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[Continued on next page]

(54) Title: DEGRADABLE CHEWING GUM

(57) Abstract: Provided herein are chewing gum compositions and products that degrade over time after chewing. More particularly, degradable chewing gums and degradable chewing gum bases containing a combination of (A) at least one delayed cud-disrupting material and (B) at least one polymeric moisture uptake promoter material for the at least one delayed cud-disrupting material are disclosed herein. Methods of preparing the gum base and chewing gum compositions, as well as methods of use, are also provided.

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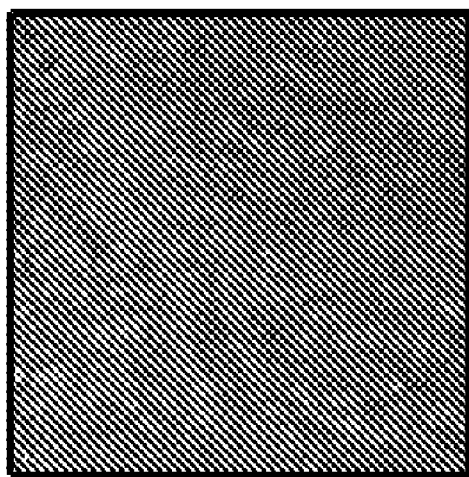


Fig. 6(c)





LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,  
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## DEGRADABLE CHEWING GUM

### **FIELD OF THE INVENTION**

[0001] Provided herein are chewing gum compositions and products that degrade over time after chewing. More particularly, degradable chewing gums and degradable chewing gum bases containing a combination of (A) at least one delayed cud-disrupting material and (B) at least one polymeric moisture uptake promoter material for the at least one delayed cud-disrupting material are disclosed herein. The combination of the two or more materials, typically polymers, work in conjunction with one another to facilitate degradation of discarded chewing gum bolus from surfaces and/or to facilitate degradation due to environmental influences or cleaning processes. Additionally, methods of producing such degradable chewing gums and degradable chewing gum bases are provided.

### **BACKGROUND**

[0002] Many elastomers, and particularly high molecular weight elastomers (e.g. 200,000 mw or greater), generally used in chewing gum compositions are usually solid at room temperature. They are usually purchased as blocks of solid material and generally require softening using solvents to be useful in chewing gum compositions. Softening elastomers in the absence of elastomer solvents is difficult, because the solid elastomer generally must still be processed into a continuous homogeneous and flowable mass to be useful in chewing gum compositions.

[0003] Conventional chewing gum products generally are not “environmentally-friendly.” They can maintain stickiness during and after chewing and adhere to the ground (as well as any other surface with which the gum product may come into contact) if care is not used with regard to disposal of the gum product. The stickiness of such conventional chewing gum products results, in large part, from the use of elastomer solvents (i.e., resins) and other “tacky” ingredients (such as wax) during the manufacturing process. In particular, conventional chewing gums manufactured using elastomer solvents exhibit a continuous or substantially continuous phase when chewed. As the continuous phase is characterized by an amorphous elastomer matrix containing sticky elastomer solvents, the gum bolus that results upon chewing also is sticky.

[0004] Although gum products that are manufactured without the use of elastomer solvents and/or other “tacky” ingredients have reportedly been developed, such gum products often rely on “non-conventional” gum ingredients to achieve desired properties. U.S. Patent

No. 5,882,702, for example, obviates the need for elastomer solvents by replacing elastomers with a plasticized proteinaceous material such as zein. The incorporation of non-conventional ingredients in gum products, however, often compromises taste and thus can be undesirable from a consumer acceptability standpoint.

[0005] Moreover, although gum products that allegedly do not stick to teeth and oral prosthetics during mastication are reported (see e.g., U.S. Patent No. 4,518,615 ), there nevertheless remains a need for chewing gum products that also exhibit reduced stickiness or non-stick properties upon disposal of the gum product subsequent to chewing. In particular, there remains a need for environmentally-friendly chewing gum boluses that exhibit either reduced stickiness to, do not stick to, or are rapidly degraded on, those surfaces where gum boluses that are improperly disposed of are often found (e.g., pavement, shoes, hair, undersides of tables and desks).

[0006] Additionally, there remains a need for environmentally-friendly chewing gum boluses that are capable of degrading in a short period of time.

## **SUMMARY OF THE INVENTION**

[0007] In an embodiment, a gum base composition is provided and comprises (a) at least one delayed cud-disrupting material and (b) at least one polymeric moisture uptake promoter material.

[0008] In another embodiment, a chewing gum composition is provided and comprises (a) an elastomer; (b) at least one delayed cud-disrupting material; (c) at least one polymeric moisture uptake promoter material; and (d) at least one sweetener.

[0009] In another aspect, a method of preparing a chewing gum composition is provided and comprises (a) providing a gum base comprising an elastomer; (b) combining the gum base with at least one delayed cud-disrupting material; at least one polymeric moisture uptake promoter material; and at least one sweetener.

[0010] In another aspect provided herein, a method of increasing degradability of a chewing gum composition includes (a) providing a gum composition comprising: (i) an elastomer; (ii) at least one delayed cud-disrupting material; (iii) at least one polymeric moisture uptake promoter material; and (iv) at least one sweetener; and (b) exposing the composition to conditions of water and/or sunlight sufficient to degrade the gum composition.

[0011] In still other aspects provided herein, methods of producing a chewing gum base having increased degradation properties include: (a) providing a molten or softened

polymer gum base component; and (b) mixing at least one delayed cud-disrupting material and at least one polymeric moisture uptake promoter material with the chewing gum base component.

[0012] In still other aspects, a method of preparing a chewing gum composition comprises: (a) providing a gum base composition comprising an elastomer and at least one polymeric moisture uptake promoter material; and (b) combining the gum base composition with at least one delayed cud-disrupting material and at least one sweetener.

[0013] In yet other aspects, a method of producing a chewing gum base having increased degradation properties comprises: (a) providing a molten or softened polymer gum base composition containing at least one polymeric moisture uptake promoter material; and (b) mixing at least one delayed cud-disrupting material with the gum base composition.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0014] Figure 1(a), Figure 1(b) and Figure 1(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Control Example (C1) (Prior Art).

[0015] Figure 2(a), Figure 2(b) and Figure 2(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Control Example (C1) (Prior Art).

[0016] Figure 3(a), Figure 3(b) and Figure 3(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Example 1.

[0017] Figure 4(a), Figure 4(b) and Figure 4(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Example 1.

[0018] Figure 5(a), Figure 5(b) and Figure 5(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Example 3.

[0019] Figure 6(a), Figure 6(b) and Figure 6(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Example 3.

[0020] Figure 7(a), Figure 7(b) and Figure 7(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Control Example (C2) (Prior Art).

[0021] Figure 8(a), Figure 8(b) and Figure 8(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Control Example (C2) (Prior Art).

[0022] Figure 9(a), Figure 9(b) and Figure 9(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Control Example (C4) (Prior Art).

[0023] Figure 10(a), Figure 10(b) and Figure 10(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Control Example (C4) (Prior Art).

[0024] Figure 11(a), Figure 11(b) and Figure 11(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Control Example (C7) (Prior Art).

[0025] Figure 12(a), Figure 12(b) and Figure 12(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Control Example (C7) (Prior Art).

[0026] Figure 13(a), Figure 13(b) and Figure 13(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Control Example (C8) (Prior Art).

[0027] Figure 14(a), Figure 14(b) and Figure 14(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Control Example (C8) (Prior Art).

[0028] Figure 15(a), Figure 15(b) and Figure 15(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Example 14.

[0029] Figures 16(a), Figure 16(b) and Figure 16(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Example 14.

[0030] Figures 17(a), Figure 17(b) and Figure 17(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Control Example (C10) (Prior Art).

[0031] Figure 18(a), Figure 18(b) and Figure 18(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Control Example (C10) (Prior Art).

[0032] Figure 19(a), Figure 19(b) and Figure 19(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Example 15.

[0033] Figure 20(a), Figure 20(b) and Figure 20(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Example 15.

[0034] Figure 21(a), Figure 21(b) and Figure 21(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Example 16.

[0035] Figure 22(a), Figure 22(b) and Figure 22(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Example 16.

[0036] Figure 23(a), Figure 23(b) and Figure 23(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Example 18.

[0037] Figure 24(a), Figure 24(b) and Figure 24(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Example 18.

[0038] Figure 25(a), Figure 25(b) and Figure 25(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Example 19.

[0039] Figure 26(a), Figure 26(b) and Figure 26(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Example 19.

[0040] Figure 27(a), Figure 27(b) and Figure 27(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Example 20.

[0041] Figure 28(a), Figure 28(b) and Figure 28(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Example 20.

[0042] Figure 29(a), Figure 29(b) and Figure 29(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Control Example (C12) (Prior Art).

[0043] Figure 30(a), Figure 30(b) and Figure 30(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Control Example (C12) (Prior Art).

[0044] Figure 31(a), Figure 31(b) and Figure 31(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Control Example (C13) (Prior Art).

[0045] Figure 32(a), Figure 32(b) and Figure 32(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Control Example (C13) (Prior Art).

[0046] Figure 33(a), Figure 33(b) and Figure 33(c) are photographs that illustrate an unbrushed chewing gum sample over several days in accordance with Example (C14).

[0047] Figure 34(a), Figure 34(b) and Figure 34(c) are photographs that illustrate a brushed chewing gum sample over several days in accordance with Example (C14).

### **DETAILED DESCRIPTION**

[0048] Incorporating a combination of (A) at least one delayed cud-disrupting material and (B) at least one polymeric moisture uptake promoter material for the at least one

delayed cud-disrupting material into chewing gum bases and chewing gum compositions using such chewing gum bases allows the resultant gum compositions and products made therefrom advantageously to have increase degradation properties, particularly when exposed to conditions suitable for hydrolysis and/or oxidation, such as exposure to water and/or sunlight. The combination of the two or more materials, typically polymers, can work in conjunction with one another to facilitate degradation of discarded chewing gum bolus from surfaces and/or to facilitate degradation due to environmental influences or cleaning processes. In addition, chewing gum bases and chewing gum compositions that include such materials can be formed in an efficient and effective manner.

[0049] Some embodiments are directed to producing gum bases and/or chewing gum compositions using such gum bases that include adding at least one delayed cud-disrupting material and at least one polymeric moisture uptake promoter material for the at least one delayed cud-disrupting material to a chewing gum base, a chewing gum composition using such gum base, or to both a chewing gum base and a chewing gum composition using such gum base together with the incorporation of optional non-stick and/or reduced stick inducing component(s).

### **Definitions**

[0050] As used herein the transitional term "comprising," (also "comprises," and the like) which is synonymous with "including," "containing," or "characterized by," is inclusive or open-ended and does not exclude additional, unrecited elements or method steps, regardless of its use in the preamble or the body of a claim.

[0051] As used herein, the terms "bubble gum" and "chewing gum" are used interchangeably and are both meant to include any gum composition.

[0052] As used herein, the term "degradation" refers to any process whereby a deposited gum cud becomes brittle and begins to breakdown into particles and/or becomes less adhesive, either by the effect of environmental factors including weather conditions such as rain, sun, frost, and the like, including cycling weather conditions, and/or by the effect of cleaning processes including the action of detergents. Moreover, as used herein, the term "degradable" refers to the tendency of a deposited gum base to break up in the environment due to the effect of weather conditions (rain, sun, frost, and the like), such as cycling weather conditions, and/or through the action of cleaning processes and/or detergents. In addition to sometimes becoming brittle, the gum cuds can transition from gum-cud like consistency into a sort of pasty consistency, which can easily be brushed away or is dissipated by simple



repeated human foot traffic, resulting in the gradual disappearance of the cud from the sidewalk. In other words, degradation as used herein also refers to the breakdown of the continuous persistent chewy /rubbery matrix such that the gum cud no longer adheres effectively to the surface (loss of adhesion) or to itself (loss of cohesion), thus easily being eroded away from the surface by any number of external forces (e.g., wind, rain, walking, street sweeper brushes, and the like).

**[0053]** As used herein, the term “delayed cud-disrupting material” refers to polymers that initially are generally inactive in the gum cud matrix, but convert to active materials once the cud is discarded. The conversion from inactive to active can occur as a result of the interaction or reaction of the material with water, in a delayed manner. This delay increases with (1) polymer molecular weight, since diffusion of a solvent (such as water) into a polymer particle gets progressively slower as molecular weight (and thus polymer entanglement) increases, or (2) inhibition of water access to the reactive polymer sites resulting from the initially hydrophobic nature of the polymer (e.g., unreacted anhydride) combined with the already significantly hydrophobic environment created by the surrounding chewing gum base. These polymers are typically added to the formulation in particle form. Delayed cud-disrupting material(s) are sometimes referred to herein as “Group A material(s)” or “Component A material(s)”. Group A materials also include or comprise subsets or subgroups, for example Groups A1 and A2, as discussed in greater detail herein. The delayed cud-disrupting material can be a material having at least one of: (1) a weight average polymer molecular weight (Mw) of at least 5,000 Da to about 5,000,000 Da and/or (2) inhibited water access prior to and/or during mastication to reactive polymer sites in the at least one delayed cud-disrupting material due to an initially hydrophobic nature of the at least one delayed cud-disrupting material and/or a significantly hydrophobic environment from other components in the gum base composition. In some aspects, the delayed cud-disrupting material has a weight average molecular weight (Mw) of at least about 5,000-4,000,000 Da. In some other aspects, the delayed cud-disrupting material has a weight average molecular weight (Mw) of at least about 20,000-3,000,000 Da. In yet other aspects, the delayed cud-disrupting material has a weight average molecular weight (Mw) of at least about 50,000-2,000,000 Da.

**[0054]** As used herein, the term “polymeric moisture uptake promoter material(s)” refers to hydrophilic polymers that are at least sufficiently organically soluble that they can interact with the gum cud matrix, but simultaneously assist in the diffusion of water through the matrix, thereby facilitating the diffusion of water through to the water reactive sites of the polymers of delayed-cud disrupting material(s) or Group A material(s). Polymeric moisture

uptake promoter material(s) are sometimes referred to herein as “Group B material(s)” or “Component B material(s)”. The Group B materials can facilitate water flow across and through the gum cud matrix by several possible mechanisms including but not limited to (1) self-assembly of the hydrophilic moieties along the non-polar backbone with other hydrophilic moieties, forming channels which can promote water transport through the otherwise impermeable gum cud matrix, or (2) general increase of the hydrophilic character of the gum base due to the hydrophilic moieties anchored into the gum cud matrix, thus rendering the matrix less hydrophobic and more readily able to interact with an aqueous phase. These materials can thus be considered as activators for the delayed cud-disrupting material(s) (i.e. Group A material(s)). Group B material(s) also include or comprise subsets or subgroups, for example Groups B1 and B2. As discussed in greater detail herein, Group B1 material(s) include nonionic hydrophilically modified polymers, while Group B2 material(s) include ionically modified polymers.

[0055] As used herein, the term “T<sub>g</sub>” refers to the glass transition temperature of an elastomer used in chewing gum compositions as measured at any time before or after processing of the elastomer. More particularly, the term “T<sub>g</sub> initial” refers to the glass transition temperature of an elastomer prior to processing of the elastomer into a substantially homogenous mass in the presence of a non-stick inducing component. The term “T<sub>g</sub> final” refers to the glass transition temperature of an elastomer subsequent to processing of the elastomer into a softened mass useful for gum base.

[0056] Glass transition temperature (T<sub>g</sub>) is generally understood to be the temperature below which molecules have very little mobility. On a larger scale, polymers are rigid and brittle below their glass transition temperature and can undergo plastic deformation above it. T<sub>g</sub> is usually applicable to amorphous phases and is commonly applicable to glasses, plastics and rubbers. In polymers, T<sub>g</sub> is often expressed as the temperature at which the Gibbs free energy is such that the activation energy for the cooperative movement of a significant portion of the polymer is exceeded. This allows molecular chains to slide past each other when a force is applied.

[0057] As used herein, the phrase “release properties” means properties that allow a chewing gum base and/or chewing gum product to exhibit reduced adherence to a surface.

[0058] As used herein, the phrase “limited capability to plasticize polymers” means that a component will not change the T<sub>g</sub> of a gum base more than about plus/minus three (+/- 3) degrees upon incorporation of the component into the gum base.

[0059] As used herein, the term “processing” refers to any step taken during the manufacture of a gum base and/or gum product, including any step that occurs when manufacturing a gum product by means of batch systems, continuous systems, or any other system manufacturing system known in the art. As used herein, the term processing includes the process of “masticating an elastomer” so that it is suitable for inclusion in a chewing gum product.

[0060] As used herein, the phrase “non-conventional gum ingredients” refers to ingredients not conventionally included in chewing gum products and includes ingredients such as zein and seed oils from the plant genus *Cuphea*.

[0061] As used herein, the phrase “conventional gum ingredients” refers to ingredients traditionally included in gum products such as elastomers and elastomer solvents.

