pigment Yellow 83)

may be selected for embodiments wherein, good chemical resistance, poor light fastness, good solvent resistance, good tinctorial strength, or a combination thereof is suitable. A diarylide yellow is not stable at a temperature of 200° C. or greater. CI Pigment Yellow 83 has superior light fastness than other diarylide yellow pigments, and has been used in an industrial coating, a powder coating, or a combination thereof.

[0548] A diazo condensation pigment (CI Pigment Yellow 93, CI Pigment Yellow 94, CI Pigment Yellow 95, CI Pigment Yellow 128, CI Pigment Yellow 166) may be selected for embodiments wherein, good chemical resistance, good heat stability, good solvent resistance, good tinctorial strength, or a combination thereof is suitable. A diazo condensation pigment typically is used in plastics, though CI Pigment Yellow 128 has been used in a coating such as an automotive coating.

[0549] A flavanthrone pigment (CI Pigment Yellow 24) may be selected for embodiments wherein, good heat stability, moderate light fastness, a reddish yellow hue superior to an anthrapyrimidine, transparency, or a combination thereof is suitable.

[0550] An isoindoline yellow pigment (CI Pigment Yellow 139, CI Pigment Yellow 185) may be selected for embodiments wherein, good chemical resistance, good heat stability, good light fastness, good solvent resistance, moderate tinctorial strength, or a combination thereof is suitable. An isoindolinone yellow pigment (CI Pigment Yellow 109, CI Pigment Yellow 110, CI Pigment Yellow 173) typically has been used in an automotive coating or an architectural coating. An isoindoline yellow pigment may be selected for embodiments wherein good light fastness, good tinctorial strength, or a combination thereof is suitable. However, an isoindoline pigment is not stable in a basic pH. An isoindoline yellow pigment typically has been used in an industrial coating.

[0551] A lead chromate (CI Pigment Yellow 34) may be selected for embodiments wherein moderate heat stability, low oil absorption, good opacity, good solvent resistance, or a combination thereof is suitable. However, a lead chromate is susceptible to an acidic or a basic pH, and a lower light fastness so that the pigment darkens upon irradiation by light. The pH and lightfastness properties of commercially produced lead chromate are often improved by treatment of a lead chromate with silica, antimony, alumina, metal, or a combination thereof. Additionally, a lead chromate comprises lead and/or chromium, which may limit suitability relative to an environmental law or regulation. A lead chromate may comprise a lead sulfate, which is used to modify color. Examples of lead chromates include a lemon chrome, which comprises from 20% to 40% lead sulfate and is greenish yellow in color; a middle chrome, which comprises little lead sulfate and is reddish yellow in color; orange chrome, which comprises no detectable lead sulfate; and primrose chrome, which comprises from 45% to 55% lead chrome and is greenish yellow in color.

[0552] An organic metal complex (CI Pigment Yellow 129, CI Pigment Yellow 153) may be selected for embodiments wherein good solvent resistance is suitable. An organic metal complex typically is transparent and dull in color.

[0553] A quinophthalone pigment (CI Pigment Yellow 138) may be selected for embodiments wherein, good heat

stability, good light fastness, good solvent resistance, a reddish yellow hue, or a combination thereof is suitable. A quinophthalone can be either highly opaque or transparent. A quinophthalone pigment has been used as a substitute for chrome as a pigment.

[0554] A yellow iron oxide (CI Pigment Yellow 42, CI Pigment Yellow 43) may be selected for embodiments wherein good covering power, good disperability, good resistance to chemicals, good light fastness, good solvent resistance, a yellow with greenish hue is desired, or a combination thereof is suitable. A yellow iron oxide can function as a U.V. absorber. However, a yellow iron oxide is generally of duller color relative to other pigments, and is susceptible to temperatures of 105° C. or greater. Additionally, a yellow iron oxide may comprise a α -crystal, a β -crystal, a γ -crystal, or a combination thereof. Overdispersion may damage the needle-shape crystal structure, which can reduce the color intensity. Additionally, a transparent yellow iron oxide can be prepared by selecting particles with minimum size, and such a pigment is used, for example, in an automotive coating or a wood coating.

(ix) Orange Pigments

[0555] In certain embodiments, a coating may comprise an orange pigment. An "orange pigment" is a pigment that confers an orange color to a coating. Examples of an orange pigment include perinone orange; pyrazolone orange; or a combination thereof.

[0556] A perinone orange pigment (CI Pigment Orange 43) may be selected for embodiments wherein very good resistance to heat, good light fastness, good solvent resistance, high tinctorial strength, or a combination thereof is suitable.

[0557] A pyrazolone orange pigment (CI Pigment Orange 13, CI Pigment Orange 34) is similar to a diarylide yellow pigment, and may be selected for embodiments wherein moderate resistance to heat, poor light fastness, moderate solvent resistance, high tinctorial strength, or a combination thereof is suitable. However, CI Pigment Orange 34 possesses greater lightfastness relative to CI Pigment Orange 13, and has been used in an industrial coating and/or a replacement for chrome.

(x) Red Pigments

[0558] In certain embodiments, a coating may comprise a red pigment. A "red pigment" is a pigment that confers a red color to a coating. Examples of a red pigment include anthraquinone; benzimidazolone; BON arylamide; cadmium red; cadmium selenide; chrome red; dibromanthrone; diketopyrrolo-pyrrole pigment (CI Pigment Red 254, CI Pigment Red 255, CI Pigment Red 264, CI Pigment Red 270, CI Pigment Red 272); disazo condensation pigment (CI Pigment Red 144, CI Pigment Red 166, CI Pigment Red 214, CI Pigment Red 220, CI Pigment Red 221, CI Pigment Red 242); lead molybdate; perylene; pyranthrone; quinacridone; quinophthalone; red iron oxide; red lead; toluidine red; tonor pigment (CI Pigment Red 48, CI Pigment Red 57, CI Pigment Red 60, CI Pigment Red 68); P-naphthol red; or a combination thereof.

[0559] A lead molybdate red pigment (CI Pigment Red 104) may be selected for embodiments wherein good resis-

tance to heat, moderate resistance to basic pH, good opacity, excellent solvent resistance, or a combination thereof is suitable. A molybdate red is bright in color, and is often combined with an organic pigment to extend a color range. However, a molybdate is easy to disperse, and overdispersion may damage this pigment. Additionally, a molybdate red comprising lead and/or chromium may have limited suitability relative to an environmental law or regulation.

[0560] A cadmium red pigment (CI Pigment Red 108) may be selected for embodiments wherein excellent resistance to heat, good lightfastness, poor resistance to acidic pH, good opacity, excellent solvent resistance, or a combination thereof is suitable. However, a cadmium red comprises cadmium, and may have limited suitability relative to an environmental law or regulation.

[0561] A red iron oxide pigment (CI Pigment Red 101, CI Pigment Red 102) may be selected for embodiments wherein excellent resistance to heat, good lightfastness, poor resistance to acidic pH, good opacity, excellent solvent resistance, or a combination thereof is suitable. However, a cadmium red comprises cadmium, and may have limited suitability relative to an environmental law or regulation.

[0562] β -naphthol red (CI Pigment Red 3) may be selected for embodiments wherein modest heat resistance, good lightfastness, modest solvent resistance, or a combination thereof is suitable.

[0563] BON arylamide (CI Pigment Red 2, CI Pigment Red 5, CI Pigment Red 12, CI Pigment Red 23, CI Pigment Red 112, CI Pigment Red 146, CI Pigment Red 170) comprises various pigments that generally have good lightfastness, good solvent resistance, or a combination thereof.

[0564] Tonor pigment (CI Pigment Red 48, CI Pigment Red 57, CI Pigment Red 60, CI Pigment Red 68) comprises various pigments that generally have good solvent resistance, but often have poor acid resistance, poor alkali resistance, or a combination thereof.

[0565] Benzimidazolone (CI Pigment Red 171, CI Pigment Red 175, CI Pigment Red 176, CI Pigment Red 185, CI Pigment Red 208) comprises various pigments that generally have good heat stability, excellent solvent resistance, or a combination thereof.

[0566] Disazo condensation pigment (CI Pigment Red 144, CI Pigment Red 166, CI Pigment Red 214, CI Pigment Red 220, CI Pigment Red 221, CI Pigment Red 242) comprises various pigments that generally have excellent heat stability, good solvent resistance, or a combination thereof.

[0567] Quinacridone (CI Pigment Red 122, CI Pigment Red 192, CI Pigment Red 202, CI Pigment Red 207, CI Pigment Red 209) comprises a various pigments that generally have bright color, excellent heat stability, excellent solvent resistance, excellent chemical resistance, good lightfastness, or a combination thereof.

[0568] Perylene (CI Pigment Red 123, CI Pigment Red 149, CI Pigment Red 178, CI Pigment Red 179, CI Pigment Red 190, CI Pigment Red 224) comprises a various pigments that generally have excellent heat stability, excellent solvent resistance, excellent lightfastness, or a combination thereof.

[0569] Anthraquinone (CI Pigment Red 177) has a bright color, good heat stability, good solvent resistance, good lightfastness, or a combination thereof.

[0570] Dibromanthrone (CI Pigment Red 168) has a bright color, moderate heat stability, good solvent resistance, excellent lightfastness, or a combination thereof.

[0571] Pyranthrone (CI Pigment Red 216, CI Pigment Red 226) has a dull color, moderate heat stability, good solvent resistance, poor lightfastness in combination with titanium dioxide, or a combination thereof.

[0572] Diketopyrrolo-pyrrole pigment (CI Pigment Red 254, CI Pigment Red 255, CI Pigment Red 264, CI Pigment Red 270, CI Pigment Red 272) comprises a various pigments that generally have a bright color, good opacity, excellent heat stability, excellent solvent resistance, or a combination thereof.

(xi) Metallic Pigments

[0573] In certain embodiments, a coating may comprise a metallic pigment. A "metallic pigment" is a pigment that confers a metallic appearance to a coating, and as previously described, is often a corrosion resistance pigment. A metallic pigment may be selected for a topcoat, particularly to confer a metallic appearance, a primer, particularly to confer a corrosion resistance property, an automotive coating, an industrial coating, or a combination thereof. Metallic flake pigments are preferred for embodiments wherein UV and/or infrared resistance is to be conferred to a coating. Examples of a metallic pigment include aluminum flake (CI Pigment Metal 1); aluminum non-leafing, gold bronze flake, zinc dust, stainless steel flake, nickel (e.g., flake, powder), or a combination thereof.

(4) Extender Pigments

[0574] An extender pigment ("inert pigment," "extender," "inert," "filler") is a substance that is insoluble in the other components of a coating, and further confers a desirable optical property (e.g., opacity, gloss), a rheological property, physical property, an antisetling property, or a combination thereof, to the coating and/or film. An extender pigment is often white or near white in color, and typically are used to provide a cheap partial substitute for a more expensive white pigment (e.g., titanium dioxide). Often an extender has a refractive index below 1.7. In some aspects, an extenders refractive index is 1.30 to 1.70, including all intermediate ranges and combinations thereof. Examples of an inorganic extender include a barium sulphate (CI Pigment White 21, CI Pigment White 22); a calcium carbonate (CI Pigment White 18); a calcium sulphate; a silicate (CI Pigment White 19, CI Pigment White 26); a silica (CI Pigment White 27); or a combination thereof.

[0575] Calcium carbonate ("calcite," "whiting," "limestone," CI Pigment White 18) is generally chemically inert with the exception of reactions with an acid. Calcium carbonate may be used in a water-borne coating or a solvent-borne coating. Properties specifically associated with calcium carbonate include conferring settling resistance, sag resistance, or a combination thereof. Precipitated calcium carbonate obtained from processing of limestone, and may have superior opacity.

[0576] Kaolin ("china clay") is typically selected for a latex coating, an alkyd coating, an architectural coating, or

a combination thereof. In addition to the typical properties of an extender (e.g., opacity), kaolin can confer scrub resistance to a coating.

[0577] Talc is a hydrated magnesium aluminum silicate, and is soluble in water. Talc may be selected for an architectural coating (e.g., interior, exterior), a primer, a traffic marker coating, an industrial coating, or a combination thereof. Talc comprising a platy particle shape can confer chemical resistance, water resistance, improved flow property, or a combination thereof.

[0578] Silica is silicon dioxide, and may be classified as crystalline silica, diatomaceous silica or synthetic silica. Crystalline silica is produced from crushed and ground quartz, and may be selected for an architectural coating, an industrial coating, a primer, a latex coating, a powder coating, or a combination thereof. Crystalline silica may confer burnish resistance to a coating and/or film. Diatomaceous silica ("diatomaceous earth," "diatomite") is the mineral fossil of diatoms, which were single celled aquatic plants. Diatomaceous silica may be selected for an architectural coating, a latex coating, or a combination thereof. Diatomaceous silica may also function as a flattening agent. Synthetic silica is produced from chemical reactions, and includes, for example, precipitated silica, fumed silica, or a combination thereof. Precipitated silica may be selected for an industrial coating, a solvent-borne coating, or a combination thereof. Precipitated silica may also function as a flattening agent. Fumed silica may be selected for an industrial coating. Fumed silica may also function as a flattening agent, a rheology modifier, or a combination thereof.

[0579] Mica is a hydrous silica aluminum potassium silicate, and typically comprises plate shaped particles. Mica may be selected for an architectural coating, an exterior coating, a traffic marker coating, a primer, or a combination thereof. Mica may also confer durability, moisture resistance, corrosion resistance, heat resistance, chemical resistance, cracking resistance, sagging resistance, or a combination thereof, to a coating and/or film.

[0580] Barium sulfate may be classified as baryte or a blanc fixe. Baryte may be selected for an automotive coating, an industrial coating, a primer, an undercoat, or a combination thereof. Blanc fixe has good opacity for an extender, and may be selected for an automotive coating, an industrial coating, or a combination thereof.

[0581] Wollastonite is a calcium metasilicate, and may be selected for a latex coating. Wollastonite may also function as an alkali pH buffer. Surface modified wollastonite may be selected for an industrial coating.

[0582] Nepheline syenite is an anhydrous sodium potassium aluminum silicate, and may be selected for an architectural coating, a latex coating, an interior coating, an exterior coating, or a combination thereof. Nepheline syenite may function may confer cracking resistance, scrub resistance, or a combination thereof.

[0583] Sodium aluminosilicate may be selected for a latex coating, an architectural coating, or a combination thereof. Sodium aluminosilicate may also function as a flattening agent.

[0584] Alumina trihydrate may be selected for an architectural coating, a thermoplastic coating, a thermosetting

coating, or a combination thereof Alumina trihydrate may confer flame retardancy to a film.

[0585] b. Dyes

[0586] A dye is a composition that is soluble in the other components of a coating, and further confers a desirable color property to the coating. It is contemplated that many of the compounds that give a cell-based particulate material of the present invention color, such as photosynthetic pigment and/or carotenoid pigment, will be partly or fully soluble in many non-aqueous liquids described herein. It is further contemplated that a cell-based particulate material of the present invention is added to a coating comprising such a liquid component, the material may act as a dye, as well as a pigment and/or extender, due to the dissolving of colored compounds into the liquid component.

[0587] 4. Coating Additives

[0588] A coating additive is any material which is added to a coating to confer a desirable property other than that described for a binder, a liquid component, a coloring agent, or a combination thereof. It is contemplated that, in addition to the examples of additives described herein, any additive known to one of ordinary skill in the art, in light of the present disclosures, may be included in a composition of the present invention.

[0589] Examples of coating additives include a cell-based particulate material of the present invention, as well as an antifoaming agent, an antiflooding agent, an antifoaming agent, an antisetling agent, an antiskinning agent, a catalyst, a corrosion inhibitor, a film-formation promoter, a leveling agent, a matting agent, a neutralizing agent, a preservative, a thickening agent, a wetting agent, or a combination thereof. The content for an individual coating additive in a coating generally is 0.000001% to 20.0%, including all intermediate ranges and combinations thereof. However, in most embodiments, it is contemplated the concentration of a single additive in a coating will comprise between 0.000001% and 10.0%, including all intermediate ranges and combinations thereof.

[0590] a. Preservatives

[0591] A coating may comprise a preservative to reduce or prevent the deterioration of a coating and/or film by a microorganism. As would be known to one of ordinary skill in the art, a microorganism is generally considered a contaminant capable damaging a film and/or coating the point of suitable usefulness in a given embodiment. It is preferred that a coating comprising a cell-based particulate material of the present invention also comprises a preservative. It is contemplated that continued growth of a microorganism from a microorganism-based particulate material of the present invention would be detrimental to a coating and/or film, and a preservative may reduce or prevent such growth. It is further contemplated that a contaminating microorganism could use the cell-based particulate material of the present invention as a readily available source of nutrients for growth, and a preservative may reduce or prevent such growth. It is also contemplated that the amount of preservative added to a coating comprising a cell-based particulate material of the present invention may be increased relative to a preservative content of a similar coating lacking such an added cell-based particulate material. Examples of preservatives include a biocide, which kills an organism, a bio-

static, which reduces or prevents the growth of an organism, or a combination thereof. Examples of a biocide include, for example, a bactericide, a fungicide, an algacide, or a combination thereof. In certain aspects, it is contemplated that the amount of preservative may be increased 1.01 to 10-fold or more, including all intermediate ranges and combinations thereof, the amount of an example of a preservative content described herein or as would be known to one of ordinary skill in the art (e.g., a manufacturer's instructions) in light of the present disclosures.

[0592] In addition to the disclosures herein, a preservative and use of a preservative in a coating is known to those of skill in the art, and all such materials and techniques for using a preservative in a coating may be applied in the practice of the present invention (see, for example, Flick, E. W. "Handbook of Paint Raw Materials, Second Edition," 263-285 and 879-998, 1989; in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp 261-267 and 654-661, 1995; in "Paint and Surface Coatings: Theory and Practice, Second Edition," (Lambourne, R. and Strivens, T. A., Eds.), pp. 193-194, 371-382 and 543-547, 1999; Wicks, Jr., Z. W., Jones, F. N., Pappas, S. P. "Organic Coatings, Science and Technology, Volume 1: Film Formation, Components, and Appearance," pp. 318-320, 1992; Wicks, Jr., Z. W., Jones, F. N., Pappas, S. P. "Organic Coatings, Science and Technology, Volume 2: Applications, Properties and Performance," pp. 145, 309, 319-323 and 340-341, 1992; in "Paints, Coatings and Solvents, Second, Completely Revised Edition," (Stoye, D. and Freitag, W., Eds.) pp 6, 127 and 165, 1998; and in "Handbook of Coatings Additives," pp. 177-224, 1987).

[0593] In certain embodiments, a preservative may comprise an in-can preservative, an in-film preservative, or a combination thereof. An in-can preservative is a composition that reduces or prevents the growth of a microorganism prior to film formation. Addition of an in-can preservative during a water-borne coating production typically occurs with the introduction of water to a coating composition. Typically, an in-can preservative is added to a coating composition for function during coating preparation, storage, or a combination thereof. An in-film preservative is a composition that reduces or prevents the growth of a microorganism after film formation. In many embodiments, an in-film preservative is the same chemical as an in-can preservative, but added to a coating composition at a higher (e.g., two-fold) concentration for continuing activity after film formation.

[0594] Examples of preservatives that have been used in coatings include a metal compound (e.g., an organo-metal compound) biocide, an organic biocide, or a combination thereof. Examples of a metal compound biocide include barium metaborate (CAS No. 13701-59-2), which is a fungicide and bactericide; copper(II) 8-quinolinolate (CAS No. 10380-28-6), which is a fungicide; phenylmercuric acetate (CAS No. 62-38-4), tributyltin oxide (CAS No. 56-35-9), which is less preferred for use against Gram-negative bacteria; tributyltin benzoate (CAS No. 4342-36-3), which is a fungicide and bactericide; tributyltin salicylate (CAS No. 4342-30-7), which is a fungicide; zinc pyrithione ("zinc 2-pyridinethiol-N-oxide"; CAS No. 13463-41-7), which is a fungicide; zinc oxide (CAS No. 1314-13-2), which is a fungistatic/fungicide and algacide; a combina-

tion of zinc-dimethyldithiocarbamate (CAS No. 137-30-4) and zinc 2-mercaptobenzothiazole (CAS No. 155-04-4), which acts as a fungicide; zinc pyrithione (CAS No. 13463-41-7), which is a fungicide; a metal soap; or a combination thereof. Examples of metals comprised in a metal soap biocide include copper, mercury, tin, zinc, or a combination thereof. Examples of an organic acid comprised in a metal soap biocide include a butyl oxide, a laurate, a naphthenate, an octoate, a phenyl acetate, a phenyl oleate, or a combination thereof.

[0595] An example of an organic biocide that acts as an algacide includes 2-methylthio-4-tert-butylamino-6-cyclopropylamino-s-triazine (CAS No. 28159-98-0). Examples of an organic biocide that acts as a bactericide include a combination of 4,4-dimethyl-oxazolidine (CAS No. 51200-87-4) and 3,4,4-trimethyloxazolidine (CAS No. 75673-43-7); 5-hydroxy-methyl-1-aza-3,7-dioxabicyclo (3.3.0.) octane (CAS No. 59720-42-2); 2(hydroxymethyl)-aminoethanol (CAS No. 34375-28-5); 2-(hydroxymethyl)-amino-2-methyl-1-propanol (CAS No. 52299-20-4); hexahydro-1,3,5-triethyl-s-triazine (CAS No. 108-74-7); 1-(3-chloroallyl)-3,5,7-triaza-1-azonia-adamantane chloride (CAS No. 51229-78-8); 1-methyl-3,5,7-triaza-1-azonia-adamantane chloride (CAS No. 76902-90-4); p-chloro-m-cresol (CAS No. 59-50-7); an alkylamine hydrochloride; 6-acetoxy-2,4-dimethyl-1,3-dioxane (CAS No. 828-00-2); 5-chloro-2-methyl-4-isothiazolin-3-one (CAS No. 26172-55-4); 2-methyl-4-isothiazolin-3-one (CAS No. 2682-20-4); 1,3-bis(hydroxymethyl)-5,5-dimethylhydantoin (CAS No. 6440-58-0); hydroxymethyl-5,5-dimethylhydantoin (CAS No. 27636-82-4); or a combination thereof. Examples of an organic biocide that acts as a fungicide include a parabens; 2-(4-thiazolyl)benzimidazole (CAS No. 148-79-8); N-trichloromethyl-thio-4-cyclohexene-1,2-dicarboximide (CAS No. 133-06-2); 2-n-octyl-4-isothiazoline-3-one (CAS No. 26530-20-1); 2,4,5,6-tetrachloro-isophthalonitrile (CAS No. 1897-45-6); 3-iodo-2-propynyl butyl carbamate (CAS No. 55406-53-6); N-(trichloromethyl-thio)phthalimide (CAS No. 133-07-3); tetrachloroisophthalonitrile (CAS No. 1897-45-6); potassium N-hydroxy-methyl-N-methyl-dithiocarbamate (CAS No. 51026-28-9); sodium 2-pyridinethiol-1-oxide (CAS No. 15922-78-8); or a combination thereof. Examples of a parabens include butyl parahydroxybenzoate (CAS No. 94-26-8); ethyl parahydroxybenzoate (CAS No. 120-47-8); methyl parahydroxybenzoate (CAS No. 99-76-3); propyl parahydroxybenzoate (CAS No. 94-13-3); or a combination thereof. Examples of an organic biocide that acts as a bactericide and fungicide include 2-mercaptobenzo-thiazole (CAS No. 149-30-4); a combination of 5-chloro-2-methyl-3(2H)-isothiazoline (CAS No. 26172-55-4) and 2-methyl-3(2H)-isothiazolone (CAS No. 2682-20-4); a combination of 4-(2-nitrobutyl)-morpholine (CAS No. 2224-44-4) and 4,4'-(2-ethylnitrotrimethylene dimorpholine (CAS No. 1854-23-5); tetra-hydro-3,5-di-methyl-2H-1,3,5-thiadiazine-2-thione (CAS No. 533-74-4); potassium dimethyldithiocarbamate (CAS No. 128-03-0); or a combination thereof. An example of an organic biocide that acts as an algacide and fungicide includes diiodomethyl-p-tolysulfone (CAS No. 20018-09-1). Examples of an organic biocide that acts as an algacide, bactericide and fungicide include glutaraldehyde (CAS No. 111-30-8); methylenebis(thiocyanate) (CAS No. 6317-18-6); 1,2-dibromo-2,4-dicyanobutane (CAS No. 35691-65-7); 1,2-benzisothiazoline-3-one ("1,2-benzisothiazolinone"; CAS No.

2634-33-5); 2-(thiocyanomethyl-thio)benzothiazole (CAS No. 21564-17-0); or a combination thereof. An example of an organic biocide that acts as an algacide, bactericide, fungicide and molluskicide includes 2-(thiocyanomethyl-thio)benzothiazole (CAS No. 21564-17-0) and methylene bis(thiocyanate) (CAS No. 6317-18-6).

[0596] In certain embodiments an environmental law or regulation may encourage the selection of an organic biocide such as a benzisothiazolinone derivative. An example of a benzisothiazolinone derivative is Busan™ 1264 (Buckman Laboratories, Inc.), Proxel™ GXL, Proxel™ TN, Proxel™ XL2, Proxel™ BD20 and Proxel™ M BZ (Avecia Inc.), Preventol® VP OC 3068 (Bayer Corporation), or Mergal® K10N (Troy Corp.) which comprises 1,2-benzisothiazoline-3-one (CAS No. 2634-33-5). In the case of Busan™ 1264, the primary use is a bactericide and/or fungicide at 0.03% to 0.5% in a water-borne coating. Proxel™ TN comprises 1,2-benzisothiazoline-3-one (CAS No. 2634-33-5) and hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine ("triazine"; CAS No. 4719-04-4), Proxel™ GXL, Proxel™ XL2 and Proxel™ BD20 comprises 1,2-benzisothiazoline-3-one (CAS No. 2634-33-5), Proxel™ BZ comprises 1,2-benzisothiazoline-3-one (CAS No. 2634-33-5) and zinc pyrithione (CAS No. 13463-41-7), and are typically used in industrial coatings and water-based coatings as a bactericide/fungicide. Mergal® K10N comprises 1,2-benzisothiazoline-3-one (CAS No. 2634-33-5), and is typically used in water-borne coatings as a bactericide/fungicide.

[0597] Often, a preservative is a proprietary commercial formulation and/or a compound sold under a tradename. Examples include organic biocides under the tradename Nuosept® (International Specialty Products), which are typically used in a water-borne coating. Specific examples of a Nuosept® biocide includes Nuosept® 95, which comprises a mixture of bicyclic oxazolidines, and is typically added to 0.2% to 0.3% concentration to a coating composition; Nuosept® 145, which comprises an amine reaction product, and is typically added to 0.2% to 0.3% concentration to a coating composition; Nuosept® 166, which comprises 4,4-dimethyloxazolidine (CAS No. 51200-87-4), and is typically added to 0.2% to 0.3% concentration to a basic pH water-borne coating composition; or a combination thereof. A further example is Nuocide® (International Specialty Products) biocides, which are typically used fungicides and/or algacides. Examples of a Nuocide® biocide is Nuocide® 960, which comprises 96% tetrachlorisophthalonitrile (CAS No. 1897-45-6), and is typically used at 0.5% to 1.2% in a water-borne or solvent-borne coating as a fungicide; Nuocide® 2010, which comprises chlorothalonil (CAS No. 1897-45-6) and IPBC (CAS No. 55406-53-6) at 30%, and is typically used at 0.5% to 2.5% in a coating as a fungicide and algacide; Nuocide® 1051 and Nuocide® 1071, each which comprises 96% N-cyclopropyl-N-(1-dimethylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine (CAS No. 28159-98-0), and is typically used as an algacide in antifouling coatings at 1.0% to 6.0% or water-based coatings at 0.05% to 0.2%, respectively; and Nuocide® 2002, which comprises chlorothalonil (CAS No. 1897-45-6) and a triazine compound at 30%, and is typically used at 0.5% to 2.5% in a coating and/or a film as a fungicide and algacide.

[0598] An additional example of a tradename biocide for coatings includes Vancide® (R. T. Vanderbilt Company, Inc.). Examples of a Vancide® biocide include Vancide®

TH, which comprises hexahydro-1,3,5-triethyl-s-triazine (CAS No. 108-74-7), and is generally used in a water-borne coating; Vancide® 89, which comprises N-trichloromethylthio-4-cyclohexene-1,2-dicarboximide (CAS No. 133-06-2) and related compounds such as captan (CAS No. 133-06-2), and is used as a fungicide in a coating composition; or a combination thereof. A bactericide and/or fungicide for coatings, particularly a water-borne coating, is a Dowicil™ (Dow Chemical Company). Examples of a Dowicil™ biocide include Dowicil™ QK-20, which comprises 2,2-dibromo-3-nitropropionamide (CAS No. 10222-01-2), and is used as a bactericide at 100 ppm to 2000 ppm in a coating; Dowicil™ 75, which comprises 1-(3-chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride (CAS No. 51229-78-8), and is used as a bactericide at 500 ppm to 1500 ppm in a coating; Dowicil™ 96, which comprises 7-ethyl bicyclooxazolidine (CAS No. 7747-35-5), and is used as a bactericide at 1000 ppm to 2500 ppm in a coating; Bioban™ CS-1135, which comprises 4,4-dimethyloxazolidine (CAS No. 51200-87-4), and is used as a bactericide at 100 ppm to 500 ppm in a coating; or a combination thereof. An additional example of a tradename biocide for coatings includes Kathon® (Rohm and Haas Company). An example of a Kathon® biocide includes Kathon® LX, which typically comprises 5-chloro-2-methyl-4-isothiazolin-3-one (CAS no 26172-55-4) and 2-methyl-4-isothiazolin-3-one (CAS no 2682-20-4) at 1.5%, and is added from 0.05% to 0.15% in a coating. Examples of tradename fungicides and algacides include those described for Fungitrol® and Biotrend® (International Specialty Products), which are often formulated for solvent-borne and water-borne coatings, and in-can and film preservation. An example is Fungitrol® 158, which comprises 15% tributyltin benzoate (CAS No. 4342-36-3) (15%) and 21.2% alkylamine hydrochlorides, and is typically used at 0.35% to 0.75% in a water-borne coating for in-can and film preservation. An additional example is Fungitrol® 11, which comprises N-(trichloromethylthio) phthalimide (CAS No. 133-07-3), and is typically used at 0.5% to 1.0% as a fungicide for solvent-borne coating. A further example is Fungitrol® 400, which comprises 98% 3-iodo-2-propynyl N-butyl carbamate ("IPBC") (CAS No. 55406-53-6), and is typically used at 0.15% to 0.45% as a fungicide for a water-borne or a solvent-borne coating.

[0599] Further examples of a tradename biocide for coatings includes various Omadine® or Triadine® products (Arch chemicals, Inc.), Densil™ P, Densil™ C404, Densil™ DN, Densil™ DG20 and Vantocil™ IB (Avecia Inc.), Polyphase® 678, Polyphase® 663, Polyphase® CST, Polyphase® 641, Troysan® 680 (Troy Corp.), Rocima® 550, Rocima® 607, Rozone® 2000 and Skane™ M-8 (Rohm and Haas Company) and Myacide™ GDA, Myacide™ GA 15, Myacide™ Ga 26, Myacide™ 45, Myacide™ AS Technical, Myacide™ AS 2, Myacide™ AS 30, Myacide™ AS 15, Protectol™ PE, Daomet™ Technical and Myacide™ HT Technical (BASF Corp.). Zinc omadine® ("zinc pyrithione"; CAS No. 13463-41-7) is a fungicide/algacide typically used as an in-film preservative and/or anti-fouling preservative; sodium omadine® ("sodium pyrithione"; CAS No. 3811-73-2) is typically used as a fungicide/algacide in-film preservative; copper omadine® ("copper pyrithione"; CAS No. 14915-37-8) is typically used as a fungicide/algacide in-film preservative and/or anti-fouling preservative; Triadine® 174 ("triazine, "1,3,5 -triazine-(2H,4H,6H)-triethanol"; "hexahydro-1,3,5

-tris(2-hydroxyethyl)-s-triazine"; Cas No. 4719-04-4) is a bacteria biostatic/bactericide typically used in water-borne coatings; Densil™ P comprises dithio-2,2-bis(benzmethylamide) (CAS No. 2527-58-4) and is typically used in industrial coatings, water-based coatings and films thereof as a fungicide/ bactericide; Densil™ C404 comprises 2,4,5,6-tetrachloroisophthalonitrile ("chlorothalonil"; CAS No. 1897-45-6) and is used as a fungicide; Densil™ DN and Densil™ DG20 comprise N-butyl-1,2-benzisothiazolin-3-one (CAS No. 4299-07-4), and each may be used as a fungicide; Vantocil™ E3 comprises poly(hexamethylene biguanide) hydrochloride (CAS No. 27083-27-8) and is a microbicide; Polyphase® 678 comprises carbendazim (CAS No. 10605-21-7) and 3-iodo-2-propynyl butyl carbamate (CAS No. 55406-53-6) and is typically used as an antimicrobial biocide for exterior coatings and surface treatments; Polyphase® 663 comprises 3-iodo-2-propynyl butyl carbamate (CAS No. 55406-53-6), carbendazim (CAS No. 10605-21-7) and diuron (CAS No. 330-54-1) and is typically used as a fungicide/algicide in exterior coatings; Rocima® 550 comprises 2-methyl-4-isothiazolin-3-one (CAS No. 2682-20-4), and is typically used as a bactericide/fungicide for water-borne coatings; Rozone® 2000 comprises 4,5-dichloro-2-N-octyl-3(2H)-isothiazolone (CAS No. 64359-81-5) and is used as a microbicide for latex coatings; Skane™ M-8 comprises 2-Octyl-4-isothiazolin-3-one (CAS No. 26530-20-1), and may be used as an in-film fungicide; Myacide™ GDA Technical, Myacide™ GA 15, Myacide™ Ga 26 and Myacide™ 45 each comprise glutaraldehyde (CAS No. 111-30-8) and are typically used as an algicide/bactericide/fungicide; Myacide™ AS Technical, Myacide™ AS 2, Myacide™ AS 30, Myacide™ AS 15 each comprise 2-bromo-2-nitropropane-1,3-diol ("bronopol"; Cas No. 52-51-7) and are typically used as an algicide; Protectol™ PE comprises phenoxyethanol (CAS No. 122-99-6) and can be used as microbicide/fungicide; Dazomet™ Technical comprises 3,5-dimethyl-2H-1,3,5-thiadiazinane-2-thione ("dazomet"; CAS No. 533-74-4) and may be used as a microbicide/fungicide; Myacide™ HT Technical comprises 1,3,5-tris-(2-hydroxyethyl)-1,3,5-hexahydrotriazine (CAS No. 4719-04-4) and can be used as a microbicide/fungicide.

[0600] As would be known to one of ordinary skill in the art, determination of whether damage to a coating and/or film is due to microorganisms (e.g., film algal defacement, film fungal defacement), as well as the efficacy of addition of a preservative to a coating and/or film composition in reducing microbial damage to a coating and/or film, may be empirically determined by techniques such as those that are described in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D3274-95, D4610-98, D2574-00, D3273-00, D3456-86, D5589-97, and D5590-00, 2002; and in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp. 654-661, 1995. Examples of microorganisms typically selected in such procedures as positive controls of a coating and/or film damaging microorganism include, for example, *Aspergillus oryzae* (ATCC No. 10196), *Aspergillus flavus* (ATCC No. 9643), *Aspergillus niger* (ATCC No. 9642), *Pseudomonas aeruginosa* (ATCC No. 10145), *Aureobasidium pullulans* (ATCC No. 9348), *Penicillium citrinum* (ATCC No. 9849), *Penicillium funiculosum* (ATCC No. 9644), or a combination thereof.

