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(54) Title: SILICON CARBIDE BASED INDUSTRIAL PAINTS

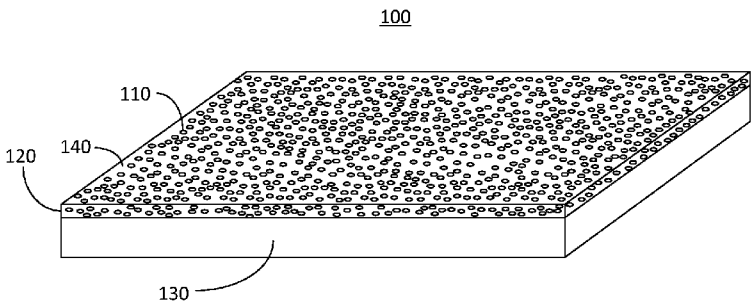

FIG. 1

(57) Abstract: An apparatus and associated method contemplate an industrial silicon-carbide based paint that comprises paint binder, paint solvent, paint pigment, and silicon-carbide. The silicon-carbide being in powder form having an average grain size that does not exceed 1.0 micrometers, wherein the silicon-carbide powder is essentially completely encapsulated by the paint binder when the paint binder, the paint solvent, the pigment and the silicon-carbide powder are homogeneously mixed together in the silicon-carbide based paint, wherein the paint is durable in a marine environment after the paint is cured.

SILICON CARBIDE BASED INDUSTRIAL PAINTS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and the benefit of U.S. Provisional Patent Application Number 61/944,114 entitled: Silicon Carbide Based Industrial Paints, filed on February 25, 2014, and U.S. Provisional Patent Application Number 62/039,345 entitled: Silicon Carbide Based Industrial Paints, filed on August 24, 2014, the entire disclosure of which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0002] The present invention relates generally to SiC based paints. More particularly, some embodiments of the present invention relate to SiC based paints used in industrial applications.

2. DESCRIPTION OF RELATED ART

[0003] Preventative maintenance due to marine fouling on manmade marine items such as ships, shipping containers, docs and other marine structures requires significant expense in time and money to keep these manmade marine items in operable condition. Shells and algae such as barnacles, mussels, oysters, hydroids, bryozoans, tube worms, tunicates, sea weeds and the like attach themselves to and grow on untreated ship hulls, buoys, dams, feed pipes, shipping containers, pylons, docks, and other sessile and non-sessile items that have prolonged exposure in a marine (chloride rich aqueous) environment. Generally speaking, these organisms are considered a form of marine fouling on surfaces which account for degradation in marine item performance, such as increased friction resistance in shipping, weight increase in containers, operability of articulating devices such

as hinges, cables, pulleys, etc. Moreover, due to the mobility of many marine items (ships and the like), marine fouling can account for spreading of diseases caused by microbes to otherwise healthy environments, invasive species, such as the zebra mussel, to North American environments where they cannot be adequately controlled, etc.

[0004] For many years, people have combatted such marine fouling with surface treatments such as surface coatings, electrodes, chemicals, biocides, etc., in an attempt to make marine surfaces difficult for marine fouling organism to inhabit. Though surface these surface treatments can be effective, they all have their downsides. For example, certain coatings containing biocides that are toxic to marine organisms have been found to leach the biocides out of the coating when in seawater, thus endangering other marine animals and putting humans at risk. Copper in paint is also harmful to the environment and is very expensive as well. Simply coating marine items with untreated paint requires frequent stripping and repainting, which is expensive, time consuming, and ultimately bad for the environment.

[0005] It is to innovations related to non-environmentally harmful additives in paint coatings that have benefits in reducing the effects of marine fouling that the present invention is generally directed.

FIGURES

FIG. 1 is an artistic depiction of SiC in paint according to embodiments of the present invention.

DETAILED DESCRIPTION

[0006] Initially, it is to be appreciated that this disclosure is by way of example only, not by limitation. The concepts related to additives comprised in surface coatings described

herein are not limited to use or application with any specific system or method for applying or making surface coatings. Thus, although the examples described herein are for the convenience of explanation and described with respect to exemplary embodiments, it will be appreciated that the principles presented herein may be applied to a wide variety of devices, items, systems and methods involving the use of SiC based paints beyond marine usage (to include chloride rich aqueous environments, which could include salted roads, for example), such as road signs, containers, train cars, and other industrial uses. The embodiments described herein can be categorized with intended uses that require gallons of paint for outside environmental uses and are not envisioned or capable of being used as pyro-paints (which are unstable in water – they dissolve), non-slip paints or sand papers.

[0007] Described herein are embodiments which contemplate the addition of SiC powders as a filler component in industrial paint used in industrial applications consistent with the present invention. Industrial paint used in an industrial application and is a paint that is produced in tens of gallons if not thousands of gallons for items such as for painting ships, dams, docks, shipping containers, buildings, etc. An industrial application is used herein to mean a setting which manufactured items such as machines or objects are painted in large scale (multiple gallons of paint) for durable use (that which is exposed to standard and extreme environmental elements and conditions generally found in habitable places on Earth). Examples of non-industrial paint for non-industrial use include paint for artistic renditions (canvas paintings, for example), models, crafts or other small or even large scale hobbies. Non-industrial paint is used primarily for aesthetic appeal and not intended for durable use intended to withstand the abuse of environmental traumas such as ocean, extreme temperature changes (from arctic cold environments to desert heat on the equator), impact of collisions, etc. Embodiments to the present invention described herein are directed to industrial paint applications.