[0062] As used herein, the term “surface”, when used in connection with non-stick and/or reduced stick properties or degradable properties, refers to any surface with which a chewing gum base, chewing gum composition, chewing gum product or chewing gum bolus comes into contact. Such surfaces include without limitation, for example, the following: any surface in the oral cavity such as the surface of a tooth or the surface of any dental or orthodontic device contained in the oral cavity; any surface on a human body including the skin, such as the skin on the face, and hair; and any surface external to a human body, such as the surface of pavements, sidewalks, roadways, brick, glass, wood, plastic, stone, furniture, carpeting, the soles of footwear including shoes or sneakers, cardboard, paper, metal, and surfaces of porous nature to which conventional gum ingredients stick and are difficult to remove.

[0063] As used herein, the term “HLB” refers to hydrophilic lipophilic balance.

[0064] The terms “a” and “an” and “the” herein do not denote a limitation of quantity, and are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context.

[0065] Ranges disclosed herein are inclusive of the recited endpoint and are independently combinable.

[0066] “Combination” is inclusive of blends, mixtures, alloys, reaction products, and the like. Also, “combinations comprising at least one of the foregoing” means that the list is inclusive of each element individually, as well as combinations of two or more elements of the list, and combinations of one or more elements of the list with non-list elements.

[0067] The terms “first,” “second,” and so forth, herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another. In

addition, reference throughout the specification to “one embodiment”, “another embodiment”, “an embodiment”, and so forth, means that a particular element (e.g., feature, structure, and/or characteristic) described in connection with the embodiment is included in at least one embodiment described herein, and may or may not be present in other embodiments. In addition, it is to be understood that the described elements can be combined in any suitable manner in the various embodiments.

**[0068]** The modifier “about” used in connection with a quantity is inclusive of the stated value and has the meaning dictated by context, (e.g., includes the degree of error associated with measurement of the particular quantity). In addition, it is to be understood that the described elements can be combined in any suitable manner in the various embodiments.

**[0069]** The suffix “(s)” as used herein is intended to include both the singular and the plural of the term that it modifies, thereby including one or more of that term (e.g., the film(s) includes one or more films).

**[0070]** In accordance herein, the combination of materials include at least one material from Group A (the delayed cud-disrupting materials) and at least one material from Group B (the at least one polymeric moisture uptake promoter materials) being used in conjunction with a gum base or chewing gum composition. The inclusion of the Group A and Group B materials as provided herein can be accomplished at the time of mixing of the desired gum base. For example, the Group B material(s) are desirably preformed prior to being introduced and mixed with the gum base formulation. This can be particularly advantageous when aspects of the Group A and Group B material(s) are considered. For example and while not to be construed as limiting, polyethylene glycol has been used in gum bases previously, but polyethylene glycol is not soluble in gum bases alone. Rather, for interaction as provided herein, the polyethylene glycol needs to be used in connection with a larger molecule to provide desired interaction. Thus, for instance, using polyethylene glycol as a component of the Group B materials (e.g. Group B1 materials as discussed herein below), allows for desired interaction as a polymeric moisture uptake promoter material with the delayed cud-disrupting materials.

**[0071]** The delayed cud-disrupting material(s) and the polymeric moisture uptake material(s) may be used and added in chewing gum bases and/or chewing gum compositions and/or chewing gum products during manufacture, after manufacture, or during production of the gum itself.

[0072] The group A materials can encompass either a poly anhydride, which does not need assistance to blend with the gum base as it is similarly hydrophobic and encapsulating with wax only helps, or a crosslinked polyacrylic acid which behaves similarly to a powder and can be blended in much the same as a standard filler such as talc and the like. Each of the Group A materials and Group B materials can include two or more subgroups, including those discussed below.

[0073] Exemplary Group A1 materials (i.e. delayed cud-disrupting materials) include polymers that may be slow to interact with water due to extremely high weight average molecular weight (Mw) (for example >5,000 Da) and/or crosslinking. Exemplary Group A1 materials include high weight average molecular weight linear (Mw) or crosslinked polyacrylic acid, high weight average molecular weight (Mw) linear or crosslinked polyacrylamide and copolymers thereof. Typical examples of this type of polymer include, but are not limited to, those under the tradenames Carbopol 971P (which is a crosslinked poly acrylic acid) and Carbopol 974P (which is a crosslinked poly acrylic acid) and Noveon AA-1 Polycarbophil (which is a crosslinked poly acrylic acid) (which are commercially available from Lubrizol), and other similar materials.

[0074] Illustrative Group A2 delayed cud-disrupting materials can include polymers having water-labile moieties such as anhydrides, acetals, and similar hydrolytically unstable moieties, which would react with water to produce substantially more hydrophilic polymers. Such polymers may thus include water reactive sites within the polymer, but may be slow to interact with water due to an initially hydrophobic nature and optionally, subsequent coating with hydrophobic gum base, thereby limiting the ability of water to come in contact with reactive sites on the polymer. Hydrolysis reactions along the polymer or its side chains eventually convert the material to one that is more hydrophilic in nature and capable of reacting more readily with water. Exemplary Group A2 materials include, but are not limited to, poly(methyl vinyl ether-alt-maleic anhydride) (commonly known as Gantrez<sup>®</sup>), maleic anhydride copolymers with C<sub>2</sub>-C<sub>10</sub> alkenes such as disclosed in PCT Publication No. WO. 2013/032761, and other similar copolymers of maleic anhydride. Exemplary Group A2 materials include, but are not limited those disclosed in U.S. Patent Nos. 8,268,371 B2; 8,282,971 B2; 8,263,143 B2; and 8,287,928 B2.

[0075] Exemplary Group A2 materials include for example the following: copolymers of methyl vinyl ether and maleic anhydride and/or salts thereof (such as any of the GANTREZ<sup>®</sup> AN products and/or salts thereof, including GANTREZ<sup>®</sup> AN-119 (which has a molecular weight of about 200,000), GANTREZ<sup>®</sup> AN-903 (which has a molecular

weight of about 800,000), GANTREZ® AN-139 (which has a molecular weight of about 1,000,000), and GANTREZ® AN-169 (which has a molecular weight of about 2,000,000), all of which are available from Ashland, and/or salts thereof); copolymers of polystyrene and maleic anhydride and/or salts thereof; polysuccinimide and/or salts thereof; and combinations thereof. Other suitable copolymers include the free acid form of GANTREZ AN copolymers and/or salts thereof (particularly, any of the GANTREZ S® copolymers and/or salts thereof, including GANTREZ® S-96 solution (which has a molecular weight of about 700,000), GANTREZ® S-97 powder (which has a molecular weight of about 1,200,000), and GANTREZ® S-97 solution (which has a molecular weight of about 1,500,000), all of which are available from Ashland, and/or salts thereof, and half-ester derivatives of GANTREZ® S copolymers and/or salts thereof (particularly, any of the GANTREZ® ES products and/or salts thereof including GANTREZ® ES-225 (which has a molecular weight from about 100,000 to about 150,000) and GANTREZ® ES-425 (which has a molecular weight from about 90,000 to about 150,000), each of which are available from Ashland and/or salts thereof. Other suitable Group A2 materials include copolymers of vinyl pyrrolidone and vinyl acetate and/or salts thereof (such as Plasdone® S-630 (which has a molecular weight of about 27,000), available from Ashland, and/or salts thereof) and alginates and/or salts thereof. Suitable polymers for use also include the aforementioned GANTREZ products, and those more particularly described in “Polymers for Oral Care: Product and Applications Guide,” by International Specialty Products (© 2003 ISP), the contents of which are incorporated herein by reference. Any of the aforementioned polymers and/or any salts thereof may be used alone or in combination. The molecular weights of the GANTREZ products and other products available from Ashland referred to herein are weight average molecular weights (Mw).

**[0076]** Useful salts of such materials include, for example, any alkali metal salt of a material polymer and/or any alkaline earth metal salt of a material polymer and/or combinations thereof. Particularly useful alkali metal salts of such polymers include, for example, the sodium and potassium salts of such polymers and/or combinations thereof. Particularly useful alkaline earth metal salts of such polymers include, for example, the magnesium and calcium salts of Group A2 polymers and/or combinations thereof. A particularly useful polymer is GANTREZ® MS, which is a mixed sodium and calcium salt of GANTREZ® S-97, both of which are available from Ashland. A particularly useful GANTREZ® MS polymer is GANTREZ® MS 955 (sometimes referred to a MS-955)

(which is a mixed sodium and calcium salt of poly(methylvinyl ether/maleic anhydride) with a molecular weight of 1,000,000.

[0077] In particular, when the Group A2 material is GANTREZ® AN-119, the molecular weight is approximately 200,000. When the Group A2 material is GANTREZ® AN-903, the molecular weight is approximately 800,000. When the Group A2 material is GANTREZ® AN-139, the molecular weight is approximately 1,000,000. When the Group A2 material is GANTREZ® AN-169, the molecular weight is approximately 2,000,000.

[0078] Moreover, when the Group A2 materials GANTREZ® S-96, the molecular weight is approximately 700,000. When the Group A2 material is GANTREZ® S-97 powder, the molecular weight is approximately 1,200,000. When the Group A2 material is GANTREZ® S-97 solution, the molecular weight is approximately 1,500,000.

[0079] Furthermore, when the Group A2 material is GANTREZ® ES-225, the molecular weight is approximately from about 100,000 to about 150,000. When the Group A2 material is GANTREZ® ES-425, the molecular weight is approximately from about 90,000 to about 150,000. When the Group A2 material is GANTREZ® MS, the molecular weight is approximately 1,000,000.

[0080] A suitable anhydride of a Group A2 material is any suitable anhydride of a GANTREZ® polymer. Anhydrides of a GANTREZ® polymer include the following: GANTREZ® AN-119 (which as a molecular weight of approximately 200,000); GANTREZ® AN-903 (which as a molecular weight of approximately 800,000); GANTREZ® AN-139 (which as a molecular weight of approximately 1,000,000); and GANTREZ® AN-169 (which as a molecular weight of approximately 2,000,000).

[0081] A suitable acid of a Group A2 material is any suitable acid of a GANTREZ® polymer. Acids of a GANTREZ® polymer include the following: GANTREZ® S-96 (which as a molecular weight of approximately 700,000) and GANTREZ® S-97 (which as a molecular weight of between approximately 1,200,000 and 1,500,000), and combinations thereof.

[0082] A suitable ester of a Group A2 material is any suitable ester of a GANTREZ® polymer. Esters of a GANTREZ® polymer include the following: GANTREZ® ES-225 (ethyl ester) (which as a molecular weight of between approximately 100,000 and 150,000); GANTREZ® ES-425 (butyl ester) (which as a molecular weight of between approximately 90,000 and 150,000); GANTREZ® ES 435 (butyl ester); GANTREZ® ES 335 (isopropyl ester); GANTREZ® SP 215 (ethyl ester); and GANTREZ® A-425 (butyl ester),

GANTREZ™ SF (methyl vinyl ether-maleic anhydride copolymer) and combinations thereof.

[0083] The materials of Group A1 and/or Group A2 can further optionally be delayed from interaction with water by encapsulation. See e.g., published PCT Application No. WO2010/125342 A2, published on November 4, 2010, which is incorporated herein by reference in its entirety.

[0084] Group B polymers (i.e. polymeric moisture uptake promoter materials) can also include subgroups, for instance Group B1 and Group B2. Group B polymers include hydrophilic polymers that assist in the diffusion of water through the matrix, thereby facilitating the diffusion of water to Group A polymers (e.g. to reactive sites of Group A polymers). Thus, Group B polymers act as activators for Group A polymers.

[0085] Exemplary Group B1 materials include nonionic hydrophilic-modified polymers. More specifically, Group B1 materials include polymers functionalized with polyethylene glycol (PEG). For example, Group B1 materials could include polymers such as modified or copolymerized poly vinyl acetate, wherein the acetate moiety has been partially replaced with polyethylene glycol (ethylene glycol repeat units numbering from 1-1000, in a graft density on the vinyl acetate backbone between 0.1 - 20% based on polymer backbone monomer units). Group B1 materials can also include similar hydrophilic-modified polymers based on elastomeric polymers such as polyisoprene, polybutadiene, and polyisobutylene, functionalized with polyethylene glycol. Common examples of these types of polymers include polyisoprene with polyethylene glycol side chains, partially hydrolyzed polyvinyl acetate and similar materials manufactured by Kuraray, polyacrylate copolymers of similar functionality to that of the polyvinyl acetate (80-99.9% alkyl acrylate or methacrylate, and 0.1-20% hydroxyethylacrylate or methacrylate, or polyethylene glycol acrylate or methacrylate).

[0086] Group B2 materials can, for example, include ionic-modified polymers. Group B2 materials can include polymers containing short linear or branched side-chain (C<sub>1</sub>-C<sub>8</sub>) ionic groups such as sulfonate, carboxylate or ammonium salts. Group B2 materials can include, for example, polymers such as polyvinyl acetate with 0.1 - 10% of the acetate groups replaced with short linear or branched side-chain (C<sub>1</sub>-C<sub>8</sub>) ionic groups such as sulfonate, carboxylate, or ammonium salts.

[0087] In some embodiments, the at least one Group A material(s) (i.e. the at least one delayed cud-disrupting material) can be mixed at levels of 0.1-10% by weight based on the gum base composition while Group B material(s) may be combined at levels of 0.1-10 %



by weight based on the gum base composition. More preferably, these ranges are contemplated to include 0.5-5% by weight based on the gum base composition for Group A material(s) and 0.5-5% by weight based on the gum base composition for Group B material(s). In some embodiments, these ranges are contemplated to include 3% by weight based on the gum base composition for Group A material(s) and 1-3% by weight based on the gum base composition for Group B material(s). In this manner, when the component(s) from Group A is/are combined with an appropriate component(s) from Group B in a conventional chewing gum base, and the gum base is discarded onto a surface such as a sidewalk following use, the interaction of the Group A component(s) with environmental water is facilitated by the presence of the Group B component(s), thereby resulting in deterioration of the gum cud matrix and facilitating removal of the cud and restoration of the clean surface appearance.

**[0088]** Thus, the biodegradable chewing gum bases and biodegradable chewing gum compositions using such bases as provided herein can comprise: (A) at least one cud-disrupting material selected from Group A1, at least one cud-disrupting material selected from Group A2, or at least one material selected from both Group A1 and Group A2, wherein Group A1 material(s) is/are at least one polymer or copolymer that is/are slow to interact with water due to extremely high weight average molecular weight ( $M_w$ ) and/or crosslinking and wherein Group A2 material(s) is/are at least one polymer or copolymer capable of hydrolysis to provide a polymer or copolymer that is more hydrophilic relative to the polymer or copolymer prior to hydrolysis; and (B) at least one activator or polymeric moisture uptake promoter material for the at least one cud-disrupting material selected from Group B1 and Group B2 or at least one material selected from both Group B1 and Group B2, wherein Group B1 is at least one polymer or copolymer comprising nonionic hydrophilic-modified polymers and wherein Group B2 is at least one of polymer or copolymer comprising ionic-modified polymers or copolymers.

**[0089]** In some embodiments, the biodegradable chewing gum compositions can comprise: (A) at least one cud-disrupting material selected from Group A1 and Group A2 or at least one material from both Groups A1 and A2, wherein Group A1 comprises at least one high weight average molecular weight ( $M_w$ ) linear or crosslinked polyacrylic acid, high weight average molecular weight ( $M_w$ ) linear or crosslinked polyacrylamide and copolymers thereof and wherein Group A2 comprises at least one polymer or copolymer selected from maleic anhydride polymers and copolymers; and (B) at least one activator or polymeric moisture uptake promoter material for the at least one cud-disrupting material selected from Group B1 and Group B2 or at least one material selected from both Group B1 and Group B2,

wherein Group B1 is at least one hydrophilic-modified polymer or copolymer based on elastomeric polymers such as poly vinyl acetate, polyisoprene, polybutadiene, and polyisobutylene, functionalized with polyethylene glycol and wherein Group B2 is at least one hydrophilic-modified polymer or copolymer based on elastomeric polymers such as poly vinyl acetate functionalized with short linear or branched side-chain (C<sub>1</sub>-C<sub>8</sub>) ionic groups such as sulfonate, carboxylate or ammonium salts.

[0090] As discussed herein in addition to the use of the Group A and Group B materials as provided herein, reduced-stick and/or non-stick properties also may be enhanced by employing certain fats and/or oils which soften the elastomers in chewing gum without causing excess stickiness.

[0091] Some embodiments described herein are directed to producing degradable chewing gum bases and degradable chewing gum compositions using such degradable gum bases. Degradability is enhanced by incorporating at least one delayed cud-disrupting material and at least one polymeric moisture uptake promoter material for the at least one cud-disrupting material into a chewing gum base, a chewing gum composition, or both a chewing gum base and a chewing gum composition.

[0092] Other embodiments disclosed herein are directed to incorporating at least one delayed cud-disrupting material into a gum base and exposing the gum base to at least one condition that promotes hydrolysis. Such conditions include, for example, mastication, exposure to moisture, or exposure to a hydrolysis-promoting condition, such as exposure to cycling weather conditions of rain and sunlight. In some embodiments, the condition that promotes hydrolysis promotes increased degradability. Moreover, the incorporation of the at least one polymeric moisture uptake promoter material facilitates movement of water into the gum base matrix to facilitate water being accessible to reactive sites on the at least one delayed cud-disrupting material such that hydrolysis can occur.