[0601] b. Wetting Additives and Dispersants

[0602] It is contemplated that one or more types of particulate matter (e.g., a pigment, a cell-based particulate material of the present invention) may be incorporated into a coating composition of the present invention. As is known to those of ordinary skill in the art, physical force and/or chemical additives are used to promote a desirable level of dispersion of particulate matter in a coating composition, for purposes such as coating homogeneity and ease of application. Depending upon whether such an additive is admixed earlier or latter in a coating composition, such an additive is known as a wetting agent or a dispersant, respectively, though it is common that an additive has dual classification. A wetting agent and/or a dispersant often can be used to reduce the particulate matter grinding time during coating preparation, improve wetting of particulate matter, improve dispersion of particulate matter, improve gloss, improve leveling, reduce flooding, reduce floating, reduce viscosity, reduce thixotropy, or a combination thereof.

[0603] It is contemplated that in certain embodiments, a cell-based particulate material of the present invention may be used as a wetting additive and/or dispersant. Though this use of the present invention may be counter-intuitive, it is contemplated that the cell-based particulate material of the present invention may promote the separation of particulate material (e.g., a pigment, an additional preparation of a cell-based particulate material) by acting as a physical barrier between particles of particulate material. It is further contemplated that in embodiments wherein the cell-based particulate material is used as a wetting additive and/or dispersant, it may, of course, be combined with a traditional wetting additive and/or dispersant, examples of which are described below.

(1) Wetting Additives

[0604] As is known to those of ordinary skill in the art, preparation of a coating comprising particulate material often comprises a step wherein the particulate material is dispersed in an additional coating component. An example of this type of dispersion step is the dispersion of a pigment into a combination of a liquid component and a binder to form a material known as a millbase. A wetting additive ("wetting agent") is composition added to promote dispersion of particulate material during coating preparation.

[0605] In certain embodiments, a wetting agent is a molecule that comprises a polar region and a nonpolar region. An example is an ethylene oxide molecule comprising a hydrophobic moiety. Such a wetting agent is thought to act by reducing interfacial tension between a liquid component and particulate matter. In specific aspects, a wetting agent comprises a surfactant. Examples of such a wetting agent include pine oil, which is typically added at 1% to 5% of the total coating liquid component, including all intermediate ranges and combinations thereof. Other examples of wetting agents include a metal soap, such as, for example, calcium octoate, zinc octoate, aluminum stearate, zinc stearate, or a combination thereof. An additional example of a wetting agent is bis(2-ethylhexyl)sulfosuccinate ("Aerosol OT") (CAS No. 577-11-7); (octylphenoxy)polyethoxyethanol octylphenyl-polyethylene glycol ("Igepal-630") (Cas no. 9036-19-5); nonyl phenoxy poly (ethylene oxy) ethanol ("Tergitol NP-14") (CAS No. 9016-45-9); ethylene glycol octyl phenyl ether ("Triton X-100") (CAS No. 9002-93-1); or a combination thereof.

[0606] Often a wetting agent and/or dispersant is a proprietary formulation and/or commonly available under a trade name. Examples include an Anti-Terra® or Disperbyk® (BYK-Chemie GmbH) and EnviroGem® or Surfynol® (Air Products and Chemicals, Inc.) wetting agents and/or dispersants. An example is Anti-Terra®-U, which comprises a 50% solution of an unsaturated polyamine amide salt and a lower molecular weight acid, dissolved in xylene and isobutanol, and preferred for used in a solvent-borne coating. Anti-Terra®-U is typically added from 1% to 2% to an inorganic pigment, 1% to 5% to an organic pigment, and at 0.5% to 1.0% to titanium dioxide, and 30% to 50% to a bentonite. An example of a Disperbyk® is Disperbyk®, which comprises a polycarboxylic acid polymer alkylolammonium salt and water, and is added to 0.3% to 1.5% to the solvent-borne or water-borne coating composition. A further example is Disperbyk®-101, which comprises a 52% solution of a long chain polyamine amide salt and a polar acidic ester, dissolved in a mineral spirit and butylglycol, and preferred for used in a solvent-borne coating. The ranges for addition to particulate material for Disperbyk®-101 is similar to Anti-Terra®-U. An additional example is Disperbyk®-108, which comprises over 97% of a hydroxyfunctional carboxylic acid ester that includes moieties with pigment affinity, and is typically added from 3% to 5% to an inorganic pigment, 5% to 8% to an organic pigment. However, Disperbyk®-108 is typically added at 0.8% to 1.5% to titanium dioxide, or 8% to 10% to a carbon black, and is preferred for coatings lacking a non-aqueous solvent. A supplemental example is EnviroGem® ADO 1, which comprises a non-ionic wetting agent with a defoaming property, and is added to 0.1% to 2% to a water-borne coating composition. An additional example is Surfynol® TG (Air Products and Chemicals, Inc.), which comprises a non-ionic wetting agent, and is added to 0.5% to 5% to a water-borne coating composition. A further example is Surfynol® 104 (Air Products and Chemicals, Inc.), which comprises a non-ionic wetting agent, dispersant, and defoamer, and is added to 0.05% to 3% to a water-borne coating composition.

(2) Dispersants

[0607] As is known to those of ordinary skill in the art, maintenance of the dispersal of particulate matter comprised within a coating composition is often promoted by the addition of a dispersant. A dispersant ("dispersing additive," "deflocculant," "antisetling agent") is a composition that is added to promote continuing dispersal of particulate matter. In specific aspects, a dispersant is added to a coating composition to reduce or prevent flocculation. Flocculation is the process wherein a plurality of primary particles that have been previously dispersed form an agglomerate. In other aspects, a dispersant is added to a coating composition to prevent sedimentation of particulate matter. Standard procedures to determining the degree of settling by particulate matter in a coating (e.g., paint) are described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D869-85, 2002.

[0608] Often a dispersant is a compound comprising phosphate, such as, for example, tetra-potassium pyrophosphate or "TKPP" (CAS No. 7320-34-5). Examples of a tradename/proprietary phosphate compounds are those known as a Strodex™ (Dexter Chemical L.L.C.), including Strodex™

PK-90, Strodex™ PK-OVOC, and/or Strodex™ MOK-70, which comprise a phosphate ester surfactant.

[0609] In some aspects, a dispersant may be a particulate material. Examples include Winnofil® SPT Premium, Winnofil® S, Winnofil® SPM, and Winnofil® SPT (Solvay Advanced Functional Minerals), which comprise 97.4% calcium carbonate (CAS No. 471-34-1) coated with 2.6% fatty acid (CAS No. 64755-01-7) and generally used at 2% to 3%.

[0610] Various preparations of modified montmorillonite clay are known in the art as a dispersant. Examples include those under the name Bentone® (Elementis Specialties, Inc). Bentone® 34 (Elementis Specialties, Inc), which comprises tetraalkyl ammonium bentonite, and is prepared with 33% or more polar solvent prior to addition to a coating composition. M-P-A® 14 (Elementis Specialties, Inc.), which comprises a montmorillonite clay modified by and organic chemical, and is prepared with 33% or more polar solvent prior to addition to a solvent-borne coating composition. Bentone® SD-1 (Elementis Specialties, Inc.), which comprises a montmorillonite clay modified by and organic chemical, and typically added from 0.2% to 2% by weight to a solvent-borne coating composition, particularly those comprising an aliphatic liquid component.

[0611] A further example of a dispersant is a castor wax formulation under the trade names Crayvallac® SF, Crayvallac® MT, and Crayvallac® AntiSettle CVP (Cray Valley Limited), each of which are typically added from 0.2% to 1.5% as a dispersant, thixotropy additive, anti-sagging agent, or a combination thereof. Crayvallac® AntiSettle CVP comprises castor wax ("hydrogenated castor oil"), and is suitable for a solvent free epoxy-coating and a mineral spirit liquid component. Crayvallac® SF and Crayvallac® MT each comprise amide modified castor wax, and may be used in an epoxy-coating, an acrylic-coating, a chlorinated rubber-coating, or a combination thereof. Crayvallac® SF and Crayvallac® MT are preferred for use with a liquid component comprising an aromatic hydrocarbon, an alcohol, a glycol ether, or a combination thereof with Crayvallac®D MT being also preferred for use with a mineral spirit.

[0612] C. Buffers

[0613] In certain embodiments, it is preferred to maintain a coating's pH within a certain range. pH may range from 0 to 14, including all intermediate ranges and combinations thereof. A coating may be acidic, which is a pH between 0 and 7, including all intermediate ranges and combinations thereof, or basic, which is a pH between 7 and 14, including all intermediate ranges and combinations thereof. A neutral pH is pH 7.0, and it is contemplated that a coating may have a neutral pH, or a pH that is near neutral, which is a pH between 6.5 and 7.5, including all intermediate ranges and combinations thereof. A buffer may be added to maintain a coating's pH in a desired range, such as, for example acidic, basic, neutral, or near neutral. In certain aspects, a basic pH is preferred to optimize the function of a preferred enzyme, such as, for example, OPH. Examples of buffers include a bicarbonate (e.g., an ammonium bicarbonate), a monobasic phosphate buffer, a dibasic phosphate buffer, Trizma base, a 5 zwitterionic buffer, triethanolamine, or a combination thereof. In particular facets, it is contemplated that a buffer

will comprise 0.000001 M to 2.0 M, including all intermediate ranges and combinations thereof, in a coating or other surface treatment.

[0614] d. Rheology Modifiers

[0615] A rheology modifier (“rheology control agent,” “rheology additive,” “thickener and rheology modifier,” “TRM,” “rheological and viscosity control agent,” “viscosifier,” “viscosity control agent,” “thickener”) is a composition that alters (e.g., increases, decreases, maintains) a rheological property of a coating. A thickener (“thickening agent”) increases and/or maintains viscosity. A Rheological property is a property of flow and/or deformation. Examples of a rheological property include viscosity, brushability, leveling, sagging, or a combination thereof. Viscosity is a measure of a fluid’s resistance to flow (e.g., a shear force). Brushability is the ease a coating can be applied using an applicator (e.g., a brush). Leveling is the ability of a coating to flow into and fill uneven areas of coating thickness (e.g., brush marks) after application to a surface and before sufficient film formation to end such flow. Sagging is the gravitationally induced downward flow of a coating after application to a surface and before sufficient film formation to end such flow. It is specifically contemplated that a cell-based particulate material of the present invention may be added to a coating as a rheology modifier. It is further contemplated that in embodiments wherein the cell-based particulate material is used as a rheology modifier, it may, of course, be combined with a traditional rheology modifier, examples of which are described below.

[0616] A rheology modifier that alters viscosity (e.g., increases, decreases, maintains) is known as a “viscosifier.” During preparation, the viscosity of a coating (“medium-shear viscosity,” “mid-shear viscosity,” “coating consistency”) is often measured to verify a viscosity that is often suitable for a coating during storage, application, etc. The typical range of shear force for measuring mid-shear viscosity is between 10 s^{-1} to 10^3 s^{-1} . In many embodiments, particularly for architectural coatings, a medium shear viscosity will be between 60 Ku and 140 Ku, including all intermediate ranges and combinations thereof. During application (“high-shear”), a coating is usually subjected to a shear force of 10^3 s^{-1} to 10^4 s^{-1} by techniques such as brush application, and a shear force up to or greater than 10^6 s^{-1} by techniques including, for example, blade application, high-speed roller application, spray application, or a combination thereof. As would be known to one of ordinary skill in the art, a coating typically is formulated to possess a viscosity upon the shear force of application (“high-shear viscosity”) that promotes the ease of application. An example of a high shear viscosity during application is between 0.5 P (“50 mPa s”) to 2.5 P (“250 mPa s”), including all intermediate ranges and combinations thereof. In certain aspects, a coating may possess a viscosity greater or lower than this range, however, it is contemplated such a viscosity may make the coating more difficult to apply using the above application techniques. Post-preparation and/or post-application, a coating is usually subjected to a shear force of 10 s^{-1} to 10^{-3} s^{-1} produced, for example, by forces such as gravity, capillary pressure, or a combination thereof. In embodiments wherein a coating’s viscosity (“low-shear viscosity”) is too high at these levels of shear force (“low-shear”), leveling during and/or after application may be undesirably low. In embodiments wherein a viscosity is too

low at these levels of shear force, a coating may suffer in-can settling, sagging during or after application, or a combination thereof. A preferred viscosity of a coating post-preparation and/or application is between 100 P (“10 Pa s”) to 1000 P (“100 Pa s”), including all intermediate ranges and combinations thereof. Of course, the viscosity of a coating will change post-application in embodiments wherein film formation occurs; however, the post-application viscosity refers to the viscosity prior to completion of film formation, and may be determined immediately post-application (e.g., within seconds, within minutes) as appropriate to the coating, as would be known to one of ordinary skill in the art. In certain aspects, a coating may possess a viscosity greater or lower than this range, however, it is contemplated such a viscosity may make the coating more prone to sagging and/or settling defects. Techniques for measuring viscosity (e.g., low-shear viscosity, medium-shear viscosity, high-shear viscosity) are known to those of skill in the art [see, for example, “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D562-01, D2196-99, D4287-00, 2002; and in “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), 1995].

[0617] A rheology modifier is typically added to alter and/or maintain a rheology property within a desired range post-formulation, during application, post-application, or a combination thereof. In specific embodiments, a rheology modifier alters viscosity at or above 10^3 s^{-1} and/or at or below 10 s^{-1} . Viscosity, including non-Newtonian (e.g., shear-thinning) viscosity for coatings and/or coating components (e.g., binders, binder solutions, vehicles) upon formulation with or without a viscosity modifier can be empirically determined, particularly for shear rates comparable to application techniques (e.g., blade, brush, roller, spray) by standard techniques such as in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D562-01, D2196-99, D4287-00, D4212-99, D1200-94, D5125-97, and D5478-98, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D4958-97, 2002; and “ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles,” D1545-98, D1725-62, D6606-00 and D6267-98, 2002. Additionally, other Rheological properties can be determined to aid formulation of a coating of the present invention using techniques known to those of ordinary skill in the art. For example, brush drag, which is the resistance during coating (e.g., a latex) application using a brush, can be determined by standard techniques, such as, for example, in “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D4040-99, 2002. In an additional example, leveling and sagging can be empirically determined for a coating by standard techniques such as in “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D4062-99 and D4400-99, 2002.

[0618] As would be known to one of ordinary skill in the art, the addition of a coating component to a coating composition typically alters a rheological property, and many coating components have multiple classifications to include function as a rheology modifier. Examples of coat-

ing components more commonly added for function as a rheology modifier includes an inorganic rheology modifier, an organometallic rheology modifier, an organic rheology modifier, or a combination thereof. An example of an inorganic rheology modifier includes a silicate such as a montmorillonite silicate. An example of a montmorillonite silicate includes aluminum silicate, a bentonite, magnesium silicate, or a combination thereof. A silicate rheology modifier typically confers a superior washfastness property, a superior abrasion resistance property, or a combination thereof, to a coating relative to an organic rheology modifier. An example of an organic rheology modifier includes a cellulose ether, a hydrogenated oil, a polyacrylate, a polyvinylpyrrolidone, a urethane, or a combination thereof. Organic rheology modifiers of a polymeric nature (e.g., a cellulose ether, a urethane, a polyacrylate, etc.) are sometimes used as an associative thickener, and are preferred for a latex coating. An organic rheology modifier typically confers a greater water retention capacity property ("open time") to a coating relative to a silicate rheology modifier. A common example of a cellulose ether is a methyl cellulose, a hydroxyethyl cellulose, or a combination thereof. An example of a hydroxyethyl cellulose includes Natrosol® (Hercules Incorporated); Cellosize™ (Dow Chemical Company); or a combination thereof. An example of hydrogenated oil includes hydrogenated castor oil. An example of a urethane rheology modifier ("associative thickener") includes a hydrophobically modified ethylene oxide urethane ("HEUR"), which comprises a polyethylene glycol block covalently linked by urethane, and has both a hydrophilic and hydrophobic regions capable of use in an aqueous environment. An example of a HEUR includes a block of polyethylene oxide linked by an urethane and modified with a nonyl phenol hydrophobe (Rohm and Haas Company). Often a urethane rheology modifier confers a superior leveling property over another type of organic rheology modifier. An example of an organometallic rheology modifier includes a titanium chelate, a zirconium chelate, or a combination thereof.

[0619] In addition to the disclosures herein, a rheology modifier and use of a rheology modifier in a coating is known to those of skill in the art, and such compositions and techniques may be included in the practice of the present invention (see, for example, Flick, E. W. "Handbook of Paint Raw Materials, Second Edition," 808-843 and 879-998, 1989; in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp 268-285 and 348-349, 1995; in "Paint and Surface Coatings: Theory and Practice, Second Edition," (Lambourne, R. and Strivens, T. A., Eds.), pp. 73, 218, 227, 352, 558-559 and 718, 1999; Wicks, Jr., Z. W., Jones, F. N., Pappas, S. P. "Organic Coatings, Science and Technology, Volume 2: Applications, Properties and Performance," pp. 42, 215, 293, 315, 320 and 323-328, 1992; and in "Paints, Coatings and Solvents, Second, Completely Revised Edition," (Stoye, D. and Freitag, W., Eds.) pp 6, 128 and 166-167, 1998.

[0620] e. Defoamers

[0621] A coating sometimes comprises a gas capable of forming a bubble ("foam") that can undesirably alter a physical and/or aesthetic property. Undesirable gas incorporation into a coating composition is often a side affect of coating preparation processes, and a particular bane of latex

coatings. Often, a wetting agent and/or a dispersant used in a coating may promote creation or retention of foam. Additionally, cells (e.g., microorganisms) can produce gas, and in certain embodiments, a coating comprising a cell-based particulate material of the present invention may also comprise a defoamer. A defoamer ("antifoaming agent," "antifoaming additive") is a composition that releases gas (e.g., air) and/or reduces foaming in a coating during production, application, film formation, or a combination thereof. A defoamer often acts by lowering the surface tension around a bubble, allowing merging of a bubble with a second bubble, which produces a larger and less stable bubble that collapses. It is contemplated that in certain coating compositions, a cell-based particulate material may act as a defoamer by destabilizing a bubble in a coating. It is further contemplated that in embodiments wherein the cell-based particulate material is used as a defoamer, it may, of course, be combined with a traditional defoamer, examples of which are described below.

[0622] Examples of a defoamer include an oil (e.g., a mineral oil, a silicon oil), a fatty acid ester, dibutyl phosphate, a metallic soap, a siloxane, a wax, an alcohol comprising between six to ten carbons, or a combination thereof. An example of an oil defoamer is pine oil. In some aspects, an antifoaming agent is combined with an emulsifier, a hydrophobic silica, or a combination thereof. Examples of a tradename defoamer is a TEGO® Foamex 8050 (Goldschmidt Chemical Corp.), which comprises a polyether siloxane copolymer and fumed silica, and typically is used at 0.1% to 0.5% during coating preparation; and BYK®-31 (BYK-Chemie), which comprises a paraffin mineral oil and hydrophobic compounds, and typically is used at 0.1% to 0.5% in a coating.

[0623] f. Catalysts

[0624] A catalyst is an additive that promotes film formation by catalyzing a cross-linking reaction in a thermosetting coating. Examples of a catalyst include a drier, an acid or a base, and the selection of the type of catalyst is specific to the chemistry of the film formation reaction.

(1) Driers

[0625] A drier ("siccative") catalyzes an oxidative film formation reaction, such as those that occur in an oil-based coating. In addition to the disclosures herein, a drier and use of an drier in a coating is known to those of skill in the art, and such materials and techniques for using an drier in a coating may be applied in the practice of the present invention [see, for example, Flick, E. W. "Handbook of Paint Raw Materials, Second Edition," pp. 73-93 and 879-998, 1989; in "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp 30-35, 1995; in "Paint and Surface Coatings: Theory and Practice, Second Edition," (Lambourne, R. and Strivens, T. A., Eds.), pp. 190-192, 1999; Wicks, Jr., Z. W., Jones, F. N., Pappas, S. P. "Organic Coatings, Science and Technology, Volume 1: Film Formation, Components, and Appearance," pp. 138, 317-318, 1992; Wicks, Jr., Z. W., Jones, F. N., Pappas, S. P. "Organic Coatings, Science and Technology, Volume 2: Applications, Properties and Performance" pp. 138, 197-198, 330, 344, 1992; and in "Paints, Coatings and Solvents, Second, Completely Revised Edition," (Stoye, D. and Freitag, W., Eds.) pp. 11, 48, 165, 1998].

[0626] A drier may comprise a metal drier, an alternative drier, a feeder drier, or a combination thereof. Usually a drier comprising a metal ("a metal drier") catalyzes the oxidative reaction. Examples of a metal typically used in a drier include aluminum, barium, bismuth, calcium, cerium, cobalt, iron, lanthanum, lead, manganese, neodymium, potassium, vanadium, zinc, zirconium, or a combination thereof. Examples of types of metal driers include an inorganic metal salt, a metal-organic acid salt ("soap"), or a combination thereof. A "salt" is the composition formed between the anion of an acid and the cation of a base. Typically, the acid and base of a salt interact by an ionic bond. Examples of organic acids used in such a soap include a monocarboxylic acid of 7 to 22 carbon atoms. Examples of such a monocarboxylic acid include a linoleate, a naphthenate, a neodecanoate, an octoate, a rosin, a synthetic acid, a tallate, or a combination thereof. Examples of a drier comprising a synthetic acid include those under the trade-names Troymax™ (Troy Corporation). Though most driers are water insoluble, water dispersible driers can be prepared by combining a surfactant with a naphthenate drier and/or a synthetic acid drier. However, water dispersible driers are typically obtained under a tradename such as, for example, Troykyd® Calcium WD, Troykyd® Cobalt WD, Troykyd® Manganese WD, Troykyd® Zirconium WD (Troy Corporation). Additionally, a potassium soap, lithium soap, or a combination thereof, has limited aqueous solubility.

[0627] A primary drier ("surface drier," "active drier," "top drier") acts at the coating-external environment interface. A secondary drier ("auxiliary drier," "through drier") acts throughout the coating. Examples of primary driers include metal driers comprising cobalt, manganese, vanadium, or a combination thereof. Examples of secondary driers include metal driers comprising aluminum, barium, calcium, cerium, iron, lanthanum, lead, manganese, neodymium, zinc, zirconium, or a combination thereof. A rare earth drier comprises lanthanum, neodymium, cerium, or a combination thereof.

[0628] In many embodiments, it is contemplated that a coating will comprise from 0.01% to 0.1%, including all intermediate ranges and combinations thereof, of an individual metal of a primary drier, by weight of the non-volatile components of a coating composition. In many embodiments, it is contemplated that a coating will comprise from 0.1% to 1.0%, including all intermediate ranges and combinations thereof, of an individual metal of a secondary drier, by weight of the non-volatile components of a coating composition. Standard physical and/or chemical properties for various driers comprising a metal (e.g., calcium, cerium, cobalt, iron, lead, manganese, nickel, rare earth, zinc, zirconium), and procedures for determining various metals' content for a driers are described in, for example, "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons," D600-90, 2002; and "Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D2373-85, D2374-85, D2375-85, D2613-01, D3804-02, D3969-01, D3970-80, D3988-85, and D3989-01, 2202; and ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D564-87, 2002.

[0629] It is particularly preferred that in embodiments wherein a secondary drier is used, it is combined with a primary drier, as the activity of most secondary driers are

often very limited when acting without the presence of a primary drier. Skinning is film-formation disproportionately at the coating-external environment interface. Skinning often results in undesirable wrinkle formation ("wrinkling") in the film. A primary drier undesirably promotes skinning when acting without the presence of a secondary drier. In certain aspects, zinc may be selected for reducing wrinkling in thick films. In other aspects, calcium and/or zirconium may be selected instead of lead, which may be limited due to an environmental law or regulation. In some facets, an iron drier, rare earth drier, or combination thereof, may be selected for use during film formation by baking. However, an iron drier may darken a coating. In further aspects, an aluminum drier may be selected for an alkyd-coating.

[0630] An alternative drier is a type of drier developed for use in a high solid and/or water-borne coating, due to the inefficiency of a metal-soap drier in these types of coatings. Often, an alternative drier is combined with a metal-soap drier. An example of a metal soap drier include a 1, 10-phenanthroline, 2,2'-dipyridyl. A feeder drier is a type of drier designed to prolong the pot life of a coating in embodiments wherein a metal soap drier is absorbed by a coating component such as a carbon black pigment, an organic red pigment, or a combination thereof. A feeder drier dissolves over time into the coating, thereby providing a continual supply of drier. An example a feeder drier include a tradename composition such as Troykyd® Perma Dry (Troy Corporation).

(2) Acids

[0631] An acid catalyzes amino resin cross-linking between a plurality of amino resins and/or an amino resin and an addition resin, though an acid is more effective in promoting cross-linking between the additional resin and an amino resin. A coating may comprise a strong acid, a weak acid, or a combination thereof. Examples of an acid include a strong acid or a weak acid. The rate of curing is typically accelerated by selection of a strong acid over a weak acid. Examples of a strong acid include, p-toluenesulfonic acid ("PTSA"), dodecylbenzenesulfonic acid ("DDBSA"), or a combination thereof. Examples of a weak acid include phenyl acid phosphate ("PAP"), butyl acid phosphate ("BAP"), or a combination thereof.

(3) Bases

[0632] A base catalyzes cross-linking between an acrylic resin and an epoxy resin in film formation. In specific aspects, the base comprises, for example, a dodecyl trimethyl ammonium chloride, a tri(dimethylaminomethyl) phenol, a melamine-formaldehyde resin, or a combination thereof.

(4) Urethane Catalysts

[0633] In specific aspects, a urethane coating comprises a catalyst to accelerate the reaction between an isocyanate moiety and a reactive hydrogen moiety. Examples of such a urethane catalyst include a tin compound, a zinc compound, a tertiary amine, or a combination thereof. Examples of a zinc compound include zinc octoate, zinc naphthenate, or a combination thereof. Examples of a tin compound include dibutyltin dilaurate, stannous octoate, or a combination thereof. An example of a tertiary amine includes a triethylene diamine.

[0634] g. Antiskinning Agent

[0635] An antiskinning agent is a composition, other than a drier, that reduces film-formation at the coating-external environment interface, reduce shrinkage ("wrinkling"), or a combination thereof. Such antiskinning agents are often used to protect coatings from undesired film-formation after a container of coating has been opened, during normal film-formation, or a combination thereof. Examples of antiskinning agents, with commonly used coating concentrations in parentheses, include butyraloxime (0.2%), cyclohexanone oxime, dipentene, exkin 1, exkin 2, exkin 3, guaiacol (0.001% to 0.1%), methyl ethyl ketoxime (0.2%), pine oil (1% to 2%), or a combination thereof. Generally, an antiskinning agent acts by reducing the rate of film-formation and/or promotes even film-formation throughout a coating by slowing an oxidative reaction that occurs as part of film formation. Examples of antioxidant antiskinning agents include a phenolic antioxidant, an oxime, or a combination thereof. Example of a phenolic antioxidant includes guaiacol, 4-tert-butylphenol, or a combination thereof. Oximes tend to evaporate such as during film formation, are colorless, do not affect a coating's color property, and generally do not significantly alter the time of film-formation. Examples of an oxime include, butyraldoxime, methyl ethyl ketoxime, cyclohexanone oxime, or a combination thereof. In certain facets, an oxime is used to slow skinning promoted by a copper drier.

[0636] h. Light Stabilizers

[0637] A coating, a film and/or a surface may be undesirably altered by contact with an environmental agent such as, for example, oxygen, pollution, water (e.g., moisture), and/or irradiation with light (e.g., UV light). To reduce such damaging alterations to a coating and/or film, it is contemplated that a coating composition may comprise a light stabilizer. A light stabilizer ("stabilizer") is a composition that reduces or prevents damage to a coating, film and/or surface by an environmental agent. Such agents may alter the color, cause a separation between two layers of film ("delamination"), promote chalking, promote crack formation, reduce gloss, or a combination thereof. This is a particular problem for a film in an exterior environment, such as, for example, an automotive film. Additionally, wood surfaces are susceptible to damage by environmental agents, particularly UV light.

[0638] Typically, a light stabilizer may comprise a UV absorber, a radical scavenger, or a combination thereof. A UV absorber is a composition that absorbs UV light. Examples of UV absorbers include a hydroxybenzophenone, a hydroxyphenylbenzotriazole, a hydroxyphenyl-S-triazine, an oxalic anilide, yellow iron oxide, or a combination thereof. A hydroxyphenylbenzotriazole generally demonstrates the broadest range of UV wavelength absorption, and converts the absorbed UV light into heat. Additionally, a hydroxyphenylbenzotriazole and/or a hydroxyphenyl-S-triazine usually have the longest effective use in a film due to a higher resistance to photochemical reactions, relative to a hydroxybenzophenone or an oxalic anilide.

[0639] A radical scavenger light stabilizer (e.g., a sterically hindered amine) is a composition that chemically reacts with a radical ("free radical"). Examples of a sterically hindered amine ("hindered amine light stabilizer," "HALS") include the ester derivatives of decanedioic acid,

such as HALS I ["bis(1,2,2,6,6,-pentamethyl-4-piperidinyl) ester"], which is used in non-acid catalyzed coatings; HALS II ["bis(2,2,6,6,-tetramethyl-1-isooctyloxy-4-piperidinyl) ester"], which is typically used in an acid catalyzed coating.

[0640] For embodiments wherein a coating, film, and/or surface is primarily located in-doors, a range of 1% to 3%, including all intermediate ranges and combinations thereof, of a light stabilizer relative to binder content is contemplated. A range of 1% to 5%, including all intermediate ranges and combinations thereof, of a light stabilizer relative to binder content is contemplated for exterior uses. Additionally, a combination of a UV absorber and a radical scavenger light stabilizer are contemplated in some embodiments, as the heat released by a UV absorber may promote radical formation. Light stabilizers are often commercially produced, and examples of UV absorber and/or a radical scavenger light stabilizer sold under a tradename include Tinuvin® (Ciba Specialty Chemicals) or Sanduvor® [Clariant LSM (America) Inc.].

[0641] i. Corrosion Inhibitors

[0642] A coating comprising a liquid component that comprises water, particularly a water-borne coating, may promote corrosion in a container comprising iron, particularly at the lining, seams, handle, etc. A corrosion inhibitor reduces corrosion by water or another chemical. Examples of a corrosion inhibitor includes a chromate, a phosphate, a molybdate, a wollastonite, a calcium ion-exchanged silica gel, a zinc compound, a borosilicate, a phosphosilicate, a hydrotalcite, or a combination thereof.

[0643] In certain embodiments, a corrosion inhibitor is an in-can corrosion inhibitor, a flash corrosion inhibitor, or a combination thereof. An in-can corrosion inhibitor ("can-corrosion inhibitor") is a composition that reduces or prevents such corrosion. Examples of an in-can corrosion inhibitor are sodium nitrate, sodium benzoate, or a combination thereof. These compounds are typically used at a concentration of 1% each in a coating composition. In-can corrosion inhibitor are often commercially produced, and an example includes SER-AD® FA179 (Condea Servo LLC.), typically used at 0.3% in a coating composition. A flash corrosion inhibitor ("flash rust inhibitor") is a composition that reduces or prevents corrosion produced by application of a coating comprising water to a metal surface (e.g., an iron surface). Often, in-can corrosion inhibitors at increased concentrations are added to a coating composition to act as a flash corrosion inhibitor. An example of a flash corrosion inhibitor includes sodium nitrite, ammonium benzoate, 2-amino-2-methyl-propan-1-ol ("AMP"), SER-AD® FA179 (Condea Servo LLC.), or a combination thereof. Standard procedures to determining the effectiveness of corrosion inhibition by a coating comprising a flash rust inhibitor are described, for example, in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D5367-00, 2002.

[0644] j. Dehydrators

[0645] In some embodiments, preventing moisture from contacting coating component such as a binder, solvent, pigment, or a combination thereof, may be desired. For example, certain urethane coatings undergo film-formation in the presence of moisture, as well as produce a film with increased yellowing, increased hazing and/or decreased

gloss. A dehydrator may be added during coating production and/or storage to minimize contact with moisture. Examples of a dehydrator include Additive TI (Bayer Corporation), Additive OF (Bayer Corporation), or a combination thereof. Additive TI comprises a compound with one reactive isocyanate moiety, and it is capable of reacting with compounds with a chemically reactive hydrogen such as water, an alcohol, a phenol, or an amide. However, in a preferred reaction with water, the reaction products are carbon dioxide and toluenesulfonamide. The toluenesulfonamide is generally inert relative to a urethane binder, and soluble in many non-aqueous liquid components. In certain embodiments, a urethane coating may comprise 0.5% to 4% Additive TI. Additive OF is a dehydrator generally used in a urethane coating. In certain embodiments, a urethane coating may comprise 1% to 3% Additive OF.

[0646] k. Electrical Additives

[0647] In some embodiments, it is desirable to include an additive to alter an electrical property of a coating (e.g., electrical conductivity, electrical resistance). Examples of an additive to alter an electrical property of a coating and/or coating component include an anti-static additive, an electrical resistance additive, or a combination thereof. An anti-static additive may be included in a coating composition comprising a flammable component to reduce the chance of an electrostatic spark occurring and igniting the coating. An anti-static additive is a composition that increases the electrical conductivity of a coating. An example of a flammable component is a hydrocarbon solvent. Examples of an anti-static additive include Stadis® 425 (Octel-Starreon LLC USA), Stadis® 450 (Octel-Starreon LLC USA), or a combination thereof. An electrical resistance additive is a composition that reduces the resistance to electricity by a coating. An electrical resistance additive may be included in a coating to improve the ability of a coating to be applied to a surface using an electrostatic spray applicator. For example, an oxygenated compound (e.g., a glycol ether) often possesses a high electrical conductivity, which can make use of an electrostatic spray applicator to apply a coating comprising an oxygenated compound relatively more difficult than a similar coating lacking an oxygenated compound. Examples of an electrical resistance additive include Ramsprep, Byk-ES 80 (BYK-Chemie GmbH), or a combination thereof. Byk-ES 80 comprises, for example, an unsaturated acidic carboxylic acid ester alkylolammonium salt, and typically is added between 0.2% and 2% to a coating composition. Additionally, techniques for determining an electrical property (e.g., electrical resistance) of a coating comprising an electrical additive are known to those of ordinary skill in the art (see, for example, "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D5682-95, 2002).

[0648] l. Anti-Insect Additives

[0649] Certain coatings may serve a protective role for a surface or surrounding environment against insects, and thus may comprise an anti-insect agent. An example of a surface where a coating comprising an anti-insect agent may be desirable is a wooden surface. Examples of an area where coating comprising an anti-insect agent may be desirable would be a storage facility, such as a cargo hold of a ship or

railcar. An anti-insect agent is a composition that, upon contact, is detrimental to the well-being (e.g., life, reproduction) of an invertebrate pest (e.g., an insect, an arachnid, etc.). Examples of anti-insect additives that have been used in coatings include copper naphthenate, tributyl tin oxide, zinc oxide, 6-chloro epoxy hydroxy naphthalene, 1-dichloro 2,2-bis-(p-chlorophenyl)ethane, or a combination thereof.

[0650] J. Empirically Determining Coating and/or Film Properties

[0651] A coating with a desired set of properties for a particular use may be prepared by varying the ranges and/or combinations of coating components, and such coating selection and preparation is within the ability of one of ordinary skill in the art in light of the present disclosures. For example, as would be known to those of ordinary skill in the art, a variety of assays are available to measure various properties of a coating, coating application, and/or a film to determine the degree of suitability of a coating composition for use in a particular use (see, for example, in "Hess's Paint Film Defects: Their Causes and Cure," 1979).