[0093] The incorporation of at least one delayed cud-disrupting material and the at least one polymeric moisture uptake promoter material as provided herein allow for improved degradation of the chewing gum compositions. It will be appreciated that the time for degradation will vary depending on several factors, including the formulation of the chewing gum compositions and the conditions that the chewing gum compositions are exposed to subsequent to mastication. Depending on such factors, compositions as provided herein are capable of substantially degrading the chewing gum product subsequent to mastication within about thirty days, preferably within about 14 days and more preferably, in 7 days or less.

Optional Non-Stick and/or Reduced Stick Components

[0094] As discussed above, chewing gum compositions that are rendered degradable are disclosed herein. Degradability can be further enhanced by incorporation of optional non-stick and/or reduced stick components such as free-radical generators, such as photosensitizers. Some embodiments are thus directed to producing gum bases that optionally include non-stick and/or reduced stick components. Accordingly, some embodiments are directed to producing reduced-stick or non-stick gum bases and reduced-stick or non-stick chewing gum compositions using such gum bases. The reduced or non-stick properties can be achieved by employing certain fats and/or oils which soften the elastomers in chewing gum without causing excess stickiness. Other embodiments relate to rendering chewing gum compositions biodegradable. Degradability, including biodegradability, can be further enhanced by the incorporation of free-radical generators, such as photosensitizers.

[0095] The embodiments described herein can provide numerous advantages over conventional chewing gum compositions by the incorporation of certain components which aid in the processing of the gum base, as well as contribute to certain advantages and properties in the final chewing gum compositions and products made therefrom. One such advantage is the reduced-stick and/or non-stick properties that are imparted to the gum base and consequently to the chewing gum compositions as a whole, both during processing of the chewing gum base and subsequent to chewing. Another advantage is the ability to process elastomer gum base components without relying on conventional solvent additives, such as gum resins. Yet another advantage is the ability to substitute some or all of the elastomer solvent within a gum base with the non-stick inducing components. In some embodiments, only a portion of an elastomer solvent is replaced to take advantage of the softening capabilities of the solvent without imparting stickiness to chewing gum compositions made therefrom.

[0096] As used herein, the term “non-stick and/or reduced stick inducing component(s)” refers to components that are incorporated in a gum composition such that the gum composition exhibits reduced stickiness and/or reduced stick as compared to the same gum composition in the absence of the non-stick inducing components. It will be understood that the term “non-stick and/or reduced stick inducing component(s)” includes non-stick inducing component(s), reduced stick inducing component(s), and component(s) that act both as a non-stick inducing agent and as a reduced stick inducing component. It will be further

understood that in some embodiments, the non-stick inducing component may be the same as the reduced stick inducing component, and in some embodiments it may be different.

[0097] In some embodiments, various chewing gum compositions and products made therefrom are provided with non-stick and/or reduced stick properties by the incorporation of non-stick and/or reduced stick inducing components which include delayed cud-disrupting material(s) and/or various fats and/or oils. These non-stick and/or reduced stick inducing components may be used to partially or fully replace conventional components such as elastomer solvents and certain waxy materials, which are conventionally used to soften gum base elastomers such that they are processable for chewing gum compositions, but which are known to contribute to the stickiness of chewing gum compositions made therefrom. The incorporation of these non-stick and/or reduced stick inducing components have a number of advantages in the processing of gum base as well as contributing to the overall reduced stickiness and/or nonstickiness in the final chewing gum compositions and products made therefrom.

[0098] The non-stick and/or reduced stick inducing components may contribute to one or more of the following advantages: (i) facilitate the process of converting a solid or solid-like elastomer into some other form, such as a homogenous or substantially homogenous softened or malleable mass; (ii) allow sufficient softening for processing and for use in a chewing gum product; and (iii) provide softening without an increase in stickiness of the final gum product.

[0099] In some embodiments, the non-stick and/or reduced stick inducing components, when added to the gum base, allow for softening in the gum base elastomers such that they can be easily processed from solid rubbers to soft matrices, which can then be incorporated into chewing gum compositions.

[0100] In some aspects, the addition of the non-stick and/or reduced stick inducing components balances the softening of the gum base elastomer components, as well as the chewing gum composition as a whole, while reducing the overall stickiness and/or increasing the degradability of the products made therefrom.

[0101] In other embodiments, the non-stick and/or reduced stick inducing components have been found to exhibit various physical properties including the ability to migrate to the surface of the chewing gum product to create a release barrier which reduces the ability of the chewing gum product to stick to surfaces. In some embodiments, the non-stick and/or reduced stick inducing components have hydrophobic and hydrophilic character, i.e., HLB (hydrophilic lipophilic balance) values, which enhance the release barrier

characteristics due to the tendency of these materials to molecularly orient themselves such that the hydrophobic portion orients itself inward of the chewing gum and the hydrophilic portion orients itself to the surface of the chewing gum, thereby contributing to the release properties and reducing the stickiness.

[0102] Any suitable non-stick and/or reduced stick inducing components as defined herein may be incorporated in the present inventive chewing gum bases.

[0103] In some embodiments, the non-stick and/or reduced stick inducing component is incorporated into the gum base such that the gum base surface has greater hydrophilic character.

[0104] In some embodiments, the chewing gum compositions disclosed herein include a non-stick and/or reduced stick inducing component in an amount sufficient to migrate to the surface of a chewing gum product formed therefrom and provide a surface barrier. Desirably, the surface barrier has release properties such that a gum bolus formed upon chewing exhibits a reduced adherence to a variety of surfaces as compared to gum compositions not containing the non-stick and/or reduced stick inducing component.

[0105] For example, in some embodiments, the non-stick and/or reduced stick inducing component may be a surface release agent having a hydrophilic portion and a hydrophobic portion. When such a surface release agent is employed, the hydrophobic portion of the surface release agent tends to direct itself within the chewing gum composition and the hydrophilic portion tends to direct itself toward the chewing gum composition surface upon migration of the surface release agent to the surface of the chewing gum.

[0106] Additionally, the non-stick and/or reduced stick inducing component may include, for example, any suitable fat or oil or combination thereof which performs to reduce stickiness or render non-stick the composition and products made therefrom. In particular, they may include fats and oils having an HLB range of about 3.5 to about 13. Useful fats and oils include those having a wide range of melting points, for example from about 10 °C to about 75 °C, desirably from about 20°C to about 73°C and more desirably about 40 °C to about 70 °C.

[0107] More particularly, non-stick and/or reduced stick inducing components may include, without limitation, the following: various fats and oils including saturated and unsaturated fatty acids having a carbon chain length of C<sub>14</sub> to C<sub>24</sub>; including for example saturated and unsaturated fatty acids such as stearic acid, oleic acid, palmitic acid, linoleic acid, arachidonic acid, myristic acid, palmitoleic acid and vaccenic acid; monoglycerides, diglycerides, and triglycerides of saturated and unsaturated fatty acids having a chain length

of C<sub>14</sub> to C<sub>24</sub>; natural fats containing predominantly triglycerides of saturated and unsaturated fatty acids having a chain length of C<sub>14</sub> to C<sub>24</sub>, including hydrogenated and non-hydrogenated cottonseed oil, soybean oil, canola oil, olive oil, grape seed oil, peanut oil, sunflower oil, safflower oil, palm oil, cocoa butter, coconut oil, and palm kernel oil; esters of monoglycerides and diglycerides, such as acetylated monoglycerides and acetylated diglycerides and the glycerol esters of fatty acids including glycerol monostearate (GMS); animal fats such as beef tallow oil, lard, butter and chicken fat; fatty esters of sugars; esters of alcohols such as lower alkyl (C<sub>1-4</sub>) stearates including methyl and ethyl stearates, as well as high weight average molecular weight (Mw) esters of alcohols; phospholipids such as lecithin and lanolin; and mixtures and combinations thereof.

[0108] Fatty acids and their esters having lengths of C<sub>2</sub>-C<sub>13</sub> may also be employed in combination with the C<sub>14</sub>-C<sub>24</sub> fatty acid esters described above but due to the tendency of the medium chain triglycerides (MCTs having a carbon chain length of C<sub>6</sub>-C<sub>12</sub>) to be more miscible or compatible with the elastomer, their presence must be balanced such that the T<sub>g</sub> final as defined herein is maintained and/or separate crystals and/or domains are present or maintained in the elastomer matrix.

[0109] The ratio of non-stick and/or reduced stick inducing component to elastomer (non-stick: elastomer) may be in the range of about 1:1 to about 10:1 and desirably in the range of about 4:1 to about 8:1. When optional components such as elastomer solvents or waxes are employed along with the non-stick and/or reduced stick inducing component, the ratio of non-stick and/or reduced stick inducing component to elastomer solvent (non-stick solvent or wax) may be about 1:0 to about 4:1.

[0110] Desirably, some embodiments include inventive gum bases which have at least one non-stick and/or reduced stick inducing component having a melting point of about 60°C to about 70 °C and at least one other non-stick and/or reduced stick inducing component having a melting point of about 20°C to about 40 °C. More particularly, the present inventive gum bases may include at least one fat having a melting point of about 70 °C and at least one fat having a melting point of about 40 °C.

[0111] The non-stick and/or reduced stick inducing component may be present in amounts of about 10% to about 60% by weight of the chewing gum base. In some embodiments, the non-stick inducing component may be present in amounts of about 20% to about 50% by weight of the chewing gum base. In other embodiments, the non-stick and/or reduced stick inducing component may be present in amounts of about 30% to about 40% by weight of the chewing gum base.

[0112] Chewing gum bases as disclosed herein do not stick to a variety of surfaces or exhibit reduced stickiness as compared to chewing gum bases not having the compositions disclosed herein. In particular, during manufacture, the chewing gum bases do not stick to processing equipment. Moreover, during chewing, the chewing gum bases do not stick to surfaces within the oral cavity, including the teeth and any orthodontic or dental appliances. Additionally, gum boluses will not stick to, or will have reduced stickiness, to a variety of surfaces external to the oral cavity, including, for example, asphalt, bricks, wood, plastic, hair, skin, carpeting, and the soles of shoes, as compared to gum boluses not having the formulations of the gum boluses provided herein. Embodiments disclosed herein thus provide chewing gum compositions and products that have non-stick surfaces during processing and subsequent to chewing into a gum bolus.

#### Optional Hydrolysis Promoting Components

[0113] As used herein, the phrase “condition that promotes hydrolysis” refers to any condition that causes the hydrolysis of at least one reactive site. Such conditions include, for example, moisture, mastication in the mouth, and exposure to a hydrolysis-promoting component, and exposure to cycling weather conditions of rain and sunlight. As used herein, the term “hydrolysis-promoting component” refers to any component that promotes the hydrolysis of at least one reactive site. Examples of hydrolysis-promoting components include, for example, detergents having a basic pH, rain water, and deionised water. In some embodiments, hydrolysis-promoting components include filler components such as talc, carbonate-based fillers, such as calcium carbonate, and dical.

#### Additional Optional Components

[0114] In other embodiments, the chewing gum compositions may be rendered more environmentally friendly by the incorporation of additional components which enhance the degradation of the chewing gum, such that it loses its ability to maintain its cohesiveness and crumbles and breaks apart into smaller, discontinuous pieces over time. Components which contribute to the degradation include light absorbing materials which upon exposure to light, e.g. sunlight, react with the elastomer components and cause them to degrade, or otherwise become modified to become less sticky. In some embodiments, upon exposure to light, the weight average molecular weight (Mw) of the elastomer component is reduced sufficiently enough to render them and chewing gum compositions containing them less sticky. In some embodiments, there may be included components which when exposed to light cause an

increase in the weight average molecular weight (Mw) of the elastomer components sufficient to reduce the stickiness of the elastomer, as well as reduce the stickiness of chewing gum compositions containing them.

[0115] Any agent that is capable of degrading an elastomer may be incorporated in various chewing gum composition embodiments. Desirably, the agent is lipophilic and is incorporated in the gum base composition. In some embodiments, an agent serves to enhance the degradation of the gum product in the presence of light, i.e., photodegradation. A particularly useful agent that is capable of enhancing the elastomer degradation in the presence of light is chlorophyll and derivatives such as chlorophyllin, pheophytin, pyropheophytin and pheophorbide. Chlorophyll and its derivatives are capable of absorbing light and generating free radicals. The presence of free radicals may react with elastomer components to render them less sticky.

[0116] In general, chlorophyll may be present in an amount from about 0.01% to about 0.3% by weight of the gum base. Desirably, chlorophyll may be present in an amount from about 0.05% to about 0.2% by weight of the gum base. More desirably, chlorophyll may be present in an amount from about 0.07 to about 0.12% by weight of the gum base.

[0117] Other suitable components to enhance degradation include other photosensitizers such as phthalocyanine derivatives, riboflavin, hemoglobin, myoglobin, and heme. In some embodiments, the elastomer component may be degraded by oxidation to form smaller discontinuous phases of elastomer. In some embodiments, the elastomer component may interact with free radicals to increase the elastomer weight average molecular weight (Mw). When certain elastomer components are used in combination with the chlorophyll, such as elastomers with unsaturated bonds, the chlorophyll may increase the weight average molecular weight (Mw) of the elastomeric component by inducing higher weight average molecular weight (Mw) reaction products caused by free radical generation. A variety of reaction possibilities may occur depending on such factors as the type of elastomer present, the amount of degradation agent present such as free-radical inducing agent, the particular chewing gum composition, as well as the type of light and environmental exposure the chewing gum sees.

[0118] In some embodiments, the at least one agent capable of degrading an elastomer is encapsulated. Encapsulation may be desirable to prevent premature degradation of the chewing gum base prior to mastication. The at least one agent capable of degrading an elastomer may be encapsulated as microcapsules or microparticles as described in PCT Publication No. WO 2004/064544, which is incorporated herein by reference in its entirety.



Suitable encapsulants include, but are not limited to, fats, polymers, carbohydrates and combinations thereof. A particularly suitable encapsulant is gum arabic.

[0119] In some embodiments the agent capable of degrading an elastomer is present in the chewing gum composition as part of the center-fill. In such compositions the agent may be encapsulated or non-encapsulated.

[0120] In some embodiments, the agent capable of degrading an elastomer is present in a coating of the chewing gum composition. For example, such coatings are used on sugarless tablet gums to provide crunchiness as well as flavor, sweetness and sensate perception. In such compositions, the agent may be encapsulated or non-encapsulated.

[0121] In general, the at least one agent capable of assisting the combination of the Group A and Group B materials in the degradation of an elastomer(s) is present in an amount sufficient to assist in substantially degrading the chewing gum product subsequent to mastication over time. Desirably, in some embodiments, the at least one agent capable of assisting in the degrading of an elastomer(s) is present in an amount sufficient to assist with substantially degrading the chewing gum product subsequent to mastication within about twenty-five (25) weeks. More desirably, the at least one agent capable of assisting in the degrading an elastomer(s) is present in an amount sufficient to assist with substantially degrading the chewing gum product subsequent to mastication within about ten (10) weeks. Even more desirably, the at least one agent capable of assisting in the degrading an elastomer(s) is present in an amount sufficient to assist with substantially degrading the chewing gum product subsequent to mastication within about within about thirty days, preferably within about 14 days and more preferably, in 7 days or less.

[0122] Desirably, the at least one agent capable of assisting with degrading an elastomer is present in an amount from about 0.01% to about 0.3% by weight of the gum base. More desirably, the at least one agent capable of degrading an elastomer is present in an amount from about 0.05% to about 0.2% by weight of the gum base. Most desirably, the at least one agent capable of degrading an elastomer is present in an amount from about 0.07% to about 0.12% by weight of the gum base.

[0123] Additional other components which contribute to degradation of a chewing gum composition include hydrophobic components which hydrolyze or begin to hydrolyze upon exposure to a particular condition that promotes hydrolysis, such as upon exposure to mastication and/or upon exposure to moisture and/or upon exposure to a component that promotes hydrolysis and/or upon exposure to alkaline pH conditions. By incorporating such components into a chewing base and/or chewing gum composition, it is possible to enhance

the hydrophilicity of a chewing gum composition following mastication. In particular, it is possible to delay the onset of hydrophilicity using the materials disclosed herein. By delaying the onset of hydrophilicity, it is possible to produce a gum base and chewing gum product which is stable, yet is capable of hydrolyzing upon exposure to certain conditions, such as the moisture and mechanical action of mastication.

### Encapsulation

[0124] In some embodiments, one or more ingredients may be encapsulated with an encapsulating material to modify the release profile of the ingredient. In general, partially or completely encapsulating an ingredient used in a chewing gum composition with an encapsulating material may delay release of the ingredient during consumption of the chewing gum composition, thereby delaying when the ingredient becomes available inside the consumer's mouth, throat, and/or stomach, available to react or mix with another ingredient, and/or available to provide some sensory experience and/or functional or therapeutic benefit. This can be particularly true when the ingredient is water soluble or at least partially water soluble.