[0652] It is contemplated that in general embodiments, a coating comprising a cell-based particulate material of the present invention may be subjected to one or more of such assays. In one example, it is contemplated that a cell-based particulate material may comprise a desired colorant such as a chlorophyll, a carotenoid, etc., which may undergo a desired or undesired change in its optical characteristics (e.g., color, opacity) upon baking at a particular temperature. Various procedures for measuring the visual properties of a coating and/or film are described herein or would be known to those of ordinary skill in the art in light of the present disclosures may be used to determine the properties and/or tolerances of any such colorant.

[0653] General procedures for empirically determining the purity/properties of various coating components and/or coating compositions are known to those of ordinary skill in the art, and may be applied in the practice of the present invention. Such procedures include measurement of density, volume solids and/or specific gravity, of a coating component and/or coating composition, for purposes such as verification of component identity, aid in coating formulation, maintaining coating batch to batch consistency, etc. Examples of standard techniques for determining density of various solvents, liquids (e.g., a liquid coating), pigments, coatings (e.g., a powder coating) include those described in "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons," D2935-96, D1555M-00, D1555-95, and D3505-96, 2002; "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D1475-98 and D215-91, 2002; "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D153-84 and D153-84, 2002; "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D5965-02, 2002; and "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp. 289-304, 1995.

[0654] Standard surface specification and/or procedures for preparing a surface (e.g., glass, wood, steel) for empirically measuring a physical and/or visual property of a coating (e.g., a paint, a varnish, a lacquer) and/or film are

known to those of ordinary skill in the art (see, for example, “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D3891-96, D609-00, and D2201-99, 2002; and “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D358-98, D4227-99, and D4228-99, 2002). Specific procedures for preparing a metal surface and an evaluating a coating (e.g., a primer, a paint) applied to a metal surface are known to those of ordinary skill in the art (see, for example, “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D3276-00, D5161-96, D4417-93, D3322-82, D2092-95, D5065-01, D5723-95, D6386-99, and D6492-99, 2002). Specific procedures for evaluating a coating applied to a plastic surface are known to those of ordinary skill in the art (see, for example, “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D3002-02, 2002).

[0655] Standard procedures for determining the stability of a coating (e.g., a water-borne coating, a UV irradiation cured coating) in a container prior and/or after opening the container are known to those of ordinary skill in the art (see, for example, “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D2243-95 and D4144-94, 2002).

[0656] Standard procedures for evaluating an applicator (e.g., a brush, a roller, a fabric, a spray applicator, an electrocoat bath) and/or a coating being applied by an applicator are known to those of ordinary skill in the art (see, for example, “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D6737-01, D5913-96, D5959-96, D5301-92, D5068-02, D5069-92, D4707-97, D5286-01, D6337-98, D4285-83, and D5327-97, 2002; and “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D1978-91, D5794-95, D4370-01, D4399-90, and D4584-86, 2002).

[0657] Standard procedures for preparing a coating (e.g., a paint, a varnish, a lacquer) and/or film layer upon a surface for empirically measuring a physical and/or visual property are known to those of ordinary skill in the art (see, for example, “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D3924-80, D823-95, and D4708-99, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D6206-97, D1734-93, and D4400-99, 2002; and “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 415-423, 1995).

[0658] Standard procedures for empirically determining the degree and duration of film formation of various coating compositions are known to those of ordinary skill in the art, and may be applied in the practice of the present invention. Example of a standard technique for determining the degree/duration of film formation by loss of a volatile coating component and/or a cross-linking reaction for a coating (e.g., an oil-coating, a UV cured coating, an thermosetting powder coating) include those described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D3539-87, D1640-95 and D5895-01e1, 2002; “ASTM Book of Stan-

dards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D4217-02, D3732-82, D2091-96, D711-89, D4752-98, and D5909-96a, 2002; “ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles,” D2575-70 and D2354-98, 2002; and “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 407-414, 1995. Additionally, the temperature generated by a film formation reaction by a coating (e.g., a wood coating) may also be determined by one of ordinary skill in the art (see, for example, “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D3259-95, 2002). Further, standard techniques for evaluating baking conditions on an organic coating and/or film are known to those of ordinary skill in the art, (see, for example, “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D2454-95, 2002).

[0659] In embodiments wherein film formation at ambient conditions is preferred in a coating, a standard procedure that would be known to one of ordinary skill in that art may be used for measuring film formation rate and/or stages (see for example, “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D1640-95, 2002. In certain aspects wherein the ability of an oil to undergo film formation is to be determined, a standard procedure described in “ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles,” D1955-85, 2002, may be used. In embodiments wherein the hardness of a film produced by a coating composition is measured (e.g., an organic coating), a standard procedure such as, for example, “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D3363-00, D4366-95, and D1474-98, 2002.

[0660] Examples of a standard technique for determining the coating and/or film thickness after application to various surface types are described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D1212-91, D4414-95, D1005-95, D1400-00, D1186-01, and D6132-97, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D5235-97, D4138-94, D2200-95, and D5796-99, 2002; and “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 424-438, 1995.

[0661] Examples of a standard technique for determining the adhesion of a coating and/or film to various surface types are described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D3359-02, D5179-98, and D2197-98, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D4541-02 D3730-98, D4145-83, D4146-96 and D6677-01, 2002; and “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 513-524, 1995. Additionally, standard procedures for determining the ability of one or more layers of a multicoat system to function (e.g., adhere, weather) together are described in, for example, “ASTM Book of Standards,

Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D5064-01, 2002.

[0662] Various standard techniques for determining the physical properties (e.g., flexibility, tensile strength, toughness, impact resistance, hardness, mar resistance, blocking resistance) relevant to the durability of a film and/or the degree of film formation are known to those of ordinary skill in the art. Such procedures may be used to empirically characterize a film, and determine whether a coating composition produces a film suitable for a given application. Flexibility is the film's ability to undergo stress from bending and/or flexing without discernable damage (e.g., cracking). Examples of a standard technique for determining the flexibility of a film under mechanical or temperature stress are described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D522-93a and D4145-83, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D4145-83, D4146-96 and D1211-97, 2002; and “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 547-554, 1995. Related to flexibility is the tensile strength of a film, which is the ability of a film to undergo tensile deformation without developing discernable damage (e.g., cracking, tearing). Examples of a standard technique for determining the tensile strength of a film are described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D2370-98 and D522-93a, 2002; and “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 534-545, 1995. Toughness is the film's ability to undergo strain imposed in a short period of time (e.g., one second or less) without discernable damage (e.g., breaking, tearing). Examples of a standard technique for determining the toughness of a film (e.g., a film for a pipeline) are described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D2794-93, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” G14-88, 2002; and “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 547-554, 1995. Impact resistance is the ability of a film to undergo impact with an indenter without developing discernable damage at the dimple site (e.g., cracking). Examples of a standard technique for determining the impact resistance of a film (e.g., a film for a pipeline) are described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D2794-93, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” G13-89 and G14-88, 2002; and “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 553-554, 1995. Hardness is the film's ability to undergo an applied static force without developing discernable damage (e.g., a scratch, an indentation). Examples of a standard technique for determining the hardness of a film are described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance” D1640-95, D1474-98, D2134-93, D4366-95 and D3363-00, 2002; and “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 555-584, 1995.

Mar resistance (“mar abrasion resistance”) is the film's ability to undergo an applied dynamic force without developing a change in the film surface appearance (e.g., gloss) due to a permanent deformation (e.g., an indentation). Examples of a standard technique for determining the mar resistance of a film are described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D5178-98 and D6037-96, 2002; and “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 525-533 and 579-584, 1995. Abrasion resistance (“wear abrasion resistance”) is the film's ability to undergo an applied dynamic force (e.g., washing) without removal of film material. Examples of a standard technique for determining the abrasion resistance (e.g., burnish resistance) of a film are described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D968-93 and D4060-01, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D3170-01, D4213-96, D5181-91, D4828-94, D2486-00, D3450-00, D6736-01 and D6279-99e1, 2002; and “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 525-533, 1995. Blocking resistance (“block resistance”) is the ability of a film to resist adhering to a second film, particularly when the two films are pressed together (e.g., a coated door and coated doorframe). Examples of a standard technique for determining the blocking resistance of a film are described in “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D2793-99 and D3003-01, 2002. Abrasion resistance (“wear abrasion resistance”) is the film's ability to undergo an applied dynamic force (e.g., washing) without removal of film material. Slip resistance is a coating's (e.g., a floor coating) slipperiness, and can be evaluated as described in “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 600-606, 1995.

[0663] Weathering resistance is film's ability to endure and/or protect a surface from an external environmental condition. Examples of environmental conditions that may damage a film and/or surface include contact with varying conditions of temperature, moisture, sunlight (e.g., UV resistance), pollution, biological organisms, or a combination thereof. Examples of a standard technique for determining the weathering resistance of a film (e.g., an automotive film, an external architectural film, a varnish, a wood coating, a steel coating) by evaluating the degree of damage (e.g., fungal growth, color alteration, dirt accumulation, gloss loss, chalking, cracking, blistering, flaking, erosion, surface rust), are described in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D4141-01, D1729-96, D660-93, D661-93, D662-93, D772-86, D4214-98, D3274-95, D714-02, D1654-92, D2244-02, D523-89, D1006-01, D1014-95 and D1186-01, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D3719-00, D610-01, D1641-97, D2830-96 and D6763-02, 2002; and “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 619-642, 1995. Additionally, standard techniques are known to those of ordinary skill in the art for determining the resistance of a film to

artificial weathering conditions. These procedures are used to contact a film with a simulated weathering condition (e.g., heat, moisture, light, UV irradiation) at an accelerated timetable are described in "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D822-01, D4587-01, D5031-01, D6631-01, D6695-01, D5894-96 and D4141-01, 2002; "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D5722-95, D3361-01 and D3424-01, 2002; and "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook" (Koleske, J. V. Ed.), pp. 643-653, 1995.

[0664] Standard techniques for determining a film's resistance to damage by various chemicals are known to those of ordinary skill in the art. Examples of chemicals that can be used in such procedures include an acid (e.g., 3% acetic acid), a base, an alcohol (e.g., 50% ethyl alcohol, hydrochloric acid, sulfuric acid), a detergent (e.g., a sodium phosphate solution), gasoline, a glycol based antifreeze, an oil (e.g., a vegetable oil, a lubricating petroleum oil, a grease), a solvent, water (e.g., a salt solution, a salt vapor), a polish abrasive, another coating (e.g., graffiti), or a combination thereof. Standard techniques for determining the chemical resistance of a film (e.g., an architectural film, an automotive film, a paint, a lacquer, a varnish, a traffic-coating, a metal surface-film) by evaluating possible damage (e.g., adhesion loss, alteration of gloss, blistering, discoloration, loss of hardness, staining, swelling, wrinkling) are described in, for example, "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D1308-02, D2571-95, D2792-69, D4752-98, D3260-01, D6137-97, D6686-01, D6688-01 and D6578-00, 2002; "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D2370-98, D2248-01a, and D870-02, 2002; "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D1647-89, 2002; and "Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook," (Koleske, J. V. Ed.), pp. 662-666, 1995. Additionally, examples of a standard technique for determining the solvent resistance of a film are described in "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D4752-98 and D5402-93, 2002.

[0665] Standard techniques for determining a film's and/or surface's (e.g., metal, wood) resistance to water permeability and/or damage (e.g., corrosion, blistering, adhesion reduction, hardness alteration, color alteration, gloss alteration) by contact with water and/or moisture are described in, for example, "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D870-02, D1653-93, D1735-02, D2247-02 and D4585-99, 2002; and "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D2065-96, D2921-98, D3459-98 and D6665-01, 2002.

[0666] Standard techniques for determining a film's resistance to damage by a temperature greater than ambient condition are known to those of ordinary skill in the art. Thermal resistance is the film's ability to undergo stress from a temperature at or below 200° C. without discernable

damage, while heat resistance is the film's ability to undergo stress from a temperature above 200° C. (e.g., fire resistance, fire retardancy, flame resistance) without discernable damage. Standard techniques for determining the thermal and/or heat resistance of a film (e.g., a metal-film, a wood-lacquer) by evaluating possible damage (e.g., adhesion loss, alteration of gloss, blistering, chalking, discoloration) are described in, for example, "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D2370-98, D2485-91, D1360-98, D4206-96 and D3806-98, 2002; and "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D1211-97 and D6491-99, 2002.

[0667] In some embodiments, it may be desirable to measure the component composition of a coating and/or film such as to verify the presence, absence and/or amount of one or more coating components in a particular formulation. Standard procedures for sampling a coating and/or film, and analyzing the material composition (e.g., a pigment, a binder, liquid component, toxic material), have been described in, for example, "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D2371-85, D5380-93, D2372-85, D2698-90, D3723-84, D4451-02, D4563-02, D5145-90, D3925-02, D2348-02, D2245-90, D3624-85a, D3717-85a, D2349-90, D2350-90, D2351-90, D2352-85, D3271-87, D3272-76, D4017-02, D3792-99, D4457-02, D6133-00, D6191-97, D4764-01, D3718-85a, D3335-85a, D6580-00, E848-94, D4834-88, D4358-84, D2621-87, D3618-85a, D6438-99, D4359-90, D3168-85 and D4948-89, 2002; "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D5702-02, 2002; and "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D1469-00, 2002.

[0668] The nonvolatile content of a coating component and/or coating ("total solids content") can provide an estimate, for example, of the volume of film that will be produced by a coating or coating component (e.g., a paint, a clear coating, an electrocoat bath applied coating, a binder solution, an emulsion, a varnish, an oil, a drier, a solvent) and/or the surface area a coating can cover relative to a film's thickness. The nonvolatile content of coating and/or coating component can be determined by any technique known in the art (see, for example, "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance," D6093-97, D2697-86, D1259-85, D1644-01, D2832-92 and D4209-82 D5145-90, 2002; "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings," D4713-92, D5095-91, 2002; and "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles," D4139-82, 2002). Additionally, the volatile component of a coating can provide an estimate, for example, of VOC release and/or thermoplastic film formation time. The nonvolatile content of coating and/or coating component (e.g., a paint, a clear coating, an automotive coating, an emulsion, a binder solution, a varnish, an oil, a drier, a solvent) can be determined by any technique known in the art (see, for example, "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical,

Physical, and Optical Properties; Appearance,” D2369-01e1, D2832-92, D3960-02, D4140-82, D4209-82, D5087-02 and D6266-00a, 2002; and “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D5403-93, 2002).

[0669] Standard procedures for determining the visual appearance of a coating component, coating and or film (e.g., reflectance, retroreflectance, fluorescence, photoluminescent light transmission, color, tinting strength, whiteness, measurement instruments, computerized data analysis) have been described, for example, in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” E284-02b, E312-02, E805-01a, E179-96, E991-98, E1247-92, E308-01, E313-00, E808-01, E1336-96, E1341-96, E1347-97, E1360-90, D332-87, D387-00, E1455-97, E1477-98a, E1478-97, E1164-02, E1331-96, E1345-98, E1348-02, E1349-90, D5531-94, D3964-80, E1651-94, E1682-96, E1708-95, E1767-95, E1808-96, E1809-01, E2022-01, E2072-00, E2073-02, E2152-01, E2153-01, D1544-98, E259-98, D3022-84, D1535-01, E2175-01, E2214-02 and E2222-02, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D4838-88 and D5326-94a, 2002; and “ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles,” D2090-98, D2090-98 and D6166-97, 2002. Specific techniques for matching two or more colored coatings and/coating components to minimize differences (e.g., metamerism) have been described, for example, in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D4086-92a, E1541-98 D2244-02 2002. Specific techniques for determining differences in the color of a coatings and/coating components, particularly to insure color consistency of a coating composition, “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” D1729-96, D2616-96, E1499-97 and D3134-97, 2002.

[0670] Gloss is the film’s “angular selectivity of reflectance, involving surface-reflected light, responsible for the degree to which reflected highlights or images of objects may be seen as superimposed on a surface” (“ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” E284-02b, 2002). An example of a high gloss coating would be a paint film with a glass-like surface appearance, as opposed to a low-gloss (“flat”) paint. Standard techniques for determining the gloss (e.g., specular gloss, sheen, haze, image clarity, waviness, directionality) of a coating and/or film are described, for example, in “ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance,” E284-02b, D523-89, D4449-90, E167-96, E430-97, D4039-93, D5767-95 and D2244-02, 2002; “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D3928-00a, 2002; and “Paint and Coating Testing Manual, Fourteenth Edition of the Gardner-Sward Handbook,” (Koleske, J. V. Ed.), pp. 470-480, 1995.

[0671] K. Removing a Coating or Film

[0672] In certain embodiments, it may be desirable to remove a coating and/or film from a surface such as a

non-film forming coating, a temporary film, a self-cleaning film, a coating and/or film that has been damaged, or is otherwise no longer desired or no longer is suitable for use. Various coating removers (e.g., a paint remover) are known to those of ordinary skill in the art, and often comprise solvents described herein capable of dissolving a coating component (e.g., a binder) integral to a film’s structural integrity. Standard procedures for determining the effectiveness of a coating remover have been described, for example, in “ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings,” D6189-97, 2002.

EXAMPLE 1

Preparation of Microorganism Powder

[0673] In a typical preparation, a single colony of bacteria is selected and cultured in a rich media. After growth to saturation, the cells are concentrated by centrifugation at 7000 rotations per minute (“rpm”) for 10 minutes for example. The cell pellet is then resuspended in a volatile organic solvent such as acetone one or two times in order to dessicate the cells and to remove a substantial portion of the water contained in the cell pellet. The pellet may then be ground or milled to a powder form. The powder may be frozen or stored at ambient conditions for future use, or may be added immediately to a surface coating formulation. Additionally, the powder may be freeze dried, combined with a cryoprotectant (e.g., cryopreservative), or a combination thereof.

EXAMPLE 2

Two-Pack Microorganism Paint Coating

[0674] In an example of use of the powder prepared as described in Example 1, 3 mg of the milled powder was added to 3 ml of 50% glycerol. The suspension was then added to 100 ml of Olympic® premium interior flat latex paint (Olympic®, One PPG Place, Pittsburg, Pa. 15272 USA). The paint was applied to a hard, metal surface. The surface used was a non-galvanized steel surface that was cleaned through being degreased, and pretreated with a primer coat.

EXAMPLE 3

Large-Scale Batch Fermentation to Produce a Microorganism

[0675] Batch Culture-Rich Medium comprised 24 g/L yeast extract; 12 g/L casein hydrolysate; 4 ml/L glycerol; 2.31 g/L KH_2PO_4 ; 12.54 g/L K_2HPO_4 ; 0.24 g/L $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$; 2 g/L glucose; 0.2 ml/L PPG2000; and 100 $\mu\text{g/ml}$ ampicillin.

[0676] Batch Culture-5 L scale was grown at the following conditions: 30° C.; 400-450 rpm agitation; DO controlled at 20%; uncontrolled initial pH between 6.8-6.9; 5 Lpm (1 vvm) aeration; and atmospheric pressure. Over a time period of 0 to 50 hours, the *Escherichia coli* strain’s growth was measured by optical density at 600 nm, the pH measured over a range of pH 6 to pH 9, the agitation measured over a range of 0 rpm to 500 rpm, and the dissolved oxygen measured over a range of 0% to 100%.

[0677] Batch Culture-400 L scale was grown at the following conditions: 30° C.; 150-200 rpm agitation; DO at 0-100%; uncontrolled initial pH 6.58; 200-300 Lpm (0.5-0.75 vvm) aeration; and tank pressure at 0-10 psi. Over a time period of 0 to 30 hours, the *Escherichia coli* strain's growth was measured by optical density at 600 nm, the pH measured over a range of pH 6 to pH 8, the agitation measured over a range of 0 rpm to 200 rpm, the dissolved oxygen measured over a range of 0% to 100%, the aeration rate measured over a range of 0 to 300 Lpm, and the tank pressure measured over a range of 0 psi to 12 psi.

EXAMPLE 4

Large-Scale Fed-Batch Fermentation to Produce a Microorganism

[0678] Fed Batch Culture-Defined Medium comprised 13.3 g/L KH_2PO_4 ; 4 g/L $(\text{NH}_4)_2\text{SO}_4$; 1.7 g/L citric acid; 10 g/L glycerol; 1.2 g/L $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$; 0.024 g/L $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$; 2.26 mg/L $\text{CuCl}_2 \cdot \text{H}_2\text{O}$; 5 mg/L H_3BO_3 ; 4.5 mg/L Thiamine.HCl; 4 mg/L $\text{Na}_2\text{MoO}_4 \cdot 7\text{H}_2\text{O}$; 0.06 g/L Fe(III) citrate; 8.4 mg/L EDTA; 4 mg/L $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$; 8 mg/L $\text{Zn}(\text{acetate})_2 \cdot \text{H}_2\text{O}$; and 100 $\mu\text{g}/\text{ml}$ ampicillin.

[0679] Feed: 500 g/L carbon source and 10 g/L $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$.

[0680] Batch Culture-5 L scale was grown at the following conditions: 30° C.; 200-1000 rpm agitation; DO controlled at 20%; pH controlled at 6.5; 5 Lpm (1 vvm) aeration; and atmospheric pressure. Feed was initiated as the 16th hour, with the feed rate profile a constant rate with stepwise increments. Over a time period of 0 to 70 hours, the *Escherichia coli* strain's growth was measured by optical density at 600 nm, the pH measured over a range of pH 6 to pH 9, and the addition of the feed measured from 0 ml to 1000 ml.

EXAMPLE 5

Coating Formulation

[0681] It is contemplated that any described coating composition may be altered (e.g., by direct addition and/or coating component substitution) to incorporate the cell-based particulate material of the present invention. The previous embodiments of the invention primarily described compositions and techniques for preparing, testing, and using a coating prepared de novo. However, it is contemplated that the cell-based particulate material of the present invention may be incorporated into a standard coating by direct addition, as described in Example 2. In specific aspects, it is contemplated that such added cell-based particulate material may comprise 0.000001% to 65% or more, including all intermediate ranges and combinations thereof, by weight or volume, of the final composition produced by a combination of a coating and the cell-based particulate material of the present invention.

[0682] Alternatively, it is contemplated that a previously described coating composition may be altered by substitution ("replacement") of one or more coating components, particularly a binder and/or a particulate material coating component (e.g., a pigment, a rheological control agent, a dispersant) by the cell-based particulate material of the present invention. It is contemplated that 0.000001% to

100%, including all intermediate ranges and combinations thereof, of the binder and/or particulate material coating component may be substituted by cell-based particulate material of the present invention. Additionally, the concentration of a cell-based particulate material of the present invention may exceed 100%, by weight or volume, of the substituted coating component. In specific aspects, a coating component may be substituted with a cell-based particulate material of the present invention equivalent to 0.000001% to 500%, including all intermediate ranges and combinations thereof, of the coating component. For example, 20% (e.g., 2 kg) of a dispersant may be replaced by 10% (e.g., 1 kg) of the cell-based particulate material of the present invention to produce a coating with similar dispersion properties as a non-substituted formulation. In an addition example, 70% of a specific pigment (e.g., 7 kg) may be replaced by the equivalent of 127% (e.g., 12.7 kg) of the cell-based particulate material of the present invention to produce a coating with similar hiding power as a non-substituted formulation. The various assays described herein, or as would be known to one of ordinary skill in the art in light of the present disclosures, may be used to determine the properties of a coating and/or film produced by direct addition and/or coating component substitution by the cell-based particulate material of the present invention.

[0683] The following is an example of an exterior gloss alkyd house paint that comprises various particulate materials (e.g., silica, a shading pigment, bentonite clay) that may incorporate a cell-based particulate material of the present invention. This example of an exterior gloss alkyd house paint comprises a grind and a letdown. The grind comprises by weight or volume: a first alkyd 232.02 lb or 29.9 gallons; a second alkyd 154.2 lb or 20 gallons; an aliphatic solvent (e.g., duodecane) 69.55 lb or 1.7 gallons; lecithin 7.8 lb or 0.91 gallons; TiO_2 185.25 lb or 5.43 gallons; 10 micron silica 59.59 lb or 2.7 gallons; bentonite clay 18.00 lb or 1.44 gallons; a second alkyd 97.22 lb or 12.61 gallons; a first alkyd 69.84 lb or 9.00 gallons; and mildewcide 7.8 lb or 0.82 gallons. The letdown comprises by weight or volume: aliphatic solvent (e.g., duodecane) 19.50 lb or 3.00 gallons; a first drier (e.g., 12% solution cobalt) 2.00 lb or 0.23 gallons; a second drier (e.g., 18% solution Zr) 2.92 lb or 0.32 gallons; a third drier 3 (e.g., 10% solution Ca) 8.00 lb or 0.98 gallons; methyl ethyl ketoxime (Anti skinning agent) 3.22 lb or 0.42 gallons; an aliphatic solvent 9.75 lb or 1.50 gallons; and a shading pigment 0.3 lb or 0.04 gallons. In some embodiments, the particulate material of the coating formulation may be partly or fully substituted by the cell-based particulate material of the present invention. In other embodiments, the above formulation may be enhanced by direct addition of a cell-based particulate material of the present invention.

[0684] In another example, the following exterior flat latex house paint may be modified to incorporate a cell-based particulate material of the present invention. This example of an exterior flat latex house paint formulation, in typical order of addition, by weight or volume: water, 244.5 lb or 29.47 gallons; hydroxyethylcellulose, 3 lb or 0.34 gallons; glycols, 60 lb or 6.72 gallons; polyacrylate dispersant, 6.8 lb or 0.69 gallons; biocides, 10 lb or 1 gallons; non-ionic surfactant, 1 lb or 0.11 gallons; titanium dioxide, 225 lb or 6.75 gallons; silicate mineral, 160 lb or 7.38 gallons; calcined clay, 50 lb or 2.28 gallons; acrylic latex, @ 60%, 302.9 lb or 34.42 gallons; coalescent, 9.3 lb or 1.17 gallons; defoamers, 2 lb or 0.26 gallons; ammonium hydroxide, 2.2

lb or 0.29 gallons; 2.5% HEC solution, 76 lb or 9.12 gallons. In some embodiments, the particulate material (e.g., silicate mineral, calcined clay, titanium dioxide) of this coating formulation may be partly or fully substituted by the cell-based particulate material of the present invention. In other embodiments, the above formulation may be enhanced by direct addition of a cell-based particulate material of the present invention.

[0685] It is contemplated that any such previously described coating formulation may be modified to incorporate a cell-based particulate material of the present invention. Examples of described coating compositions include over 200 industrial water-borne coating formulations (e.g., air dry coatings, air dry or force air dry coatings, anti-skid of non-slip coatings, bake dry coatings, clear coatings, coil coatings, concrete coatings, dipping enamels, lacquers, primers, protective coatings, spray enamels, traffic and air-field coatings) described in "Industrial water-based paint formulations," 1988, over 550 architectural water-borne coating formulations (e.g., exterior paints, exterior enamels, exterior coatings, interior paints, interior enamels, interior coatings, exterior/interior paints, exterior/interior enamels, exterior/interior primers, exterior/interior stains), described in "Water-based trade paint formulations," 1988, the over 400 solvent borne coating formulations (e.g., exterior paints, exterior enamels, exterior coatings, exterior sealers, exterior fillers, exterior primers, interior paints, interior enamels, interior coatings, interior primers, exterior/interior paints, exterior/interior enamels, exterior/interior coatings, exterior/interior varnishes) described in "Solvent-based paint formulations," 1977; and the over 1500 prepaint specialties and/or surface tolerant coatings (e.g., fillers, sealers, rust preventives, galvanizers, caulks, grouts, glazes, phosphatizers, corrosion inhibitors, neutralizers, graffiti removers, floor surfacers) described in "Prepaint Specialties and Surface Tolerant Coatings," by Ernest W. Flick, Noyes Publications, 1991.

EXAMPLE 6

Ranges

[0686] To provide a description of the present invention that is both concise and clear, various examples of ranges have been identified herein with the phrase "including all intermediate ranges and combinations thereof." Examples of specific values (e.g., %, kDa, °C., μm , kg/L, Ku) that can be within a cited range by the reference to "including all intermediate ranges and combinations thereof" include 0.000001, 0.000002, 0.000003, 0.000004, 0.000005, 0.000006, 0.000007, 0.000008, 0.000009, 0.00001, 0.00002, 0.00003, 0.00004, 0.00005, 0.00006, 0.00007, 0.00008, 0.00009, 0.0001, 0.0002, 0.0003, 0.0004, 0.0005, 0.0006, 0.0007, 0.0008, 0.0009, 0.001, 0.002, 0.003, 0.004, 0.005, 0.006, 0.007, 0.008, 0.009, 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, 0.10, 0.11, 0.12, 0.13, 0.14, 0.15, 0.16, 0.17, 0.18, 0.19, 0.20, 0.21, 0.22, 0.23, 0.24, 0.25, 0.26, 0.27, 0.28, 0.29, 0.30, 0.31, 0.32, 0.33, 0.34, 0.35, 0.36, 0.37, 0.38, 0.39, 0.40, 0.41, 0.42, 0.43, 0.44, 0.45, 0.46, 0.47, 0.48, 0.49, 0.50, 0.51, 0.52, 0.53, 0.54, 0.55, 0.56, 0.57, 0.58, 0.59, 0.60, 0.61, 0.62, 0.63, 0.64, 0.65, 0.66, 0.67, 0.68, 0.69, 0.70, 0.71, 0.72, 0.73, 0.74, 0.75, 0.76, 0.77, 0.78, 0.79, 0.80, 0.81, 0.82, 0.83, 0.84, 0.85, 0.86, 0.87, 0.88, 0.89, 0.90, 0.91, 0.92, 0.93, 0.94, 0.95, 0.96, 0.97, 0.98, 0.99, 1.00, 1.01, 1.02, 1.03, 1.04, 1.05,

1.06, 1.07, 1.08, 1.09, 1.10, 1.11, 1.12, 1.13, 1.14, 1.15, 1.16, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 1.23, 1.24, 1.25, 1.26, 1.27, 1.28, 1.29, 1.30, 1.31, 1.32, 1.33, 1.34, 1.35, 1.36, 1.37, 1.38, 1.39, 1.40, 1.41, 1.42, 1.43, 1.44, 1.45, 1.46, 1.47, 1.48, 1.49, 1.50, 1.51, 1.52, 1.53, 1.54, 1.55, 1.56, 1.57, 1.58, 1.59, 1.60, 1.61, 1.62, 1.63, 1.64, 1.65, 1.66, 1.67, 1.68, 1.69, 1.70, 1.71, 1.72, 1.73, 1.74, 1.75, 1.76, 1.77, 1.78, 1.79, 1.80, 1.81, 1.82, 1.83, 1.84, 1.85, 1.86, 1.87, 1.88, 1.89, 1.90, 1.91, 1.92, 1.93, 1.94, 1.95, 1.96, 1.97, 1.98, 1.99, 2.00, 2.01, 2.02, 2.03, 2.04, 2.05, 2.06, 2.07, 2.08, 2.09, 2.10, 2.11, 2.12, 2.13, 2.14, 2.15, 2.16, 2.17, 2.18, 2.19, 2.20, 2.21, 2.22, 2.23, 2.24, 2.25, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 3.0, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 4.0, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 5.0, 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 6.0, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 7.0, 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 8.0, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 9.0, 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7, 9.8, 9.9, 10.0, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 99.10, 99.20, 99.30, 99.40, 99.50, 99.60, 99.70, 99.80, 99.90, 99.91, 99.92, 99.93, 99.94, 99.95, 99.96, 99.97, 99.98, 99.99, 99.999, 99.9999, 99.99999, 99.999999, 99.9999999, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 260, 270, 275, 280, 290, 300, 310, 320, 325, 330, 340, 350, 360, 370, 375, 380, 390, 400, 410, 420, 425, 430, 440, 450, 460, 470, 475, 480, 490, 500, 510, 520, 525, 530, 540, 550, 560, 570, 575, 580, 590, 600, 610, 620, 625, 630, 640, 650, 660, 670, 675, 680, 690, 700, 710, 720, 725, 730, 740, 750, 760, 770, 775, 780, 790, 800, 810, 820, 825, 830, 840, 850, 860, 870, 875, 880, 890, 900, 910, 920, 925, 930, 940, 950, 960, 970, 975, 980, 990, 1000, 1025, 1050, 1075, 1100, 1125, 1150, 1175, 1200, 1225, 1250, 1275, 1300, 1325, 1350, 1375, 1400, 1425, 1450, 1475, 1500, 1525, 1550, 1575, 1600, 1625, 1650, 1675, 1700, 1725, 1750, 1775, 1800, 1825, 1850, 1875, 1900, 1925, 1950, 1975, 2000, 2100, 2200, 2300, 2400, 2500, 2600, 2700, 2800, 2900, 3000, 3100, 3200, 3300, 3400, 3500, 3600, 3700, 3800, 3900, 4000, 4100, 4200, 4300, 4400, 4500, 4600, 4700, 4800, 4900, 5000, 5250, 5500, 5750, 6000, 6250, 6500, 6750, 7000, 7250, 7500, 7750, 8000, 8250, 8500, 8750, 9000, 9250, 9500, 9750, 10,000, 25,000, 50,000, 75,000, 100,000, 250,000, 500,000, 1,000,000, or more. In certain parts of the specification, particularly in the Summary of the Invention, additional examples of the use of this definition to specify sub-ranges are given.

[0687] In embodiments wherein a value or range is denoted in exponent form, both the integer and the exponent values are included in the definition of "including all intermediate ranges and combinations thereof." For example, a

range of 1.0×10^{-17} to 2.5×10^{-7} , including all intermediate ranges and combinations thereof, would include a description for a sub-range such as 1.24×10^{-17} to 8.7×10^{-11} .

[0688] However, general sub-ranges for each type of unit (e.g., %, kDa, °C., pm, kg/L, Ku) are contemplated, as the values typically found within a particular type of unit are of a sub-range of the intergers described above. For example, integers typically found within a cited percentage range, as applicable, include 0.000001% to 100%, including all intermediate ranges and combinations thereof. Examples of values that are often found within a cited molecular mass range in kilo Daltons ("kDa") as applicable for many coating components include 0.50 kDa to 110 kDa, including all intermediate ranges and combinations thereof. Examples of values that are often within a cited temperature range in degrees Celsius ("°C.") as is typically applicable in the arts of coatings and surface treatments include -10° C. to 500° C., including all intermediate ranges and combinations thereof. Examples of values that can be within a thickness range in micrometers ("μm") as is typically applicable to coating and/or film thickness upon a surface include 1 μm to 2000 μm, including all intermediate ranges and combinations thereof. Examples of values that can be within a cited density range in kilograms per liter ("kg/L") as is typically applicable in the arts of coatings and surface treatments include 0.50 kg/L to 20 kDa, including all intermediate ranges and combinations thereof. Examples of values that can be within a cited shear rate range in Krebs Units ("Ku"), as is typically applicable in the arts of coatings and surface treatments, include 20 Ku to 300 Ku, including all intermediate ranges and combinations thereof.

EXAMPLE 7

Elastomers

[0689] It is contemplated that a cell-based particulate material may also be incorporated into an elastomer. Elastomers ("rubbers") are polymers that can undergo large, but reversible, deformations upon a relatively low physical stress. It is contemplated that an elastomer composition may incorporate a cell-based particulate material of the present invention, such as by preparation with the cell-based particulate material and/or direct addition such as by a multi-pack composition. Elastomers (e.g., tire rubbers, polyurethane elastomers, polymers ending in an anionic diene, segmented polyurethane-urea copolymers, diene triblock polymers with styrene- α -methylstyrene copolymer end blocks, poly(p-methylstyrene-*b*-p-methylstyrene), polydimethylsiloxane-vinyl monomer block polymers, chemically modified natural rubber, polymers from hydrogenated polydienes, polyacrylic elastomers, polybutadienes, trans-polyisoprene, polyisobutene, cis-1,4-polybutadiene, polyolefin thermoplastic elastomers, block polymers, polyester thermoplastic elastomer, thermoplastic polyurethane elastomers) and techniques of elastomer synthesis and elastomer property analysis have been described, for example, in Walker, B. M., ed., *Handbook of Thermoplastic Elastomers*, Van Nostrand Reinhold Co., New York, 1979; Holden, G., ed., et. al., *Thermoplastic Elastomers*, 2nd Ed., Hanser Publishers, Verlag, 1996.

EXAMPLE 8

Fillers and Filled Polymers

[0690] A filler is a bulk material in a composition. Extender pigments are used as a filler for coatings. In certain

embodiments, a cell-based particulate material may be used as a filler for various compositions. Examples of compositions that use fillers that are contemplated herein for incorporation of a cell-based particulate material of the present invention, include a composition comprising a polymer, thermoplastic material, a thermostat material, an elastomer, or a combination thereof. Such filler comprising materials have been described in Gerard, J. F., ed., *Fillers and Filled Polymers-Macromolecular Symposia* 169, Wiley-VCH, Verlag, 2001; Slusarski, L., ed., *Fillers for the New Millennium-Macromolecular Symposia* 194, Wiley-VCH, Verlag, 2003; and Landrock, A. H., *Adhesives Technology Handbook*, Noyes Publications, New Jersey, 1985.

EXAMPLE 9

Adhesives and Sealants

[0691] An adhesive is a composition that is capable of holding at least two surfaces together in a strong and permanent manner. A sealant is a composition capable of attaching to at least two surfaces, filling the space between them to provide a barrier or protective coating. In certain embodiments, a cell-based particulate material of the present invention may be used as a component of an adhesive or a sealant, such as, for example, by direct addition, substitution of an adhesive or sealant component (e.g., a particulate material), or a combination thereof.

[0692] Examples of adhesives and sealants (e.g., caulks, acrylics, elastomers, phenolic resin, epoxy, polyurethane, anarobic and structural acrylic, high-temperature polymers, water-based industrial type adhesives, water-based paper and packaging adhesives, water-based coatings, hot melt adhesives, hot melt coatings for paper and plastic, epoxy adhesives, plastisol compounds, construction adhesives, flocking adhesives, industrial adhesives, general purpose adhesives, pressure sensitive adhesives, sealants, mastics, urethanes,) for various surfaces (e.g., metal, plastic, textile, paper), adhesive and sealant components (e.g., antifoams, antioxidants, extenders, fillers, pigments, flame/fire retardants, oils, polymer emulsions, preservatives, bactericides, fungicides, resins, rheological/viscosity control agents, starches, waxes, acids, aluminum silicates, antiskinning agents, calcium carbonates, catalysts, cross-linking agents, curing agents, clays, corn starch, starch derivatives, defoamers, antifoams, dispersing agents, emulsifying agents, epoxy resin diluents, lattices, polybutenes, polyvinyl acetates, preservatives, acrylic resins, epoxy resins, ester gums, ethylene/vinyl acetate resins, maleic resins, natural resins, phenolic resins, polyamide resins, polyethylene resins, polypropylene resins, polyterpene resins, powder coating resins, radiation coating resins, urethane resins, vinyl chloride resins, emulsion resins, dispersion resins, resin esters, rosins, silicas, silicon dioxide, stabilizers, surfactants/surface active agents, tales, thickeners, thixotropic agents, waxes) techniques of preparation and assays for properties, have been described in Skeist, I., ed., *Handbook of Adhesives*, 3rd Ed., Van Nostrand Reinhold, New York, 1990; Satriana, M. J. *Hot Melt Adhesives: Manufacture and Applications*, Noyes Data Corporation, New Jersey, 1974; Petrie, E. M., *Handbook of Adhesives and Sealants*, McGraw-Hill, New York, 2000; Hartshorn, S. R., ed., *Structural Adhesives-Chemistry and Technology*, Plenum Press, New York, 1986; Flick, E. W., *Adhesive and Sealant Compound Formulations*, 2nd Ed.,

Noyes Publications, New Jersey, 1984; Flick, E., *Handbook of Raw Adhesives* 2nd Ed., Noyes Publications, New Jersey, 1989; Flick, E., *Handbook of Raw Adhesives*, Noyes Publications, New Jersey, 1982; Dunning, H. R., *Pressure Sensitive Adhesives-Formulations and Technology*, 2nd Ed., Noyes Data Corporation, New Jersey, 1977; and Flick, E. W., *Construction and Structural Adhesives and Sealants*, Noyes Publications, New Jersey, 1988.

EXAMPLE 10

Textiles

[0693] It is contemplated that a cell-based particulate material of the present invention may also be incorporated (e.g., direct addition to a formulation, incorporation as a component of a de novo formulation during preparation, etc.) into a material applied to a textile, such as, for example, a textile finish. Materials for application to a textile, textile finishes (e.g., soil-resistant finishes, stain-resistant finishes) and finish components (e.g., antioxidants, defoamers, antimicrobials, wetting agents, flame retardants, softeners, soil repellents, hand modifiers, antistatic agents, biocides, fixatives, scouring agents, dispersants, defoamers, anticracking agents, binders, stiffeners, cohesive agents, fiber lubricants, emulsifiers, antistats, yarn to hard surface lubricants) as well as assays for determining their properties are described, for example, in Johnson, K., *Antistatic Compositions for Textiles and Plastics*, Noyes Data Corporation, New Jersey, 1976; Rouette, H. K., *Encyclopedia of Textile Finishing*, Springer, Verlag, 2001; "Textile Finishing Chemicals: An Industrial Guide," by Ernest W. Flick, Noyes Publications, 1990; "Handbook of Fiber Finish Technology," by Philip E. Slade, Marcel Dekker, 1998; "ASTM Book of Standards, Volume 07.01 Textiles (I)," 2003; and "ASTM Book of Standards, Volume 07.02 Textiles (II)," 2003. A specific example of a textile finish is the trademark formulations of water repellent and/or oil repellent finish known as Scotch-guard™ (3M Corporate Headquarters, Maplewood, Minn., U.S.A.).

EXAMPLE 11

Waxes

[0694] It is contemplated that a cell-based particulate material of the present invention may also be incorporated (e.g., direct addition to a formulation, incorporation as a component of a de novo formulation during preparation, etc.) into a material applied to a surface after manufacture, such as, for example, a wax. Waxes, polishes, floor coverings, cleaning materials, and related formulations (e.g., natural waxes, fossil waxes, earth waxes, peat waxes, montana waxes, lignite paraffins, petroleum waxes, synthetic waxes, commercial modified, blended, and compounded waxes, emulsifiable waxes, waxy alcohols, waxy acids, metallic soaps, compounded waxes, paraffin wax compounds, ethyl cellulose and wax mixtures, compositions with resins and rubber) and methods of preparation of waxes, polishes, floor coverings, cleaning materials, and related formulations and assays for their properties have been described, for example, in Warth, A. H., "The Chemistry and Technology of Waxes," Reinhold Publishing Corporation, New York, 1956; Bennet, H., "Industrial Waxes Volume II Compounded Waxes and Technology," Chemical Publishing Co., New York, 1975; "Industrial Waxes Volume

I Natural & Synthetic Waxes," Chemical Publishing Co., New York, 1975; Flick, E. W., "Advanced Cleaning Product Formulations Household, Industrial, Automotive," 1989; Flick, E. W., "Institutional and Industrial Cleaning Product Formulations," 1985; Flick, E. W., "Household and Automotive Chemical Specialties Recent Formulations," 1979; Flick, E. W., "Household, Automotive, and Industrial Chemical Formulations 2nd Edition," 1984; Flick, E. W., "Household and Automotive Cleaners and Polishes 3rd Edition," 1986; "Ullmann's Encyclopedia of Industrial Chemistry, Volume 28," 1996; "Coatings Technology Handbook 2nd Edition Revised and Expanded," 2001; Sequeira, A. Jr., "Lubricant Base Oil and Wax Processing," 1994; "ASTM Book of Standards, Volume 15.04 Soaps and Other Detergents; Polishes; Leather; Resilient Floor Coverings," 2003; "ASTM Book of Standards, Volume 05.01 Petroleum Products and Lubricants (I)," 2003; "ASTM Book of Standards, Volume 05.02 Petroleum Products and Lubricants (II)," 2003; and "ASTM Book of Standards, Volume 05.03 Petroleum Products and Lubricants (III)," 2003.

EXAMPLE 12

Physical and Chemical Structure of Gram-positive Eubacteria

[0695] Gram-positive Eubacteria comprise a cell wall that surrounds a phospholipid bilayer known as the "cell membrane" or "cytoplasmic membrane." The thickness of a Gram-positive cell wall is generally 200 Å to 500 Å. The Gram-positive cells often comprise 15% to 20% cell wall, by dry weight. The dry weight amino-sugar component of a Gram-positive cell wall is typically 10% to 30%, generally attributed to the presence of peptidoglycan. Often, the majority of the phosphorus content of cell walls is between 2% and 5% attributed to the presence of teichoic acid, though 0.2% to 0.5% phosphorus content is thought to be attributed to other sources. The dry weight lipid content of a Gram-positive cell wall is commonly 0% to 2%.

EXAMPLE 13

Physical and Chemical Structure of Gram-negative Eubacteria

[0696] Gram-negative cells often comprise 5% to 10% cell wall, by dry weight. The thickness of a Gram-negative cell wall is generally 100 Å to 150 Å. The dry weight amino-sugar component of Gram-negative cell wall is typically 1% to 10%. The dry weight lipid content of a Gram-negative cell wall is commonly 10% to 20%. Gram-negative cells comprise a phospholipid bilayer known as the "outer cell membrane" that surrounds the cell wall. The outer cell membrane is generally impermeable to molecules smaller than 0.7 kDa. The cell wall surrounds a second phospholipid bilayer known as the "inner cell membrane" or "cytoplasmic membrane." The region between the cell wall and the inner cell membrane is known as the "periplasmic space," wherein some enzymes produced by the cell are targeted.

EXAMPLE 14

Examples of Eubacteria

[0697] Additional examples of Eubacteria and their biological culture collection sources are shown at Table 12

below. It is contemplated that the cell sizes, shapes and biochemistry will be similar to the previously described Eubacteria.

TABLE 12

<u>Additional Examples of Eubacteria</u>	
Genus	Examples of Culture Collection Strains
Abiotrophia	ATCC Nos. 49176 and 700209; DSMZ No. 9849
Acetitomaculum	ATCC No. 43876; DSMZ No. 5522
Acetohalobium	ATCC No. 49924; DSMZ No. 5501
Acetonema	ATCC No. 51454; DSMZ No. 6540
Achromobacter	DSMZ Nos. 10342, 653, 4612, 8374 and 11850
Acidimicrobium	DSMZ No. 10331
Acidithiobacillus	DSMZ Nos. 14366 8584, 14882 and 14887
Acidobacterium	ATCC No. 51196; DSMZ No. 11244
Acidocella	ATCC Nos. 35904, 51361 and 51362; DSMZ No. 11237
Acrocarpospora	DSMZ Nos. 43316, 44705 and 44706
Actinoalloteichus	DSMZ No. 43889
Actinobacillus	DSMZ Nos. 11374, 13472 and 5568
Actinobaculum	ATCC No. 27412; DSMZ Nos. 15541 and 20639
Actinocorallia	DSMZ Nos. 43924, 44360, 44254, 43554 and 44361
Aequorivita	DSMZ Nos. 14231, 14293, 14236 and 14238
Afipia	ATCC No. 49718; DSMZ Nos. 7327, 7315 and 7326
Agreia	DSMZ No. 14575
Agrococcus	ATCC No. 700088; DSMZ Nos. 14215, 12453 and 9580
Ahrensia	ATCC No. 25656; DSMZ No. 5890
Albibacter	DSMZ No. 13819
Albidovulum	ATCC No. BAA-387; DSMZ Nos. 12048 and 12049
Alcanivorax	ATCC Nos. 700651 and 700854; DSMZ No. 12178
Alicyclophilus	DSMZ No. 14773
Alicyclobacillus	DSMZ Nos. 14558, 446, 4006, 12489 and 14955
Alkalibacterium	DSMZ Nos. 13175, 12937 and 12938
Alkalilimnicola	DSMZ No. 13718
Alkalispirillum	DSMZ No. 12769
Alkanindiges	DSMZ No. 15370
Aminobacterium	ATCC No. BAA-7; DSMZ Nos. 12261 and 12262
Aminomonas	ATCC No. BAA-6; DSMZ No. 12260
Ammonifex	DSMZ No. 10501
Ammoniphilus	ATCC No. 700648; DSMZ Nos. 11538 and 11537
Anaerococcus	ATCC No. 51455; DSMZ No. 6283
Anaerobacter	DSMZ No. 5272
Anaerobaculum	DSMZ Nos. 13181 and 13490
Anaerobranca	DSMZ Nos. 13577, 9786 and 10095
Anaerococcus	DSMZ Nos. 7454, 7456, 11663, 2951 and 7457
Anaerofilum	DSMZ Nos. 4272 and 7168
Anaeromusa	ATCC No. 43704; DSMZ No. 3853
Anaerophaga	DSMZ No. 12881
Anaeroplasmia	DSMZ No. 3268
Anaerosinus	ATCC No. 51177; DSMZ No. 5192
Anaerostipes	DSMZ No. 14662
Anaerovorax	DSMZ No. 5092
Aneurinibacillus	DSMZ Nos. 5562 2895, 8373, 10154 and 10155
Angiococcus	DSMZ Nos. 52473, 52474, 52475, 52476 and 52477
Anoxybacillus	ATCC No. 700785; DSMZ Nos. 2641 and 12423
Antarctobacter	DSMZ Nos. 11445 and 11440
Aquabacter	ATCC No. 43981; DSMZ No. 9035
Aquabacterium	DSMZ Nos. 11900, 11901 and 11968
Aquamicrobium	DSMZ No. 11603
Aquifex	DSMZ No. 6858
Acobacter	DSMZ Nos. 8739, 7289, 7299 and 7302
Arhodomonas	ATCC No. 49307; DSMZ No. 8974
Asanoa	ATCC No. 49966; DSMZ Nos. 44099 and 44718
Atopobium	DSMZ Nos. 20586, 20585, 20469 and 7090
Azoarcus	DSMZ Nos. 12081, 14744, 6898, 9506 and 15124
Azorhizophilus	ATCC Nos. 23368 and 35116; DSMZ Nos. 2283 and 88
Azospira	DSMZ No. 13638
Bacteriovorax	ATCC Nos. 15145 and 27052; DSMZ No. 12778
Bartonella	ATCC Nos. 35685, 49793, 49927, 51672 and 51694
Beutenbergia	ATCC No. BAA-8; DSMZ Nos. 12333 and 12334
Bilophila	ATCC Nos. 49260 and 51581; DSMZ No. 11045
Blastococcus	DSMZ Nos. 4725, 44517 and 44518
Blastomonas	ATCC No. 35951; DSMZ Nos. 3183 and 9006
Bogoriella	ATCC No. 700413; DSMZ No. 11294
Bosea	ATCC Nos. 700366 and 700918; DSMZ No. 9653

TABLE 12-continued

<u>Additional Examples of Eubacteria</u>	
Genus	Examples of Culture Collection Strains
Brachymonas	DSMZ No. 15123
Brackiella	DSMZ No. 13743
Brenneria	DSMZ Nos. 11811, 30175, 4561, 4483 and 30166
Brevibacillus	DSMZ Nos. 6348, 6347, 7064, 9887, 335, 9885 and 8552
Bulleidia	ATCC No. BAA-170; DSMZ No. 13220
Burkholderia	DSMZ Nos. 9511, 50341, 13243, 13276 and 11319
Caenibacterium	DSMZ No. 15264
Caldicellulosiruptor	DSMZ Nos. 12137, 9545, 13100 and 8903
Caldithrix	DSMZ No. 13497
Caloramator	DSMZ Nos. 12679, 5463, 10124 and 13723
Caloranaerobacter	DSMZ No. 13643
Caminibacter	DSMZ No. 14510
Caminicella	DSMZ No. 14501
Carbophilus	ATCC No. 51424; DSMZ No. 1086
Carboxydibrachium	DSMZ No. 12653
Carboxydocella	DSMZ No. 12326
Carboxydotherrmus	DSMZ No. 6008
Catenococcus	ATCC No. 51228; DSMZ No. 9165
Catenuloplanes	DSMZ Nos. 44707, 44128, 44102, 44710 and 44709
Cellulosimicrobium	ATCC No. 27401; DSMZ Nos. 43879 and 10177
Chelatococcus	ATCC No. 51531; DSMZ Nos. 6462 and 6461
Chlorobaculum	DSMZ No. 12025
Chryseobacterium	ATCC Nos. 13255, 27950, 29896, 29897 and 33487
Chrysiogenes	ATCC No. 700172; DSMZ No. 11915
Citricoccus	DSMZ No. 14442
Collinsella	ATCC No. 29738; DSMZ Nos. 3979, 13280 and 13279
Colwellia	ATCC No. 27364; DSMZ No. 8813
Conexibacter	DSMZ No. 14684
Coprothermobacter	ATCC No. 35245; DSMZ Nos. 11748, 5265 and 9218
Couchioplanes	ATCC Nos. 31157 and 33937; DSMZ Nos. 43900 and 43634
Crossiella	ATCC No. 51143; DSMZ Nos. 44230 and 44580
Cryobacterium	ATCC No. 43563; DSMZ No. 4854
Cryptosporangium	DSMZ Nos. 44712, 46144, 44713 and 44714
Dechloromonas	ATCC No. 700666; DSMZ No. 13637
Deferribacter	DSMZ Nos. 14873, 14783 and 14813
Defluviibacter	DSMZ No. 11099
Dehalobacter	DSMZ No. 9455
Delftia	ATCC No. 13751 and 29861; DSMZ Nos. 1621 and 12781
Demetria	DSMZ No. 11295
Dendrosporobacter	ATCC No. 25974; DSMZ No. 1736
Denitrovibrio	DSMZ No. 12809
Dermacoccus	ATCC No. 29093; DSMZ No. 20448
Desemzia	ATCC No. 8363; DSMZ No. 20581
Desulfacinum	DSMZ Nos. 13146 and 9756
Desulfitobacterium	DSMZ Nos. 11544, 9161, 10664, 15288 and 10344
Desulfobacca	DSMZ No. 11109
Desulfobacula	ATCC No. 43956; DSMZ Nos. 3384 and 7467
Desulfocapsa	DSMZ Nos. 10523 and 7269
Desulfocella	DSMZ No. 11763
Desulfofaba	DSMZ No. 12344
Desulfofrigus	DSMZ Nos. 12345 and 12341
Desulfofustis	ATCC No. 700454; DSMZ No. 9705
Desulfoshalobium	DSMZ No. 5692
Desulfomusa	DSMZ No. 12642
Desulfonatronovibrio	DSMZ No. 9292
Desulfonatronum	DSMZ Nos. 10312 and 14708
Desulfonauticus	DSMZ No. 15269
Desulfonispora	ATCC No. 700533; DSMZ No. 11270
Desulforegula	DSMZ No. 13527
Desulforhabdus	ATCC No. 51979; DSMZ No. 10338
Desulforhopalus	DSMZ Nos. 12130, 13038 and 9700
Desulfospira	ATCC No. 700409; DSMZ No. 10085
Desulfosporosinus	ATCC No. 23598; DSMZ Nos. 13351, 13257 and 7439
Desulfotalea	DSMZ Nos. 12342 and 12343
Desulfotignum	ATCC No. BAA-19; DSMZ Nos. 7044 and 13687
Desulfovirga	DSMZ No. 12016
Desulfurobacterium	DSMZ No. 11699
Desulfuromusa	DSMZ Nos. 7345, 7343 and 8270
Dethiosulfovibrio	DSMZ Nos. 12590, 12537, 11002 and 12538
Devosia	ATCC No. 9526; DSMZ No. 7230
Dialister	ATCC Nos. 33048 and 51894; DSMZ No. 11619
Diaphorobacter	DSMZ No. 13225

TABLE 12-continued

<u>Additional Examples of Eubacteria</u>	
Genus	Examples of Culture Collection Strains
Dichelobacter	ATCC Nos. 25549, 27521 and 31545; DSMZ No. 20708
Dictyoglomus	ATCC No. 35947; DSMZ Nos. 3960 and 6724
Dietzia	ATCC No. 35013; DSMZ Nos. 43672, 44198 and 44016
Dolosicoccus	ATCC No. BAA-56; DSMZ No. 15742
Dorea	DSMZ Nos. 3992 and 13814
Eggerthella	ATCC Nos. 25559 and 43055; DSMZ No. 2243
Empedobacter	ATCC Nos. 14234, 43319 and 31962; DSMZ No. 30096
Enhygromyxa	DSMZ Nos. 15217 and 15201
Eremococcus	ATCC No. BAA-57; DSMZ No. 15696
Ferrimonas	DSMZ No. 9799
Filifactor	ATCC Nos. 33388 and 35896; DSMZ No. 1645
Filobacillus	ATCC No. 700960; DSMZ No. 13259
Finegoldia	ATCC Nos. 15794 and 53516; DSMZ Nos. 20470 and 20362
Flexistipes	DSMZ No. 4947
Formivibrio	ATCC No. 49791; DSMZ No. 6150
Friedmanniella	ATCC No. BAA-165; DSMZ Nos. 11053, 12936 and 11465
Frigoribacterium	ATCC No. BAA-3; DSMZ No. 10309
Fulvimonas	DSMZ No. 14263
Fusibacter	ATCC No. 700852; DSMZ No. 12116
Gallicola	ATCC No. 49795; DSMZ No. 3244
Garciella	DSMZ No. 15102
Gelidibacter	ATCC No. 700364; DSMZ Nos. 12408 and 14095
Gelria	ATCC No. BAA-262; DSMZ No. 14054
Gemmatimonas	DSMZ No. 14586
Gemmobacter	ATCC No. 49971; DSMZ No. 3857
Geobacillus	DSMZ Nos. 12041, 7263, 13552, 11667 and 13551
Geobacter	DSMZ Nos. 12179, 13689, 7210, 12255 and 12127
Georgenia	DSMZ Nos. 14418 and 14419
Geothrix	ATCC No. 700665; DSMZ No. 14018
Geovibrio	DSMZ No. 11263
Glaciecola	ATCC Nos. 700756 and 700757; DSMZ No. 14239
Gluconacetobacter	DSMZ Nos. 13594, 6161, 11804, 11826 and 2004
Gracilibacillus	ATCC Nos. 700347 and 700849; DSMZ Nos. 11805
Granulicatella	ATCC Nos. 49175, 700633 and 700813; DSMZ No. 9848
Grimontia	DSMZ No. 15132
Halanaerobacter	ATCC No. 49944; DSMZ Nos. 9569, 6640 and 12146
Halanaerobium	DSMZ Nos. 3532, 11287, 2228, 6643 and 10165
Haliangium	DSMZ Nos. 14365 and 14436
Halobacillus	ATCC No. 700077; DSMZ Nos. 2266, 10405 and 10404
Halocella	DSMZ Nos. 7362
Halonatronum	DSMZ Nos. 13868
Halothermothrix	DSMZ Nos. 9562
Halothiobacillus	DSMZ Nos. 6132, 7121, 13162, 15147 and 581
Helcococcus	ATCC Nos. 51366 and BAA-59; DSMZ Nos. 10548
Heliophilum	ATCC No. 51790; DSMZ Nos. 11170
Heliorestis	DSMZ Nos. 13446
Herbidospora	ATCC No. 51904; DSMZ No. 44071
Hippea	ATCC No. 700847; DSMZ Nos. 10411 and 10412
Holdemania	ATCC No. 51649; DSMZ No. 12042
Holophaga	DSMZ Nos. 6591
Hydrogenobacter	DSMZ Nos. 2913 and 6534
Hydrogenobaculum	DSMZ Nos. 11251
Hydrogenophilus	DSMZ Nos. 11420
Hydrogenothermus	ATCC No. BAA-483; DSMZ Nos. 12046
Hydrogenovibrio	DSMZ Nos. 11271
Hymenobacter	DSMZ Nos. 13606, 13607, 11622, 11621 and 13611
Ignavigranum	ATCC No. 700630; DSMZ Nos. 15695
Iodobacter	ATCC Nos. 33051, 49620 and 49621; DSMZ Nos. 3764
Isobaculum	DSMZ Nos. 13760
Janibacter	DSMZ Nos. 13953, 11140, 11141 and 13876
Kineococcus	ATCC Nos. 51238 and BAA-149; DSMZ Nos. 14245
Kineosphaera	DSMZ Nos. 14548
Kitasatosporia	DSMZ Nos. 41650, 41680, 43929, 43860 and 43861
Knoellia	DSMZ Nos. 12331 and 12332
Kocuria	DSMZ Nos. 20032, 14382, 11926, 20447 and 20033
Kozakia	DSMZ Nos. 14400
Kribbella	ATCC No. 39419; DSMZ Nos. 15626
Kutzneria	ATCC No. 25242; DSMZ Nos. 43870, 43851 and 43850
Kytococcus	ATCC No. 14392; DSMZ Nos. 13884 and 20547
Lachnobacterium	ATCC No. BAA-151; DSMZ Nos. 14045
Laribacter	DSMZ Nos. 14985
Lautropia	ATTC Nos. 51599, 51600 and 51601; DSMZ Nos. 11362

TABLE 12-continued

<u>Additional Examples of Eubacteria</u>	
Genus	Examples of Culture Collection Strains
Lechevalieria	ATCC Nos. 29533 and 35161; DSMZ Nos. 40034 and 43385
Leifsonia	DSMZ Nos. 20146, 15166, 15304, 15165 and 46306
Leisingera	DSMZ Nos. 14336
Lentzea	DSMZ Nos. 44437, 44073, 43393, 44664 and 44232
Leucobacter	DSMZ Nos. 8803
Limnobacter	DSMZ Nos. 13612
Listonella	ATCC Nos. 19264, 68554 and 33504; DSMZ No. 11323
Lonepinella	ATCC No. 700131; DSMZ No. 10053 and 8617
Luteimonas	ATCC No. BAA-11; DSMZ Nos. 12574
Luteococcus	ATCC Nos. 51526, 51527 and BAA-60; DSMZ No. 10546
Macrocooccus	DSMZ Nos. 15607, 15608, 20597 and 15609
Macromonas	DSMZ Nos. 12705
Magnetospirillum	ATCC Nos. 31632 and 700264; DSMZ Nos. 6361 and 3856
Mannheimia	ATCC Nos. 29695 and 49246; DSMZ Nos. 10531 and 5283
Maricaulis	ATCC Nos. 15268 and 15269; DSMZ Nos. 4734 and 4729
Marinibacillus	ATCC Nos. 29840 and 29841; DSMZ Nos. 1297 and 1298
Marinitoga	DSMZ Nos. 13578 and 14283
Marinobacterium	ATCC No. 33635; DSMZ Nos. 11526, 6295 and 7027
Marinospirillum	ATCC Nos. 19192 and 19193; DSMZ No. 6287
Marmoricola	DSMZ No. 12652
Meiothermus	DSMZ Nos. 11376, 9957, 1279, 9946 and 14542
Methylocapsa	DSMZ No. 13967
Methylopila	ATCC No. 700716; DSMZ Nos. 6130 and 6342
Methylosarcina	ATCC Nos. 700908 and 700909; DSMZ No. 13736
Microbulbifer	ATCC No. 700072; DSMZ Nos. 6810 and 11525
Microbunatus	ATCC No. 700054; DSMZ No. 10555
Micromonas	ATCC Nos. 23195 and 33270; DSMZ Nos. 20468 and 20474
Microsphaera	ATCC No. 700099; DSMZ No. 44233
Microvirgula	DSMZ Nos. 15089 and 736
Modestobacter	DSMZ Nos. 44406 and 44402
Mogibacterium	ATCC Nos. 33093, 700696, 700697, 700923 and 700924
Moorella	ATCC Nos. 35608 and 49707; DSMZ Nos. 11254 and 2955
Moritella	ATCC Nos. 15381 and BAA-105; DSMZ No. 14879
Muricauda	DSMZ No. 13258
Mycetocola	DSMZ Nos. 15177, 15178 and 15179
Mycoplasma	ATCC Nos. 21759, 4278 and 49678; DSMZ No. 7126
Myroides	ATCC Nos. 4651 and 700471; DSMZ Nos. 2801 and 2802
Natroniella	DSMZ No. 9952
Natronincola	DSMZ No. 11416
Nautilia	DSMZ No. 13520
Nesterenkonia	ATCC No. 21727; DSMZ Nos. 20541 and 12544
Nonomurea	DSMZ Nos. 43748, 44320, 43142, 43551 and 43926
Novosphingobium	DSMZ Nos. 12444, 30196, 7313, 10699 and 12447
Oceanimonas	ATCC Nos. 35187, 700832 and 35186; DSMZ No. 7028
Oceanobacillus	DSMZ No. 14371
Oceanobacter	ATCC Nos. 27133, 35192 and 35193; DSMZ No. 6294
Octadecabacter	DSMZ No. 13978
Oenococcus	ATCC No. 23279 and 39402; DSMZ Nos. 20252 and 20255
Oleiphilus	DSMZ No. 13489
Oligotropha	ATCC No. 49405; DSMZ No. 1227
Olsenella	ATCC No. 49627; DSMZ Nos. 13989 and 7084
Opitutus	DSMZ Nos. 14424 and 11246
Orenia	ATCC No. 700911; DSMZ Nos. 5156, 13466 and 12596
Ornithinococcus	ATCC No. BAA-9; DSMZ Nos. 12335 and 12336
Ornithinimicrobium	DSMZ No. 12362
Oxalicibacterium	DSMZ Nos. 15506 and 15507
Oxalophagus	ATCC No. 49686; DSMZ No. 5503
Oxobacter	ATCC No. 43583; DSMZ No. 3222
Paenibacillus	DSMZ Nos. 1327, 5582, 10247, 13559 and 6554
Pandora	ATCC Nos. BAA-106, BAA-107, BAA-108 and BAA-65
Papillibacter	DSMZ No. 12816
Paralactobacillus	ATCC No. BAA-66; DSMZ No. 13344
Paraliobacillus	DSMZ No. 15140
Parascardovia	DSMZ Nos. 10105 and 10106
Paucimonas	ATCC No. 17989; DSMZ No. 7445
Pectobacterium	DSMZ Nos. 30184, 30168, 4610 and 3873
Pelczaria	ATCC No. 49321; DSMZ No. 12801
Pelospora	DSMZ No. 6652
Pelotomaculum	DSMZ Nos. 13744 and 13752
Peptoniphilus	DSMZ Nos. 20463, 10020, 20464, 10022 and 7455
Petrogla	DSMZ Nos. 10691, 10674, 13574 and 13575
Phascolarctobacterium	DSMZ Nos. 14760, 14761 and 14762

TABLE 12-continued

<u>Additional Examples of Eubacteria</u>	
Genus	Examples of Culture Collection Strains
Phocoenobacter	ATCC No. 700972; DSMZ No. 15746
Photorhabdus	DSMZ Nos. 15149, 12190, 15139 and 14550
Pigmentiphaga	ATCC No. BAA-795; DSMZ No. 13608
Planomicrobium	ATCC Nos. 33414 and 700539; DSMZ No. 13963
Planotetraspora	ATCC Nos. 51423 and 51498; DSMZ No. 44359
Plantibacter	DSMZ No. 14012
Plesiocystis	DSMZ Nos. 14875 and 14876
Polaribacter	ATCC Nos. 43844 and 700397; DSMZ No. 13964
Prauserella	ATCC No. 43014; DSMZ Nos. 44590, 44617 and 43194
Propioniferax	ATCC No. 49929; DSMZ No. 8251
Propionimicrobium	ATCC No. 27520; DSMZ No. 4903
Propionispora	DSMZ No. 13305
Propionivibrio	DSMZ Nos. 5885, 6832 and 12018
Pseudaminobacter	DSMZ No. 6986
Pseudoalteromonas	DSMZ Nos. 14585, 6820, 29660, 23821 and 27025
Pseudobutyrvibrio	DSMZ Nos. 9787 and 14809
Pseudoramibacter	ATCC Nos. 17928 and 23264; DSMZ No. 3980
Pseudorhodobacter	DSMZ No. 5888
Pseudospirillum	ATCC No. 19191; DSMZ No. 7165
Pseudoxanthomonas	ATCC No. BAA-10; DSMZ No. 12573
Psychroflexus	ATCC Nos. 51278 and 700755; DSMZ No. 5423
Psychromonas	ATCC Nos. BAA-353 and BAA-724; DSMZ No. 10704
Psychroserpens	ATCC No. 700359; DSMZ No. 12212
Ralstonia	DSMZ Nos. 11853, 416, 2839, 6297 and 9544
Ramlibacter	DSMZ Nos. 14656 and 14655
Raoultella	ATCC No. 31898; DSMZ Nos. 7464, 2688 and 7332
Rathayibacter	ATCC No. 19379; DSMZ Nos. 7484, 7488 and 7486
Rhodothermus	ATCC Nos. 43812 and 43813; DSMZ Nos. 4252 and 4252
Roseateles	DSMZ Nos. 11813 and 11814
Roseburia	DSMZ No. 14610
Roseiflexus	DSMZ No. 13941
Roseinatronobacter	DSMZ No. 13087
Roseospirillum	DSMZ No. 12498
Roseovarius	DSMZ Nos. 15170, 11457 and 11463
Rubritepida	DSMZ No. 14296
Ruegeria	ATCC No. 700000; DSMZ Nos. 10251, 5823 and 5887
Sagittula	ATCC No. 700073; DSMZ No. 11524
Salana	DSMZ No. 13521
Salegentibacter	ATCC No. 51522; DSMZ No. 5424
Salinibacter	ATCC No. BAA-605; DSMZ No. 13855
Salinivibrio	ATCC Nos. 33508 and 43149; DSMZ Nos. 11403 and 8285
Sanguibacter	ATCC Nos. 51766 and 51767; DSMZ Nos. 10542 and 10543
Scardovia	DSMZ Nos. 10107 and 10108
Schineria	DSMZ No. 13226
Schwartzia	DSMZ Nos. 10502 and 10503
Sedimentibacter	ATCC No. 51151; DSMZ Nos. 7310 and 13558
Shewanella	DSMZ Nos. 9167, 8812, 12621, 6067 and 8071
Shuttleworthia	DSMZ No. 14600
Silicibacter	ATCC No. 700808; DSMZ Nos. 11314, 15171 and 15172
Skermania	ATCC No. 49497; DSMZ No. 43998
Slackia	ATCC No. 29202 and 700122; DSMZ No. 20476
Sphingobium	ATCC No. 700291; DSMZ Nos. 7098, 11019 and 7462
Sphingomonas	DSMZ Nos. 7418, 10564, 1805, 13885 and 6014
Sphingopyxis	DSMZ Nos. 13593, 14889, 8826, 8831 and 14551
Spirilliplanes	DSMZ No. 44325
Sporanaerobacter	DSMZ No. 13106
Sporobacter	DSMZ No. 10068
Sporobacterium	DSMZ No. 12504
Sporotomaculum	ATCC No. 700645; DSMZ Nos. 5475, 14795 and 14947
Staleyia	ATCC No. BAA-5; DSMZ No. 11458
Stappia	ATCC Nos. 15215 and 25650; DSMZ Nos. 13394 and 5886
Starkeya	ATCC No. 8093; DSMZ No. 506
Stenotrophomonas	DSMZ Nos. 13117, 13118, 50170, 8573 and 13637
Sterolibacterium	DSMZ No. 13999
Streptacidiphilus	DSMZ Nos. 41753, 41754 and 41755
Streptomonospora	DSMZ Nos. 44588 and 44593
Subtercola	ATCC No. BAA-169; DSMZ Nos. 13056, 13057 and 14246
Succiniclasticum	DSMZ Nos. 9236 and 11005
Succinispira	ATCC No. 700845; DSMZ No. 6222
Sulfitobacter	DSMZ Nos. 11443, 12244, 10014 and 10015
Sulfurospirillum	DSMZ Nos. 9755, 10660, 6946, 13726 and 12446
Sutterella	ATCC No. 51579; DSMZ No. 14016