[0125] In some embodiments, encapsulation may be employed to provide barrier protection to or from a component rather than to modify the release of the component. For instance, it often is desirable to limit the exposure of acids to other components in a chewing gum composition. Such acids may be encapsulated to limit their exposure to other components, or alternatively, the other components in the chewing gum composition may be encapsulated to limit their exposure to the acid.

[0126] In some embodiments, a material used to encapsulate an ingredient may include water insoluble polymers, co-polymers, or other materials capable of forming a strong matrix, solid coating, or film as a protective barrier with or for the ingredient. In some embodiments, the encapsulating material may completely surround, coat, cover, or enclose an ingredient. In other embodiments, the encapsulating material may only partially surround, coat, cover, or enclose an ingredient. Different encapsulating materials may provide different release rates or release profiles for the encapsulated ingredient. In some embodiments, encapsulating material used in a delivery system may include one or more of the following: polyvinyl acetate, polyethylene, crosslinked polyvinyl pyrrolidone, polymethylmethacrylate, polylactic acid, polyhydroxyalkanoates, ethylcellulose, polyvinyl acetatephthalate, polyethylene glycol esters, methacrylic acid-co-methylmethacrylate, ethylene-vinylacetate (EVA) copolymer, and the like, and combinations thereof.

[0127] In some embodiments, an ingredient may be pre-treated prior to encapsulation with an encapsulating material. For example, an ingredient may be coated with a “coating material” that is not miscible with the ingredient or is at least less miscible with the ingredient relative to the ingredient’s miscibility with the encapsulating material.

[0128] In some embodiments, an encapsulation material may be used to individually encapsulate different ingredients in the same chewing gum composition. For example, a delivery system may include aspartame encapsulated by polyvinyl acetate. Another delivery system may include ace-k encapsulated by polyvinyl acetate. Both delivery systems may be used as ingredients in the same chewing gum or in other chewing gum compositions. For additional examples, see U.S. Patent Application Serial No. 60/683,634 entitled “Methods and Delivery Systems for Managing Release of One or More Ingredients in an Edible Composition” and filed May 23, 2005, the entire contents of which are incorporated herein by reference for all purposes.

[0129] In some embodiments, different encapsulation materials may be used to individually encapsulate different ingredients used in the same chewing gum composition. For example, a delivery system may include aspartame encapsulated by polyvinyl acetate. Another delivery system may include ace-k encapsulated by EVA. Both delivery systems may be used as ingredients in the same chewing gum or other chewing gum compositions. Examples of encapsulated ingredients using different encapsulating materials can be found in U.S. Patent Application Serial No. 60/655,894 filed February 25, 2005, and entitled “Process for Manufacturing a Delivery System for Active Components as Part of an Edible Composition,” the entire contents of which are incorporated herein by reference for all purposes.

[0130] In some embodiments, a delayed cud-disrupting material (i.e. a Group A1 and/or Group A2 material(s)) and/or an anhydride and/or an acid and/or a salt and/or an ester and/or an ether form thereof is encapsulated in an encapsulating material such as polyvinylacetate in a chewing gum base and/or chewing gum composition and/or chewing gum product. By encapsulating a delayed cud-disrupting material (i.e. a Group A1 and/or Group A2 material(s)) and/or an anhydride and/or an acid and/or a salt and/or an ester and/or an ether form thereof in an encapsulating material such as polyvinylacetate, it is possible to increase and/or decrease the rate at which the delayed cud-disrupting material (i.e. a Group A1 and/or Group A2 material(s)) and/or an anhydride and/or an acid and/or a salt and/or an ester and/or an ether form thereof is released. By controlling the rate at which the delayed cud-disrupting material (i.e. a Group A1 and/or Group A2 material(s)) and/or an anhydride

and/or an acid and/or a salt and/or an ester and/or an ether form thereof is released, it is possible to control when degradation of the chewing gum base and/or chewing gum composition and/or chewing gum product occurs.

#### Methods of Encapsulation

[0131] There are many ways to encapsulate one or more ingredients with an encapsulating material. For example, in some embodiments, a sigma blade or Banbury™ type mixer may be used. In other embodiments, an extruder or other type of continuous mixer may be used. In some embodiments, spray coating, spray chilling, absorption, adsorption, inclusion complexing (e.g., creating a flavor/cyclodextrin complex), coacervation, fluidized bed coating, or other process may be used to encapsulate an ingredient with an encapsulating material.

[0132] Examples of encapsulation of ingredients can be found in U.S. Patent Application Serial Number 60/655,894, filed February 25, 2005, and entitled “Process for Manufacturing a Delivery System for Active Components as Part of an Edible Composition,” the entire contents of which are incorporated herein by reference for all purposes. Other examples of encapsulation of ingredients can be found in U.S. Patent Application Serial Number 10/955,255 filed September 30, 2004, and entitled “Encapsulated Compositions and Methods of Preparation,” the entire contents of which are incorporated herein by reference for all purposes. Further examples of encapsulation of ingredients can be found in U.S. Patent Application Serial Number 10/955,149 filed September 30, 2004, and entitled “Thermally Stable High Tensile Strength Encapsulation Compositions for Actives,” the entire contents of which are incorporated herein by reference for all purposes. Still further examples of encapsulation of ingredients can be found in U.S. Patent Application Serial Number 11/052,672 filed February 7, 2005, and entitled “Stable Tooth Whitening Gum with Reactive Components,” the entire contents of which are incorporated herein by reference for all purposes. Further encapsulation techniques and resulting delivery systems may be found in U.S. Patent Nos. 6,770,308, 6,759,066, 6,692,778, 6,592,912, 6,586,023, 6,555,145, 6,479,071, 6,472,000, 6,444,241, 6,365,209, 6,174,514, 5,693,334, 4,711,784, 4,816,265, and 4,384,004, the contents of all of which are incorporated herein by reference for all purposes.

[0133] In some embodiments, a delivery system may be ground to a powdered material with a particular size for use as an ingredient in a chewing gum composition. For example, in some embodiments, an ingredient may be ground to approximately the same particle size of the other chewing gum ingredients so as to create a homogeneous mixture. In

some embodiments, the delivery system may be ground to a powdered material with an average particle size such as, for example, about 4 to about 100 mesh or about 8 to about 25 mesh or about 12 to about 20 mesh.

#### Other Aspects

[0134] The elastomers (rubbers) employed in the gum base will vary greatly depending upon various factors such as the type of gum base desired, the consistency of gum composition desired and the other components used in the composition to make the final chewing gum product. The elastomer may be any water-insoluble polymer known in the art, and includes those gum polymers utilized for chewing gums and bubble gums. Illustrative examples of suitable polymers in gum bases include both natural and synthetic elastomers. For example, those polymers which are suitable in gum base compositions include, without limitation, natural substances (of vegetable origin) such as chicle, natural rubber, crown gum, nispero, rosidinha, jelutong, perillo, niger gutta, tunu, balata, guttapercha, lechi capsii, sorva, gutta kay, and the like, and combinations thereof. Examples of synthetic elastomers include, without limitation, styrene-butadiene copolymers (SBR), polyisobutylene, isobutylene-isoprene copolymers, polyethylene, polyvinyl acetate and the like, and combinations thereof. Specific examples of elastomers include polyisobutylene, styrene butadiene rubber, butyl rubber, and combinations thereof.

[0135] Additional useful polymers include: polybutylmethacrylate/acrylic acid copolymers, polyvinylacetate/vinylalcohol copolymers, microcrystalline cellulose, sodium carboxymethyl cellulose, hydroxylpropylmethyl cellulose, crosslinked cellulose acetate phthalate, crosslinked hydroxyl methyl cellulose polymers, zein, crosslinked polyvinyl pyrrolidone, polymethylmethacrylate/acrylic acid copolymers, copolymers of lactic acid, polyhydroxyalkanoates, plasticized ethylcellulose, polyvinyl acetatephthalate and combinations thereof.

[0136] In general, the elastomer employed in the gum base may have an average weight average molecular weight (Mw) of at least about 200,000. Desirably, the elastomer employed in the gum base has an average weight average molecular weight (Mw) from about 200,000 to about 2,000,000.

[0137] In some embodiments, it is particularly useful to include an elastomer composition including a predominant amount of a material selected from polyisobutylene, butyl rubber, butadiene-styrene rubber and combinations thereof, the elastomer composition having an average weight average molecular weight (Mw) of at least about 200,000; and a

mastication processing aid, wherein the addition of the non-stick and/or reduced stick inducing component maintains the glass transition temperature of the elastomer within a three degree ( $3^{\circ}$ ) range, i.e., +/- three degrees. By "predominant" is meant that the composition includes greater than about 50% to about 98% of a material selected from polyisobutylene, butyl rubber, butadiene-styrene rubber and combinations thereof.

[0138] The amount of elastomer employed in the gum base may vary depending upon various factors such as the type of gum base used, the consistency of the gum composition desired and the other components used in the composition to make the final chewing gum product. In general, the elastomer may be present in the gum base in an amount from about 1% to about 30% by weight of the gum base. Desirably, the elastomer is present in an amount from about 2% to about 15% by weight of the gum base. More desirably, the elastomer is present in the gum base in an amount from about 3% to about 10% by weight of the gum base.

[0139] In some embodiments, the elastomer will be present in the gum base in an amount from about 10% to about 60% by weight, desirably from about 35% to about 40% by weight.

[0140] In some embodiments, the chewing gum base may include a texture-modifier. In general, the texture-modifier has a weight average molecular weight (Mw) of at least about 2,000-500,000. In some aspects, the texture-modifier has a weight average molecular weight (Mw) of at least about 3,000-300,000. In some other aspects, the texture-modifier has a weight average molecular weight (Mw) of at least about 4,000-200,000. In yet other aspects, the texture-modifier has a weight average molecular weight (Mw) of at least about 10,000-100,000.

[0141] In some embodiments, the texture-modifier includes a vinyl polymer. Suitable texture-modifiers include, for example, polyvinyl acetate, polyvinyl laurate acetate, polyvinyl alcohol or mixtures thereof.

[0142] Desirably, the texture-modifier is present in an amount from about 15% to about 70% by weight of the gum base. More desirably, the texture-modifier is present in an amount from about 20% to about 60% by weight of the gum base. Most desirably, the texture-modifier is present in an amount from about 30% to about 45% by weight of the gum base.

[0143] In addition to the components set out above, the gum base may include a variety of other ingredients, such as components selected from elastomer solvents, emulsifiers, plasticizers, fillers, and mixtures thereof. As mentioned above, the use of

elastomer solvents is not needed to masticate the rubber during the manufacturing process. It may be present in limited amounts, but can lessen from the non-stick properties if used in amounts above about 5% by weight of the gum base. In certain embodiments, elastomer solvents may be used in amounts of about 4% to about 5% by weight of the gum base to provide non-stick properties which are sufficient to provide non-stick properties to teeth, dentures, oral implants and other oral prosthetics.

[0144] In some embodiments, the gum base may also contain less than conventional amounts of elastomer solvents to aid in softening the elastomer component. In particular, in some embodiments, such solvents are not required, but may be used in limited amounts along with the non-stick and/or reduced stick inducing components. By less than conventional amounts is meant that the elastomer solvent is employed in the gum base, for example, in amounts from about 0% to about 5.0% and preferably from about 0.1% to about 3.0%, by weight, of the gum base. In some embodiments, the gum base includes a maximum of about 5.0% by weight of an elastomer solvent. In other embodiments, the gum base is free of added elastomer solvents. In some embodiments the gum base is also free of added waxes.

[0145] In other embodiments, conventional amounts of elastomer solvents are incorporated in the gum bases to aid in softening the elastomer component.

[0146] Such elastomer solvents may include those elastomer solvents known in the art, for example, terpinene resins such as polymers of alpha-pinene or beta-pinene, methyl, glycerol and pentaerythritol esters of rosins and modified rosins and gums such as hydrogenated, dimerized and polymerized rosins, and mixtures thereof. Examples of elastomer solvents suitable for use herein may include the pentaerythritol ester of partially hydrogenated wood and gum rosin, the pentaerythritol ester of wood and gum rosin, the glycerol ester of wood rosin, the glycerol ester of partially dimerized wood and gum rosin, the glycerol ester of polymerized wood and gum rosin, the glycerol ester of tall oil rosin, the glycerol ester of wood and gum rosin and the partially hydrogenated wood and gum rosin and the partially hydrogenated methyl ester of wood and rosin, and the like, and mixtures thereof.

[0147] Desirably, the incorporation of an elastomer solvent in the gum base does not interfere with the non-stick inducing components of the gum base and/or with the ability of the gum base to degrade. In particular, in some embodiments where non-stickiness or reduced stickiness is desired, the elastomer solvent desirably softens the gum base without contributing to stickiness. Moreover, the Tg of the gum base desirably does not change more than +/- three (3 °) upon incorporation of the elastomer solvent in the gum base in some embodiments where non-stickiness or reduced stickiness is desired.

[0148] In some embodiments, when the delayed-cud disrupting material(s) and polymeric uptake promoter material(s) are incorporated into the inventive gum bases, an elastomer solvent may or may not be present. In particular, in some embodiments when the delayed-cud disrupting material(s) and polymeric uptake promoter material(s) are used, the elastomer solvent is present in less than conventional amount, i.e., in amounts from about 0% to about 5% and preferably from about 0.1% to about 3%, by weight, of the gum base. In other embodiments when the delayed-cud disrupting material(s) and polymeric uptake promoter material(s) are used, the elastomer solvent is present in conventional amounts, i.e., in amounts greater than about 5% by weight for the gum base. For example, the elastomer solvent may be present in an amount from about 2.0% to about 15% and, more particularly, from about 5% by weight to about 15% by weight of the gum base and, even more particularly, in amounts from about 7% by weight of the gum base to about 11% by weight of the gum base.

[0149] In some embodiments, the elastomer solvent employed may have at least one hydrophilic portion and at least one hydrophobic portion such that the hydrophilic portion orients inwardly within a gum base and such that the hydrophobic portion orients outwardly within a gum base made from elastomers. Suitable elastomer solvents having at least one hydrophilic portion and at least one hydrophobic portion include, for example, methyl ester liquid rosin. In some embodiments, it is especially useful to incorporate a methyl ester liquid rosin in relatively low amounts. Methyl ester liquid rosin interferes less with the non-stick and/or reduced stick inducing components as compared to other resins, but yet acts to increase softening of the gum base without contributing to increased stickiness when used in combination with the non-stick inducing component.

[0150] Desirably, in some embodiments, a methyl ester liquid rosin is incorporated in a gum base in an amount from about 0.5% by weight to about 5.0% by weight of the gum base. More desirably, a methyl ester liquid rosin is incorporated in a gum base in an amount from about 1.0% by weight to about 3.0% by weight of the gum base.

[0151] The gum base also may include emulsifiers which aid in dispersing the immiscible components of the gum base into a single stable system. Useful emulsifiers include glyceryl monostearate, lecithin, fatty acid monoglycerides, diglycerides, propylene glycol monostearate, and the like, and mixtures thereof. In some embodiments, the emulsifier may be employed in amounts from about 0% to about 50% and, more specifically, from about 2% to about 7%, by weight, of the gum base. In other embodiments, the



emulsifier may be employed in amounts from about 2% to about 15% and, more specifically, from about 7% to about 11% by weight of the gum base.

[0152] The gum base also may include plasticizers or softeners to provide a variety of desirable textures and consistency properties. Because of the low weight average molecular weight (Mw) of these ingredients, the plasticizers and softeners are able to penetrate the fundamental structure of the gum base making it plastic and less viscous. Useful plasticizers and softeners include triacetin (glyceryl triacetate), lanolin, palmitic acid, oleic acid, stearic acid, sodium stearate, potassium stearate, glyceryl triacetate, glyceryl lecithin, glyceryl monostearate, propylene glycol monostearate, acetylated monoglyceride, glycerine, waxes, and the like, and mixtures thereof. Other softeners include carob, tragacanth, locust bean, and carboxymethyl cellulose. In some embodiments, the aforementioned plasticizers and softeners are generally employed in the gum base in amounts up to about 20% by weight of the gum base, and more specifically in amounts from about 2% to about 12%, by weight of the gum base. In other embodiments, the plasticizers and softeners are generally employed in the gum base in amounts up to about 20% by weight of the gum base and, more specifically, in amounts from about 9% to about 17% by weight of the gum base.

[0153] Plasticizers also include hydrogenated vegetable oils, such as soybean oil and cottonseed oils, which may be employed alone or in combination. These plasticizers provide the gum base with good texture and soft chew characteristics. These plasticizers and softeners are generally employed in amount from about 5% to about 14% and, more specifically, in amounts from about 5% to about 13.5%, by weight, of the gum base.

[0154] Suitable waxes, include for example, natural and synthetic waxes, hydrogenated vegetable oils, petroleum waxes such as polyurethane waxes, polyethylene waxes, paraffin waxes, microcrystalline waxes, fatty waxes, sorbitan monostearate, tallow, propylene glycol, mixtures thereof, and the like. Wax can be present in the gum base in an amount from about 1% to about 15% by weight of the gum base. In some embodiment, when used, the wax is desirably present in an amount from about 2% to about 10% by weight of the gum base and, more desirably, is present in an amount from about 3% to about 8% by weight of the gum base. In other embodiments when wax is used, the wax may be present in the gum base in an amount from about 6% to about 10% and, more desirably, from about 7% to about 9.5% by weight of the gum base.