TABLE 12-continued

<u>Additional Examples of Eubacteria</u>	
Genus	Examples of Culture Collection Strains
Suttonella	ATCC No. 25869; DSMZ No. 8309
Syntrophobotulus	DSMZ No. 8271
Syntrophothermus	DSMZ Nos. 12680 and 12681
Syntrophus	DSMZ Nos. 2612A, 2612B, 8423, 2612A and 2612B
Telluria	ATCC Nos. 49107 and 49108; DSMZ No. 4832
Tenacibaculum	ATCC Nos. 43398 and 51887; DSMZ Nos. 13766 and 13764
Tepidibacter	DSMZ No. 15285
Tepidimonas	DSMZ No. 12034
Tepidiphilus	DSMZ No. 15129
Terasakiella	ATCC No. 33338; DSMZ No. 6293
Terracoccus	ATCC No. 700812; DSMZ Nos. 44267 and 44274
Tessaracoccus	DSMZ No. 12906
Tetragenococcus	ATCC Nos. 13622 and 21786; DSMZ Nos. 20339 and 20337
Tetrasphaera	DSMZ Nos. 12890, 14184 and 13192
Thalassomonas	DSMZ Nos. 13754 and 13753
Thauera	DSMZ Nos. 14742, 12138, 12266, 14743 and 12139
Thermaerobacter	ATCC Nos. BAA-137 and 700841; DSMZ No. 12885
Thermanaeromonas	DSMZ No. 14490
Thermanaerovibrio	ATCC No. 49978; DSMZ Nos. 6589 and 12556
Thermicanus	ATCC No. 700890; DSMZ No. 12793
Thermithiobacillus	ATCC No. 43215; DSMZ No. 3134
Thermoanaerobacterium	DSMZ Nos. 10170, 13641, 572, 3896 and 7097
Thermobifida	ATCC No. 27730; DSMZ Nos. 43795, 44535 and 43792
Thermobispora	ATCC Nos. 15737 and 19993; DSMZ Nos. 43833 and 43038
Thermobrachium	ATCC No. 700318; DSMZ No. 8682
Thermocrinis	DSMZ No. 12173
Thermocrispum	ATCC Nos. 51796 and 51797; DSMZ Nos. 44070 and 44069
Thermodesulforhabdus	DSMZ No. 9990
Thermodesulfovibrio	DSMZ Nos. 12570 and 11347
Thermohydrogenium	DSMZ Nos. 11055 and 11056
Thermomonas	DSMZ Nos. 13605 and 13598
Thermosyntropha	ATCC No. 700317; DSMZ No. 11003
Thermoterrabacterium	DSMZ No. 11255
Thermovenabulum	DSMZ No. 14006
Thermovibrio	DSMZ No. 14644
Thi alkalimicrobium	DSMZ Nos. 13739, 14477 and 13740
Thi alkalivibrio	DSMZ Nos. 13742, 14478, 13741, 13532 and 13738
Thioalkalivibrio	DSMZ No. 13533
Thiobaca	DSMZ Nos. 13587 and 13588
Thiomonas	ATCC Nos. 15466 and 23370; DSMZ No. 5495
Tindallia	DSMZ No. 10318
Tolomonas	DSMZ No. 9187
Turicella	ATCC Nos. 51513 and 51514; DSMZ No. 8821
Turicibacter	DSMZ No. 14220
Ureibacillus	ATCC No. BAA-384; DSMZ Nos. 12654 and 10633
Verrucosipora	DSMZ No. 44337
Victivallis	ATCC No. BAA-548; DSMZ No. 14823
Virgibacillus	DSMZ Nos. 14868, 14866, 490, 13055 and 11483
Vogesella	ATCC Nos. 14036 and 19706; DSMZ No. 3303
Weissella	DSMZ Nos. 20196, 7378, 14295, 20288 and 20410
Williamsia	DSMZ No. 44343
Xenophilus	ATCC Nos. BAA-794; DSMZ No. 13620
Zavarzinia	ATCC Nos. 51430; DSMZ No. 1231
Zooshikella	DSMZ Nos. 15267 and 15268
Zymobacter	ATCC Nos. 51623; DSMZ No. 10491

[0698] Additional examples of Eubacteria contemplated for use in the present invention, many of which can be obtained from the Texas A&M University ("TAMU") at College Station, Texas 77843 U.S.A., include: *Acinetobacter calcoaceticus* ("A. baumannii"; ATCC No. 19606), *Aeromonas hydrophila* (ATCC No. 7966), *Aeromonas proteolytica* ("Vibrio proteolytica"), *Bacillus subtilis* (fr. Zuberer), *Bacillus subtilis* (ATCC No. 18685), *Bacillus subtilis* BRB41, *Bacillus subtilis* Q, *Bacillus thuringensis* (fr. Zuberer), *Burkholderia cepacia* LB400 (USDA ARS Patent Culture Collection #NRRL-B18064, Peoria, Ill. USA), *Burkholderia cepacia* T, *Citrobacter diversus*, *Cit-*

robacter freundii (ATCC No. 8090), *Edwardsiella tarda* (ATCC No. 15947), *Enterobacter aerogenes* (ATCC No. 13048), *Enterobacter cloacae* 96-3 (ATCC No. 43560), *Enterobacter liquefaciens* 363, *Enterobacter liquefaciens* 670, *Erwinia carotovora* EC189-67 (University of Missouri, Columbia, Mo. 65211, U.S.A.), *Erwinia herbicola*, *Erwinia herbicola* (agglomerans), *Escherichia coli* E63 (*E. Coli* Genetic Stock Center Yale University, New Haven, Conn., U.S.A.), *Hafnia alvei* (ATCC No. 13337), *Klebsiella pneumoniae* (ATCC No. 13883), *Lactobacillus casei* 686 (Department of Food Science and Technology University of Nebraska, Lincoln, Nebr. 68583, U.S.A.), *Lactococcus lactis*

subsp. *lactis* pIL253 (Department of Food Science and Technology University of Nebraska, Lincoln, Nebr. 68583, U.S.A.), *Proteus morganii*, *Proteus vulgaris* (ATCC No. 13315), *Pseudomonas aeruginosa* (ATCC No. 10145), *Pseudomonas aeruginosa* (ATCC No. 27853), *Pseudomonas fluorescens*, *Pseudomonas putida* (ATCC No. 12633), *Pseudomonas putida* PpY101, *Pseudomonas* sp. P, *Pseudomonas* sp. Arm. A isolate 1 (Yerevan Physics Institute, Alikhanian Brothers St. 2 Yerevan 375036 Armenia), *Pseudomonas* sp. Arm. A isolate 2 (Yerevan Physics Institute, Alikhanian Brothers St. 2 Yerevan 375036 Armenia), *Salmonella typhimurium* ("S. *choleraesuis*"; ATCC No. 14028), *Serratia marcescens* (ATCC No. 8100), *Serratia marcescens* HY (ATCC 8195), *Serratia marcescens* Nima (Baylor College of Medicine, One Baylor Plaza, Houston, Tex. 77030, U.S.A.), *Shigella flexneri* (ATCC No. 12022), *Shigella sonnei* (ATCC No. 25931), *Staphylococcus aureus* (ATCC No. 25923), *Staphylococcus* sp. S, *Streptococcus faecalis* ("Enterococcus faecalis"; ATCC No. 19433), *Vibrio parahaemolyticus* ("TAMU 109"), *Yersinia enterocolitica* (ATCC No. 9610), *Yersinia enterocolitica* ("TAMU 84," "IP 175"; National Yersinia Center, Institut Pasteur, 75724 Paris Cedex 15, France), *Yersinia frederiksenii* ("TAMU 91," "IP 867," National Yersinia Center, Institut Pasteur, 75724 Paris Cedex 15, France), *Yersinia intermedia* (ATCC No. 29909), *Yersinia intermedia* ("TAMU 86," "IP 3953," National Yers-

inia Center, Institut Pasteur, 75724 Paris Cedex 15, France), *Yersinia kristensenii* (ATCC No. 33640), *Yersinia kristensenii* ("TAMU 95," "IP 1475," National Yersinia Center, Institut Pasteur, 75724 Paris Cedex 15, France), *Yersinia* sp. ("Y. *frederiksenii*," ATCC No. 29912), *Vibrio proteolyticus* (ATCC No. 15338), *Thermus* sp. (ATCC No. 31674), *Streptomyces cinnamonensis* subsp. *proteolyticus* (ATCC No. 19893), *Deinococcus proteolyticus* (ATCC No. 35074), *Clostridium proteolyticum* (ATCC No. 49002), *Aeromonas jandaei* (ATCC No. 49568), *Aeromonas veronii* biogroup *sobria* (ATCC No. 9071), *Pseudoalteromonas haloplanktis* (ATCC No. 23821), *Xanthomonas campestris* (ATCC No. 33913), *Pseudoalteromonas espejiana* (ATCC No. 27025), *Shewanella putrefaciens* (ATCC No. 8071), *Stenotrophomonas maltophilus* (ATCC No. 13637), *Ochrobactrum anthropi* (ATCC No. 19286), *Desulfovibrio vulgaris* (ATCC No. 29579), or a combination thereof.

EXAMPLE 15

Examples of Bacteriophages

[0699] Additional examples of bacteriophages, host cells for their production, and their biological culture collection sources are shown at Table 13 below. It is contemplated that the virus sizes, shapes and biochemistry will be similar to the previously described bacteriophages.

TABLE 13

Additional Examples of Bacteriophages			
Virus	ATCC No.	Host	ATCC No.
Ac 20	15261-B1	<i>Asticcacaulis excentricus</i>	15261
Ac 21	15261-B2	<i>Asticcacaulis excentricus</i>	15261
Ac 24	15261-B3	<i>Asticcacaulis excentricus</i>	15261
PAV-1	13705-B1	<i>Azotobacter vinelandii</i>	13705
	12826-B1	<i>Bacillus cereus</i>	12826
	12826-B2	<i>Bacillus cereus</i>	12826
256 (R)	27877-B2	<i>Bacillus cereus</i>	27877
282 (S)	27877-B1	<i>Bacillus cereus</i>	27877
NRS 201	7064-B1	<i>Bacillus cereus</i>	7064
	14575-B1	<i>Bacillus firmus</i>	14575
239	7056-B1	<i>Bacillus megaterium</i>	7056
G [HER 276]	43725-B1	<i>Bacillus megaterium</i>	43725
	11986-B1	<i>Bacillus mycoides</i>	11986
236	6631-B1	<i>Bacillus pumilus</i>	6631
eTAmy+	31595-B1	<i>Bacillus subtilis</i>	31595
SPP1	27689-B1	<i>Bacillus subtilis</i>	27689
B56-3	700786-B1	<i>Bacteroides fragilis</i>	700786
NRS 605	10027-B1	<i>Brevibacillus parabrevis</i>	10027
Cb3	19090-B2	<i>Brevundimonas bacteroides</i>	19090
Cb6	19090-B3	<i>Brevundimonas bacteroides</i>	19090
Cb8r	19090-B1	<i>Brevundimonas bacteroides</i>	19090
17 [formerly 13]	43133-B1	<i>Campylobacter coli</i>	43133
18 [formerly 7]	43134-B1	<i>Campylobacter coli</i>	43134
19 [formerly 5]	43135-B1	<i>Campylobacter coli</i>	43135
20 [formerly 4]	43136-B1	<i>Campylobacter coli</i>	43136
10 [L286]	35925-B1	<i>Campylobacter jejuni</i>	35925
		subsp. <i>jejuni</i>	
11 [WI 386]	35925-B2	<i>Campylobacter jejuni</i>	35925
		subsp. <i>jejuni</i>	
12 [WI 3106]	35922-B2	<i>Campylobacter jejuni</i>	35922
		subsp. <i>jejuni</i>	
13 [J1 263]	35924-B2	<i>Campylobacter jejuni</i>	35924
		subsp. <i>jejuni</i>	
14 [J2106]	35922-B3	<i>Campylobacter jejuni</i>	35922
		subsp. <i>jejuni</i>	
2 [J1 328]	35919-B1	<i>Campylobacter jejuni</i>	35919
		subsp. <i>jejuni</i>	

TABLE 13-continued

<u>Additional Examples of Bacteriophages</u>			
Virus	ATCC No.	Host	ATCC No.
4 [J2101]	35921-B1	<i>Campylobacter jejuni</i> subsp. <i>jejuni</i>	35921
7 [L2 106]	35922-B1	<i>Campylobacter jejuni</i> subsp. <i>jejuni</i>	35922
8 [L2 305]	35923-B1	<i>Campylobacter jejuni</i> subsp. <i>jejuni</i>	35923
9 [WI 3263]	35924-B1	<i>Campylobacter jejuni</i> subsp. <i>jejuni</i>	35924
DLC 2921/49	12052-B1	<i>Corynebacterium</i> sp.	12052
phi W-14	9355-B1	<i>Delftia acidovorans</i>	9355
57	23355-B1	<i>Enterobacter cloacae</i>	23355
42	19948-B1	<i>Enterococcus faecalis</i>	19948
113	19950-B1	<i>Enterococcus faecium</i>	19950
120	19952-B1	<i>Enterococcus</i> sp.	19952
36	19382-B1	<i>Erwinia amylovora</i>	19382
4S	19383-B2	<i>Erwinia amylovora</i>	19383
NCPPB 1507 [4S]	29850-B3	<i>Erwinia amylovora</i>	29850
NCPPB 1508 [4L]	29850-B2	<i>Erwinia amylovora</i>	29850
NCPPB 782 [E1]	29850-B1	<i>Erwinia amylovora</i>	29850
phi Ea100	29780-B4	<i>Erwinia amylovora</i>	29780
phi Ea104	29780-B5	<i>Erwinia amylovora</i>	29780
phi Ea116C	29780-B6	<i>Erwinia amylovora</i>	29780
phi Ea125	29780-B3	<i>Erwinia amylovora</i>	29780
184	11303-B19	<i>Escherichia coli</i>	11303
205	11303-B12	<i>Escherichia coli</i>	11303
221	11303-B22	<i>Escherichia coli</i>	11303
24B	12142-B2	<i>Escherichia coli</i>	12142
250	11303-B20	<i>Escherichia coli</i>	11303
49B	12142-B1	<i>Escherichia coli</i>	12142
50Br	12142-B3	<i>Escherichia coli</i>	12142
53 alpha	12142-B4	<i>Escherichia coli</i>	12142
547	11303-B17	<i>Escherichia coli</i>	11303
6A	12144-B3	<i>Escherichia coli</i>	12144
6B	12144-B1	<i>Escherichia coli</i>	12144
6C	12144-B4	<i>Escherichia coli</i>	12144
AP211	11303-B14	<i>Escherichia coli</i>	11303
BG3	11303-B10	<i>Escherichia coli</i>	11303
C204	11303-B13	<i>Escherichia coli</i>	11303
C33	11303-B21	<i>Escherichia coli</i>	11303
C36	8677-B1	<i>Escherichia coli</i>	8677
FCZ	12142-B5	<i>Escherichia coli</i>	12142
G178	11303-B16	<i>Escherichia coli</i>	11303
MU9	21816-B1	<i>Escherichia coli</i>	21816
P4 sid1	29746-B1	<i>Escherichia coli</i>	29746
phiXes70am-3	49696-B1	<i>Escherichia coli</i>	49696
r1589	11303-B32	<i>Escherichia coli</i>	11303
r187	11303-B35	<i>Escherichia coli</i>	11303
r196	11303-B34	<i>Escherichia coli</i>	11303
r638	11303-B36	<i>Escherichia coli</i>	11303
r71	11303-B25	<i>Escherichia coli</i>	11303
RA105	11303-B37	<i>Escherichia coli</i>	11303
rED220	11303-B26	<i>Escherichia coli</i>	11303
REDa41	11303-B24	<i>Escherichia coli</i>	11303
REDb44	11303-B27	<i>Escherichia coli</i>	11303
REDb45	11303-B28	<i>Escherichia coli</i>	11303
REDb50	11303-B29	<i>Escherichia coli</i>	11303
RH23	11303-B30	<i>Escherichia coli</i>	11303
RH88	11303-B33	<i>Escherichia coli</i>	11303
rJ3	11303-B31	<i>Escherichia coli</i>	11303
T7M (Meselson)	11303-B38	<i>Escherichia coli</i>	11303
UV1	11303-B15	<i>Escherichia coli</i>	11303
UV375	11303-B18	<i>Escherichia coli</i>	11303
UV47	11303-B11	<i>Escherichia coli</i>	11303
ZJ/2	25298-B2	<i>Escherichia coli</i>	25298
	12016-B1	<i>Geobacillus</i> <i>stearothermophilus</i>	12016
60	23356-B1	<i>Klebsiella pneumoniae</i> subsp. <i>pneumoniae</i>	23356
92	23357-B1	<i>Klebsiella pneumoniae</i> subsp. <i>pneumoniae</i>	23357

TABLE 13-continued

Additional Examples of Bacteriophages			
Virus	ATCC No.	Host	ATCC No.
<i>Lactobacillus plantarum</i> phage	8014-B1	<i>Lactobacillus plantarum</i>	8014
<i>Lactobacillus plantarum</i> phage W	8014-B2	<i>Lactobacillus plantarum</i>	8014
	11603-B1	<i>Lactococcus lactis</i> subsp. <i>Cremoris</i>	11603
F-68	11955-B1	<i>Lactococcus lactis</i> subsp. <i>Lactis</i>	11955
D-34	4243-B1	Mycobacteria Associated with Leprous Lesions	4243
Bo 4	27207-B1	<i>Mycobacterium fortuitum</i> subsp. <i>fortuitum</i>	27207
Bo 7	27207-B2	<i>Mycobacterium fortuitum</i> subsp. <i>fortuitum</i>	27207
Bo 3	27206-B1	<i>Mycobacterium phlei</i>	27206
BK3	27203-B1	<i>Mycobacterium smegmatis</i>	27203
Bo 1	27204-B1	<i>Mycobacterium smegmatis</i>	27204
Bo 6 I	27205-B1	<i>Mycobacterium smegmatis</i>	27205
Bo 6 II	27205-B2	<i>Mycobacterium smegmatis</i>	27205
Bo 6 III	27205-B3	<i>Mycobacterium smegmatis</i>	27205
Mc-2	607-B6	<i>Mycobacterium smegmatis</i>	607
<i>Mycobacterium smegmatis</i> phage	11727-B1	<i>Mycobacterium smegmatis</i>	11727
<i>Mycobacterium smegmatis</i> phage	11759-B1	<i>Mycobacterium smegmatis</i>	11759
	11760-B1	<i>Mycobacterium</i> sp.	11760
	11761-B1	<i>Mycobacterium</i> sp.	11761
DS6A	25618-B2	<i>Mycobacterium tuberculosis</i>	25618
LG	25618-B1	<i>Mycobacterium tuberculosis</i>	25618
X1 [IMET 5013]	43080-B1	<i>Nocardioideis albus</i>	43080
X10 [IMET 5057]	43082-B1	<i>Nocardioideis albus</i>	43082
X24 [IMET 5056]	43083-B1	<i>Nocardioideis albus</i>	43083
X3 [IMET 5015]	43081-B1	<i>Nocardioideis albus</i>	43081
X5 [IMET 5017]	43080-B2	<i>Nocardioideis albus</i>	43080
AN-11	27893-B13	<i>Nostoc</i> sp.	27893
AN-12	27893-B12	<i>Nostoc</i> sp.	27893
AN-13	27893-B11	<i>Nostoc</i> sp.	27893
AN-14	27893-B10	<i>Nostoc</i> sp.	27893
AN-16	27893-B9	<i>Nostoc</i> sp.	27893
AN-17	27893-B8	<i>Nostoc</i> sp.	27893
AN-18	27893-B7	<i>Nostoc</i> sp.	27893
AN-19	27893-B6	<i>Nostoc</i> sp.	27893
AN-21	27893-B5	<i>Nostoc</i> sp.	27893
AN-23	27893-B4	<i>Nostoc</i> sp.	27893
AN-25	27893-B2	<i>Nostoc</i> sp.	27893
AN-26	27893-B1	<i>Nostoc</i> sp.	27893
A	12060-B1	<i>Paenibacillus polymyxa</i>	12060
C	12060-B3	<i>Paenibacillus polymyxa</i>	12060
D	12060-B4	<i>Paenibacillus polymyxa</i>	12060
<i>Propionibacterium acnes</i> phage	29399-B1	<i>Propionibacterium acnes</i>	29399
113	14213-B1	<i>Pseudomonas aeruginosa</i>	14213
HER-1 [7Lindberg]	BAA-26-B1	<i>Pseudomonas aeruginosa</i>	BAA-26
HER-10 [F8Lindberg]	BAA-28-B1	<i>Pseudomonas aeruginosa</i>	BAA-28
HER-16 [M4 Lindberg]	BAA-30-B1	<i>Pseudomonas aeruginosa</i>	BAA-30
HER-17 [M6Lindberg]	BAA-31-B1	<i>Pseudomonas aeruginosa</i>	BAA-31
HER-18 [F116L]	BAA-47-B1	<i>Pseudomonas aeruginosa</i>	BAA-47
HER-2 [16Lindberg]	BAA-27-B1	<i>Pseudomonas aeruginosa</i>	BAA-27
HER-3	BAA-28-B2	<i>Pseudomonas aeruginosa</i>	BAA-28
HER-4 [24Lindberg]	BAA-79-B1	<i>Pseudomonas aeruginosa</i>	BAA-79
HER-5 [31Lindberg]	BAA-81-B2	<i>Pseudomonas aeruginosa</i>	BAA-81
HER-6 [44Lindberg]	BAA-81-B1	<i>Pseudomonas aeruginosa</i>	BAA-81
HER-9 [F7Lindberg]	BAA-29-B1	<i>Pseudomonas aeruginosa</i>	BAA-29 and BAA-31
Pa	12055-B1	<i>Pseudomonas aeruginosa</i>	12055
Pb	12055-B2	<i>Pseudomonas aeruginosa</i>	12055
Pc	12055-B3	<i>Pseudomonas aeruginosa</i>	12055
Pf	25102-B1	<i>Pseudomonas aeruginosa</i>	25102
11	14205-B1	<i>Pseudomonas aeruginosa</i>	14205
73	14210-B1	<i>Pseudomonas aeruginosa</i>	14210
Ps-G3	49780-B1	<i>Pseudomonas</i> sp.	49780

TABLE 13-continued

<u>Additional Examples of Bacteriophages</u>			
Virus	ATCC No.	Host	ATCC No.
PB2	23341-B1	<i>Rhizobium radiobacter</i>	23341
T-150	29681-B1	<i>Saccharopolyspora rectivirgula</i>	29681
23 [Olsen phage]	19938-B1	<i>Salmonella choleraesuis</i> subsp. <i>choleraesuis</i>	19938
46	19942-B1	<i>Salmonella choleraesuis</i> subsp. <i>choleraesuis</i>	19942
Chi	9842-B1	<i>Salmonella choleraesuis</i> subsp. <i>choleraesuis</i>	9842
SL-1	40282	<i>Salmonella choleraesuis</i> subsp. <i>choleraesuis</i>	14028
2	23351-B1	<i>Shigella dysenteriae</i>	23351
37	23354-B1	<i>Shigella</i> sp.	23354
P14	11988-B1	<i>Staphylococcus aureus</i> subsp. <i>aureus</i>	11988
17	23361-B1	<i>Staphylococcus aureus</i> subsp. <i>aureus</i>	23361
CDC29	27705-B1	<i>Staphylococcus aureus</i> subsp. <i>aureus</i>	27705
CDC42D	27712-B1	<i>Staphylococcus aureus</i> subsp. <i>aureus</i>	27712
CDC47	27691-B1	<i>Staphylococcus aureus</i> subsp. <i>aureus</i>	27691
CDC52	27692-B1	<i>Staphylococcus aureus</i> subsp. <i>aureus</i>	27692
CDC52A	27693-B1	<i>Staphylococcus aureus</i> subsp. <i>aureus</i>	27693
CDC53	27694-B1	<i>Staphylococcus aureus</i> subsp. <i>aureus</i>	27694
CDC79	27693-B2	<i>Staphylococcus aureus</i> subsp. <i>aureus</i>	27693
CDC80	27700-B1	<i>Staphylococcus aureus</i> subsp. <i>aureus</i>	27700
CDC81	27701-B1	<i>Staphylococcus aureus</i> subsp. <i>aureus</i>	27701
CDC83A	27706-B1	<i>Staphylococcus aureus</i> subsp. <i>aureus</i>	27706
A1	12202-B1	<i>Streptococcus pyogenes</i>	12202
enterococcus phage 1A	12169-B1	<i>Streptococcus</i> sp.	12169
118	19951-B2	<i>Streptococcus</i> sp.	19951
enterococcus phage 1B	12170-B1	<i>Streptococcus</i> sp.	12170
22653 [Carvajal's strain 1]	11984-B1	<i>Streptomyces griseus</i> subsp. <i>griseus</i>	11984
AS-1	27344-B1	<i>Synechococcus</i> sp.	27344
138	14100-B1	<i>Vibrio cholerae</i>	14100
145	14100-B2	<i>Vibrio cholerae</i>	14100
163	14100-B4	<i>Vibrio cholerae</i>	14100
D-10	51352-B5	<i>Vibrio cholerae</i>	51352
M-4	51352-B4	<i>Vibrio cholerae</i>	51352
N-4	51352-B1	<i>Vibrio cholerae</i>	51352
S-20	51352-B3	<i>Vibrio cholerae</i>	51352
S-5	51352-B2	<i>Vibrio cholerae</i>	51352
Phage UTAK	51589-B1	<i>Vibrio</i> sp.	51589
<i>Vibrio</i> sp. phage	11985-B1	<i>Vibrio</i> sp.	11985
XP1	10016-B1	<i>Xanthomonas arboricola</i>	10016
XP2	10016-B2	<i>Xanthomonas arboricola</i>	10016
XP3	10016-B3	<i>Xanthomonas arboricola</i>	10016
XP4	10016-B4	<i>Xanthomonas arboricola</i>	10016
XP8	10016-B6	<i>Xanthomonas arboricola</i>	10016
IMI strain A	14981-B1	<i>Xanthomonas axonopodis</i>	14981
IMI strain C	14982-B1	<i>Xanthomonas axonopodis</i>	14982
IMI strain D	14983-B1	<i>Xanthomonas axonopodis</i>	14983
EMI strain J	14984-B1	<i>Xanthomonas axonopodis</i>	14984
IMI strain K	14986-B1	<i>Xanthomonas axonopodis</i>	14986

EXAMPLE 16

Cells That Alter Infrared Detection of a Surface Treatment

[0700] It is contemplated that a cell-based particulate material of the present invention comprising one or more biomolecules that absorb or reflect infrared radiation will alter the ability of a surface treatment to be detected by an infrared detection device. For example, some bacteria may comprise a bacteriochlorophyll ("Bchl") that absorbs near infrared light, such as from 720 nm to 1020 nm, which is in the detection range of some infrared detection devices, and coating components comprising a bacteriochlorophyll is specifically contemplated for use in a camouflage coating. The near infrared absorbancy of various bacteriochlorophylls are shown at Table 14.

TABLE 14

Infrared Absorption Maxima by Bacteriochlorophylls	
Bacteriochlorophyll	Absorption Maxima
Bchl a	800–810 nm and 830–890 nm
Bchl b	835–850 nm and 1015–1035 nm
Bchl c	745–760 nm
Bchl d	725–745 nm
Bchl e	715–725 nm
Bchl g	780–790 nm

[0701] Often, cells that comprise a bacteriochlorophyll and an additional light absorbing compound (e.g., a carotenoid) will have the absorbance maxima shifted and/or expanded from the ranges given in Table 14. For example, *Roseospirillum parvum* (DSMZ No. 12498) comprises Bchl a and has an absorption maximum of 911 nm. Examples of cells that comprise a bacteriochlorophyll a purple sulfur bacteria, a purple non-sulfur bacteria, a green sulfur bacteria, a green bacteria, an incertae sedis bacteria, (Permentier, H. P. et al., 2001).

[0702] Purple sulfur bacteria (e.g., Family Chromatiaceae, Family Ectothiorhodospiraceae) typically comprise bacteriochlorophyll a or bacteriochlorophyll b, and a carotenoid (e.g., spirilloxanthin, spheroidene, spheroidenone, okenone, rhodopinal). Purple sulfur bacteria generally have an absorbance maxima between 790 nm and 1030 nm. Examples of a purple sulfur bacteria genera with typical colors and bacteriochlorophyll type, include *Allochrochromatium* (brown or violet-red; Bchl a), *Ectothiorhodospira* (green and Bchl b, or red and Bchl a), *Halochromatium* (red-brown, Bchl a), *Halorhodospira* (green and Bchl b, or red and Bchl a), *Isochromatium* (violet, Bchl a), *Lamprocystis* (violet, red, Bchl a), *Marichromatium* (violet-red or red-brown; Bchl a), *Rhabdochromatium*, *Thermochromatium* (brown-red; Bchl a), *Thiocapsa* (pink to red; Bchl a), *Thiococcus* (yellow to yellowish brown; Bchl b), *Thiocystis* (violet or violet-red; Bchl a), *Thiodictyon* (violet; Bchl a), *Thiohalocapsa* (pink to red; Bchl a), *Thiolamprovirus* (pink-red; Bchl a), and *Thiorhodovibrio*. Specific examples of purple sulfur bacteria species, with typical colors, include: *Allochrochromatium warmingii* (violet; DSMZ Nos. 173 and 174), *Isochromatium buderi* (violet; DSMZ Nos. 176 and 177), *Thiocystis violascens* (violet, DSMZ Nos. 198, 199, 200, 201 and 202), *Thiocystis violacea* (violet, DSMZ Nos. 207, 208, 212, 213 and 214), *Thiodictyon bacillosum* (violet, DSMZ No. 234),

Thiodictyon elegans (violet, DSMZ No. 232), *Lamprocystis roseopersicina* (violet to red; DSMZ No. 229), *Marichromatium purpuratum* (violet-red; DSMZ No. 1591 and 1711), *Thiocystis gelatinosa* (violet-red; DSMZ No. 215), *Thiocapsa roseopersicina* (pink to red; DSMZ Nos. 217, 221 and 5653), *Thiocapsa pendens* (pink to red; DSMZ Nos. 236 and 5652), *Thiocapsa rosea* (pink to red; DSMZ No. 235), *Thiohalocapsa halophila* (pink to red; ATCC No. 49740; DSMZ No. 6210), *Thiolamprovirus pedioformis* (pink; DSMZ No. 3802), *Halorhodospira halophila* (red; DSMZ No. 244), *Allochrochromatium minutissimum* (red-brown; DSMZ No. 1376), *Allochrochromatium vinosum* (red-brown; DSMZ Nos. 180 and 182), *Ectothiorhodospira mobilis* (red-brown; ATCC Nos. 49921 and 49923, DSMZ Nos. 237, 238, 239, 240, 242 and 4180), *Ectothiorhodospira shaposhnikovii* (red-brown; ATCC No. 43036, DSMZ Nos. 243 and 2111), *Marichromatium gracile* (red-brown; DSMZ Nos. 203, 204, 726, 1712 and 1713), *Halochromatium salexigens* (red-brown; DSMZ No. 4395), *Thermochromatium tepidum* (red-brown; DSMZ No. 3771), *Thiococcus pfennigii* (yellow to orange-brown; DSMZ Nos. 226, 227 and 228), *Halorhodospira abdelmalekii* (green; ATCC No. 35917, DSMZ No. 2110), and *Halorhodospira halochloris* (green; ATCC No. 35916, DSMZ No. 1059).

[0703] Purple non-sulfur bacteria (e.g., Family Rhodospirillaceae) typically comprise bacteriochlorophyll a or bacteriochlorophyll b, and a carotenoid (e.g., spirilloxanthin, spheroidene, spheroidenone, okenone, rhodopinal). Purple non-sulfur bacteria generally have an absorbance maxima between 790 nm and 1030 nm. The typical growth environment for these types of cells is in anaerobic conditions, though growth in aerobic conditions is possible, but may alter the color of the cells. Examples of purple non-sulfur bacteria genera include *Rhodospila* (violet-red; Bchl a), *Rhodomicrobium* (orange-brown; Bchl a), *Rhodocyclus* (violet; Bchl a), *Rhodoferrax* (orange-brown; Bchl a), *Rhodoplanes* (pink; Bchl a), *Rhodovulum* (yellow-brown to red brown; Bchl a), *Rhodospirillum* (red or brown, Bchl a), *Rhodopseudomonas* (red-brown; bchl a), *Rhodobacter* (yellow-brown, Bchl a), *Rhodoblastus* (red; bchl a), *Rubrivivax* (yellow-brown; bchl a), *Rhodobium* (pink to red; bchl a), *Rhodocista* (red; Bchl a), *Blastochloris* (green; Bchl a), *Phaeospirillum* (brown, Bchl a), *Rhodothalassium* (red; Bchl a), *Rhodovibrio* (red, Bchl a), and *Rhodobaca* (yellow-brown to red; Bchl a). Specific examples of a purple sulfur bacteria include: *Rhodocyclus purpureus* (violet; DSMZ No. 168, LMG No. 7759), *Rhodospila globiformis* (violet-red, DSMZ No. 161; LMG 4312), *Rhodoblastus acidophilus* (red, violet-red or orange-brown; DSMZ Nos. 137, 142 and 145; LMG No. 4300), *Rhodospirillum rubrum* (red; ATCC Nos. 27048 and 9791, DSMZ Nos. 467, 107, 468, 1068, 11221, 11222 and 50914), *Rhodocista centenaria* (red; DSMZ No. 9894), *Rhodothalassium salexigens* (red; ATCC No. 35888, DSMZ No. 2132), *Rhodovibrio salinarum* (red; ATCC No. 35394, DSMZ No. 9154), *Rhodovibrio sodomensis* (red; DSMZ No. 9895), *Rhodobium marinum* (pink to red; ATCC No. 35675, DSMZ Nos. 2698 and 2780), *Rhodobium orientis* (pink to red; ATCC No. 51972, DSMZ Nos. 11290 and 11349), *Rhodoplanes elegans* (pink; ATCC No. 51906, DSMZ No. 11907), *Rhodoplanes roseus* (pink; DSMZ No. 5909 and 13233), *Rhodopseudomonas palustris* (red-brown; ATCC Nos. 17004 and 49781, DSMZ Nos. 123, 126, 127, 130, 131 and 8283), *Rhodobacter capsulatus* (brown to red-brown, DSMZ Nos. 1710, 152, 155, 156, 157 and 938),

Phaeospirillum fulvum (brown; ATCC No. 35113, DSMZ Nos. 113 and 114), *Phaeospirillum molischianum* (brown; ATCC No. 14031, DSMZ Nos. 120, 118 and 119), *Rhodospirillum photometricum* (brown; ATCC Nos. 27871 and 49918, DSMZ Nos. 122, 121, 1774 and 2341), *Rhodocrobium vannielii* (orange-brown, ATCC No. 17100, DSMZ Nos. 162, 166, 725 and 2342), *Rhodoferrax fermentans* (orange-brown, ATCC Nos. 49786 and 49787; DSMZ Nos. 10138, 10139 and 13235), *Rhodoferrax antarcticus* (orange-brown, ATCC No. 700587), *Rhodobacter blasticus* (yellow-brown; ATCC No. 33485, DSMZ No. 2131), *Rhodovulum adriaticum* (yellow-brown anaerobic, red-brown aerobic; ATCC No. 35885, DSMZ No. 2781), *Rhodobaca* (yellow-brown anaerobic, red aerobic; ATCC No. 700920), *Rhodovulum euryhalinum* (yellow-brown anaerobic, red-brown aerobic; DSMZ No. 4868), *Rhodovulum iodolum* (yellow-brown anaerobic, red-brown aerobic; DSMZ No. 12328), *Rhodovulum robiginosum* (yellow-brown anaerobic, red-brown aerobic; DSMZ No. 12329), *Rhodovulum strictum* (yellow-brown anaerobic, red-brown aerobic; ATCC No. 35886, DSMZ Nos. 11289 and 11292), *Rhodovulum sulfidophilum* (yellow-brown anaerobic, red-brown aerobic; ATCC No. 35886, DSMZ Nos. 1374 and 2351), *Rubrivivax gelatinosus* (yellow-brown to pink; ATCC Nos. 17011 and 49846; DSMZ Nos. 1709, 149, 151 and 6859), *Rhodobacter sphaeroides* (green-brown to black, DSMZ Nos. 158, 159, 160, 2340, 5864, 8371, 9483 and 9484), *Blastochloris sulfoviridis* (green; DSMZ Nos. 729 and 13255), *Blastochloris viridis* (green; ATCC No. 19567, DSMZ Nos. 133, 134 and 136), and *Rhodocyclus tenuis* (violet or brown orange; ATCC No. 25093, DSMZ Nos. 109, 110, 111 and 112).

[0704] Green sulfur bacteria (e.g., Family Chlorobiaceae) typically comprise bacteriochlorophyll c, bacteriochlorophyll d, and/or bacteriochlorophyll e, a relatively small amount of bacteriochlorophyll a, and a carotenoid (e.g., a chlorobactene, isorenieratene). Green sulfur bacteria generally have an absorbance maxima between 700 nm and 755 nm, and are generally green or brown in color, due to the presence of chlorobactene or isorenieratene, respectively. Additionally, green colored green sulfur bacteria typically comprise Bchl c and/or Bchl d, with Bchl c being more common, and a small amount of Bchl a. Brown colored green sulfur bacteria typically comprise Bchl e. Examples of green sulfur bacteria genera include Chlorobium, Prosthecochloris, Pelodictyon, and Chloroherpeton. Specific examples of a green sulfur bacteria species include *Chlorobium limicola* (green; DSMZ Nos. 245, 248, 249, 254, 257 and 258), *Chlorobium luteolum* (green; DSMZ No. 273), *Prosthecochloris vibrioformis* (green; DSMZ Nos. 260, 261, 262, 263 and 265), *Prosthecochloris aestuarii* (green; DSMZ No. 271, 272 and 1685), *Chlorobaculum tepidum* (green; DSMZ No. 12025), *Chloroherpeton thalassium* (green; ATCC No. 35110), *Chlorobium phaeobacteroides* (brown; DSMZ Nos. 266, 267, 1677 and 1855), *Chlorobium phaeovibrioides* (brown; DSMZ Nos. 269, 270 and 1678), and *Pelodictyon phaeum* (brown; DSMZ No. 728).

[0705] Multicellular filamentous green bacteria ("green non-sulfur bacteria") (e.g., Family Chloroflexaceae) generally comprises Bchl c, Bchl d, Bchl e, Bchl a, and a chlorobactene carotenoid (e.g., beta carotenoid, gamma carotenoid). Examples of oligo-to multicellular filamentous green bacteria genera include Chloroflexus (yellowish green

in anaerobic growth conditions or orange red in aerobic growth conditions; Bchl c, and some Bchl a).

[0706] Heliobacteriaceae typically comprise Bchl g and carotenoids (e.g., neurosporene) and are Gram-positive Eubacteria, but possess relatively little peptidoglycan. Examples of Heliobacteriaceae include the genera Heliobacterium, Heliobacillus, and Heliophilum. Specific examples of Heliobacteriaceae include *Heliobacterium gestii* (green; ATCC Nos. 43375, 51791 and 51792, DSMZ No. 11169), *Heliobacterium modesticaldum* (green; ATCC No. 51547, DSMZ 9504), *Heliobacterium chlorum* (brown-green; DSMZ No. 3682), *Heliobacterium undosum* (green; DSMZ 13378), *Heliobacillus mobilis* (green; ATCC No. 43427, DSMZ No. 6151), and *Heliophilum fasciatum* (green; ATCC No. 51790, DSMZ No. 11 170).

[0707] The Eubacteria Class Proteobacteria includes the purple sulfur bacteria and other Eubacteria genera that comprise a bacteriochlorophyll. Such additional Proteobacteria typically comprise bacteriochlorophyll a and carotenoids (e.g., bacteriorubixanthinal, erythroxanthin sulfate), and are often pink, red, yellow and/or orange. Examples of such additional Proteobacteria genera include Acidiphilium (red-pink), Erythrobacter (orange, yellow and/or red), Erythromicrobium (red-orange), Porphyrobacter (red-orange, yellow-orange), Roseobacter (pink), Roseococcus (pink-red), Methylobacterium, Roseospirillum, Roseovarius, Blastomonas, and Roseateles. Specific examples of Proteobacteria include *Acidiphilium rubrum* (red-violet; ATCC No. 35905), *Roseobacter denitrificans* (pink; ATCC No. 33942; DSMZ No. 7001), *Roseobacter litoralis* (pink; ATCC No. 49566; DSMZ No. 6996), *Acidiphilium angustum* (pink; ATCC No. 35903), *Roseococcus thiosulfatophilus* (pink-red; ATCC No. 700004, DSMZ No. 8511), *Erythrobacter litoralis* (red to orange; ATCC No. 700002, DSMZ No. 8509), *Erythromicrobium ramosum* (red orange; ATCC No. 700003, DSMZ No. 8510), *Porphyrobacter neustonensis* (red-orange; DSMZ Nos. 9434 and 9435), *Porphyrobacter tepidarius* (red-orange; DSMZ No. 10594), *Porphyrobacter cryptus* (red-orange; DSMZ No. 12079), *Erythrobacter longus* (orange; ATCC No. 33941, DSMZ No. 6997), *Porphyrobacter sanguineus* (yellow-orange; ATCC Nos. 25659, 25660 and 25661, DSMZ No. 11032), and *Erythrobacter citreus* (yellow; DSMZ No. 14432).

[0708] In further embodiments, a silica-based shell, cell wall, and/or exoskeleton, may possess an IR absorption property, and it is contemplated that a cell-based particulate material (e.g., a diatom-based particulate material) comprising such silica-based cellular material may be used in a camouflage coating or other camouflage surface treatment. In further aspects, an anthocyanin or a cell-based particulate material may possess an IR (e.g., near IR) absorption property and also may be suitable for use in camouflage materials.

EXAMPLE 17

Cells With UV-Absorption Properties

[0709] Often a colored biomolecule of a cell absorb ultra-violet wavelengths (e.g., 200 nm to 400 nm), and are contemplated for use in cell-based particulate material and/or dyes that function as a light stabilizer, specifically a UV absorber. However, a cell that comprises an anthocyanin, a

carotenoid, a chlorophyll and/or a phycobilin is generally preferred. Typically, such a preferred cell will have a greater amount of a UV absorbing biomolecule than a cell that comprises a bacteriochlorophyll. This is often due to the photosynthetic wavelength absorbance differences between such preferred cells and cells that comprise a bacteriochlorophyll. Additionally, a biomolecule such as an anthocyanin or a carotenoid protectively absorb UV light in both photosynthetic and non-photosynthetic cells, and may additionally possess radical scavenger capability. Examples of such preferred cells include a plant cell, eukaryotic algae, and colored Archaea, fungal cells, and various bacterial cells described herein or as would be known to one of ordinary skill in the art in light of these disclosures. Examples of a preferred bacteria cell include a Cyanobacteria ("blue-green algae"), such as a cell of the genera *Anabaena*, *Arthrospira*, *Calothrix*, *Chlorogloeopsis*, *Chroococcidiopsis*, *Crinalium*, *Cylindrospermum*, *Dermocarpella*, *Fischerella*, *Gloeobacter*, *Gloeocapsa*, *Myxosarcina*, *Nostoc*, *Oscillatoria*, *Pleurocapsa*, *Pseudanabaena*, *Scytonema*, *Spirulina*, *Synechococcus*, *Synechocystis*, *Tolypothrix*, or *Xenococcus* (Castenholz, R. W., 2001). Cyanobacteria typically comprise a chlorophyll and a phycobilin, and are often blue-green in color.

[0710] In further embodiments, a silica-based shell, cell wall, and/or exoskeleton, typically possesses UV absorption property, and it is contemplated that a cell-based particulate material (e.g., a diatom-based particulate material) comprising such silica-based cellular material may be used as an UV absorber.

EXAMPLE 18

Plants

[0711] In one embodiment, a cell-based particulate material of the present invention may be prepared from a multicellular plant. In certain aspects, the plant is a land plant, such as any commercial plant (e.g., an agricultural plant, an ornamental plant), a weed, or a combination thereof. As used herein, a "plant" refers to both the whole organism, as well as plant parts and structures including, but not limited to, seeds, seedlings, flowers, fruit, leaves, stems, roots, xylem or phloem and the like. Often a plant is classified as a dicotyledonous plant or a monocotyledonous plant, and it is contemplated that either can be used in the practice of the present invention. Examples of specific commercial plants include alfalfa, almond, apple, apricot, asparagus, avocado, barley, beet, blackberry, blueberry, boysenberry, broccoli, brussel sprout, buckwheat, cabbage, caneberry, carrot, cauliflower, celery, chayote, cherry, chestnut, a citrus plant (e.g., oranges, lemons, limes, grapefruit, tangerine), clover, collards, corn, cotton, cranberry, crown vetch, cucumber, currant, dandelion, date, dewberry, eggplant, endive, fig, filbert, flax, garlic, gooseberry, grape, a grass, guava, hop, horseradish, kale, kohlrabi, kudzu, kumquat, leek, a legume ("bean"), lentil, lespedeza, lettuce, loganberry, lupinus, macadamia, mango, a melon, milk vetch, millet, mushroom, mustard green, mustard (e.g., Chinese mustard, Japanese mustard, oriental mustard), nectarine, oat, okra, onion, an ornamental (e.g., a flower, a turf, a woody plant), papaya, parsley, parsnip, passion fruit, peach, pear, pea, peanut, pecan, peppermint, a pepper, persimmon, pineapple, plum, potato, pumpkin, quince, radish, raspberry, rice, rutabaga,

rye, sainfoin, safflower, salsify, shallot, sorghum, soybean, spearmint, spinach, squash, strawberry, sunflower, sweet potato, swiss chard, tobacco, tomato, turnip, walnut, watercress, watermelon, wheat, or a combination thereof.

References

- [0712] "ASTM Book of Standards, Volume 05.01 Petroleum Products and Lubricants (i)" (2003) ASTM International, West Conshohocken, Pa., U.S.A.
- [0713] "ASTM Book of Standards, Volume 05.02 Petroleum Products and Lubricants (II)" (2003) ASTM International, West Conshohocken, Pa., U.S.A.
- [0714] "ASTM Book of Standards, Volume 05.03 Petroleum Products and Lubricants (III)" (2003) ASTM International, West Conshohocken, Pa., U.S.A.
- [0715] "ASTM Book of Standards, Volume 06.01, Paint—Tests for Chemical, Physical, and Optical Properties; Appearance" (2002) ASTM International, West Conshohocken,
- [0716] "ASTM Book of Standards, Volume 06.02, Paint—Products and Applications; Protective Coatings; Pipeline Coatings" (2002) ASTM International, West Conshohocken, Pa., U.S.A.
- [0717] "ASTM Book of Standards, Volume 06.03, Paint—Pigments, Drying Oils, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles" (2002) ASTM International, West Conshohocken, Pa., U.S.A.
- [0718] "ASTM Book of Standards, Volume 06.04, Paint—Solvents; Aromatic Hydrocarbons" (2002) ASTM International, West Conshohocken, Pa., U.S.A.
- [0719] "ASTM Book of Standards, Volume 07.01 Textiles (I)" (2003) ASTM International, West Conshohocken, Pa., U.S.A.
- [0720] "ASTM Book of Standards, Volume 07.02 Textiles (II)" (2003) ASTM International, West Conshohocken, Pa., U.S.A.
- [0721] "ASTM Book of Standards, Volume 15.04 Soaps and Other Detergents; Polishes; Leather; Resilient Floor Coverings" (2003) ASTM International, West Conshohocken, Pa., U.S.A.
- [0722] Albizo, J. M. and White, W. E., "The Hydrolysis of GD and VX by Acetone Dried Preparations of Cured and Plasmid-Containing *Pseudomonas Diminuta*" Chemical Research, Development & Engineering Center Scientific conference on Chemical Defense Research, November 18-21, pp. 643-649, 1986.
- [0723] Alexopoulos, C. J., et al., *Introductory Mycology* (4th Ed.). John Wiley and Sons, New York, U.S.A., 1996, p. 868
- [0724] Arora, D. K., et al., Eds., *Handbook of Applied Mycology Fungal Biotechnology Volume 4*, Marcel Dekker, Inc., New York, U.S.A., 1992.
- [0725] Asenjo, J. A., et al., Eds., *Bioreactor System Design*, Marcel Dekker, Inc., New York, U.S.A., 1995.

- [0726] Ash, M. and Ash, I., *Handbook of Paint and Coating Raw Materials, Second Edition*, Ashgate Publishing Company, Brookfield, Vt., U.S.A., 1996.
- [0727] Azzoni, A. R., et al., *Biotech. Bioeng.* 80(3):268-276, 2002.
- [0728] Baird, R. M., et al., Eds., *Handbook of Microbiological Quality Control Pharmaceuticals and Medical Devices*, Taylor & Francis, London, England, 2000.
- [0729] Ball, C., Ed., *Genetics and Breeding of Industrial Microorganisms*, CRC Press, Boca Raton, Fla., U.S.A., 1984.
- [0730] Barry, C. E., et al., *Prog Lipid Res* 37:143, 1998.
- [0731] Bennet, H., *Industrial Waxes Volume II Compounded Waxes and Technology*, Chemical Publishing Co, New York, 1975.
- [0732] Blankenship, R. E., et al., Eds., *Anoxygenic Photosynthetic Bacteria*, Dordrecht: Kluwer, 1995.
- [0733] Buxbaum, G., Ed., *Industrial Inorganic Pigments*, 2nd. Ed., Wiley—VCH, 1998.
- [0734] Cablo, L. J., Ed., *Handbook of Coatings Additives*, Marcel Dekker, Inc., New York, N.Y., 1987.
- [0735] Castenholz, R. W., "Phylum BX. Cyanobacteria. Oxygenic Photosynthetic Bacteria," In: *Bergey's Manual of Systematic Bacteriology. Volume 1: The Archaea and the Deeply Branching and Phototropic Bacteria. Second Edition*. (Garrrity, G., Boone, D. R., and Castenholz, R. W., Eds.) (2001) Springer-Verlag, N.Y.
- [0736] Chanda, V. B., Ed., *Current Protocols in Molecular Biology*, John Wiley & Sons, 2002.
- [0737] Chen, W. and Mulchandani, A. *Tibtech* 16:71-76, 1998.
- [0738] Coico, R., Ed., *Current Protocols in Immunology*, John Wiley & Sons, 2002.
- [0739] Collins, C. H., et al., Eds., *Microbiological Methods*, Seventh Edition, Butterworth-Heinemann, Ltd, Jordan Hill, Oxford, England, 1995.
- [0740] "Colour Index International" 3rd Ed. *Pigment and Solvent Dyes*, Society of Dyers and Colourists American Association of Textile Chemists and Colorists, 1997.
- [0741] "Colour Index International" 3rd Ed. Society of Dyers and Colourists American Association of Textile Chemists and Colorists, 1971.
- [0742] Demain, A. L., et al., Eds., *Manual of Industrial Microbiology and Biotechnology*, 2nd Edition, ASM Press, Washington, D.C., U.S.A., 1999.
- [0743] Denner, E. B. M., et al., "Erythrobacter citreus sp. nov., a yellow pigmented bacterium that lacks bacteriochlorophyll a, isolated from the western Mediterranean Sea," *International Journal of Systematic and Evolutionary Microbiology* 52:655-1661, 2002.
- [0744] Dunning, H. R., *Pressure Sensitive Adhesives-Formulations and Technology*, 2nd Ed., Noyes Data Corporation, New Jersey, 1977.
- [0745] Easter, M. C., Ed., *Rapid Microbiological Methods in the Pharmaceutical Industry*, CRC Press, LLC, Boca Raton, Fla., U.S.A., 2003.
- [0746] Efremenko, E. N., et al., *J. Biochem. Biophys Methods* 51:195-201, 2002.
- [0747] Elvers, B., et al., Eds., *Ullmann's Encyclopedia of Industrial Chemistry*, Volume 28, VCH Verlagsgesellschaft mbH, D-6945 1, Weinheim (Federal Republic of Germany), 1996.
- [0748] Endress, R. "Plant Cell Biotechnology," Springer-Verlag, Germany, 1994.
- [0749] Fleming, D. O., et al., Eds., *Biological Safety Principles and Practice 3rd Edition*, ASM Press, Washington, D.C., U.S.A., 2000.
- [0750] Flick, E. W., *Adhesive and Sealant Compound Formulations*, 2nd Ed., Noyes Publications, New Jersey, 1984.
- [0751] Flick, E. W., *Advanced Cleaning Product Formulations Household, Industrial, Automotive*, Noyes Publications, New Jersey, 1989.
- [0752] Flick, E. W., *Construction and Structural Adhesives and Sealants*, Noyes Publications, New Jersey, 1988.
- [0753] Flick, E. W., *Handbook of Paint Raw Materials, Second Edition*, Noyes Data Corporation/Noyes Publications, Park Ridge, N.J., U.S.A., 1989.
- [0754] Flick, E. W., *Household and Automotive Chemical Specialties Recent Formulations*, Noyes Publications, New Jersey, 1979.
- [0755] Flick, E. W., *Household and Automotive Cleaners and Polishes 3rd Edition*, Noyes Publications, New Jersey, 1986.
- [0756] Flick, E. W., *Household, Automotive, and Industrial Chemical Formulations 2nd Edition*, Noyes Publications, New Jersey, 1984.
- [0757] Flick, E. W., *Industrial Surfactants*, Noyes Publications, New Jersey, 1988.
- [0758] Flick, E. W., *Industrial Water-Based Paint Formulations*, Park Ridge, N.J. Noyes, 1988, xvi, 277; p. 25.
- [0759] Flick, E. W., *Institutional and Industrial Cleaning Product Formulations*, Noyes Publications, New Jersey, 1985.
- [0760] Flick, E. W., *Prepaint Specialties and Surface Tolerant Coatings*, Noyes Publications, 1991.
- [0761] Flick, E. W., *Textile Finishing Chemicals: An Industrial Guide*, Noyes Publications, 1996.
- [0762] Flick, E., *Contemporary Industrial Coatings-Environmentally Safe Formulations*, Noyes Publications, New Jersey, 1985.
- [0763] Flick, E., *Engineering Resins-An Industrial Guide*, Noyes Publications, New Jersey, 1988.
- [0764] Flick, E., *Handbook of Raw Adhesives*, 2nd Ed., Noyes Publications, New Jersey, 1989.

- [0765] Flick, E., *Handbook of Raw Adhesives*, Noyes Publications, New Jersey, 1982.
- [0766] Flick, E., *Water-Soluble Resins-An Industrial Guide*, Noyes Publications, New Jersey, 1986.
- [0767] Fox, T. G., *Bulletin of the American Physics Society*, 1:123, 1956.
- [0768] Freeman, H. S., et al. Eds., *Colorants for Non-Textile Applications*, Elsevier, 2000.
- [0769] Gaberlein, S., et al., *Appl Microbiol Biotechnol* 54:652-658, 2000a.
- [0770] Gerard, J. F., ed., *Fillers and Filled Polymers-Macromolecular Symposia* 169, Wiley-VCH, Verlag, 2001.
- [0771] Gillette, M. L., "Using Acid-Base Indicators to Visually Estimate the pH of Solutions," Chemical Education Resources, Inc. (1985).
- [0772] Gordon, R. K., et al., *Chemico-Biological Interactions* 119-120:463-470, 1999.
- [0773] Graham, L. E., et al., *Algae*, Prentice-Hall, Inc. Upper Saddle River, N.J., U.S.A., 2000.
- [0774] Greene, T. W., et al., *Productive Groups in Organic Synthesis*, Second Edition, pp. 309-315, John Wiley & Sons, Inc., USA, 1991.
- [0775] Griffin, D., *Fungal Physiology* (2nd Ed.), Wiley-Liss, New York, 1993.
- [0776] Hamburg, H. R., et al., Eds., *Hess's Paint Film Defects: Their Causes and Cure*, 3rd Edition, Halsted Press, 1979.
- [0777] Harkins, E. W., Ed., *Current Protocols in Nucleic Acid Chemistry*, John Wiley & Sons, 2002.
- [0778] Hartshorn, S. R., Ed., *Structural Adhesives-Chemistry and Technology*, Plenum Press, New York, 1986.
- [0779] Havens, P. L., et al., *Ind. Eng. Chem. Res.* 32:2254-2258, 1993.
- [0780] Hensl, W. R., Ed., *Bergey's Manual of Determinative Bacteriology Ninth Edition*, William & Wilkins, Baltimore, Md., U.S.A., 1994.
- [0781] Holden, G., et al., Eds., *Thermoplastic Elastomers*, 2nd Ed., Hanser Publishers, Verlag, 1996.
- [0782] Hong, M. S., et al., *Bioremediation Journal* 2(2):145-157, 1998.
- [0783] Hoskin, F. C. G., et al., *Chemico-Biological Interactions* 119-120:399-404, 1999.
- [0784] Hoskin, F. C. G., et al., *Chemico-Biological Interactions* 119-120:439-444, 1999.
- [0785] Hung, S. -C., et al., *Appl. Biochem. Biotechnol.* 56(1):37-47, 1996.
- [0786] Hunger, K., et al., *Industrial Organic Pigments*, Wiley-VCH, 1993.
- [0787] Imho, et al., "Rearrangement of the species and genera of the phototrophic 'purple nonsulfur bacteria.'" *Int. J. Sys. Bac.* 34:340-343, 1984.
- [0788] *Industrial Waxes Volume I Natural & Synthetic Waxes*, Chemical Publishing Co., New York, 1975.
- [0789] Johnson, K., *Antistatic Compositions for Textiles and Plastics*, Noyes Data Corporation, New Jersey, 1976.
- [0790] Karsa, D. R., et al., Eds., *Waterborne Coatings and Additives*, The Royal Society of Chemistry, 1995.
- [0791] Kim, J. -W. et al., *Biotechnol. Prog.* 18:429-436, 2002.
- [0792] Kirsop, B. E., et al., *Maintenance of Microorganism and Cultured Cells—A Manual of Laboratory Methods*, 2nd Edition Academic Press, New York, U.S.A., 1991.
- [0793] Kolakowski, J. E., et al., *Biocatal. Biotransform.* 15:297-312, 1997.
- [0794] Koleske, J. V., Ed., *Paint and Coating Testing Manual*, Fourteenth Edition of the Gardner-Sward Handbook, American Society for Testing and Materials, Philadelphia, Pa., U.S.A., 1995.
- [0795] Kurtzman, C. P., et al., Eds., *The Yeasts—A Taxonomic Study*, Fourth Revised and Enlarged Edition, Elsevier Science, B. V., Amsterdam, The Netherlands, 1998.
- [0796] Labeda, D. P., Ed., *Environmental Biotechnology Isolation of Biotechnological Organisms From Nature*, McGraw-Hill Publishing Company, New York, U.S.A., 1990.
- [0797] Lai, K., et al., *J. Biol. Chem.* 269:16579-16584, 1994.
- [0798] Lambourne, R., et al., Eds., *Paint and Surface Coatings, Theory and Practice*, Second Edition, Woodhead Publishing Ltd., Cambridge, England, 1999.
- [0799] Landrock, A. H., *Adhesives Technology Handbook*, Noyes Publications, New Jersey, 1985.
- [0800] Laskin, A. I., et al., Eds., *CRC Handbook of Microbiology. Volume 1, Bacteria*, CRC Press, Inc., Boca Raton, Fla., U.S.A., 1977.
- [0801] Laskin, A. I., et al., Eds., *CRC Handbook of Microbiology. Volume 2, Fungi, algae, protozoa, and viruses*, CRC Press, Inc., Boca Raton, Fla., U.S.A., 1977.
- [0802] Laskin, A. I., et al., Ed., *CRC Handbook of Microbiology. Volume 3, microbial compositions: amino acids, proteins, and nucleic acids*, CRC Press, Inc., Boca Raton, Fla., U.S.A., 1977.
- [0803] Laskin, A. I., et al., Ed., *CRC Handbook of Microbiology. Volume 4, microbial compositions: carbohydrates, lipids, and minerals* CRC Press, Inc., Boca Raton, Fla., U.S.A., 1977.
- [0804] Laskin, A. I., et al., Ed., *CRC Handbook of Microbiology. Volume 5, microbial products*, CRC Press, Inc., Boca Raton, Fla., U.S.A., 1977.
- [0805] Laskin, A. I., et al., Ed., *CRC Handbook of Microbiology. Volume 6, growth and metabolism*, CRC Press, Inc., Boca Raton, Fla., U.S.A., 1977.

- [0806] Laskin, A. I., et al., Eds., *CRC Handbook of Microbiology. Volume 7, microbial transformation*, CRC Press, Inc., Boca Raton, Fla., U.S.A., 1977.
- [0807] Laskin, A. I., et al., Eds., *CRC Handbook of Microbiology. Volume 8, toxins and enzymes*, CRC Press, Inc., Boca Raton, Fla., U.S.A., 1977.
- [0808] Laskin, A. I., et al., Eds., *CRC Handbook of Microbiology. Volume 9, pt. A. antibiotics—Volume 9, pt. B. antimicrobial inhibitors*, CRC Press, Inc., Boca Raton, Fla., U.S.A., 1977.
- [0809] Leduc, M., et al., *J. Bacteriol.* 161:627-635, 1985.
- [0810] LeJeune, K. E., et al., *Ann. NY Acad. Sci.* 864:153-170, 1998a.
- [0811] LeJeune, K. E., et al., *Biotech. and Bioeng.* 51(4):450-457, 1996.
- [0812] LeJeune, K. E., et al., *Biotech. and Bioeng.* 54(2):105-114, 1997.
- [0813] LeJeune, K. E., et al., *Biotech. and Bioeng.* 64(2):250-254, 1999.
- [0814] Leong, S. A., et al., Eds., *Molecular Industrial Mycology Systems and Applications for Filamentous Fungi*, Marcel Dekker, Inc., New York, U.S.A., 1991.
- [0815] Martinez, M. B., et al., *Biochem.* 35(4):1179-1186, 1996.
- [0816] Martinez, M. B., et al., *Biochem.* 40(40):11965-11974, 2001.
- [0817] Molins, R. A., Ed., *Food Irradiation: Principles and Applications*, Wiley-Interscience, Hoboken, N.J., U.S.A., 2001.
- [0818] Morgan, K., Ed., *Current Protocols in Cell Biology*, John Wiley & Sons, 2002.
- [0819] Mulchandani, A., et al., *Anal. Chem.* 70:4140-4145, 1998b.
- [0820] Mulchandani, A., et al., *Anal. Chem.* 70:5042-5046, 1998c.
- [0821] Mulchandani, A., et al., *Biosensors & Bioelectronics* 16:225-230, 2001.
- [0822] Mulchandani, A., et al., *Biotech. and Bioeng.* 63(2):216-223, 1999b.
- [0823] Mulchandani, A., et al., *Electroanalysis* 10:733-737, 1998a.
- [0824] Mulchandani, P., et al., *Biosensors & Bioelectronics* 16:433-437, 2001b.
- [0825] Munnecke, D. M., *Biotechnol. Bioeng.* 21:2247-2261, 1979.
- [0826] Munnecke, D. M., *Process Biochemistry* 13:14-16, 31, 1978.
- [0827] Murooka, Y., et al., Eds., *Recombinant Microbes for Industrial and Agricultural Applications*, Marcel Dekker, Inc., New York, U.S.A., 1994.
- [0828] Murray, P. R., et al., Eds., *Manual of Clinical Microbiology*, 8th Edition, Volume 1, ASM Press, Washington, D.C. U.S.A., 2003.
- [0829] Murray, P. R., et al., Eds., *Manual of Clinical Microbiology*, 8th Edition, Volume 2, ASM Press, Washington, D.C. U.S.A., 2003.
- [0830] Parks, L. C., Ed., *Handbook of Microbiological Media*, CRC Press, Inc., Boca Raton, Fla., U.S.A., 1993.
- [0831] Patton, T. C., *Paint Flow and Pigment Dispersion, A Rheological Approach to Coating and Ink Technology*, 1979.
- [0832] *PCI Paints & Coatings Industry*, pp. 56, 58, 60, 62, 64, 66-68, 70, 72, and 74, July 2003. Pa., U.S.A.
- [0833] Permentier, H. P. et al., *Biochemistry* 40:5573-5578, 2001.
- [0834] Petrie, E. M., *Handbook of Adhesives and Sealants*, McGraw-Hill, New York, 2000.
- [0835] Pfennig, N. "General physiology and ecology of photosynthetic bacteria." In: *The Photosynthetic Bacteria*, [Clayton, R. and Sistrom, W. R. (Eds.)] pp. 3-18. New York: Plenum Press, (1978).
- [0836] Rainina, E. I., et al., *Biosensors Bioelectronics* 11:991-1000, 1996.
- [0837] Riley, H. E., "Plasticizers," *Paint Testing Manual*, American Society for Testing Materials, 1972.
- [0838] Robinson, J. P., Ed., *Current Protocols in Cytometry*, John Wiley & Sons, 2002.
- [0839] Rouette, H. K., *Encyclopedia of Textile Finishing*, Springer-Verlag, Berlin Heidelberg, 2001.
- [0840] Sambrook, J., et al., Eds., *Molecular Cloning*, 3rd Edition, Cold Spring Harbor, N.Y.: Cold Spring Harbor Laboratory Press, 2001.
- [0841] Satas, D., et al., Eds., *Coatings Technology Handbook 2nd Edition Revised and Expanded*, Marcel Dekker, Inc., New York, N.Y., U.S.A., 2001.
- [0842] Satriana, M. J., *Hot Melt Adhesives: Manufacture and Applications*, Noyes Data Corporation, New Jersey, 1974.
- [0843] Scherrer, R., *Trends Biochem. Sci.* 9: 242-245, 1984.
- [0844] Sequeira, A., Jr., *Lubricant Base Oil and Wax Processing*, Marcel Dekker, Inc., New York, N.Y., U.S.A., 1994.
- [0845] Skeist, I., Ed., *Handbook of Adhesives*, 3rd Ed., Van Nostrand Reinhold, N.Y., 1990.
- [0846] Slade, P. E., et al., *Handbook of Fiber Finish Technology*, Marcel Dekker, 1998.
- [0847] Slater, A., et al., *Plant Biotechnology—The Genetic Manipulation of Plants*, Oxford University Press, Inc., New York, U.S.A., 2003.
- [0848] Slusarski, L., Ed., *Fillers for the New Millenium-Macromolecular Symposia* 194, Wiley-VCH, Verlag, 2003.

- [0849] Smith, H. M., Ed., *High Performance Pigments*, Wiley-VCH, 2002.
- [0850] Solomon, D. H., et al., *Chemistry of Pigments and Fillers*, Krieger Publishing Co., 1983.
- [0851] Somani, S. M., et al., "Chemical Warfare Agents: Toxicity at Low Levels," CRC Press, Boca Raton, 2001. Chapter 1, Health Effects of Low-Level Exposure to Nerve Agents, p 2.
- [0852] Somani, S. M., et al., "Chemical Warfare Agents: Toxicity at Low Levels," CRC Press, Boca Raton, 2001. Chapter 14, Emergency Response to a Chemical Warfare Agent Incident: Domestic Preparedness, First Response, and Public Health Considerations, p 414.
- [0853] Somani, S. M., et al., "Chemical Warfare Agents: Toxicity at Low Levels," CRC Press, Boca Raton, 2001. Chapter-2, Toxicokinetics of Nerve Agents, pp 26-29.
- [0854] Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternation Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet) (ASTM D5894-96).
- [0855] Standard Practice for Modified Salt Spray (Fog) Testing. Appendix A5: Dilute Electrolyte Cyclic Fog/Dry Test (ASTM G85-94).
- [0856] Standard Practice for Operating Light and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials. (ASTM G53-88).
- [0857] Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments (ASTM D1654-92).
- [0858] Stoye, D., et al., Eds., *Paints, Coatings and Solvents*, Second, Completely Revised Edition, Wiley-Vch, New York, U.S.A., 1988.
- [0859] Taylor, G., Ed., *Current Protocols in Pharmacology*, John Wiley & Sons, 2002.
- [0860] Taylor, G., Ed., *Current Protocols in Protein Science*, John Wiley & Sons, 2002.
- [0861] Tidona, C. A., et al., Eds., *The Springer Index of Viruses*, Springer-Verlag, New York, U.S.A., 2001.
- [0862] Truant, A. L., Ed., *Manual of Commercial Methods in Clinical Microbiology*, ASM Press, Washington, D.C. U.S.A., 2002.
- [0863] Volz, H. G., *Industrial Color Testing: Fundamentals and Techniques*, Second, Completely Revised Edition, Wiley-VCH, 1995.
- [0864] Waites, M. J., et al., *Microbiology—An Introduction*, Blackwell Science, Oxford, England, 2001.
- [0865] Walker, B. M., Ed., *Handbook of Thermoplastic Elastomers*, Van Nostrand Reinhold Co., New York, 1979.
- [0866] Walker, G. M., *Yeast Physiology and Biotechnology*, John Wiley & Sons, New York, U.S.A., 1998.
- [0867] Warth, A. H., *The Chemistry and Technology of Waxes*, Reinhold Publishing Corporation, New York, 1956.
- [0868] Wicks, Jr., Z. W., et al., *Organic Coatings, Science and Technology, Volume 2: Applications, Properties and Performance*, John Wiley & Sons, Inc., New York, U.S.A., 1992.
- [0869] Wicks, Jr., Z. W., et al., *Organic Coatings, Science and Technology, Volume 1: Film Formation, Components, and Appearance*, John Wiley & Sons, Inc., New York, U.S.A., 1992.
- [0870] Wicks, Jr., Z. W., et al., *Organic Coatings: Science and Technology*, 2nd edition, by Wiley-Interscience (John Wiley & Sons, Inc. 605 Third Avenue, New York, N.Y.) Table 31.1 Exterior White House Paint, p. 562.
- [0871] Wild, J. R., et al., *Proc. U.S. Army Chem. Res. Devel. Eng. Center Sci. Conf. Chem. Defense Res.* 18-21 Nov., p. 629-634, 1986.
- [0872] Yurkov, V. V., et al., "Aerobic Anoxygenic Phototrophic Bacteria" *Microbiology and Molecular Biology Reviews* 62(3):695-724, 1998.