[0155] In some embodiments, the gum base includes a maximum of about 8% of a wax. In other embodiments, the gum base is free of added wax.

[0156] In some embodiments when wax is present, the waxes employed may have a melting point below about 60°C and, more desirably, between about 45°C and about 55°C. The wax having a low melting point may be, for example, a paraffin wax.

[0157] In addition to low melting point waxes, in some embodiments, waxes having a higher melting point may be used in the gum base in amounts up to about 5% by weight of the gum base. Such high melting waxes include, for example, beeswax, vegetable wax, candelilla wax, carnuba wax, most petroleum waxes, and the like and mixtures thereof.

[0158] Anhydrous glycerin also may be employed as a softening agent, such as the commercially available United States Pharmacopeia (USP) grade. Glycerin is a syrupy liquid with a sweet warm taste and has a sweetness of about 60% of that of cane sugar. Because glycerin is hygroscopic, the anhydrous glycerin may be maintained under anhydrous conditions throughout the preparation of the chewing gum composition.

[0159] In some embodiments, the gum base may include bulking agents that are water-insoluble and/or mineral-based. In particular, the gum base also may include effective amounts of bulking agents such as mineral adjuvants which may serve as fillers and textural agents. Useful mineral adjuvants include calcium carbonate, magnesium carbonate, alumina, aluminum hydroxide, aluminum silicate, talc, starch, tricalcium phosphate, dicalcium phosphate, calcium sulfate, atomite, and the like, and mixtures thereof. These fillers or adjuvants may be used in the gum base compositions in various amounts. The filler may be present in an amount from about zero to about 60% by weight of the gum base and/or composition and, more specifically, from about zero to about 50% by weight and, even more specifically, from about zero to about 40%, by weight, of the gum base and/or chewing gum composition. In some embodiments, the filler may be present in an amount from about 0% by weight to about 30% by weight of the gum base and/or chewing gum composition. Moreover, in some embodiments, the amount of filler will be from about zero to about 15% by weight of the gum base and/or chewing gum composition and, more specifically, from about 3% to about 11%, by weight, of the gum base and/or chewing gum composition. In other embodiments, the amount of filler, when used, may be present in an amount from about 15% to about 40% and, desirably, from about 20% to about 30 % by weight of the gum base.

[0160] In some embodiments, the gum base also may include at least one hydrophilic, water-absorbing polymer to help reduce the stickiness of the gum base and any resultant gum product made from the gum base. Suitable hydrophilic, water-absorbing polymers include the following: native and modified starches; chemically modified cellulose, including methyl cellulose, ethyl cellulose, carboxymethyl cellulose, hydroxypropyl cellulose; gums including

xanthan gum, carrageenan gum, guar gum, gum arabic, locust bean gum, curdlan, arabinoxylan, agara, and alginates; and pectin and gelatin.

[0161] In general, at least one hydrophilic, water-absorbing polymer is included in an amount from about 0.1% to about 10% by weight of the gum base. Desirably, at least one hydrophilic, water-absorbing polymer is present in an amount from about 2% by weight to about 8% by weight of the gum base. More desirably, at least one hydrophilic, water-absorbing polymer is present in an amount from about 3% by weight to about 6% by weight of the gum base.

[0162] In some embodiments, at least one antioxidant may be present in the chewing gum bases. Desirably, the antioxidant is water-soluble. Suitable antioxidants include, for example, butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA), propyl gallate, vitamin C, vitamin E and mixtures thereof.

[0163] When an antioxidant is included in the gum base, the antioxidant is generally present in an amount from about 0.01% by weight to about 0.3% by weight of the gum base. Desirably, the antioxidant is included in the gum base in an amount from about 0.05% by weight to about 0.1% by weight of the gum base. When incorporated in embodiments together with the agent capable of degrading the elastomer, it is desirable to keep the antioxidant down to lower amounts to prevent any interference with free radicals which may be generated by photosensitizers.

[0164] In some embodiments, the chewing gum compositions include at least one elastomer and at least one agent capable of changing the weight average molecular weight (Mw) of the elastomer over time, such as by degrading the elastomer or increasing the weight average molecular weight (Mw) of the elastomer.

[0165] In some embodiments, a chewing gum base as discussed above may be incorporated in a chewing gum composition in an amount from about 5% by weight to about 95% by weight. More desirably, a chewing gum base may be present in an amount from about 28% by weight to about 42% by weight of the total chewing gum composition, and even more specifically, the range may be from about 28% to about 30% by weight of the total chewing gum composition. In the case of center-filled chewing gum compositions, this weight percent may be based on the gum region rather than the center-filled region.

[0166] The present inventive chewing gum compositions may include bulk sweeteners such as sugars, sugarless bulk sweeteners, or the like, or mixtures thereof. In some embodiments, bulk sweeteners generally are present in amounts of about 5% to about 99% by weight of the chewing gum composition.

[0167] Suitable sugar sweeteners generally include mono-saccharides, di-saccharides and poly-saccharides such as but not limited to, sucrose (sugar), dextrose, maltose, dextrin, xylose, ribose, glucose, mannose, galactose, fructose (levulose), invert sugar, fructo oligo saccharide syrups, partially hydrolyzed starch, corn syrup solids, isomaltulose, and mixtures thereof.

[0168] Suitable sugarless bulk sweeteners include sugar alcohols (or polyols) such as, but not limited to, sorbitol, xylitol, mannitol, galactitol, maltitol, hydrogenated isomaltulose (ISOMALT), lactitol, erythritol, hydrogenated starch hydrolysate, stevia and mixtures thereof.

[0169] Suitable hydrogenated starch hydrolysates include those disclosed in U.S. Pat. Nos. 25,959, 3,356,811, 4,279,931 and various hydrogenated glucose syrups and/or powders which contain sorbitol, hydrogenated disaccharides, hydrogenated higher polysaccharides, or mixtures thereof. Hydrogenated starch hydrolysates are primarily prepared by the controlled catalytic hydrogenation of corn syrups. The resulting hydrogenated starch hydrolysates are mixtures of monomeric, dimeric, and polymeric saccharides. The ratios of these different saccharides give different hydrogenated starch hydrolysates different properties. Mixtures of hydrogenated starch hydrolysates, such as LYCASIN®, a commercially available product manufactured by Roquette Freres of France, and HYSTAR®, a commercially available product manufactured by SPI Polyols, Inc. of New Castle, Delaware, also are useful.

[0170] The sweetening agents used may be selected from a wide range of materials including water-soluble sweeteners, water-soluble artificial sweeteners, water-soluble sweeteners derived from naturally occurring water-soluble sweeteners, dipeptide based sweeteners, and protein based sweeteners, including mixtures thereof. The term “sweetener” or “sweetening agent” may encompass bulk sweeteners as well as high intensity sweeteners. Without being limited to particular sweeteners, representative categories and examples include:

[0171] (a) water-soluble sweetening agents such as dihydrochalcones, monellin, stevia, steviosides, rebaudioside A, glycyrrhizin, dihydroflavenol, and sugar alcohols such as sorbitol, mannitol, maltitol, xylitol, erythritol, and L-aminodicarboxylic acid aminoalkenoic acid ester amides, such as those disclosed in U.S. Pat. No. 4,619,834, which disclosure is incorporated herein by reference, and mixtures thereof;

[0172] (b) water-soluble artificial sweeteners such as soluble saccharin salts, i.e., sodium or calcium saccharin salts, cyclamate salts, the sodium, ammonium or calcium salt of 3,4-dihydro-6-methyl-1,2,3-oxathiazine-4-one-2,2-dioxide, the potassium salt of 3,4-dihydro-



[0179] In general, the sweetener is present in an amount sufficient to provide the level of sweetness desired, and this amount may vary with the sweetener or combination of sweeteners selected. The exact range of amounts for each type of sweetener may be selected by those skilled in the art. In general, a sweetener is present in amounts from about 0.001% to about 3.0% by weight and, more specifically, from about 0.01% to about 2.0% by weight of the chewing gum composition.

[0180] The chewing gum compositions also may include flavors (i.e., flavorings or flavor agents). Flavors which may be used include those flavors known to the skilled artisan, such as natural and artificial flavors. These flavors may be chosen from synthetic flavor oils and flavoring aromatics and/or oils, oleoresins and extracts derived from plants, leaves, flowers, fruits, and so forth, and combinations thereof. Non-limiting representative flavor oils include spearmint oil, cinnamon oil, oil of wintergreen (methyl salicylate), peppermint oil, Japanese mint oil, clove oil, bay oil, anise oil, eucalyptus oil, thyme oil, cedar leaf oil, oil of nutmeg, allspice, oil of sage, mace, oil of bitter almonds, and cassia oil. Also useful flavorings are artificial, natural and synthetic fruit flavors such as vanilla, and citrus oils including lemon, orange, lime, grapefruit, yuzu, sudachi, and fruit essences including apple, pear, peach, grape, strawberry, raspberry, cherry, plum, pineapple, watermelon, apricot, banana, melon, ume, cherry, raspberry, blackberry, tropical fruit, mango, mangosteen, pomegranate, papaya, and so forth. Other potential flavors include a milk flavor, a butter flavor, a cheese flavor, a cream flavor, and a yogurt flavor; a vanilla flavor; tea or coffee flavors, such as a green tea flavor, a oolong tea flavor, a tea flavor, a cocoa flavor, a chocolate flavor, and a coffee flavor; mint flavors, such as a peppermint flavor, a spearmint flavor, and a Japanese mint flavor; spicy flavors, such as an asafetida flavor, an ajowan flavor, an anise flavor, an angelica flavor, a fennel flavor, an allspice flavor, a cinnamon flavor, a camomile flavor, a mustard flavor, a cardamom flavor, a caraway flavor, a cumin flavor, a clove flavor, a pepper flavor, a coriander flavor, a saffron flavor, a savory flavor, a Zanthoxyli Fructus flavor, a perilla flavor, a juniper berry flavor, a ginger flavor, a star anise flavor, a horseradish flavor, a thyme flavor, a tarragon flavor, a dill flavor, a capsicum flavor, a nutmeg flavor, a basil flavor, a marjoram flavor, a rosemary flavor, a bayleaf flavor, and a wasabi (Japanese horseradish) flavor; alcoholic flavors, such as a wine flavor, a whisky flavor, a brandy flavor, a rum flavor, a gin flavor, and a liqueur flavor; floral flavors; and vegetable flavors, such as an onion flavor, a garlic flavor, a cabbage flavor, a carrot flavor, a celery flavor, mushroom flavor, and a tomato flavor. These flavors may be used in liquid or solid form and may be used individually or in admixture. Commonly used flavors include

mints such as peppermint, menthol, spearmint, artificial vanilla, cinnamon derivatives, and various fruit flavors, whether employed individually or in admixture.

[0181] Other useful flavorings include aldehydes and esters such as cinnamyl acetate, cinnamaldehyde, citral diethylacetal, dihydrocarvyl acetate, eugenyl formate, p-methylamisol, and so forth may be used. Generally any flavoring or food additive such as those described in *Chemicals Used in Food Processing*, publication 1274, pages 63-258, by the National Academy of Sciences, may be used. This publication is incorporated herein by reference.

[0182] Further examples of aldehyde flavorings include but are not limited to acetaldehyde (apple), benzaldehyde (cherry, almond), anisic aldehyde (licorice, anise), cinnamic aldehyde (cinnamon), citral, i.e., alpha-citral (lemon, lime), neral, i.e., beta-citral (lemon, lime), decanal (orange, lemon), ethyl vanillin (vanilla, cream), heliotrope, i.e., piperonal (vanilla, cream), vanillin (vanilla, cream), alpha-amyl cinnamaldehyde (spicy fruity flavors), butyraldehyde (butter, cheese), valeraldehyde (butter, cheese), citronellal (modifies, many types), decanal (citrus fruits), aldehyde C-8 (citrus fruits), aldehyde C-9 (citrus fruits), aldehyde C-12 (citrus fruits), 2-ethyl butyraldehyde (berry fruits), hexenal, i.e., trans-2 (berry fruits), tolyl aldehyde (cherry, almond), veratraldehyde (vanilla), 2,6-dimethyl-5-heptenal, i.e., melonal (melon), 2,6-dimethyloctanal (green fruit), and 2-dodecenal (citrus, mandarin), cherry, grape, strawberry shortcake, and mixtures thereof.

[0183] In some embodiments, the flavor agent may be employed in either liquid form and/or dried form. When employed in the latter form, suitable drying means such as spray drying the oil may be used. Alternatively, the flavor agent may be absorbed onto water-soluble materials, such as cellulose, starch, sugar, maltodextrin, gum arabic and so forth or may be encapsulated. The actual techniques for preparing such dried forms are well-known.

[0184] In some embodiments, the flavor agents may be used in many distinct physical forms well-known in the art to provide an initial burst of flavor and/or a prolonged sensation of flavor. Without being limited thereto, such physical forms include free forms, such as spray dried, powdered, beaded forms, encapsulated forms, and mixtures thereof.

[0185] The amount of flavor agent employed herein may be a matter of preference subject to such factors as the individual flavor and the strength of flavor desired. Thus, the amount of flavoring may be varied in order to obtain the result desired in the final product and such variations are within the capabilities of those skilled in the art without the need for undue experimentation. In general, the flavor agent is present in amounts from about 0.02%

to about 5.0% by weight and, more specifically, from about 0.1% to about 4.0% by weight of the chewing gum product, and even more specifically, about 0.8% to about 3.0%

[0186] A variety of other traditional ingredients also may be included in the chewing gum products in effective amounts such as coloring agents, antioxidants, preservatives, and the like. Coloring agents may be used in amounts effective to produce the desired color. The coloring agents may include pigments which may be incorporated in amounts up to about 6%, by weight of the composition. For example, titanium dioxide may be incorporated in amounts up to about 2%, and preferably less than about 1%, by weight of the composition. The colorants may also include natural food colors and dyes suitable for food, drug and cosmetic applications. These colorants are known as F.D.& C. dyes and lakes. The materials acceptable for the foregoing uses are preferably water-soluble. Illustrative non-limiting examples include the indigoid dye known as F.D.& C. Blue No.2, which is the disodium salt of 5,5-indigotindisulfonic acid. Similarly, the dye known as F.D.& C. Green No.1 comprises a triphenylmethane dye and is the monosodium salt of 4-[4-(N-ethyl-p-sulfoniumbenzylamino) diphenylmethylene]-[1-(N-ethyl -N-p-sulfoniumbenzyl)-delta-2,5-cyclohexadieneimine]. A full recitation of all F.D.& C. colorants and their corresponding chemical structures may be found in the Kirk-Othmer Encyclopedia of Chemical Technology, 3rd Edition, in volume 5 at pages 857-884, which text is incorporated herein by reference.

[0187] Additional additives, such as sensates including physiological cooling agents; warming agents and tingling agents; throat-soothing agents; spices; herbs and herbal extracts, tooth-whitening agents; breath-freshening agents; vitamins and minerals; bioactive agents; caffeine; nicotine; drugs and other actives may also be included in any or all portions or regions of the chewing gum products. Such components may be used in amounts sufficient to achieve their intended effects.

[0188] With respect to cooling agents, a variety of well-known cooling agents may be employed. For example, among the useful cooling agents are included menthol, xylitol, erythritol, dextrose, sorbitol, menthane, menthone, ketals, menthone ketals, menthone glycerol ketals, substituted p-menthanes, acyclic carboxamides, mono menthyl glutarate, substituted cyclohexanamides, substituted cyclohexane carboxamides, substituted ureas and sulfonamides, substituted menthanols, hydroxymethyl and hydroxymethyl derivatives of p-menthane, 2-mercapto-cyclo-decanone, 2-isopropanyl-5-methylcyclohexanol, hydroxycarboxylic acids with 2-6 carbon atoms, cyclohexanamides, menthyl acetate, menthyl lactate, methyl salicylate, N,2,3-trimethyl-2-isopropyl butanamide (WS-23), N-ethyl-p-menthane-3-carboxamide (WS-3), menthyl succinate, isopulegol, 3,1-menthoxypropane 1,2-



diol, glutarate esters, 3-(1-menthoxy)-2-methylpropane-1,2-diol, p-menthane-2,3-diol, p-menthane-3,8-diol, 6-isopropyl-9-methyl-1,4-dioxaspiro[4,5]decane-2-methanol, menthyl succinate and its alkaline earth metal salts, trimethylcyclohexanol, N-ethyl-2-isopropyl-5-methylcyclohexanecarboxamide, Japanese mint oil, peppermint oil, 3-(1-menthoxy)ethan-1-ol, 3-(1-menthoxy)propan-1-ol, 3-(1-menthoxy)butan-1-ol, l-menthylacetic acid N-ethylamide, l-menthyl-4-hydroxypentanoate, l-menthyl-3-hydroxybutyrate, N,2,3-trimethyl-2-(1-methylethyl)-butanamide, n-ethyl-t-2-c-6 nonadienamide, N,N-dimethyl menthyl succinamide, substituted p-menthanes, substituted p-menthane-carboxamides, 2-isopropanyl-5-methylcyclohexanol (from Hisamitsu Pharmaceuticals, hereinafter "isopregol"); menthone glycerol ketals (FEMA 3807, tradename FRESCOLAT® type MGA); 3-1-menthoxypropane-1,2-diol (from Takasago, FEMA 3784); and menthyl lactate; (from Haarman & Reimer, FEMA 3748, tradename FRESCOLAT® type ML), WS-30, WS-14, Eucalyptus extract (p-Mehtha-3,8-Diol), Menthol (its natural or synthetic derivatives), Menthol PG carbonate, Menthol EG carbonate, Menthol glyceryl ether, N-tertbutyl-p-menthane-3-carboxamide, P-menthane-3-carboxylic acid glycerol ester, Methyl-2-isopryl-bicyclo (2.2.1), Heptane-2-carboxamide; and Menthol methyl ether, and menthyl pyrrolidone carboxylate among others, and combinations thereof. These and other suitable cooling agents are further described in the following U.S. patents, all of which are incorporated in their entirety by reference hereto: U.S. 4,230,688 and 4,032,661 to Rowsell et al.; 4,459,425 to Amano et al.; 4,136,163 to Watson et al.; 5,266,592 to Grub et al.; and U.S. Patent No. 6,627,233 to Wolf et al. Cooling agents are generally present in amount of 0.01% to about 10.0%.