What is claimed is:

1. A coating comprising a cell-based particulate material.
2. The coating of claim 1, wherein the cell-based particulate material comprises a cell wall, a test, a frustule, a pellicle, a viral proteinaceous outer coat, or a combination thereof.
3. The coating of claim 1, wherein the cell-based material comprises a multicellular-based particulate material.
4. The coating of claim 3, wherein the multicellular-based particulate material comprises a plant-based particulate material.
5. The coating of claim 4, wherein the plant-based particulate material comprises a corn-based particulate material.
6. The coating of claim 1, wherein the cell-based particulate material comprises a microorganism-based particulate material.
7. The coating of claim 6, wherein the microorganism-based particulate material comprises a unicellular-based particulate material.
8. The coating of claim 6, wherein the microorganism-based particulate material comprises an oligocellular-based particulate material.
9. The coating of claim 6, wherein the microorganism-based particulate material comprises an Archaea, a Eubacteria, a fungi, a Protista, a virus, or a combination thereof.
10. The coating of claim 9, wherein the microorganism-based particulate material comprises an Archaea.
11. The coating of claim 10, wherein the Archaea comprises *Acidianus*, *Acidilobus*, *Aeropyrum*, *Archaeoglobus*, *Caldivirga*, *Desulfurococcus*, *Ferroglobus*, *Ferroplasma*, *Haloarcula*, *Halobacterium*, *Halobaculum*, *Halococcus*, *Haloferax*, *Halogeometricum*, *Halomicrobium*, *Halorhabdus*, *Halorubrum*, *Haloterrigena*, *Hyperthermus*, *Ignicoccus*, *Metallosphaera*, *Methanobacterium*, *Methanobrevibacter*, *Methanocaldococcus*, *Methanococcoides*, *Methanococcus*, *Methanocorpusculum*, *Methanoculleus*, *Methanofollis*, *Methanogenium*, *Methanohalobium*, *Methanohalophilus*, *Methanolacinia*, *Methanlobus*, *Methanomi-*

crobium, Methanomicrococcus, Methanoplanus, Methanopyrus, Methanosaeta, Methanosalsum, Methanosarcina, Methanosphaera, Methanospirillum, Methanothermobacter, Methanothermococcus, Methanothermus, Methanotherrix, Methanotorris, Natrialba, Natronobacterium, Natronococcus, Natronomonas, Palaeococcus, Picrophilus, Pyrobaculum, Pyrococcus, Pyrodicticum, Pyrolobus, Staphylothermus, Stetteria, Stygiolobus, Sulfolobus, Sulfophobococcus, Sulfurisphaera, Thermococcus, Thermofilum, Thermoplasma, Thermoproteus, Thermosphaera, Vulcanisaeta, or a combination thereof.

12. The coating of claim 9, wherein the microorganism-based particulate material comprises a Eubacteria.

13. The coating of claim 12, wherein the Eubacteria comprises a Gram-positive Eubacteria.

14. The coating of claim 13, wherein the Gram-positive Eubacteria comprises Acetobacterium, Actinokineospora, Actinomadura, Actinomyces, Actinoplanes, Actinopolyspora, Actinosynnema, Aerococcus, Aeromicrobium, Agromyces, Amphibacillus, Amycolatopsis, Arcanobacterium, Arthrobacter, Aureobacterium, Bacillus, Bifidobacterium, Brachybacterium, Brevibacterium, Brochothrix, Carnobacterium, Caryophanon, Catellatospora, Cellulomonas, Clavibacter, Clostridium, Coprococcus, Coriobacterium, Corynebacterium, Curtobacterium, Dactylosporangium, Deinobacter, Deinococcus, Dermabacter, Dermatophilus, Desulfotomaculum, Enterococcus, Erysipelothrix, Eubacterium, Exiguobacterium, Falcivibrio, Frankia, Gardnerella, Gemella, Geodermatophilus, Glycomyces, Gordonia, Intraspangium, Jonesia, Kibdelosporangium, Kineosporia, Kitasatospora, Kurthia, Lactobacillus, Lactococcus, Leuconostoc, Listeria, Marinococcus, Melissococcus, Microbacterium, Microbispora, Micrococcus, Micromonospora, Microtetraspora, Mobiluncus, Mycobacterium, Nocardia, Nocardioidea, Nocardioopsis, Oerskovia, Pediococcus, Peptococcus, Peptostreptococcus, Pilimelia, Planobispora, Planococcus, Planomonospora, Promicromonospora, Propionibacterium, Pseudonocardia, Rarobacter, Renibacterium, Rhodococcus, Rothia, Rubrobacter, Ruminococcus, Saccharococcus, Saccharomonospora, Saccharopolyspora, Saccharothrix, Salinicoccus, Sarcina, Sphaerobacter, Spirillospora, Sporichthya, Sporohalobacter, Sporolactobacillus, Sporosarcina, Staphylococcus, Streptoalloteichus, Streptococcus, Streptomyces, Streptosporangium, Syntrophospora, Terrabacter, Thermacetogenium, Thermoactinomyces, Thermoanaerobacter, Thermoanaerobium, Thermomonospora, Trichococcus, Tsukamurella, Vagococcus, or a combination thereof.

15. The coating of claim 12, wherein the microorganism-based particulate material comprises a Gram-negative Eubacteria.

16. The coating of claim 15, wherein the Gram-negative Eubacteria comprises Acetivibrio, Acetoanaerobium, Acetobacter, Acetomicrobium, Acidaminobacter, Acidaminococcus, Acidiphilium, Acidomonas, Acidovorax, Acinetobacter, Aeromonas, Agitococcus, Agrobacterium, Agromonas, Alcaligenes, Allochromatium, Alteromonas, Alysia, Aminobacter, Anaerobacter, Anaerobiospirillum, Anaerorhabdus, Anaerovibrio, Ancalomicrobium, Ancylobacter, Angulomicrobium, Aquaspirillum, Archangium, Arsenophonus, Arthrospira, Asticcacaulis, Azomonas, Azorhizobium, Azospirillum, Azotobacter, Bacteroides, Bdellovibrio, Beggiatoa, Beijerinckia, Blastobacter, Blastochloris, Bordetella, Borrelia, Brachyspira, Bradyrhizobium, Brevundimonas,

Brucella, Budvicia, Butiauxella, Butyrivibrio, Calothrix, Campylobacter, Capnocytophaga, Cardiobacterium, Caulobacter, Cedecea, Cellulophaga, Cellvibrio, Centipeda, Chitinophaga, Chlorobium, Chloroflexus, Chlorogloeopsis, Chloroherpeton, Chondromyces, Chromobacterium, Chromohalobacter, Chroococcidiopsis, Citrobacter, Cobetia, Comamonas, Crinalium, Cupriavidus, Cyclobacterium, Cylandrospermum, Cystobacter, Cytophaga, Dermocarpella, Derxia, Desulfobacter, Desulfobacterium, Desulfobulbus, Desulfococcus, Desulfomicrobium, Desulfomonile, Desulfonema, Desulfosarcina, Desulfovibrio, Desulfurella, Desulfuromonas, Dichotomicrobium, Ectothiorhodospira, Edwardsiella, Eikenella, Enhydrobacter, Ensifer, Enterobacter, Erwinia, Erythrobacter, Erythromicrobium, Escherichia, Ewingella, Fervidobacterium, Fibrobacter, Filomicrobium, Fischerella, Flammeovirga, Flavobacterium, Flectobacillus, Flexibacter, Flexithrix, Francisella, Fraetoria, Fusobacterium, Gemmata, Gemmiger, Gloeobacter, Gloeocapsa, Gluconobacter, Haemophilus, Hafnia, Haliscomenobacter, Haloanaerobium, Halobacteroides, Halochromatium, Halomonas, Halorhodospira, Helicobacter, Heliobacillus, Heliobacterium, Herbaspirillum, Herpetosiphon, Hirschia, Hydrogenophaga, Hyphomicrobium, Hyphomonas, Ilyobacter, Isochromatium, Isosphaera, Janthinobacterium, Kingella, Klebsiella, Kluyvera, Labrys, Lachnospira, Lamprocystis, Lampropedia, Leclercia, Legionella, Leminorella, Leptospira, Leptospirillum, Leptothrix, Leptotrichia, Leucothrix, Lysobacter, Malonomonas, Marinilabilia, Marichromatium, Marinobacter, Marinomonas, Megamonas, Megasphaera, Melittangium, Meniscus, Mesophilobacter, Metallogenium, Methylobacillus, Methylobacterium, Methylococcus, Methylophaga, Methylophilus, Methylovorus, Microscilla, Mitsuokella, Moellerella, Moraxella, Morganella, Morococcus, Myxococcus, Myxosarcina, Nannocystis, Neisseria, Nevskia, Nitrobacter, Nitrococcus, Nitrosococcus, Nitrosomonas, Nitrosospira, Nitrospira, Nostoc, Obesumbacterium, Oceanospirillum, Ochrobactrum, Oligella, Oscillatoria, Oxalobacter, Pantoea, Paracoccus, Pasteurella, Pectinatus, Pedobacter, Pedomicrobium, Pelobacter, Pelodictyon, Persicobacter, Phaeospirillum, Phenyllobacterium, Photobacterium, Phyllobacterium, Pirellula, Planctomyces, Plesiomonas, Pleurocapsa, Polyangium, Porphyrobacter, Porphyromonas, Pragia, Prevotella, Propionigenium, Propionispira, Prosthecobacter, Prosthecochloris, Prosthecomicrobium, Proteus, Providencia, Pseudanabaena, Pseudomonas, Psychrobacter, Rahnella, Rhabdochromatium, Rhizobacter, Rhizobium, Rhizomonas, Rhodobacter, Rhodobium, Rhodoblastus, Rhodobaca, Rhodocista, Rhodocyclus, Rhodoferax, Rhodomicrobium, Rhodopila, Rhodoplanes, Rhodopseudomonas, Rhodospirillum, Rhodothalassium, Rhodovibrio, Rhodovulum, Rikenella, Roseobacter, Roseococcus, Rugamonas, Rubrivivax, Ruminobacter, Runella, Salmonella, Saprospira, Scytonema, Sebaldeia, Selenomonas, Seliberia, Serpens, Serpulina, Seratia, Shigella, Simonsiella, Sinorhizobium, Sphaerotilus, Sphingobacterium, Spirillum, Spirochaeta, Spirosoma, Spirulina, Sporocytophaga, Sporomusa, Stella, Stigmatella, Streptobacillus, Succinimonas, Succinivibrio, Sulfobacillus, Synechococcus, Synechocystis, Syntrophobacter, Syntrophococcus, Syntrophomonas, Tatumella, Taylorella, Thermochromatium, Thermodesulfobacterium, Thermoleophilum, Thermomicrobium, Thermonema, Thermosiphon, Thermotoga, Thermus, Thiobacillus, Thiocapsa, Thiococ-

cus, Thiocystis, Thiodictyon, Thiohalocapsa, Thiolampro-
vum, Thiomicrospira, Thiorhodovibrio, Thiothrix, Tissier-
ella, Tolypothrix, Treponema, Vampirovibrio, Variovorax,
Veillonella, Verrucomicrobium, Vibrio, Vitreoscilla, Week-
sella, Wolinella, Xanthobacter, Xanthomonas, Xenococcus,
Xenorhabdus, Xylella, Xylophilus, Yersinia, Yokenella,
Zobellia, Zoogloea, Zymomonas, Zymophilus, or a combi-
nation thereof.

17. The coating of claim 12, wherein the Eubacteria
comprises Abiotrophia, Acetitomaculum, Acetohalobium,
Acetonema, Achromobacter, Acidimicrobium, Acidithioba-
cillus, Acidobacterium, Acidocella, Acrocarpospora, Acti-
noalloteichus, Actinobacillus, Actinobaculum, Actinocoral-
lia, Aequorivita, Afipia, Agreia, Agrococcus, Ahrensia,
Albibacter, Albidovulum, Alcanivorax, Alicyclophilus, Ali-
cyclobacillus, Alkalibacterium, Alkalilimnicola, Alkalispir-
illum, Alkanindiges, Aminobacterium, Aminomonas,
Ammonifex, Ammoniphilus, Anaerococcus, Anaerobacter,
Anaerobaculum, Anaerobranca, Anaerococcus, Anaerofi-
lum, Anaeromusa, Anaerophaga, Anaeroplasm, Anaerosi-
nus, Anaerostipes, Anaerovorax, Aneurinibacillus, Angio-
coccus, Anoxybacillus, Antarcticobacter, Aquabacter,
Aquabacterium, Aquamicrobium, Aquifex, Arcobacter,
Arhodomonas, Asanoa, Atopobium, Azococcus, Azorhizophi-
lus, Azospira, Bacteriovorax, Bartonella, Beutenbergia,
Bilophila, Blastococcus, Blastomonas, Bogoriella, Bosea,
Brachymonas, Brackiella, Brenneria, Brevibacillus, Bul-
leidia, Burkholderia, Caenibacterium, Caldicellulosiruptor,
Caldithrix, Caloramator, Caloranaerobacter, Caminibacter,
Caminicella, Carbophilus, Carboxydibacterium, Carboxydo-
cella, Carboxydothermus, Catenococcus, Catenuolanes,
Cellulosimicrobium, Chelatococcus, Chlorobaculum, Chry-
seobacterium, Chrysiogenes, Citricoccus, Collinsella, Col-
wellia, Conexibacter, Coprothermobacter, Couchioplanes,
Crossiella, Cryobacterium, Cryptosporangium, Dechloro-
monas, Deferribacter, Dechlorobacter, Dehalobacter, Delfi-
tia, Demetria, Dendrosporobacter, Denitrovibrio, Derna-
coccus, Desemzia, Desulfacinum, Desulfatobacterium,
Desulfobacca, Desulfobacula, Desulfocapsa, Desulfocella,
Desulfofaba, Desulfofrigus, Desulfofustis, Desulfohalo-
bium, Desulfomusa, Desulfonatronovibrio, Desul-
fonatronum, Desulfonauticus, Desulfonisporea, Desulfo-
regula, Desulforhabdus, Desulforhopalus, Desulfospira,
Desulfosporosinus, Desulfotalea, Desulfotignum, Desul-
fovira, Desulfurobacterium, Desulfuromusa, Dethiosul-
fovibrio, Devosia, Dialister, Diaphorobacter, Dichelobacter,
Dictyoglomus, Dietzia, Dolosicoccus, Dorea, Eggerthella,
Empedobacter, Enhygromyxa, Eremococcus, Ferrimonas,
Filifactor, Filobacillus, Finegoldia, Flexistipes, Formivibrio,
Friedmanniella, Frigoribacterium, Fulvimonas, Fusibacter,
Gallicola, Garciella, Gelidibacter, Gelria, Gemmatimonas,
Gemmobacter, Geobacillus, Geobacter, Georgenia, Geo-
thrix, Geovibrio, Glaciecola, Gluconacetobacter, Graciliba-
cillus, Granulicatella, Grimontia, Halanaerobacter, Hala-
naerobium, Haliangium, Halobacillus, Halocella,
Halonatronum, Halothermothrix, Halothiobacillus, Helco-
coccus, Heliophilum, Heliorestis, Herbidosporea, Hippea,
Holdemania, Holophaga, Hydrogenobacter, Hydrogeno-
baculum, Hydrogenophilus, Hydrogenothermus, Hydrogen-
ovibrio, Hymenobacter, Ignavigranum, Iodobacter, Isobacu-
lum, Janibacter, Kineococcus, Kineosphaera,
Kitasatospora, Knoellia, Kocuria, Kozakia, Kribbella,
Kutzneria, Kytococcus, Lachnobacterium, Laribacter, Lau-
tropia, Lechevalieria, Leifsonia, Leisingera, Lentzea, Leu-

cobacter, Limnobacter, Listonella, Lonepinella, Luteimonas,
Luteococcus, Macrococcus, Macromonas, Magnetospiril-
lum, Mannheimia, Maricaulis, Marinibacillus, Marinitoga,
Marinobacterium, Marinospirillum, Marmoricola, Meio-
thermus, Methylocapsa, Methylopila, Methylosarcina,
Microbulbifer, Microlunatus, Micromonas, Microsphaera,
Microvirgula, Modestobacter, Mogibacterium, Moorella,
Moritella, Muricauda, Mycetocola, Mycoplana, Myroides,
Natroniella, Natronincola, Nautilia, Nesterenkonia, Nono-
murea, Novosphingobium, Oceanimonas, Oceanobacillus,
Oceanobacter, Octadecabacter, Oenococcus, Oleiphilus,
Oligotropha, Olsenella, Opitutus, Orenia, Ornithinococcus,
Ornithinimicrobium, Oxalicibacterium, Oxalophagus, Oxo-
bacter, Paenibacillus, Pandoraea, Papillibacter, Paralactoba-
cillus, Paralobacillus, Parascardovia, Paucimonas, Pecto-
bacterium, Pelczaria, Pelospora, Pelotomaculum,
Peptoniphilus, Petrotoga, Phascolarctobacterium, Phoc-
oenobacter, Photorhabdus, Pigmentiphaga, Planomicro-
bium, Planotetrastroma, Plantibacter, Plesiocystis, Polarib-
acter, Prauserella, Propioniferax, Propionimicrobium,
Propionisporea, Propionivibrio, Pseudaminobacter,
Pseudoalteromonas, Pseudobutyrvibrio, Pseudoramibacter,
Pseudorhodobacter, Pseudospirillum, Pseudoxanthomonas,
Psychroflexus, Psychromonas, Psychroserpens, Ralstonia,
Ramlibacter, Raoultella, Rathayibacter, Rhodothermus,
Roseateles, Roseburia, Roseiflexus, Roseinatronobacter,
Roseospirillum, Roseovarius, Rubritepida, Ruegeria, Sagit-
tula, Salana, Salegentibacter, Salinibacter, Salinivibrio, San-
guibacter, Scardovia, Schineria, Schwartzia, Sedimentib-
acter, Shewanella, Shuttleworthia, Silicibacter, Skermania,
Slackia, Sphingobium, Sphingomonas, Sphingopyxis, Spir-
illiplanes, Sporanaerobacter, Sporobacter, Sporobacterium,
Sporotomaculum, Staleyia, Stappia, Starkeya, Stenotropho-
monas, Sterolibacterium, Streptacidiphilus, Streptomono-
spora, Subtercola, Succinilasticum, Succinisporea, Sulfito-
bacter, Sulfurospirillum, Sutterella, Suttonella,
Syntrophobotulus, Syntrophothermus, Syntrophus, Telluria,
Tenacibaculum, Tepidibacter, Tepidimonas, Tepidiphilus,
Terasakiella, Terracoccus, Tessaracoccus, Tetracenococcus,
Tetrasphaera, Thalassomonas, Thauera, Thermoaerobacter,
Thermanaeromonas, Thermanaerovibrio, Thermicanus,
Thermithiobacillus, Thermoanaerobacterium, Thermobifida,
Thermobispora, Thermobrachium, Thermocrinis, Thermoc-
rispum, Thermodesulforhabdus, Thermodesulfobacterium,
Thermohydrogenium, Thermomonas, Thermosyntropha,
Thermoterrabacterium, Thermovenabulum, Thermovibrio,
Thiobacillus, Thiobaculum, Thiobaculum, Thioalkalivibrio,
Thioalkalivibrio, Thioalkalivibrio, Thioalkalivibrio,
Thiobaca, Thiomonas, Tindallia, Tolumonas, Turicella,
Turicibacter, Ureibacillus, Verrucosipora, Victivallis, Vir-
gibacillus, Vogesella, Weissella, Williamsia, Xenophilus,
Zavarzinia, Zooshikella, Zymobacter, or a combination
thereof.

18. The coating of claim 9, wherein the microorganism-
based particulate material comprises a fungi.

19. The coating of claim 18, wherein the fungi comprises
Aciculoconidium, Agaricostilbum, Ambrosiozyma, Arx-
iozyma, Arxula, Ascoidea, Babjevia, Bensingtonia, Blastob-
otrys, Botryozyma, Bullera, Bulleromyces, Candida,
Cephalosporium, Chionosphaera, Citeromyces, Clavispora,
Cryptococcus, Cystofilobasidium, Debaryomyces, Dekkera,
Dipodascopsis, Dipodascus, Endomyces, Eremothecium,
Erythrobasidium, Fellomyces, Filobasidiella, Filobasidium,
Galactomyces, Geotrichum, Hanseniaspora, Hyalodendron,
Issatchenkia, Itersonilia, Kloeckera, Kluyveromyces,

Kockovaella, Kurtzmanomyces, Leucosporidium, Lipomyces, Lodderomyces, Malassezia, Metschnikowia, Moniliella, Mrakia, Myxozyma, Nadsonia, Oosporidium, Pachysolen, Phaffia, Pichia, Protomyces, Pseudozyma, Reniforma, Rhodosporidium, Rhodotorula, Saccaromycopsis, Saccharomyces, Saccharomyces, Saitoella, Saturnispora, Schizoblastosporion, Schizosaccharomyces, Sporidiobolus, Sporobolomyces, Sporopachydermia, Stephanoascus, Sterigmatomyces, Sterigmatosporidium, Sympodiomyces, Sympodiomycopsis, Taphrina, Tilletiaria, Tilletiopsis, Torulaspora, Trichosporon, Trichosporonoides, Trigonopsis, Tsuchiyaea, Wickerhamia, Wickerhamiella, Williopsis, Xanthophyllomyces, Yarrowia, Zygoascus, Zygosaccharomyces, Zygozima, or a combination thereof.

20. The coating of claim 9, wherein the microorganism-based particulate material comprises a Protista.

21. The coating of claim 20, wherein the Protista comprises Acetabularia, Achnanthes, Amphidinium, Ankirodesmus, Anophryoides, Aphanomyces, Astasia, Asterionella, Blepharisma, Botrydiopsis, Botrydium, Botryococcus, Bracteacoccus, Brevilegnia, Bulbochaete, Caenomorphia, Cephaluros, Ceratium, Chaetoceros, Chaetophora, Characiosiphon, Chlamydomonas, Chlorella, Chloridella, Chlorobotrys, Chlorococcum, Chromulina, Chroodactylon, Chrysamoeba, Chrysocapsa, Cladophora, Closterium, Cocconeis, Coelastrum, Cohnilembus, Colacium, Coleps, Colpidium, Colpoda, Cosmarium, Cryptoglena, Cyclidium, Cyclotella, Cylandrocystis, Derbesia, Dexiostoma, Dictyosphaerium, Dictyuchus, Didinium, Dinobryon, Distigma, Draparnaldia, Dunaliella, Dysmorphococcus, Enteromorpha, Entosiphon, Eudorina, Euglena, Euplotes, Eustigmatos, Flintiella, Fragilaria, Fritschella, Glaucoma, Gonium, Gonyaulax, Gymnodinium, Gyropaigne, Haematococcus, Halophytophthora, Heterosigma, Hyalotheca, Hydrodictyon, Khawkinia, Lagenidium, Lepidolegnia, Mallomonas, Mantoniella, Melosira, Menoidium, Mesanophrys, Mesotaenium, Metopus, Micrasterias, Microspora, Microthamnion, Mischochococcus, Monodopsis, Mougeotia, Nannochloropsis, Navicula, Nephroselmis, Nitzschia, Ochromonas, Oedogonium, Ophiocytium, Opisthonecta, Oxyrrhis, Pandorina, Paramecium, Paranophrys, Paraphysomonas, Parmidium, Pediastrum, Peranema, Peridinium, Peronophythora, Petalomonas, Phacus, Pithophora, Plagiopyla, Plasmopara, Platyophrya, Plectospira, Pleodorina, Pleurochloris, Pleurococcus, Pleurotaenium, Ploetia, Polyedriella, Porphyridium, Prorocentrum, Prototheca, Pseudocharaciopsis, Pseudocohnilembus, Pyramimonas, Pythiopsis, Pythium, Rhabdomonas, Rhizochromulina, Rhizoclonium, Rhodella, Rhodosorus, Rhynchopus, Saprolegnia, Scenedesmus, Scytomonas, Selenastrum, Skeltonema, Spathidium, Sphaerocystis, Spirogyra, Spirostomum, Spondylosium, Staurastrum, Stauroneis, Stentor, Stephanodiscus, Stephanosphaera, Stichococcus, Stigeoclonium, Synedra, Synura, Tetracystis, Tetraedron, Tetrahymena, Tetraselmis, Thalassiosira, Thaumatomastix, Thraustotheca, Trachelomonas, Trebouxia, Trentepohlia, Tribonema, Trimyema, Ulothrix, Uronema, Vaucheria, Vischeria, Volvox, Vorticella, Xanthidium, Zygnema, or a combination thereof.

22. The coating of claim 9, wherein the microorganism-based particulate material comprises a virus.

23. The coating of claim 22, wherein the virus comprises a bacteriophage.

24. The coating of claim 23, wherein the bacteriophage comprises Inoviridae genus Inovirus, Leviviridae, Microviridae, Myoviridae, Podoviridae, Siphoviridae, or a combination thereof.

25. The coating of claim 24, wherein the bacteriophage comprises 10/I, 149, 212/XV, 24/II, 249, 371/XXIX, 5, 8, A-1 (L), A19, A-4 (L), A-41, alpha 3, AN-10, AN-15, AN-20, AN-22, AN-24, B1, B40-8, B5, BK1, D20, E1, F [HER 346], F1, fr, hp, I, If1, If2, II, III, IV, J1, Mc-4, Minetti, MOR-1, MS2, Mu-1, N-1, N1 [N], N3 [Cay], N4 [X-5-A], N8 [Horse], Ox6, P/SW1/a [NCMB 384], P1, P22 [PLT-22(22)], PEa1 (h), PEa7, phi 92, phi R, phi V-1, phi X174, phi-S1, ps 1, Q-beta, R 17, R-1, S13, S-a, SP10, SP8, T2, T3, T6, V, VD13, Vi I, wy, XP5, Z1K/1, or a combination thereof.

26. The coating of claim 23, wherein the bacteriophage comprises 10 [L286], 11, 11 [WI 386], 113, 118, 12 [WI 3106], 120, 13 [J1 263], 138, 14 [J2106], 145, 163, 17, 17 [formerly 13], 18 [formerly 7], 184, 19 [formerly 5], 2, 2 [J1 328], 20 [formerly 4], 205, 221, 22653 [Carvajal's strain 1], 23 [Olsen phage], 236, 239, 24B, 250, 256 (R), 282 (S), 36, 37, 4 [J2101], 42, 46, 49B, 4S, 50Br, 53 alpha, 547, 57, 60, 6A, 6B, 6C, 7 [2 106], 73, 8 [L2 305], 9 [WI 3263], 92, A, A1, Ac 20, Ac 21, Ac 24, AN-11, AN-12, AN-13, AN-14, AN-16, AN-17, AN-18, AN-19, AN-21, AN-23, AN-25, AN-26, AP211, AS-1, B56-3, BG3, BK3, Bo 1, Bo 3, Bo 4, Bo 6 I, Bo 6 II, Bo 6 III, Bo 7, C, C204, C33, C36, Cb3, Cb6, Cb8r, CDC29, CDC42D, CDC47, CDC52, CDC52A, CDC53, CDC79, CDC80, CDC81, CDC83A, chi, D, D-10, D-34, DLC 2921/49, DS6A, enterococcus phage 1A, enterococcus phage 1B, eTAmv+, F-68, FCZ, G [HER 276], G178, HER-1 [7Lindberg], HER-10 [F8Lindberg], HER-16 [M4 Lindberg], HER-17 [M6Lindberg], HER-18 [F116L], HER-2 [16Lindberg], HER-3, HER-4 [24Lindberg], HER-5 [31Lindberg], HER-6 [44Lindberg], HER-9 [F7Lindberg], IMI strain A, IMI strain C, IMI strain D, IMI strain J, IMI strain K, Lactobacillus plantarum phage, LG, M-4, Mc-2, MU9, Mycobacterium smegmatis phage, N-4, NCPPB 1507 [4S], NCPPB 1508 [4L], NCPPB 782 [E1], NRS 201, NRS 605, P14, P4 sid1, Pa, PAV-1, Pb, PB2, Pc, Pf, phage UTAK, phi Ea100, phi Ea104, phi Ea116C, phi Ea125, phi W-14, phiXcs70am-3, Propionibacterium acnes phage, Ps-G3, r1589, r187, r196, r638, r71, RA105, rED220, rEDA41, rEDb44, rEDb45, rEDb50, RH23, RH88, rJ3, S-20, S-5, SL-1, SPP1, T-150, T7M (Meselson), UV1, UV375, UV47, Vibrio sp. phage, w, X1 [IMET 5013], X10 [IMET 5057], X24 [IMET 5056], X3 [IMET 5015], X5 [IMET 5017], XP1, XP2, XP3, XP4, XP8, ZI/2, or a combination thereof.

27. The coating of claim 1, wherein the cell-based particulate material is an attenuated cell-based particulate material.

28. The coating of claim 1, wherein the cell-based particulate material is a sterilized cell-based particulate material.

29. The coating of claim 1, wherein the cell-based particulate material comprises 0.1% to 65% of the coating by weight or volume.

30. The coating of claim 1, wherein the cell-based particulate material comprises 1% to 65% of the coating by weight or volume.

31. The coating of claim 1, wherein the cell-based particulate material comprises 2% to 65% of the coating by weight or volume.

32. The coating of claim 1, wherein the cell-based particulate material comprises 3% to 65% of the coating by weight or volume.

33. The coating of claim 1, wherein the cell-based particulate material comprises 4% to 65% of the coating by weight or volume.

34. The coating of claim 1, wherein the cell-based particulate material comprises 5% to 65% of the coating by weight or volume.

35. The coating of claim 1, wherein the cell-based particulate material comprises 6% to 65% of the coating by weight or volume.

36. The coating of claim 1, wherein the cell-based particulate material comprises 7% to 65% of the coating by weight or volume.

37. The coating of claim 1, wherein the cell-based particulate material comprises 8% to 65% of the coating by weight or volume.

38. The coating of claim 1, wherein the cell-based particulate material comprises 9% to 65% of the coating by weight or volume.

39. The coating of claim 1, wherein the cell-based particulate material comprises 10% to 65% of the coating by weight or volume.

40. The coating of claim 1, wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 50 kDa to 1.5×10^{14} kDa.

41. The coating of claim 1, wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 151 kDa to 1.5×10^{14} kDa.

42. The coating of claim 1, wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 241 kDa to 1.5×10^{14} kDa.

43. The coating of claim 1, wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 482 kDa to 1.5×10^{14} kDa.

44. The coating of claim 1, wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 753 kDa to 1.5×10^{14} kDa.

45. The coating of claim 1, wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 1,000 kDa to 1.5×10^{14} kDa.

46. The coating of claim 1, wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 1,506 kDa to 1.5×10^{14} kDa.

47. The coating of claim 1, wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 2,108 kDa to 1.5×10^{14} kDa.

48. The coating of claim 1, wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 3,613 kDa to 1.5×10^{14} kDa.

49. The coating of claim 1, wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 4,818 kDa to 1.5×10^{14} kDa.

50. The coating of claim 1, wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa.

51. The coating of claim 1, wherein the average biomolecule content per primary particle of the cell-based particulate material is 0.00001% to 100%.

52. The coating of claim 1, wherein the average biomolecule content per primary particle of the cell-based particulate material is 0.001% to 100%.

53. The coating of claim 1, wherein the average biomolecule content per primary particle of the cell-based particulate material is 0.1% to 100%.

54. The coating of claim 1, wherein the average biomolecule content per primary particle of the cell-based particulate material is 1.0% to 100%.

55. The coating of claim 1, wherein the average biomolecule content per primary particle of the cell-based particulate material is 2.0% to 100%.

56. The coating of claim 1, wherein the average biomolecule content per primary particle of the cell-based particulate material is 3.0% to 100%.

57. The coating of claim 1, wherein the average biomolecule content per primary particle of the cell-based particulate material is 4.0% to 100%.

58. The coating of claim 1, wherein the average biomolecule content per primary particle of the cell-based particulate material is 5.0% to 100%.

59. The coating of claim 1, wherein the average biomolecule content per primary particle of the cell-based particulate material is 7.5% to 100%.

60. The coating of claim 1, wherein the average biomolecule content per primary particle of the cell-based particulate material is 10.0% to 100%.

61. The coating of claim 1, wherein the cell-based particulate material is a whole cell particulate material.

62. The coating of claim 1, wherein the cell-based particulate material is a cell fragment particulate material.

63. The coating of claim 1, wherein the coating is 5 μ m to 5000 μ m thick upon a surface.

64. The coating of claim 1, wherein the coating is 15 μ m to 500 μ m thick upon a surface.

65. The coating of claim 1, wherein the coating is 15 μ m to 150 μ m thick upon a surface.

66. The coating of claim 1, wherein the coating comprises a paint.

67. The coating of claim 1, wherein the coating comprises a clear coating.

68. The coating of claim 67, wherein the clear coating comprises a lacquer, a varnish, a shellac, a stain, a water repellent coating, or a combination thereof.

69. The coating of claim 1, wherein the coating comprises a multicoat system.

70. The coating of claim 69, wherein the multicoat system comprises 2 to 10 layers.

71. The coating of claim 69, wherein one layer of the multicoat system comprises the cell-based particulate material.

72. The coating of claim 69, wherein a plurality of layers of the multicoat system comprise the cell-based particulate material.

73. The coating of claim 72, wherein at least one layer of said plurality of layers comprises a different preparation of

the cell-based particulate material than at least a second layer of said plurality of layers that comprises the cell-based particulate material.

74. The coating of claim 69, wherein each layer of the multicoat system is coating is 5 μm to 5000 μm thick upon a surface.

75. The coating of claim 69, wherein each layer of the multicoat system is coating is 15 μm to 500 μm thick upon a surface.

76. The coating of claim 69, wherein each layer of the multicoat system is coating is 15 μm to 150 μm thick upon a surface.

77. The coating of claim 69, wherein the multicoat system comprises a sealer, a water repellent, a primer, an undercoat, a topcoat, or a combination thereof.

78. The coating of claim 69, wherein the multicoat system comprises a topcoat.

79. The coating of claim 78, wherein the topcoat comprises the cell-based particulate material.

80. The coating of claim 1, wherein the coating is a coating that is capable of film formation.

81. The coating of claim 80, wherein film formation occurs at ambient conditions.

82. The coating of claim 80, wherein film formation occurs at baking conditions.

83. The coating of claim 82, wherein baking conditions is between 40° C. and 50° C.

84. The coating of claim 82, wherein baking conditions is between 40° C. and 65° C.

85. The coating of claim 82, wherein baking conditions is between 40° C. and 110° C.

86. The coating of claim 80, wherein the coating comprises a volatile component and a non-volatile component.

87. The coating of claim 86, wherein the coating undergoes film formation by loss of part of the volatile component.

88. The coating of claim 86, wherein the volatile component comprises a volatile liquid component.

89. The coating of claim 88, wherein the volatile liquid component comprises a solvent, a thinner, a diluent, or a combination thereof.

90. The coating of claim 86, wherein the non-volatile component comprises a binder, a colorant, a plasticizer, a coating additive, or a combination thereof.

91. The coating of claim 80, wherein film formation occurs by crosslinking of a binder.

92. The coating of claim 91, wherein film formation occurs by crosslinking of a plurality of binders.

93. The coating of claim 80, wherein film formation occurs by irradiating the coating.

94. The coating of claim 80, wherein the coating produces a self-cleaning film.

95. The coating of claim 80, wherein the coating produces a temporary film.

96. The coating of claim 95, wherein the temporary film has a poor resistance to a coating remover.

97. The coating of claim 95, wherein the temporary film has a poor abrasion resistance, a poor solvent resistance, a poor water resistance, a poor weathering property, a poor adhesion property, a poor microorganism/biological resistance property, or a combination thereof.

98. The coating of claim 1, wherein the coating is a non-film forming coating.

99. The coating of claim 98, wherein the non-film forming coating comprises a non-film formation binder.

100. The coating of claim 98, wherein the non-film forming coating comprises a coating component in a concentration that is insufficient to produce a solid film.

101. The coating of claim 100, wherein the coating component comprises a binder that contributes to thermoplastic film formation.

102. The coating of claim 100 wherein the coating component contributes to thermosetting film formation.

103. The coating of claim 102, wherein the coating component comprises a binder, catalyst, initiator, or combination thereof.

104. The coating of claim 100, wherein the coating component has a concentration of 0%.

105. The coating of claim 1, wherein the coating comprises an architectural coating, an industrial coating, a specification coating, or a combination thereof.

106. The coating of claim 105, wherein the coating comprises an architectural coating.

107. The coating of claim 106, wherein the architectural coating comprises a wood coating, a masonry coating, an artist's coating, or a combination thereof.