[0189] Warming agents may be selected from a wide variety of compounds known to provide the sensory signal of warming to the individual user. These compounds offer the perceived sensation of warmth, particularly in the oral cavity, and often enhance the perception of flavors, sweeteners and other organoleptic components. Useful warming agents include those having at least one allyl vinyl component, which may bind to oral receptors. Examples of suitable warming agents include, but are not limited to: vanillyl alcohol n-butylether (TK-1000, supplied by Takasago Perfumery Company Ltd., Tokyo, Japan); vanillyl alcohol n-propylether; vanillyl alcohol isopropylether; vanillyl alcohol isobutylether; vanillyl alcohol n-aminoether; vanillyl alcohol isoamylether; vanillyl alcohol n-hexylether; vanillyl alcohol methylether; vanillyl alcohol ethylether; gingerol; shogaol; paradol; zingerone; capsaicin; dihydrocapsaicin; nordihydrocapsaicin; homocapsaicin; homodihydrocapsaicin; ethanol; isopropyl alcohol; iso-amylalcohol; benzyl alcohol;

glycerine; chloroform; eugenol; cinnamon oil; cinnamic aldehyde; phosphate derivatives thereof; and combinations thereof.

[0190] Tingling agents may provide a tingling, stinging or numbing sensation to the user. Tingling agents include, but are not limited to: Jambu Oleoresin or para cress (*Spilanthes* sp.), in which the active ingredient is *Spilanthol*; Japanese pepper extract (*Zanthoxylum piperitum*), including the ingredients known as Saanshool-I, Saanshool-II and Sanshoamide; black pepper extract (*piper nigrum*), including the active ingredients chavicine and piperine; Echinacea extract; Northern Prickly Ash extract; and red pepper oleoresin. In some embodiments, alkylamides extracted from materials such as jambu or sanshool may be included. Additionally, in some embodiments, a sensation is created due to effervescence. Such effervescence is created by combining an alkaline material with an acidic material, either or both of which may be encapsulated. In some embodiments, an alkaline material may include alkali metal carbonates, alkali metal bicarbonates, alkaline earth metal carbonates, alkaline earth metal bicarbonates and mixtures thereof. In some embodiments, an acidic material may include acetic acid, adipic acid, ascorbic acid, butyric acid, citric acid, formic acid, fumaric acid, glyconic acid, lactic acid, phosphoric acid, malic acid, oxalic acid, succinic acid, tartaric acid and combinations thereof. Examples of "tingling" type sensates can be found in U.S. Patent No. 6,780,443, the entire contents of which are incorporated herein by reference for all purposes. Tingling agents are described in U.S. Patent No. 6,780,443 to Nakatsu et al., U.S. Patent No. 5,407,665 to McLaughlin et al., U.S. Patent No. 6,159,509 to Johnson et al. and U.S. Patent No. 5,545,424 to Nakatsu et al., each of which is incorporated by reference herein in its entirety.

[0191] The sensation of warming or cooling effects may be prolonged with the use of a hydrophobic sweetener as described in U.S. Patent Application Publication 2003/0072842 A1 to Johnson et al. which is incorporated in its entirety herein by reference. For example, such hydrophobic sweeteners include those of the formulae I-XI referenced therein. Perillartine may also be added as described in U.S. Patent No. 6,159,509 also incorporated in its entirety herein by reference.

[0192] Breath-freshening agents, in addition to the flavors and cooling agents described hereinabove, may include a variety of compositions with odor-controlling properties. Such breath-freshening agents may include, without limitation, cyclodextrin and magnolia bark extract. The breath-freshening agents may further be encapsulated to provide a prolonged breath-freshening effect. Examples of malodor-controlling compositions are included in U.S. Patent No. 5,300,305 to Stapler et al. and in U.S. Patent Application

Publication Nos. 2003/0215417 and 2004/0081713, which are incorporated in their entirety herein by reference.

[0193] A variety of oral care products also may be included in some embodiments of the instant chewing gum compositions. Such oral care products may include tooth whiteners, stain removers, anti-calculus agents, and anti-plaque agents. Oral care agents that may be used include those actives known to the skilled artisan, such as, but not limited to, surfactants, breath-freshening agents, anti-microbial agents, antibacterial agents, oral malodor control agents, fluoride compounds, quaternary ammonium compounds, remineralization agents and combinations thereof. Examples of these include, but are not limited to hydrolytic agents including proteolytic enzymes, abrasives such as hydrated silica, calcium carbonate, sodium bicarbonate and alumina, other active stain-removing components such as surface-active agents, such as anionic surfactants such as sodium stearate, sodium palmitate, sulfated butyl oleate, sodium oleate, salts of fumaric acid, glycerol, hydroxylated lecithin, sodium lauryl sulfate and chelators such as polyphosphates, which are typically employed in dentifrice compositions as tartar control ingredients. Also included are tetrasodium pyrophosphate and sodium tri-polyphosphate, sodium tripolyphosphate, xylitol, hexametaphosphate, and an abrasive silica. Further examples are included in the following U.S. Patents which are incorporated in their entirety herein by reference: U.S. Patent Nos. 5,227,154 to Reynolds, 5,378,131 to Greenberg and 6,685,916 to Holme et al. Suitable oral care actives such as remineralization agents, antimicrobials, and tooth-whitening agents are described in assignee's co-pending U.S. Patent Application No. 10/901,511, filed July 29, 2004 and entitled "Tooth-Whitening Compositions and Delivery Systems Therefor," which is incorporated herein by reference in its entirety, and the like, and mixtures thereof.

[0194] A variety of drugs, including medications, herbs, and nutritional supplements may also be included in the chewing gum compositions. Examples of useful drugs include ace-inhibitors, antianginal drugs, anti-arrhythmias, anti-asthmatics, anti-cholesterolemics, analgesics, anesthetics, anti-convulsants, anti-depressants, anti-diabetic agents, anti-diarrhea preparations, antidotes, anti-histamines, anti-hypertensive drugs, anti-inflammatory agents, anti-lipid agents, anti-manics, anti-nauseants, anti-stroke agents, anti-thyroid preparations, anti-tumor drugs, anti-viral agents, acne drugs, alkaloids, amino acid preparations, anti-tussives, anti-uricemic drugs, anti-viral drugs, anabolic preparations, systemic and non-systemic anti-infective agents, anti-neoplastics, anti-parkinsonian agents, anti-rheumatic agents, appetite stimulants, biological response modifiers, blood modifiers, bone metabolism regulators, cardiovascular agents, central nervous system stimulates, cholinesterase inhibitors,

contraceptives, decongestants, dietary supplements, dopamine receptor agonists, endometriosis management agents, enzymes, erectile dysfunction therapies such as sildenafil citrate, which is currently marketed as Viagra®, fertility agents, gastrointestinal agents, homeopathic remedies, hormones, hypercalcemia and hypocalcemia management agents, immunomodulators, immunosuppressives, migraine preparations, motion sickness treatments, muscle relaxants, obesity management agents, osteoporosis preparations, oxytocics, parasympatholytics, parasympathomimetics, prostaglandins, psychotherapeutic agents, respiratory agents, sedatives, smoking cessation aids such as bromocryptine or nicotine, sympatholytics, tremor preparations, urinary tract agents, vasodilators, laxatives, antacids, ion exchange resins, anti-pyretics, appetite suppressants, expectorants, anti-anxiety agents, anti-ulcer agents, anti-inflammatory substances, coronary dilators, cerebral dilators, peripheral vasodilators, psycho-tropics, stimulants, anti-hypertensive drugs, vasoconstrictors, migraine treatments, antibiotics, tranquilizers, anti-psychotics, anti-tumor drugs, anti-coagulants, anti-thrombotic drugs, hypnotics, anti-emetics, anti-nauseants, anti-convulsants, neuromuscular drugs, hyper- and hypo-glycemic agents, thyroid and anti-thyroid preparations, diuretics, anti-spasmodics, terine relaxants, anti-obesity drugs, erythropoietic drugs, anti-asthmatics, cough suppressants, mucolytics, DNA and genetic modifying drugs, and combinations thereof.

[0195] Examples of active ingredients contemplated for use in the present inventive chewing gum compositions include antacids, H<sub>2</sub>-antagonists, and analgesics. For example, antacid dosages can be prepared using the ingredients calcium carbonate alone or in combination with magnesium hydroxide, and/or aluminum hydroxide. Moreover, antacids can be used in combination with H<sub>2</sub>-antagonists.

[0196] Analgesics include opiates and opiate derivatives, such as Oxycontin, ibuprofen, aspirin, acetaminophen, and combinations thereof that may optionally include caffeine.

[0197] Other drug ingredients for use in embodiments include anti-diarrheals such as immodium AD, anti-histamines, anti-tussives, decongestants, vitamins, and breath-fresheners. Also contemplated for use herein are anxiolytics such as Xanax; anti-psychotics such as clozaril and Haldol; non-steroidal anti-inflammatories (NSAID's) such as ibuprofen, naproxen sodium, Voltaren and Lodine, anti-histamines such as Claritin, Hismanal, Relafen, and Tavist; anti-emetics such as Kytril and Cesamet; bronchodilators such as Bentolin, Proventil; anti-depressants such as Prozac, Zoloft, and Paxil; anti-migraines such as Imigra, ACE-inhibitors such as Vasotec, Capoten and Zestril; anti-Alzheimer's agents, such as Nicergoline; and CaH-antagonists such as Procardia, Adalat, and Calan.

[0198] Moreover, some embodiments of chewing gum compositions can include H<sub>2</sub>-antagonists. Examples of suitable H<sub>2</sub>-antagonist include cimetidine, ranitidine hydrochloride, famotidine, nizatidien, ebrotidine, mifentidine, roxatidine, pisatidine and aceroxatidine.

[0199] Active antacid ingredients include, but are not limited to, the following: aluminum hydroxide, dihydroxyaluminum aminoacetate, aminoacetic acid, aluminum phosphate, dihydroxyaluminum sodium carbonate, bicarbonate, bismuth aluminate, bismuth carbonate, bismuth subcarbonate, bismuth subgallate, bismuth subnitrate, bismuth subsilylate, calcium carbonate, calcium phosphate, citrate ion (acid or salt), amino acetic acid, hydrate magnesium aluminate sulfate, magaldrate, magnesium aluminosilicate, magnesium carbonate, magnesium glycinate, magnesium hydroxide, magnesium oxide, magnesium trisilicate, milk solids, aluminum mono-ordibasic calcium phosphate, tricalcium phosphate, potassium bicarbonate, sodium tartrate, sodium bicarbonate, magnesium aluminosilicates, tartaric acids and salts.

[0200] A variety of other nutritional supplements also may be included in the gum compositions. Virtually any vitamin or mineral may be included. For example, vitamin A, vitamin C, vitamin D, vitamin E, vitamin K, vitamin B<sub>6</sub>, vitamin B<sub>12</sub>, thiamine, riboflavin, biotin, folic acid, niacin, pantothenic acid, sodium, potassium, calcium, magnesium, phosphorus, sulfur, chlorine, iron, copper, iodine, zinc, selenium, manganese, choline, chromium, molybdenum, fluorine, cobalt and combinations thereof, may be used.

[0201] Examples of nutritional supplements are set forth in U.S. Patent Application Publication Nos. 2003/0157213 A1, 2003/0206993 and 2003/0099741 A1, which are incorporated in their entirety herein by reference.

[0202] Various herbs also may be included such as those with various medicinal or dietary supplement properties. Herbs are generally aromatic plants or plant parts that can be used medicinally or for flavoring. Suitable herbs can be used singly or in various mixtures. Commonly used herbs include Echinacea, Goldenseal, Calendula, Aloe, Blood Root, Grapefruit Seed Extract, Black Cohosh, Cranberry, Ginko Biloba, St. John's Wort, Evening Primrose Oil, Yohimbe Bark, Green Tea, Maca, Bilberry, Lutein, and combinations thereof.

[0203] Acidulants also may be included in the chewing gum compositions. Suitable acidulants include, for example, malic acid, adipic acid, citric acid, tartaric acid, fumaric acid, and mixtures thereof.

[0204] Any of the aforementioned additives for use in a chewing gum composition, as well as other conventional additives known to one having ordinary skill in the art, such as

thickeners, may be incorporated into the chewing gum base of the chewing gum compositions or any coating that the chewing gum product may contain.

[0205] In particular, in some embodiments, when chewing gum base and/or a chewing gum composition and/or a chewing gum product includes at least one delayed cud-disrupting material(s), at least one polymeric moisture uptake promoter material(s) and an elastomer, the chewing gum base and/or chewing gum composition and/or chewing gum product may further include at least one component selected from the group comprising sweeteners, flavors, sensates and combinations thereof.

[0206] The chewing gum compositions may be formed into a variety of shapes and sizes and may take various product forms, including without limitation, sticks, slabs, chunks, balls, pillows, tablet, pellet, center-filled, pressed tablet, deposited, compressed chewing gum or any other suitable format, as well as coated and uncoated forms.

[0207] When the chewing gum compositions are formed into coated products, the coating may be applied by any method known in the art. The coating composition may be present in an amount from about 2% to about 60%, more specifically from about 25% to about 35% by weight of the total center-filled gum piece or from about 25% to about 45% by weight of the total chewing gum piece and even more specifically, in an amount about 30% by weight of the gum piece.

[0208] Such coated chewing gums are typically referred to as pellet gums. The outer coating may be hard or crunchy. Any suitable coating materials known to those skilled in the art may be employed. Typically, the outer coating may include sorbitol, maltitol, xylitol, isomalt, erythritol, isomalt, and other crystallizable polyols; sucrose may also be used. Furthermore, the coating may include several opaque layers, such that the chewing gum composition is not visible through the coating itself, which can optionally be covered with a further one or more transparent layers for aesthetic, textural and protective purposes. The outer coating may also contain small amounts of water and gum arabic. The coating can be further coated with wax. The coating may be applied in a conventional manner by successive applications of a coating solution, with drying in between each coat. As the coating dries it usually becomes opaque and is usually white, though other colorants may be added. A polyol coating can be further coated with wax. The coating can further include colored flakes or speckles. If the composition includes a coating, it is possible that one or more oral care actives can be dispersed throughout the coating. This is especially preferred if one or more oral care actives is incompatible in a single phase composition with another of the actives. Flavors may also be added to yield unique product characteristics.

[0209] Other materials may be added to the coating to achieve desired properties. These materials may include, without limitations, cellulose such as carboxymethyl cellulose, gelatin, xanthan gum, and gum arabic.

[0210] In the case of center-filled chewing gum products, the coating may also be formulated to assist with increasing the thermal stability of the gum piece and preventing leaking of the liquid fill. In some embodiments, the coating may include a gelatin composition. The gelatin composition may be added as a 40% by weight solution and may be present in the coating composition from about 5% to about 10% by weight of the coating composition, and more specifically about 7% to about 8%. The gel strength of the gelatin may be from about 130 bloom to about 250 bloom.

[0211] Other materials may be added to the coating to achieve desired properties. These materials may include without limitations, cellulose such as carboxymethyl cellulose, gelatin, pullulan, alginate, starch, carrageenan, xanthan gum, gum arabic and polyvinyl acetate (PVA).

[0212] The coating composition may also include a pre-coating which is added to the individual gum pieces prior to an optional hard coating. The pre-coating may include an application of polyvinyl acetate (PVA). This may be applied as a solution of PVA in a solvent, such as ethyl alcohol. When an outer hard coating is desired, the PVA application may be approximately 3% to 4% by weight of the total coating or about 1% of the total weight of the gum piece (including a liquid-fill, gum region and hard coating).

[0213] Some embodiments extend to methods of processing an elastomer in a gum base. In particular, some embodiments extend to methods of processing an elastomer for use in a gum base without substantially changing the Tg of the gum base as measured by differential scanning calorimetry (DSC). Such methods include the step of mixing at least one elastomer and at least one fat.

[0214] Differential scanning calorimetry (DSC) is a thermoanalytical technique in which the difference in the amount of heat required to increase the temperature of a sample and reference are measured as a function of temperature. The basic principle underlying this technique is that, when the sample undergoes a physical transformation such as phase transitions, more (or less) heat will need to flow to it than the reference to maintain both at the same temperature. Whether more or less heat must flow to the sample depends on whether the process is exothermic or endothermic. For example, as a solid sample melts to a liquid it will require more heat flowing to the sample to increase its temperature at the same rate as the reference. This is due to the absorption of heat by the sample as it undergoes the

endothermic phase transition from solid to liquid. Likewise, as the sample undergoes exothermic processes (such as crystallization) less heat is required to raise the sample temperature. By observing the difference in heat flow between the sample and reference, differential scanning calorimeters are able to measure the amount of energy absorbed or released during such transitions. DSC is used to observe more subtle phase changes, such as glass transitions.

[0215] Other embodiments extend to methods of processing a solid elastomer that include: providing a solid elastomer composition suitable for use in a chewing gum base and combining with the solid elastomer composition a non-stick and/or reduced stick inducing component including at least one fat having an HLB range of about 3.5 to about 13. In such methods, the non-stick and/or reduced stick inducing component is present in amounts sufficient to permit mastication of the solid elastomer composition into a homogenous mass.

[0216] In some embodiments, the above-described methods of processing an elastomer are carried out in the presence of very low amounts of elastomer solvent. In such embodiments, the elastomer solvent includes a maximum of about 5.0% of any gum base made by masticating an elastomer as described above.

[0217] In other embodiments, the above-described methods of processing an elastomer are carried out in the absence of added elastomer solvent.

[0218] Some embodiments extend to methods of making a chewing gum base. In some embodiments, the methods of making a chewing gum base include providing at least one elastomer and mixing at least one non-stick and/or reduced stick inducing component with the elastomer to form a chewing gum base, wherein the at least one non-stick and/or reduced stick inducing component softens the elastomer without causing the chewing gum base to become sticky. In such embodiments, the chewing gum base has reduced stickiness in the presence of the non-stick and/or reduced stick inducing component as compared to in the absence of the non-stick and/or reduced stick inducing component.

[0219] In additional embodiments, the methods of making a chewing gum base include processing an elastomer for use in a gum base without substantially changing the T<sub>g</sub> of the gum base as measured by DSC by mixing at least one elastomer and at least one fat or oil.

[0220] Moreover, in further embodiments, the methods of making a chewing gum base include providing a solid elastomer composition suitable for use in a chewing gum base and combining with the solid elastomer composition a non-stick and/or reduced stick inducing component that includes at least one fat or oil having an HLB range of about 3.5 to



about 13. In such methods, the non-stick and/or reduced stick inducing component is present in amounts sufficient to permit processing of the solid elastomer composition into a softened, processable mass.

[0221] In some embodiments, the above-described methods of making a chewing gum base may be carried out in the presence of lower than conventional amounts of elastomer solvent. In such embodiments, the elastomer solvent includes a maximum of about 5.0% of the gum base. Desirably, an elastomer solvent can be mixed with an elastomer and non-stick and/or reduced stick component to soften the elastomer without causing the resultant chewing gum base to become sticky.

[0222] In other embodiments, the above-described methods of making a chewing gum base are carried out in the absence of added elastomer solvent.

[0223] The manner in which the gum base components are mixed is not critical and such mixing is performed using standard apparatuses known to those skilled in the art. In a typical method, at least one elastomer is admixed with at least one mastication processing aid, which for purposes herein includes one or more non-stick and/or reduced stick inducing components, and agitated for a period of from 1 to 30 minutes. The remaining ingredients, such as the texture-modifier and/or softener are then admixed, either in bulk or incrementally, while the gum base mixture is blended again for 1 to 30 minutes.

[0224] The products may be prepared using standard techniques and equipment known to those skilled in the art, which processes generally involve melting the gum base, incorporating the desired ingredients while mixing and forming the batch into individual chewing gum pieces. The apparatus useful in accordance with the embodiments described herein includes mixing and heating apparatuses well-known in the chewing gum manufacturing arts, and therefore the selection of the specific apparatus will be apparent to the artisan. For general chewing gum preparation processes which are useful in some embodiments see U.S. Patent Nos. 4,271,197 to Hopkins et al., 4,352,822 to Cherukuri et al. and 4,497,832 to Cherukuri et al., each of which is incorporated herein by reference in its entirety.

[0225] For instance, center-fill chewing gum embodiments may include a center-fill region, which may be a liquid or powder or other solid, and a gum region. Some embodiments also may include an outer gum coating or shell, which typically provides a crunchiness to the piece when initially chewed. The outer coating or shell may at least partially surround the gum region. Center-fill chewing gums and methods of preparing same are more fully described in assignee's co-pending U.S. Patent Application No. 10/925,822,

filed on August 24, 2004 and assignee's co-pending U.S. Patent Application No. 11/210,954, filed on August 24, 2005, both entitled "Liquid-Filled Chewing Gum Composition," the contents of both of which are incorporated herein by reference.

[0226] Some other chewing gum embodiments may be in a compressed gum format, such as, for example, a pressed tablet gum. Such embodiments may include a particulate chewing gum base, which may include a compressible gum base composition and a tableting powder. Compressed chewing gums are more fully described in assignee's co-pending U.S. Provisional Application No. 60/734,680, filed on November 8, 2005, and entitled "Compressible Gum System," the contents of which are incorporated herein by reference.

[0227] The features and advantages of gum bases and chewing gum compositions disclosed herein are more fully shown by the following examples which are provided for purposes of illustration, and are not to be construed as limiting in any way.

## EXAMPLES

[0228] In the following Comparative and Control Examples and Examples, all percentages are by weight unless otherwise noted. Except for Control Examples (C3) and (C9) which were not encapsulated and are designated in Table 1 with an "\*" and considered "free material"), samples of encapsulated GANTREZ<sup>®</sup> AN-169 in polyethylene wax were prepared. The samples were prepared by melting 42g of polyethylene wax at 90°C and removing the wax from the heat. 14g of Gantrez anhydride was then added to the molten wax and mixed for 5 minutes as the wax cooled and solidified. The cooled wax containing Gantrez was ground into fine particles.

[0229] The samples were then combined with standard gum base ingredients (these ingredients remained constant though this series of examples) that included the following: elastomer 19%, rosin ester 10%, calcium carbonate 33%, triacetin 1.4%, wax and hydrogenated vegetable oil 18%, glycerol monostearate 4%, and BHT 0.1%. More specifically, the elastomer used in these examples was butyl rubber, styrene-butadiene rubber (SBR), polyisobutylene, and the like. The wax employed was a microcrystalline wax and the rosin ester used was a glycerol ester of wood rosin, partially hydrogenated rosin, or fully hydrogenated wood rosin. The rosin could also include methyl ester, pentaerythritol ester, or the like. The filler used was calcium carbonate, talc, dicalcium triphosphate, and the like. Thus, conventional gum base ingredients include those as defined in detailed description of gum base, butyl rubber, glycerol ester of rosin, talc or calcium carbonate, PVA, PIB, wax, fat, and the like, and standard chewing gum ingredients such as sorbitol, flavor, color, intense

sweetener, emulsifier, and the like were formulated. More specifically, the general gum base formula in the present Control Examples and Examples included:

Elastomer	19
PVA	14.3
Rosin ester	10
Fat and wax	18
emulsifier	4
triacetin	1
filler	33
BHT	0.1

**[0230]** In the examples, it is noted that the PVA level is a variable in order to balance the overall PVA level when Component B polymers are added in during the inventive samples in order to maintain the same overall PVA level.

**[0231]** The same gum base and gum formulation was used for each example herein, the distinctions being the use and inclusion of the inventive components described herein, i.e. at least one polymer from Group A (the delayed cud-disrupting material) and/or at least one polymer from Group B (at least one polymeric moisture uptake promoter material).

**[0232]** Step 1. Sample Preparation: Samples were prepared by mixing a combination of gum and gum base ingredients with Group A and/or Group B materials(s) in a dual sigma-blade brabender prep mixing apparatus. As discussed above, the Group A and/or Group B materials(s) are preformed prior to mixing with the gum and gum base components. Group B materials were blended along with the gum base ingredients during gum base production, typically at the same time as the PVA was added during gum base production. Once the gum base was mixed containing any B components, Group A components were mixed in along with any gum ingredients such as polyols, sweeteners, flavors and the like. After mixing the gum ingredients and any group A components, the resulting final chewing gum mixture was collected and set aside to be used for testing purposes.

**[0233]** Step 2. Mechanical chew simulation: Once prepared in the previous step, all samples were mixed in a Brabender 60mL dual sigma-blade prep mixing apparatus for 30 minutes at approximately 40-60 rpm with 4L of excess water circulating through the mixing chamber (to simulate a 30 minute human chew environment with saliva). During this time most of the water soluble ingredients such as polyols and the like get chewed out of the matrix and enter the water, leaving only the chewed gum cud at the end of the mechanical

chew. Due to the varying degrees of hydrophilicity and ingredient levels, some samples did not remain intact during this chew treatment, and deteriorated. Therefore, only those samples that held together and maintained their structural integrity and cohesivity during the mechanical chew were taken to the next stage of testing.

**[0234]** Step 3. Degradation testing post-chew: Samples that maintained consistency and cohesivity during the previous step were taken from the mixing apparatus and separated into 1.0g bolus sizes. These samples were then placed on a pre-washed 16" x 16" x 1.5" inch concrete slabs to represent a standard municipal sidewalk surface. 12 samples from each formulation were placed on the concrete slabs. A sheet of parchment paper was then laid on top of the samples and a human that was wearing flat-soled shoes walked on the samples for five minutes. The paper was then removed from the samples and the concrete slabs were left on the benchtop for 1 week to rest. After one week, each concrete slab was laid into a tub containing approximately 0.5" of water. This was enough water to submerge approximately the lower half of each concrete slab, but sufficiently shallow to intentionally leave the cuds open to the air and not fully submerged. The water soaks upward into the entire concrete slab by capillary action and the surface of the slab therefore stays moist as long as water is maintained in the bottom of the tub. This ensured that the concrete surface would remain wet but the cuds would remain open to the air, such as in a rainy climate. The concrete slabs containing the samples were left in the tub with water for one week, with daily visual inspections being made for observations to changes to the cuds. After being in the water for one week, the concrete slabs were removed from the tub and the gum cuds were evaluated visually and by brushing with a flexible plastic bristled brush to simulate the action of a street sweeper. In the figures, the term "brushed" refers to a sample that was exposed to a simulated street sweeper (i.e. a rotating plastic bristle brush in a laboratory environment) at the Mid Week 2 and Final conditions while the term "unbrushed" means that the sample was not contacted by the brushes at any time.

**[0235]** Step 4. Evaluation: The slabs and cud residues were evaluated immediately after removal from the water tub, and then once again 1 day later, to identify any changes from the original appearance when fresh cuds were first applied. Ratings were given on a scale of 1 to 5 to represent a range of successful cud removal. A rating of 1 means that no change was observed and that all of the cud still remains, while a rating of 5 means that the entire cud was removed. The middle values represent the spectrum of partial cud removal from small to moderate to high (2-4, respectively). After the cuds were out of the water tub

for 1 day, once inspected they were scraped by hand with a flexible metal blade to determine removability.

[0236] In the Figures for the Examples, the samples are shown in the initial condition (i.e. pre-water bath condition (corresponding to the (a) figures, i.e. “Before” in the (a) figures), while the (b) figures show the samples after being wet for a few days (i.e. “Mid Week 2”) and the (c) figures show the final (“Final”) condition after being wet for one week. Thus, “Final” as used in the figures refers to the same day as the day the cuds were removed from the water bath after brushing. The day following removal from the water bath, the dried cuds were scraped using a putty-knife type of flexible scraper to observe if there was an enhanced ability to “pop off” the concrete. Results can be seen in Table 2.

[0237] Components were used as follows: The final chewing gum composition was made by mixing gum base at a level of 28.5% with the chewing gum ingredients as described above. The gum base was prepared in a previous step by incorporating group B components into the gum base at the weight percents listed with respect to total gum base formula. Then the gum base was made into gum by mixing in the chewing gum ingredients, along with group A components at the given weight percent with respect to gum base, to obtain the final chewing gum product.

[0238] The results of the examples are shown in Tables 1 and 2 as well as in the Figures. In the tables below, the following is provided as an ingredient key:

p(MA-MVE)	Poly(maleic anhydride-alt-methyl vinyl ether)
PVA-graft-PEG	Poly(vinyl acetate-graft-PEG)
p(VAc-VOH)	Poly(vinyl acetate-co-vinyl alcohol)
pDMAEA.MCQ	Poly(vinyl acetate-co-dimethylaminoethyl acrylate methyl chloride quat)
PMA-PAA	Poly(methyl acrylate-co-acrylic acid)
PI-graft-PEG	Poly(isoprene-graft-polyethylene glycol)

[0239] More specifically, some of the polymer trade names used in the tables include: GANTREZ<sup>®</sup> AN-169 which is a poly(maleic anhydride-alt-methyl vinyl ether) (“also called p(MA-MVE”) and commercially available from Ashland; PI-graft-PEG which is a polyisoprene-graft-polyethylene glycol; LM25 which is a partially hydrolyzed polyvinyl acetate (also referred to as “pVAc-VOH”) and commercially available from Kuraray; PVA-graft-PEG which is a poly(vinyl acetate-co-polyethyleneglycol acrylate) and commercially available from Scientific Polymer Products; pDMAEA.MCQ which is a poly(vinyl acetate-co-dimethylaminoethyl acrylate methyl chloride quat) and commercially available from Scientific Polymer Products; PMA-PAA which is a poly(methyl acrylate-co-acrylic acid) and

commercially available from Scientific Polymer Products. Various commercially available polyvinyl acetates used in the Comparative and Control Examples and the Examples in Table 1 were characterized with a weight average molecular weight (Mw) between about 35,000-45,000 Da.

**[0240]** As can be seen from Comparative or Control Example (C2), using p(MA-MVE) alone caused degradability at 5% but was ineffective alone at lower levels of 3% (Example Comparative or Control (C8)) and 1.5% (Example Comparative or Control (C7)). As can also be seen from the Examples, combining p(MA-MVE) at about 5% with copolymers at 3.5% allowed for enhanced degradability. Copolymers (Component B materials) at 3.5% with no p(MA-MVE) showed little to no enhanced degradability (see e.g. Comparative or Control Examples (C4), Comparative or Control (C6) and Comparative or Control (C10)). Copolymers at higher levels (e.g. 7%; see Comparative or Control Examples (C12), (C13) and (C14)) showed degradability even with no p(MA-MVE) present, but at times tended to smear rather than disintegrate. When copolymers (B1 and/or B2 materials) at low levels (e.g. 1.5-3.5%) which did not produce the desired effect alone, were combined with p(MA-MVE) (e.g. A2 materials) at low levels (e.g. less than or equal to 3%), there was a cooperative effect and enhanced degradation was observed.

**[0241]** As can be seen from the figures, the combination of A1 and/or A2 materials (e.g. GANTREZ material(s)) with B1 and/or B2 materials (e.g. hydrophilically modified copolymers) at low levels can be used to provide enhanced degradability in various gum products.

[0242] Table 1.

No.	Component A		Component B					
	p(MA-MVE)		PI-graft-PEG	p(VAc-VOH)	PVA-graft-PEG	pDMAEA.MCQ	PMA-PAA	Poly Vinyl Acetate
Comparative or Control (C1)								14.3
1	5					3.5		10.8
3	5						3.5	10.8
Comparative or Control (C2)	5							14.3
Comparative or Control (C3)	5*							14.3
Comparative or Control (C4)						3.5		10.8
Comparative or Control (C6)							3.5	10.8
Comparative or Control (C7)	1.5							14.3
Comparative or Control (C8)	3							14.3
Comparative or Control (C9)	3*							14.3
4	3			1.5				12.8
6	3			5.5				8.8
7	3		1					13.3
8	3		2					12.3
9	3		3					11.3
10	3		3.5					10.8
11	1.5		1					13.3
12	1.5		2					12.3
13	1.5		3					11.3
14	5				3.5			10.8
Comparative or Control (C10)					3.5			10.8
15	3				1.5			12.8
16	3				3.5			10.8
17	3				5.5			8.8
18	2				1			13.3
19	2				1.5			12.8
20	3				1			13.3
Comparative or Control (C11)			4.8					9.5
Comparative or Control (C12)					7			7.3
Comparative or Control (C13)						7		7.3
Comparative or Control (C14)				7				7.3

[0243] Table 2.