108. The coating of claim 106, wherein the architectural coating has a pot life of at least 12 months at ambient conditions.

109. The coating of claim 106, wherein the architectural coating undergoes film formation at ambient conditions.

110. The coating of claim 105, wherein the coating comprises an industrial coating.

111. The coating of claim 110, wherein the industrial coating comprises an automotive coating, a can coating, a sealant coating, a marine coating, or a combination thereof.

112. The coating of claim 110, wherein the industrial coating undergoes film formation at baking conditions.

113. The coating of claim 105, wherein the coating comprises a specification coating.

114. The coating of claim 113, wherein the specification coating comprises a camouflage coating, a pipeline coating, a traffic marker coating, an aircraft coating, a nuclear power plant coating, or a combination thereof.

115. The coating of claim 1, wherein the coating comprises a water-borne coating.

116. The coating of claim 115, wherein the water-borne coating is a latex coating.

117. The coating of claim 115, wherein the water-borne coating has a density of 1.20 kg/L to 1.50 kg/L.

118. The coating of claim 1, wherein the coating comprises a solvent-borne coating.

119. The coating of claim 118, wherein the solvent-borne coating has a density of 0.90 kg/L to 1.2 kg/L.

120. The coating of claim 1, wherein the coating has a low-shear viscosity of 100 P to 3000 P.

121. The coating of claim 1, wherein the coating has a low-shear viscosity of 100 P to 1000 P.

122. The coating of claim 1, wherein the coating has a medium-shear viscosity of 60 Ku and 140 Ku.

123. The coating of claim 1, wherein the coating has a medium-shear viscosity of 72 Ku to 95 Ku.

124. The coating of claim 1, wherein the coating has a high-shear viscosity of 0.5 P to 2.5 P.

125. The coating of claim 1, wherein the coating comprises a binder, a liquid component, a colorant, an additive, or a combination thereof.

126. The coating of claim 125, wherein the coating comprises a binder.

127. The coating of claim 126, wherein the binder comprises a thermoplastic binder, a thermosetting binder, or a combination thereof.

128. The coating of claim 127, wherein the coating comprises a thermoplastic binder.

129. The coating of claim 128, wherein the coating is a coating capable of producing a film by thermoplastic film formation.

130. The coating of claim 127, wherein the coating comprises a thermosetting binder.

131. The coating of claim 130, wherein the coating is a coating capable of producing a film by thermosetting film formation.

132. The coating of claim 126, wherein the binder comprises an oil-based binder.

133. The coating of claim 132, wherein the oil-based binder comprises an oil, an alkyd, an oleoresinous binder, a fatty acid epoxide ester, or a combination thereof.

134. The coating of claim 132, wherein the coating produces a layer 15 μm to 25 μm thick upon the vertical surface or 15 μm to 40 μm thick upon the horizontal surface.

135. The coating of claim 126, wherein the binder comprises a polyester resin.

136. The coating of claim 135, wherein the polyester resin comprises a hydroxy-terminated polyester or a carboxylic acid-terminated polyester.

137. The coating of claim 135, wherein the coating comprises a urethane, an amino resin, or a combination thereof.

138. The coating of claim 126, wherein the binder comprises a modified cellulose.

139. The coating of claim 138, wherein the modified cellulose comprises a cellulose ester or a nitrocellulose.

140. The coating of claim 138, wherein the coating comprises an amino binder, an acrylic binder, a urethane binder, or a combination thereof.

141. The coating of claim 126, wherein the binder comprises a polyamide.

142. The coating of claim 141, wherein the coating comprises an epoxide.

143. The coating of claim 126, wherein the binder comprises an amino resin.

144. The coating of claim 143, wherein the coating comprises an acrylic binder, an alkyd resin, a polyester binder, or a combination thereof.

145. The coating of claim 126, wherein the binder comprises a urethane binder.

146. The coating of claim 145, wherein the coating comprises a polyol, an amine, an epoxide, a silicone, a vinyl, a phenolic, a triacrylate, or a combination thereof.

147. The coating of claim 126, wherein the binder comprises a phenolic resin.

148. The coating of claim 147, wherein the coating comprises an alkyd resin, an amino resin, a blown oil, an epoxy resin, a polyamide, a polyvinyl resin, or a combination thereof.

149. The coating of claim 126, wherein the binder comprises an epoxy resin.

150. The coating of claim 149, wherein the coating comprises an amino resin, a phenolic resin, a polyamide, a ketimine, an aliphatic amine, or a combination thereof.

151. The coating of claim 149, wherein the epoxy resin comprises a cycloaliphatic epoxy binder.

152. The coating of claim 151, wherein the coating comprises a polyol.

153. The coating of claim 126, wherein the binder comprises a polyhydroxyether binder.

154. The coating of claim 153, wherein the coating comprises an epoxide, a polyurethane comprising an isocyanate moiety, an amino resin, or a combination thereof.

155. The coating of claim 126, wherein the binder comprises an acrylic resin.

156. The coating of claim 155, wherein the coating comprises an epoxide, a polyurethane comprising an isocyanate moiety, an amino resin, or a combination thereof.

157. The coating of claim 126, wherein the binder comprises a polyvinyl binder.

158. The coating of claim 157, wherein the coating comprises an alkyd, a urethane, an amino-resin, or a combination thereof.

159. The coating of claim 126, wherein the binder comprises a rubber resin.

160. The coating of claim 159, wherein the rubber resin comprises a chlorinated rubber resin, a synthetic rubber resin, or a combination thereof.

161. The coating of claim 159, wherein the coating comprises an acrylic resin, an alkyd resin, a bituminous resin, or a combination thereof.

162. The coating of claim 126, wherein the binder comprises a bituminous binder.

163. The coating of claim 162, wherein the coating comprises an epoxy resin.

164. The coating of claim 126, wherein the binder comprises a polysulfide binder.

165. The coating of claim 164, wherein the coating comprises a peroxide, a binder comprising an isocyanate moiety, or a combination thereof.

166. The coating of claim 126, wherein the binder comprises a silicone binder.

167. The coating of claim 166, wherein the coating comprises an organic binder.

168. The coating of claim 125, wherein the coating comprises a liquid component.

169. The coating of claim 168, wherein the liquid component comprises a solvent, a thinner, a diluent, a plasticizer, or a combination thereof.

170. The coating of claim 168, wherein the liquid component comprises a liquid organic compound, an inorganic compound, water, or a combination thereof.

171. The coating of claim 170, wherein the liquid component comprises a liquid organic compound.

172. The coating of claim 171, wherein the liquid organic compound comprises a hydrocarbon, an oxygenated compound, a chlorinated hydrocarbon, a nitrated hydrocarbon, a miscellaneous organic liquid, a plasticizer, or a combination thereof.

173. The coating of claim 172, wherein the liquid organic compound comprises a hydrocarbon.

174. The coating of claim 173, wherein the hydrocarbon comprises an aliphatic hydrocarbon, a cycloaliphatic hydrocarbon, a terpene, an aromatic hydrocarbon, or a combination thereof.

175. The coating of claim 174, wherein the hydrocarbon comprises a petroleum ether, pentane, hexane, heptane, isododecane, a kerosene, a mineral spirit, a VMP naphtha,

cyclohexane, methylcyclohexane, ethylcyclohexane, tetrahydronaphthalene, decahydronaphthalene, wood terpentine oil, pine oil, α -pinene, β -pinene, dipentene, D-limonene, benzene, toluene, ethylbenzene, xylene, cumene, a type I high flash aromatic naphtha, a type II high flash aromatic naphtha, mesitylene, pseudocumene, cymol, styrene, or a combination thereof.

176. The coating of claim 172, wherein the liquid organic compound comprises an oxygenated compound.

177. The coating of claim 176, wherein the oxygenated compound comprises an alcohol, an ester, a glycol ether, a ketone, an ether, or a combination thereof.

178. The coating of claim 177, wherein the oxygenated compound comprises methanol, ethanol, propanol, isopropanol, 1-butanol, isobutanol, 2-butanol, tert-butanol, amyl alcohol, isoamyl alcohol, hexanol, methylisobutylcarbinol, 2-ethylbutanol, isooctyl alcohol, 2-ethylhexanol, isodecanol, cyclohexanol, methylcyclohexanol, trimethylcyclohexanol, benzyl alcohol, methylbenzyl alcohol, furfuryl alcohol, tetrahydrofurfuryl alcohol, diacetone alcohol, trimethylcyclohexanol, methyl formate, ethyl formate, butyl formate, isobutyl formate, methyl acetate, ethyl acetate, propyl acetate, isopropyl acetate, butyl acetate, isobutyl acetate, sec-butyl acetate, amyl acetate, isoamyl acetate, hexyl acetate, cyclohexyl acetate, benzyl acetate, methyl glycol acetate, ethyl glycol acetate, butyl glycol acetate, ethyl diglycol acetate, butyl diglycol acetate, 1-methoxypropyl acetate, ethoxypropyl acetate, 3-methoxybutyl acetate, ethyl 3-ethoxypropionate, isobutyl isobutyrate, ethyl lactate, butyl lactate, butyl glycolate, dimethyl adipate, glutarate, succinate, ethylene carbonate, propylene carbonate, butyrolactone, methyl glycol, ethyl glycol, propyl glycol, isopropyl glycol, butyl glycol, methyl diglycol, ethyl diglycol, butyl diglycol, ethyl triglycol, butyl triglycol, diethylene glycol dimethyl ether, methoxypropanol, isobutoxypropanol, isobutyl glycol, propylene glycol monoethyl ether, 1-isopropoxy-2-propanol, propylene glycol mono-n-propyl ether, propylene glycol n-butyl ether, methyl dipropylene glycol, methoxybutanol, acetone, methyl ethyl ketone, methyl propyl ketone, methyl isopropyl ketone, methyl butyl ketone, methyl isobutyl ketone, methyl amyl ketone, methyl isoamyl ketone, diethyl ketone, ethyl amyl ketone, dipropyl ketone, diisopropyl ketone, cyclohexanone, methylcyclohexanone, trimethylcyclohexanone, mesityl oxide, diisobutyl ketone, isophorone, diethyl ether, diisopropyl ether, dibutyl ether, di-sec-butyl ether, methyl tert-butyl ether, tetrahydrofuran, 1,4-dioxane, metadioxane, or a combination thereof.

179. The coating of claim 172, wherein the liquid organic compound comprises a chlorinated hydrocarbon.

180. The coating of claim 179, wherein the chlorinated hydrocarbon comprises methylene chloride, trichloromethane, tetrachloromethane, ethyl chloride, isopropyl chloride, 1,2-dichloroethane, 1,1,1-trichloroethane, trichloroethylene, 1,1,2,2-tetrachloroethane, 1,2-dichloroethylene, perchloroethylene, 1,2-dichloropropane, chlorobenzene, or a combination thereof.

181. The coating of claim 172, wherein the liquid organic compound comprises a nitrated hydrocarbon.

182. The coating of claim 181, wherein the nitrated hydrocarbon comprises a nitroparaffin, N-methyl-2-pyrrolidone, or a combination thereof.

183. The coating of claim 172, wherein the liquid organic compound comprises a miscellaneous organic liquid.

184. The coating of claim 183, wherein the miscellaneous organic liquid comprises carbon dioxide; acetic acid, methylal, dimethylacetal, N,N-dimethylformamide, N,N-dimethylacetamide, dimethylsulfoxide, tetramethylene sulfone, carbon disulfide, 2-nitropropane, N-methylpyrrolidone, hexamethylphosphoric triamide, 1,3-dimethyl-2-imidazolidinone, or a combination thereof.

185. The coating of claim 172, wherein the liquid organic compound comprises a plasticizer.

186. The coating of claim 185, wherein the plasticizer comprises di(2-ethylhexyl) azelate; di(butyl) sebacate; di(2-ethylhexyl) phthalate; di(isononyl) phthalate; dibutyl phthalate; butyl benzyl phthalate; di(isooctyl) phthalate; di(idodecyl) phthalate; tris(2-ethylhexyl) trimellitate; tris(isononyl) trimellitate; di(2-ethylhexyl) adipate; di(isononyl) adipate; acetyl tri-n-butyl citrate; an epoxy modified soybean oil; 2-ethylhexyl epoxytallate; isodecyl diphenyl phosphate; tricresyl phosphate; isodecyl diphenyl phosphate; tri-2-ethylhexyl phosphate; an adipic acid polyester; an azelaic acid polyester; a bisphenoxyethylformal, or a combination thereof.

187. The coating of claim 185, wherein the plasticizer comprises an adipate, an azelate, a citrate, a chlorinated plasticizer, an epoxide, a phosphate, a sebacate, a phthalate, a polyester, a trimellitate, or a combination thereof.

188. The coating of claim 170, wherein the liquid component comprises an inorganic compound.

189. The coating of claim 188, wherein the inorganic compound comprises ammonia, hydrogen cyanide, hydrogen fluoride, hydrogen cyanide, sulfur dioxide, or a combination thereof.

190. The coating of claim 170, wherein the liquid component comprises water.

191. The coating of claim 190, wherein the liquid component further comprises methanol, ethanol, propanol, isopropyl alcohol, tert-butanol, ethylene glycol, methyl glycol, ethyl glycol, propyl glycol, butyl glycol, ethyl diglycol, methoxypropanol, methyldipropylene glycol, dioxane, tetrahydrofuran, acetone, diacetone alcohol, dimethylformamide, dimethyl sulfoxide, ethylbenzene, tetrachloroethylene, p-xylene, toluene, diisobutyl ketone, trichloroethylene, trimethylcyclohexanol, cyclohexyl acetate, dibutyl ether, trimethylcyclohexanone, 1,1,1-trichloroethane, hexane, hexanol, isobutyl acetate, butyl acetate, isophorone, nitropropane, butyl glycol acetate, 2-nitropropane, methylene chloride, methyl isobutyl ketone, cyclohexanone, isopropyl acetate, methylbenzyl alcohol, cyclohexanol, nitroethane, methyl tert-butyl ether, ethyl acetate, diethyl ether, butanol, butyl glycolate, isobutanol, 2-butanol, propylene carbonate, ethyl glycol acetate, methyl acetate, methyl ethyl ketone, or a combination thereof.

192. The coating of claim 125, wherein the coating comprises a colorant.

193. The coating of claim 192, wherein the colorant comprises a pigment, a dye, or a combination thereof.

194. The coating of claim 193, wherein the colorant comprises a pigment.

195. The coating of claim 194, wherein the cell-based particulate material comprises 0.000001% to 100% of the pigment.

196. The coating of claim 194, wherein the pigment volume concentration of the coating is 20% to 70%.

197. The coating of claim 194, wherein the pigment comprises a corrosion resistance pigment, a camouflage pigment, a color property pigment, an extender pigment, or a combination thereof.

198. The coating of claim 197, wherein the pigment comprises a corrosion resistance pigment.

199. The coating of claim 198, wherein the corrosion resistance pigment comprises aluminum flake, aluminum triphosphate, aluminum zinc phosphate, ammonium chromate, barium borosilicate, barium chromate, barium metaborate, basic calcium zinc molybdate, basic carbonate white lead, basic lead silicate, basic lead silicochromate, basic lead silicosulfate, basic zinc molybdate, basic zinc molybdate-phosphate, basic zinc molybdenum phosphate, basic zinc phosphate hydrate, bronze flake, calcium barium phosphosilicate, calcium borosilicate, calcium chromate, calcium plumbate, calcium strontium phosphosilicate, calcium strontium zinc phosphosilicate, dibasic lead phosphite, lead chromosilicate, lead cyanamide, lead suboxide, lead sulfate, mica, micaceous iron oxide, red lead, steel flake, strontium borosilicate, strontium chromate, tribasic lead phosphosilicate, zinc borate, zinc borosilicate, zinc chromate, zinc dust, zinc hydroxy phosphite, zinc molybdate, zinc oxide, zinc phosphate, zinc potassium chromate, zinc silicophosphate hydrate, zinc tetraoxylchromate, or a combination thereof.

200. The coating of claim 198, wherein the coating is a metal surface coating.

201. The coating of claim 198, wherein the coating comprises a primer.

202. The coating of claim 197, wherein the pigment comprises a camouflage pigment.

203. The coating of claim 202, wherein the camouflage pigment comprises an anthraquinone black, a chromium oxide green, a cell-based particulate material, or a combination thereof.

204. The coating of claim 202, wherein the camouflage pigment reduces the ability of the coating to be detected by a device that measures infrared radiation.

205. The coating of claim 197, wherein the pigment comprises a color property pigment.

206. The coating of claim 205, wherein the color property pigment comprises a black pigment, a brown pigment, a white pigment, a pearlescent pigment, a violet pigment, a blue pigment, a green pigment, a yellow pigment, an orange pigment, a red pigment, a metallic pigment, a cell-based particulate material, or a combination thereof.

207. The coating of claim 206, wherein the color property pigment comprises aniline black; anthraquinone black; carbon black; copper carbonate; graphite; iron oxide; micaceous iron oxide; manganese dioxide; azo condensation; metal complex brown; antimony oxide; basic lead carbonate; lithopone; titanium dioxide; white lead; zinc oxide; zinc sulphide; titanium dioxide and ferric oxide covered mica; bismuth oxychloride crystal; dioxazine violet; carbazole Blue; cobalt blue; indanthrone; phthalocyanine blue; Prussian blue; ultramarine; chrome green; hydrated chromium oxide; phthalocyanine green; anthrapyrimidine; arylamide yellow; barium chromate; benzimidazolone yellow; bismuth vanadate; cadmium sulfide yellow; complex inorganic color; diarylide yellow; disazo condensation; flavanthrone; isoidoline; isoidolinone; lead chromate; nickel azo yellow; organic metal complex; yellow iron oxide; zinc chromate; perinone orange; pyrazolone orange; anthraquinone; benz-

imidazolone; BON arylamide; cadmium red; cadmium selenide; chrome red; dibromanthrone; diketopyrrolo-pyrrole; lead molybdate; perylene; pyranthrone; quinacridone; quinophthalone; red iron oxide; red lead; toluidine red; tonor; β -naphthol red; aluminum flake; aluminum non-leaving, gold bronze flake, zinc dust, stainless steel flake, nickel flake, nickel powder, or a combination thereof.

208. The coating of claim 197, wherein the pigment comprises an extender pigment.

209. The coating of claim 208, wherein the extender pigment comprises a barium sulphate, a calcium carbonate, a kaolin, a calcium sulphate, a silicate, a silica, an alumina trihydrate, a cell-based particulate material, or a combination thereof.

210. The coating of claim 194, wherein the pigment comprises barium ferrite; borosilicate; burnt sienna; burnt umber; calcium ferrite; cerium; chrome orange; chrome yellow; chromium phosphate; cobalt-containing iron oxide; fast chrome green; gold bronze powder; luminescent; magnetic; molybdate orange; molybdate red; oxazine; oxysulfide; polycyclic; raw sienna; surface modified pigment; thiazine; thioindigo; transparent cobalt blue; transparent cobalt green; transparent iron blue; transparent zinc oxide; triarylcarbonium; zinc cyanamide; zinc ferrite; or a combination thereof.

211. The coating of claim 125, wherein the coating comprises an additive.

212. The coating of claim 211, wherein the additive comprises 0.000001% to 20.0% by weight, of the coating.

213. The coating of claim 211, wherein said additive comprises an accelerator, an adhesion promoter, an anti-foamer, anti-insect additive, an antioxidant, an antiskinning agent, a buffer, a catalyst, a coalescing agent, a corrosion inhibitor, a defoamer, a dehydrator, a dispersant, a drier, electrical additive, an emulsifier, a filler, a flame/fire retardant, a flattening agent, a flow control agent, a gloss aid, a leveling agent, a marproofing agent, a preservative, a silicone additive, a slip agent, a surfactant, a light stabilizer, a Theological control agent, a wetting additive, a cryopreservative, a xeroprotectant, or a combination thereof.

214. The coating of claim 213, wherein the additive comprises a preservative.

215. The coating of claim 214, wherein the preservative comprises an in-can preservative, an in-film preservative, or a combination thereof.

216. The coating of claim 214, wherein the preservative comprises a biocide.

217. The coating of claim 216, wherein the biocide comprises a bactericide, a fungicide, an algacide, or a combination thereof.

218. The coating of claim 214, wherein the preservative comprises 1-(3-chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride; 1,2-benzisothiazoline-3-one; 1,2-dibromo-2,4-dicyanobutane; 1,3-bis(hydroxymethyl)-5,5-dimethylhydantoin; 1-methyl-3,5,7-triaza-1-azonia-adamantane chloride; 2-bromo-2-nitropropane-1,3-diol; 2-(4-thiazolyl)benzimidazole; 2-(hydroxymethyl)-amino-2-methyl-1-propanol; 2(hydroxymethyl)-aminoethanol; 2,2-dibromo-3-nitropropionamide; 2,4,5,6-tetrachloro-isophthalonitrile; 2-mercaptobenzo-thiazole; 2-methyl-4-isothiazolin-3-one; 2-n-octyl-4-isothiazoline-3-one; 3-iodo-2-propynyl N-butyl carbamate; 4,5-dichloro-2-N-octyl-3(2H)-isothiazolone; 4,4-dimethyloxazolidine; 5-chloro-2-methyl-4-isothiazolin-3-one; 5-hydroxy-methyl-1-aza-3,7-dioxabicyclo (3.3.0.)

octane; 6-acetoxy-2,4-dimethyl-1,3-dioxane; 7-ethyl bicyclooxazolidine; a combination of 1,2-benzisothiazoline-3-one and hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine; a combination of 1,2-benzisothiazoline-3-one and zinc pyrithione; a combination of 2-(thiocyanomethyl-thio)benzothiazole and methylene bis(thiocyanate); a combination of 4-(2-nitrobutyl)-morpholine and 4,4'-(2-ethylnitrotrimethylene) dimorpholine; a combination of 4,4-dimethyl-oxazolidine and 3,4,4-trimethyloxazolidine; a combination of 5-chloro-2-methyl-4-isothiazolin-3-one and 2-methyl-4-isothiazolin-3-one; a combination of carbendazim and 3-iodo-2-propynyl N-butyl carbamate; a combination of carbendazim, 3-iodo-2-propynyl N-butyl carbamate and diuron; a combination of chlorothalonil and 3-iodo-2-propynyl N-butyl carbamate; a combination of chlorothalonil and a triazine compound; a combination of tributyltin benzoate and alkylamine hydrochlorides; a combination of zinc-dimethyldithiocarbamate and zinc 2-mercaptobenzothiazole; a copper soap; a metal soap; a mercury soap; a mixture of bicyclic oxazolidines; a tin soap; an alkylamine hydrochloride; an amine reaction product; barium metaborate; butyl parahydroxybenzoate; carbendazim; copper(II) 8-quinolinolate; diiodomethyl-p-tolysulfone; dithio-2,2-bis(benzmethylamide); diuron; ethyl parahydroxybenzoate; glutaraldehyde; hexahydro-1,3,5-triethyl-s-triazine; hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine; hydroxymethyl-5,5-dimethylhydantoin; methyl parahydroxybenzoate; N-butyl-1,2-benzisothiazolin-3-one; N-(trichloromethylthio) phthalimide; N-cyclopropyl-N-(1-dimethylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine; N-trichloromethyl-thio-4-cyclohexene-1,2-dicarboximide; p-chloro-m-cresol; phenoxyethanol; phenylmercuric acetate; poly(hexamethylene biguanide) hydrochloride; potassium dimethyldithiocarbamate; potassium N-hydroxy-methyl-N-methyl-dithiocarbamate; propyl parahydroxybenzoate; sodium 2-pyridinethiol-1-oxide; tetra-hydro-3,5-di-methyl-2H-1,3,5-thiadiazine-2-thione; tributyltin benzoate; tributyltin oxide; tributyltin salicylate; zinc pyrithione; sodium pyrithione; copper pyrithione; zinc oxide; a zinc soap; or a combination thereof.

219. The coating of claim 213, wherein the additive comprises a wetting additive, a dispersant, or a combination thereof.

220. The coating of claim 219, wherein the additive comprises a combination of an unsaturated polyamine amide salt and a lower molecular weight acid; a polycarboxylic acid polymer alkylolammonium salt; a combination of a long chain polyamine amide salt and a polar acidic ester; a hydroxyfunctional carboxylic acid ester; a non-ionic wetting agent; or a combination thereof.

221. The coating of claim 219, wherein the additive comprises a wetting additive.

222. The coating of claim 221, wherein the wetting additive comprises an ethylene oxide molecule comprising a hydrophobic moiety; a surfactant; pine oil; a metal soap; calcium octoate; zinc octoate; aluminum stearate; zinc stearate; bis(2-ethylhexyl)sulfosuccinate; (octylphenoxy)polyethoxyethanol octylphenyl-polyethylene glycol; nonyl phenoxy poly (ethylene oxy) ethanol; ethylene glycol octyl phenyl ether; or a combination thereof.

223. The coating of claim 219, wherein the additive comprises a dispersant.

224. The coating of claim 223, wherein the dispersant comprises tetra-potassium pyrophosphate, a phosphate ester surfactant; a particulate material, a calcium carbonate coated

with fatty acid, a modified montmorillonite clay, a caster wax, or a combination thereof.

225. The coating of claim 213, wherein the additive comprises an antifoamer, a defoamer, or a combination thereof.

226. The coating of claim 225, wherein the additive comprises an oil; a mineral oil; a silicon oil; a fatty acid ester; dibutyl phosphate; a metallic soap; a siloxane; a wax; an alcohol comprising six to ten carbons; a pine oil; or a combination thereof.

227. The coating of claim 225, wherein the coating further comprises an emulsifier, a hydrophobic silica, or a combination thereof.

228. The coating of claim 213, wherein the additive comprises a rheological control agent.

229. The composition of claim 228, wherein the rheology control agent comprises a silicate; a montmorillonite silicate; aluminum silicate, a bentonite, magnesium silicate, a cellulose ether, a hydrogenated oil, a polyacrylate, a polyvinylpyrrolidone, a urethane, a methyl cellulose, a hydroxyethyl cellulose, hydrogenated castor oil; a hydrophobically modified ethylene oxide urethane; a titanium chelate, a zirconium chelate, a cell-based particulate material, or a combination thereof.

230. The coating of claim 228, wherein the rheological control agent comprises a thickener, a viscosifier, or a combination thereof.

231. The coating of claim 213, wherein the additive comprises a corrosion inhibitor.

232. The coating of claim 231, wherein the corrosion inhibitor comprises a chromate, a phosphate, a molybdate, a wollastonite, a calcium ion-exchanged silica gel, a zinc compound, a borosilicate, a phosphosilicate, a hydrotalcite, or a combination thereof.

233. The coating of claim 231, wherein said corrosion inhibitor comprises an in-can corrosion inhibitor, a flash corrosion inhibitor, or a combination thereof.

234. The coating of claim 233, wherein the corrosion inhibitor comprises sodium nitrate, sodium benzoate, ammonium benzoate, 2-amino-2-methyl-propan-1-ol, or a combination thereof.

235. The coating of claim 213, wherein the additive comprises a light stabilizer.

236. The coating of claim 235, wherein the light stabilizer comprises a UV absorber, a radical scavenger, or a combination thereof.

237. The coating of claim 236, wherein the light stabilizer comprises a UV absorber.

238. The coating of claim 237, wherein the UV absorber comprises a hydroxybenzophenone, a hydroxyphenylbenzotriazole, a hydroxyphenyl-S-triazine, an oxalic anilide, yellow iron oxide, a cell-based particulate material, or a combination thereof.

239. The coating of claim 236, wherein the light stabilizer comprises a radical scavenger.

240. The coating of claim 239, wherein the radical scavenger comprises a sterically hindered amine; bis(1,2,2,6,6,6-pentamethyl-4-piperidiny) ester, bis(2,2,6,6,6-tetramethyl-1-isooctyloxy-4-piperidiny) ester, or a combination thereof.

241. The coating of claim 213, wherein said additive comprises a buffer.

242. The coating of claim 241, wherein the buffer comprises a bicarbonate, a monobasic phosphate buffer, a dibasic

phosphate buffer, Trizma base, a 5 zwitterionic buffer, triethanolamine, or a combination thereof.

243. The coating of claim 242, wherein the buffer comprises a bicarbonate.

244. The coating of claim 243, wherein the bicarbonate comprises an ammonium bicarbonate.

245. The coating of claim 241, wherein the concentration of the buffer in the coating is 0.000001 M to 2.0 M.

246. The coating of claim 213, wherein said additive comprises a cryopreservative, a xeroprotectant, or a combination thereof.

247. The coating of claim 246, wherein the additive comprises a cryopreservative.

248. The coating of claim 247, wherein the cryopreservative comprises glycerol, DMSO, a protein, a sugar of 4 to 10 carbons, or a combination thereof.

249. The coating of claim 246, wherein the additive comprises a xeroprotectant.

250. The coating of claim 249, wherein the xeroprotectant comprises glycerol, a glycol, a mineral oil, a bicarbonate, DMSO, a sugar of 4 to 10 carbons, or a combination thereof.

251. The coating of claim 1, wherein the cell-based particulate material comprises 0.000001% to 80%, by weight or volume, a cryopreservative, a xeroprotectant, or a combination thereof.

252. The coating of claim 1, wherein the coating is a multi-pack coating.

253. The coating of claim 252, wherein the multi-pack coating is stored in a two to five containers prior to application to a surface.

254. The coating of claim 252, wherein 0.000001% to 100% of the cell-based particulate material is stored in a container of the multi-pack coating, and at least one coating component is stored in another container of the multi-pack coating.

255. The coating of claim 254, wherein the container that stores the cell-based particulate material further stores an additional coating component.

256. The coating of claim 255, wherein the additional coating component comprises a preservative, a wetting agent, a dispersing agent, a buffer, a liquid component, a rheological modifier, a cryopreservative, a xeroprotectant, or a combination thereof.

257. The coating of claim 1, wherein the coating is a coating capable of being applied to a surface by a spray applicator.

258. The coating of claim 1, wherein the cell-based particulate material is microencapsulated.

259. The coating of claim 1, wherein the coating comprises a pH indicator.

260. The coating of claim 259, wherein the pH indicator is a colorimetric indicator.

261. The coating of claim 260, wherein the colorimetric indicator comprises Alizarin, Alizarin S, Brilliant Yellow, Lacmoid, Neutral Red, Rosolic Red, or a combination thereof.

262. The coating of claim 259, wherein the pH indicator is a fluorimetric indicator.

263. The coating of claim 262, wherein the fluorimetric indicator comprises SNARF-1, BCECF, HPTS, Fluorescein, or a combination thereof.

264. The coating of claim 259, wherein the pH indicator is a pH indicator that undergoes a color or fluorescence change between pH 8 to pH 9.

265. A coating comprising a whole cell-based particulate material.

266. A coating comprising a microorganism-based particulate material.

267. A coating comprising a microorganism-based particulate material, wherein the microorganism-based particulate material is a whole cell particulate material.

268. A coating comprising a microorganism-based particulate material, wherein the microorganism-based particulate material is a unicellular-based particulate material or an oligocellular-based particulate material.

269. A coating comprising a cell-based particulate material, wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa.

270. A coating, the improvement comprising inclusion of a cell-based particulate material.

271. A coating, the improvement comprising inclusion of a microorganism-based particulate material.

272. A coating, the improvement comprising inclusion of a whole cell particulate material.

273. A coating, the improvement comprising inclusion of a microorganism-based particulate material, wherein the microorganism-based particulate material is a whole cell particulate material.

274. A coating, the improvement comprising inclusion of a microorganism-based particulate material, wherein the microorganism-based particulate material is a unicellular-based particulate material or an oligocellular-based particulate material.

275. A coating, the improvement comprising inclusion of a cell-based particulate material, wherein the average wet molecular weight or dry molecular weight of a primary particle of a cell-based particulate material is 6,022 kDa to 1.5×10^{14} kDa.

276. A paint comprising a cell-based particulate material.

277. A paint comprising a microorganism-based particulate material.

278. A paint comprising a whole cell particulate material.

279. A paint comprising a microorganism-based particulate material, wherein the microorganism-based particulate material is a whole cell particulate material.

280. A paint comprising 0.000001% to 65% by weight or volume of a cell-based particulate material.

281. A paint comprising 0.000001% to 65% by weight or volume of a whole cell particulate material.

282. A paint comprising 0.000001% to 65% by weight or volume of a microorganism-based particulate material.

283. A paint comprising 0.000001% to 65% by weight or volume of a microorganism-based particulate material, wherein the microorganism-based particulate material is a whole cell particulate material.

284. A paint, the improvement comprising inclusion of a cell-based particulate material.

285. A paint, the improvement comprising inclusion of a microorganism-based particulate material.

286. A paint, the improvement comprising inclusion of a whole cell particulate material.

287. A paint, the improvement comprising inclusion of a microorganism-based particulate material, wherein the microorganism-based particulate material is a whole cell particulate material.

288. A paint, the improvement comprising inclusion of 0.000001% to 65% by weight or volume of a cell-based particulate material

289. A paint, the improvement comprising inclusion of 0.000001% to 65% by weight or volume of a microorganism-based particulate material.

290. A paint, the improvement comprising inclusion of 0.000001% to 65% by weight or volume of a whole cell particulate material.

291. A paint, the improvement comprising inclusion of 0.000001% to 65% by weight or volume of a microorganism-based particulate material, wherein the microorganism-based particulate material is a whole cell particulate material.

292. A multi-pack paint, wherein one container comprises 0.000001% to 65%, by weight or volume of the paint, a cell-based particulate material.

293. A multi-pack paint, wherein one container comprises 0.000001% to 65%, by weight or volume of the paint, a microorganism-based particulate material.

294. A multi-pack paint, wherein one container comprises 0.000001% to 65%, by weight or volume of the paint, a whole cell particulate material.

295. A multi-pack paint, wherein one container comprises 0.000001% to 65%, by weight or volume of the paint, a microorganism-based particulate material, wherein the microorganism-based particulate material is a whole cell particulate material.

296. A multi-pack paint, wherein one container comprises 100 parts by volume paint, wherein a second container comprises three parts by volume of a whole cell particulate material composition, and wherein each part of the whole cell particulate material composition comprises 1 mg per milliliter of whole cell particulate material and 50% glycerol.

297. A non-film forming coating comprising a cell-based particulate material.

298. An elastomer comprising a cell-based particulate material.

299. A filler comprising a cell-based particulate material.

300. An adhesive comprising a cell-based particulate material.

301. A sealant comprising a cell-based particulate material.

302. A material applied to a textile, comprising a cell-based particulate material.

303. A wax comprising a cell-based particulate material.

304. A surface treatment comprising a cell-based particulate material.

305. A surface treatment of claim 304, wherein the surface treatment is a coating, a paint, a non-film forming coating, an elastomer, an adhesive, an sealant, a material applied to a textile, or a wax..

306. A method of making a surface treatment, comprising the step of admixing a cell-based particulate material to at least one additional surface treatment component.

307. A method of making a surface treatment comprising a cell-based particulate material, comprising the steps of: obtaining a cell or a virus; processing the cell or virus by sterilizing, attenuating, concentrating, drying, milling, extracting, resuspending, temperature maintaining, permeabilizing, disrupting, chemically modifying, encapsulating, or a combination thereof, to produce a cell-based particulate material; and admixing the cell-based particulate material with at least one additional surface treatment component, wherein a surface treatment comprising the cell-based particulate material is produced.

308. A surface treatment comprising a cell-based particulate material produced by the process which comprises obtaining a cell or a virus; processing the cell or virus by sterilizing, attenuating, concentrating, drying, milling, extracting, resuspending, temperature maintaining, permeabilizing, disrupting, chemically modifying, encapsulating, or a combination thereof, to produce a cell-based particulate material; and admixing the cell-based particulate material with at least one additional surface treatment component, wherein a surface treatment comprising the cell-based particulate material is produced.

* * * * *