Sample #		p(M A-MV E)	Poly(vinyl acetate-graft-PEG)	p(VAc -VOH)	pDMAEA-MCQ	PMA-PAA	PI-graft-PEG	Turn White	Removed: brushing after 1 week wet	Removed after scraped
Comparative or Control (C1)	Control	0	0	0	0	0	0	0	1	2.5
Comparative or Control (C2)	Various	5	0	0	0	0	0	5	4.5	5
Comparative or Control (C8)		3	0	0	0	0	0	0.5	0	2
Comparative or Control (C7)		1.5	0	0	0	0	0	0	0.5	2.5
14	Moderate	5	3.5	0	0	0	0	5	4.5	4.5
1	% A	5	0	0	3.5	0	0	5	4.5	4.5
3	3.5% B	5	0	0	0	3.5	0	4.5	5	4.5
Comparative or Control (C10)	0% A Low Various %B	0	3.5	0	0	0	0	0	2	2.5
Comparative or Control (C4)		0	0	0	3.5	0	0	0	0.5	3
Comparative or Control (C6)		0	0	0	0	3.5	0	1	3.5	4
Comparative or Control (C11)		0	0	0	0	0	4.8	0	0	2.5
18	Low %A Low %B	2	1	0	0	0	0	0.5	1	2.5
20		3	1	0	0	0	0	0.5	1.5	2.5
19		2	1.5	0	0	0	0	0.5	2	4.5
15		3	1.5	0	0	0	0	4	3.5	4
16		3	3.5	0	0	0	0	4	2.5	3
4		3	0	1.5	0	0	0	0	1.5	3
7		3	0	0	0	0	1	0.5	3	3
8		3	0	0	0	0	2	1	3.5	4
11		1.5	0	0	0	0	1	0	3	3
12		1.5	0	0	0	0	2	0	2.5	3.5



[0244] Embodiment 1. A gum base composition comprising: (a) at least one delayed cud-disrupting material; and (b) at least one polymeric moisture uptake promoter material.

[0245] Embodiment 2. The gum base composition of Embodiment 1 wherein the at least one delayed cud-disrupting material comprises material having at least one of: (1) a polymer having a weight average molecular weight (Mw) of at least 5,000 Da to about 5,000,000 Da or (2) inhibited water access prior to and/or during mastication to reactive polymer sites in the at least one delayed cud-disrupting material due to an initially hydrophobic nature of the at least one delayed cud-disrupting material or (3) a significantly hydrophobic environment from other components in the gum base composition.

[0246] Embodiment 3. The gum base composition of Embodiments 1 or 2, wherein the at least one delayed cud-disrupting material is present in particle form.

[0247] Embodiment 4. The gum base composition of any of Embodiments 1-3, wherein the at least one delayed cud-disrupting material is present in an amount between about 0.1-10% by weight based on the gum base composition.

[0248] Embodiment 5. The gum base composition of any of Embodiments 1-4, wherein the at least one delayed cud-disrupting material is present in an amount between about 0.5-5% by weight based on the gum base composition.

[0249] Embodiment 6. The gum base composition of any of Embodiments 1-5, wherein the at least one delayed cud-disrupting material comprises at least one of: linear or crosslinked polyacrylic acid, linear or crosslinked polyacrylamide and copolymers thereof.

[0250] Embodiment 7. The gum base composition of any of Embodiments 1-6, wherein the at least one delayed cud-disrupting material comprises at least one of: poly(methyl vinyl ether-alt-maleic anhydride) polymer, maleic anhydride copolymers with C<sub>2</sub>-C<sub>10</sub> alkenes, copolymers of maleic anhydride and copolymers thereof.

[0251] Embodiment 8. The gum base composition of any of Embodiments 1-7, wherein the at least one delayed cud-disrupting material is encapsulated, thereby further delaying the delayed cud-disrupting material from interaction with water.

[0252] Embodiment 9. The gum base composition of any of Embodiments 1-8, wherein the at least one polymeric moisture uptake promoter material comprises at least one material selected from: nonionic hydrophilically modified polymers and ionically modified polymers.

[0253] Embodiment 10. The gum base composition of any of Embodiments 1-9, wherein the at least one polymeric moisture uptake promoter material comprises at least one

polymer selected from: modified or copolymerized polyisoprene, modified or copolymerized polybutadiene, modified or copolymerized polyisobutylene, modified or copolymerized polyacrylate or copolymers thereof, wherein the at least one polymeric moisture uptake promoter materials is functionalized with polyethylene glycol.

**[0254]** Embodiment 11. The gum base composition of any of Embodiments 1-10, where the at least one polymeric moisture uptake promoter materials that is functionalized with polyethylene glycol comprises at least partial replacement of a moiety with polyethylene glycol.

**[0255]** Embodiment 12. The gum base composition of any of Embodiments 1-11, wherein the at least one polymeric moisture uptake promoter material comprises at least one polymer selected from: modified or copolymerized poly vinyl acetate, wherein at least one acetate moiety has been partially replaced with polyethylene glycol.

**[0256]** Embodiment 13. The gum base composition of Embodiment 12, wherein the polyethylene glycol comprises ethylene glycol repeat units numbering from 1-1000, in a graft density on the vinyl acetate backbone of the poly vinyl acetate between 0.1 - 20% based on the polymer backbone monomer units.

**[0257]** Embodiment 14. The gum base composition of any of Embodiments 1-13, wherein the at least one polymeric moisture uptake promoter material comprises at least one polymer selected from: ionic-modified polymers functionalized with short linear or branched side-chain (C<sub>1</sub>-C<sub>8</sub>) ionic groups selected from sulfonate, carboxylate, ammonium salts and combinations thereof.

**[0258]** Embodiment 15. The gum base composition of Embodiment 14, wherein the at least one polymeric moisture uptake promoter material comprises at least polyvinyl acetate having 0.1-10% of the acetate groups replaced with short linear or branched side-chain (C<sub>1</sub>-C<sub>8</sub>) ionic groups selected from sulfonate, carboxylate, or ammonium salts.

**[0259]** Embodiment 16. The gum base composition of any of Embodiments 1-15, wherein the at least one polymeric moisture uptake promoter material is present in amounts of about 0.1-10% by weight based on the gum base composition.

**[0260]** Embodiment 17. The gum base composition of any of Embodiments 1-16, wherein the at least one polymeric moisture uptake promoter material is present in amounts of about 0.5-5% by weight based on the gum base composition.

**[0261]** Embodiment 18. A chewing gum composition comprising: (a) an elastomer; (b) at least one delayed cud-disrupting material; (c) at least one polymeric moisture uptake promoter material; and (d) at least one sweetener.

[0262] Embodiment 19. The chewing gum composition of Embodiment 18, wherein the at least one delayed cud-disrupting material comprises material having at least one of: (1) a polymer weight average molecular weight ( $M_w$ ) of at least 5,000 Da to about 5,000,000 Da or (2) inhibited water access prior to and/or during mastication to reactive polymer sites in the at least one delayed cud-disrupting material due to an initially hydrophobic nature of the at least one delayed cud-disrupting material and/or with a significantly hydrophobic environment from by other components in the gum base composition.

[0263] Embodiment 20. The chewing gum composition of Embodiments 18 or 19, wherein the at least one delayed cud-disrupting material is present in particle form.

[0264] Embodiment 21. The chewing gum composition of any of Embodiments 18-20, wherein the at least one delayed cud-disrupting material is present in amounts of about 0.1-10% by weight based on the gum base composition.

[0265] Embodiment 22. The chewing gum composition of any of Embodiments 18-21, wherein the at least one delayed cud-disrupting material is present in amounts of about 0.5-5% by weight based on the gum base composition.

[0266] Embodiment 23. The chewing gum composition of any of Embodiments 18-22, wherein the at least one delayed cud-disrupting material comprises at least one of: linear or crosslinked polyacrylic acid, linear or crosslinked polyacrylamide and copolymers thereof.

[0267] Embodiment 24. The chewing gum composition of any of Embodiments 18-23, wherein the at least one delayed cud-disrupting material comprises at least one of: poly(methyl vinyl ether-alt-maleic anhydride) polymer, maleic anhydride copolymers with  $C_2$ - $C_{10}$  alkenes, copolymers of maleic anhydride and copolymers thereof.

[0268] Embodiment 25. The chewing gum composition of any of Embodiments 18-24, wherein the at least one delayed cud-disrupting material is encapsulated, thereby further delaying the delayed cud-disrupting material from interaction with water.

[0269] Embodiment 26. The chewing gum composition of any of Embodiments 18-25, wherein the at least one polymeric moisture uptake promoter material comprises at least one material selected from: nonionic hydrophilically modified polymers and ionically modified polymers.

[0270] Embodiment 27. The gum base composition of any of Embodiments 18-26, wherein the at least one polymeric moisture uptake promoter material comprises at least one polymer selected from: modified or copolymerized polyisoprene, modified or copolymerized polybutadiene, modified or copolymerized polyisobutylene, modified or copolymerized

polyacrylate or copolymers thereof, wherein the at least one polymeric moisture uptake promoter materials is functionalized with polyethylene glycol.

[0271] Embodiment 28. The gum base composition of any of Embodiment 18-27, where the at least one polymeric moisture uptake promoter materials that is functionalized with polyethylene glycol comprises at least partial replacement of a moiety with polyethylene glycol.

[0272] Embodiment 29. The chewing gum composition of any of Embodiments 18-28, wherein the at least one polymeric moisture uptake promoter material comprises at least one polymer selected from: modified or copolymerized poly vinyl acetate, wherein at least one acetate moiety has been partially replaced with polyethylene glycol.

[0273] Embodiment 30. The chewing gum composition of Embodiment 29, wherein the polyethylene glycol comprises ethylene glycol repeat units numbering from 1-1000, in a graft density on the vinyl acetate backbone of the poly vinyl acetate between 0.1-20% based on the polymer backbone monomer units.

[0274] Embodiment 31. The chewing gum composition of any of Embodiments 18-30, wherein the at least one polymeric moisture uptake promoter material comprises at least one polymer selected from: ionic-modified polymers functionalized with short linear or branched side-chain ( $C_1-C_8$ ) ionic groups selected from sulfonate, carboxylate, ammonium salts and combinations thereof.

[0275] Embodiment 32. The chewing gum composition of any of Embodiments 18-31, wherein the at least one polymeric moisture uptake promoter material comprises at least polyvinyl acetate having 0.1-10% of the acetate groups replaced with short linear or branched side-chain ( $C_1-C_8$ ) ionic groups selected from sulfonate, carboxylate, or ammonium salts.

[0276] Embodiment 33. The chewing gum composition of any of Embodiments 18-32, wherein the at least one polymeric moisture uptake promoter material is present in amounts of about 0.1-10% by weight of the gum base composition.

[0277] Embodiment 34. The chewing gum composition of any of Embodiments 18-33, wherein the at least one polymeric moisture uptake promoter material is present in amounts of about 0.5-5% by weight of the gum base composition.

[0278] Embodiment 35. The chewing gum composition of any of Embodiments 18-34, further including at least one flavor or sensate.

[0279] Embodiment 36. A method of preparing a chewing gum composition comprising: (a) providing a gum base comprising an elastomer; and (b) combining the gum

base with at least one delayed cud-disrupting material; at least one polymeric moisture uptake promoter material; and at least one sweetener.

**[0280]** Embodiment 37. A method of increasing degradability of a chewing gum composition comprising: (a) providing a gum composition comprising: (i) an elastomer; (ii) at least one delayed cud-disrupting material; (iii) at least one polymeric moisture uptake promoter material; and (iv) at least one sweetener; and (b) exposing the composition to conditions of water and/or sunlight sufficient to degrade the gum composition.

**[0281]** Embodiment 38. A method of producing a chewing gum base having increased degradation properties comprising: (a) providing a molten or softened polymer gum base composition; and (b) mixing at least one delayed cud-disrupting material and at least one polymeric moisture uptake promoter material with the gum base composition.

**[0282]** Embodiment 39. A method of preparing a chewing gum composition comprising: (a) providing a gum base composition comprising an elastomer and at least one polymeric moisture uptake promoter material; and (b) combining the gum base composition with at least one delayed cud-disrupting material and at least one sweetener.

**[0283]** Embodiment 40. A method of producing a chewing gum base having increased degradation properties comprising: (a) providing a molten or softened polymer gum base composition containing at least one polymeric moisture uptake promoter material; and (b) mixing at least one delayed cud-disrupting material with the gum base composition.

**[0284]** All cited patents, patent applications, and other references are incorporated herein by reference in their entirety. However, if a term in the present application contradicts or conflicts with a term in the incorporated reference, the term from the present application takes precedence over the conflicting term from the incorporated reference.

**[0285]** While particular embodiments have been described, alternatives, modifications, variations, improvements, and substantial equivalents that are or may be presently unforeseen may arise to Applicants or others skilled in the art. Accordingly, the appended claims as filed and as they may be amended are intended to embrace all such alternatives, modifications variations, improvements, and substantial equivalents.

**CLAIMS**

1. A gum base composition comprising:
  - (a) at least one delayed cud-disrupting material; and
  - (b) at least one polymeric moisture uptake promoter material.
2. The gum base composition of claim 1, wherein the at least one delayed cud-disrupting material comprises material having at least one of: (1) a polymer having a weight average molecular weight (Mw) of at least 5,000 Da to about 5,000,000 Da or (2) inhibited water access prior to and/or during mastication to reactive polymer sites in the at least one delayed cud-disrupting material due to an initially hydrophobic nature of the at least one delayed cud-disrupting material or (3) a significantly hydrophobic environment from other components in the gum base composition.
3. The gum base composition of claims 1 or 2, wherein the at least one delayed cud-disrupting material is present in particle form.
4. The gum base composition of any of claims 1-3, wherein the at least one delayed cud-disrupting material is present in an amount between about 0.1-10% by weight based on the gum base composition.
5. The gum base composition of any of claims 1-4, wherein the at least one delayed cud-disrupting material is present in an amount between about 0.5-5% by weight based on the gum base composition.
6. The gum base composition of any of claims 1-5, wherein the at least one delayed cud-disrupting material comprises at least one of: linear or crosslinked polyacrylic acid, linear or crosslinked polyacrylamide and copolymers thereof.
7. The gum base composition of any of claims 1-5, wherein the at least one delayed cud-disrupting material comprises at least one of: poly(methyl vinyl ether-alt-maleic anhydride) polymer, maleic anhydride copolymers with C<sub>2</sub>-C<sub>10</sub> alkenes, copolymers of maleic anhydride and copolymers thereof.
8. The gum base composition of any of claims 1-7, wherein the at least one delayed cud-disrupting material is encapsulated, thereby further delaying the delayed cud-disrupting material from interaction with water.
9. The gum base composition of any of claims 1-8, wherein the at least one polymeric moisture uptake promoter material comprises at least one material selected from: nonionic hydrophilically modified polymers and ionically modified polymers.
10. The gum base composition of any of claims 1-9, wherein the at least one polymeric moisture uptake promoter material comprises at least one polymer selected from:

modified or copolymerized polyisoprene, modified or copolymerized polybutadiene, modified or copolymerized polyisobutylene, modified or copolymerized polyacrylate or copolymers thereof, wherein the at least one polymeric moisture uptake promoter materials is functionalized with polyethylene glycol.

11. The gum base composition of any of claims 1-10, where the at least one polymeric moisture uptake promoter materials that is functionalized with polyethylene glycol comprises at least partial replacement of a moiety with polyethylene glycol.

12. The gum base composition of any of claims 1-11, wherein the at least one polymeric moisture uptake promoter material comprises at least one polymer selected from: modified or copolymerized poly vinyl acetate, wherein at least one acetate moiety has been partially replaced with polyethylene glycol.

13. The gum base composition of claim 12, wherein the polyethylene glycol comprises ethylene glycol repeat units numbering from 1-1000, in a graft density on the vinyl acetate backbone of the poly vinyl acetate between 0.1 - 20% based on the polymer backbone monomer units.

14. The gum base composition of any of claims 1-13, wherein the at least one polymeric moisture uptake promoter material comprises at least one polymer selected from: ionic-modified polymers functionalized with short linear or branched side-chain ( $C_1-C_8$ ) ionic groups selected from sulfonate, carboxylate, ammonium salts and combinations thereof.

15. The gum base composition of claim 14, wherein the at least one polymeric moisture uptake promoter material comprises at least polyvinyl acetate having 0.1-10% of the acetate groups replaced with short linear or branched side-chain ( $C_1-C_8$ ) ionic groups selected from sulfonate, carboxylate, or ammonium salts.

16. The gum base composition of any of claims 1-15, wherein the at least one polymeric moisture uptake promoter material is present in amounts of about 0.1-10% by weight based on the gum base composition.

17. The gum base composition of any of claims 1-16, wherein the at least one polymeric moisture uptake promoter material is present in amounts of about 0.5-5% by weight based on the gum base composition.

18. A chewing gum composition comprising:

- (a) the gum base composition of any of Claims 1-17; and
- (d) at least one sweetener.

19. The chewing gum composition of claim 18, further including at least one flavor or sensate.

20. A method of producing the chewing gum base of any of Claims 1-17 having increased degradation properties comprising:

- (a) providing a molten or softened polymer gum base composition; and
- (b) mixing at least one delayed cud-disrupting material and at least one polymeric moisture uptake promoter material with the gum base

composition.