[0008] Certain embodiments contemplate SiC as a substitute to Cu (copper) based paints. Improvements in paint using SiC instead of Cu include chemical inertness over Cu, lighter weight over Cu or Cu intermetallics, harder than Cu (Moh 9 vs. Moh 3), likely cost competitive over copper. Furthermore, based on tests performed in California and New Hampshire to evaluate SiC as an additive to paint useful for marine application showed promise for reduction of marine growth and abrasion (from fine sand, organic debris and inorganic moieties). Accordingly, certain embodiments of SiC paint can be used to improve certain drawback to presently used paints in marine applications, bridges, containers, road signs, aerospace, airplanes, concrete, anchored boats, tramels/cylindrical drums, conveyors, shipping containers, docks, etc.

[0009] FIG. 1 depicts an artist rendition of a SiC based industrial paint 120 coated on a substrate 130 consistent with embodiments of the present invention. As illustratively shown, SiC 110 is essentially distributed homogenously in the binder 140 generally comprising the industrial paint 120.

[00010] Embodiments of paints described herein can generally comprise binders (also called vehicles or resins), diluents (also called solvents), pigments and fillers, and additives. A binder, commonly called a vehicle, is the film-forming component of paint. Binders used herein can include synthetic or natural resins such as alkyds, acrylics, vinyl-acrylics, vinyl acetate/ethylene (VAE), other vinyl esters, polyurethanes, polyesters, melamine resins, epoxy, or oils. The aforementioned binders can be categorized according to mechanisms for drying or curing. In some examples, drying may refer to evaporation of solvent or thinner (lacquers). In other examples, drying refers to oxidative cross-linking of the binders and is indistinguishable from curing, such as Latex.

[00011] Latex is a paint binder type that depends on water-borne dispersion of sub-micrometer polymer particles. This covers all paint binders that use synthetic polymers such

as acrylic, vinyl acrylic (PVA), styrene acrylic, etc. The term "latex" in the context here means an aqueous dispersion in the paint binder. These dispersions are prepared by emulsion polymerization. Latex paints cure by a process called coalescence where first the water, and then the trace, or coalescing, solvent, evaporate and draw together and soften the binder particles and fuse them together into irreversibly bound networked structures, so that the paint cannot redissolve in the solvent/water that originally carried it. When applied, the exposure to oxygen in the air starts a process that crosslinks and polymerizes the binder component. Some binder embodiments rely on oxidative cure coatings which can be catalyzed by metal complex driers such as cobalt naphthenate. Other paint binders contemplated are two package coatings that polymerize by way of a chemical reaction, and cure into a cross-linked film are epoxies or polyurethanes, urithanes reacting with isocyanate, etc. Other paint binders can include plastisols/organosols, which are made by blending PVC granules with a plasticizer. When cured, these binders are generally durable to water (i.e., do not dissolve in water, whether salt or fresh, once cured). Paints that dissolve in water when dried or cured are not applicable to embodiments described herein.

[00012] Diluents or solvents contemplated can be water in a water-borne paint and in a solvent in oil based paint, for example. The main purposes of the diluent are to dissolve the polymer and adjust the viscosity of the paint. It is volatile and does not become part of the paint film. It also controls flow and application properties, and in some cases may affect the stability of the paint while in liquid state. Its main function is as the carrier for the non-volatile components. To spread heavier oils (for example, linseed) as in oil-based interior house paint, a thinner oil is required. These volatile substances impart their properties temporarily. Once the solvent has evaporated, the remaining paint is fixed to the surface. Solvent-borne, also called oil-based, paints can have various combinations of organic solvents as the diluent, including aliphatics, aromatics, alcohols, ketones and white spirit.

Specific examples are organic solvents such as petroleum distillate, esters, glycol ethers, and the like. In some cases, volatile low-molecular weight synthetic resins can also serve as diluents. Because a diluent may not be necessary in paint, some embodiments contemplate no diluent whatsoever.

[00013] Fillers contemplated herein include SiC, which provides a marine antifouling effect in the paint. SiC and other fillers thicken the paint film, support its structure and increase the volume of the paint. Other filler contemplate in addition to SiC include diatomaceous earth, talc, lime, barytes, clay, titanium dioxide (TiO_2), silicon dioxide (SiO_2), lead, copper, aluminum dioxide (Al_2O_3), zirconium, barium sulfate, calcium carbonate, wollanstonite ($CaSiO_2$), red iron oxide, etc. The SiC can be coated with silica, alumina, zirconium (or a combination thereof) or other material for improved spacing in the thin film, which may improve hiding performance (opacity). It is contemplated that the SiC powder be of various shapes and sizes to best fill up gaps in the paint to provide a "porous free" or low porous surface, one such that marine animals find it difficult to adhere to foul the surface. Some embodiments contemplate other aforementioned fillers included with the SiC. These other aforementioned fillers may be of different sizes to help provide a porous free surface. Because many marine animals anchor themselves to surfaces by mechanically locking into small pours in these surfaces, a porous free surface or a surface with pours that are below the size that a marine animal can anchor to the surface will improve resistance to this kind of marine fouling. In other words, some animals will not be able to mechanically adhere to a surface wherein there is a lack of sufficient pour size to stick to. The SiC is essentially encapsulated, which means that the bulk of the SiC is surrounded by the binders and other components in the paint. A small percentage of the SiC may be exposed on the surface of the paint when cured. SiC as a filler is essentially homogenized (uniformly mixed) in the paint when in liquid form.

[00014] The size of SiC and other particles used as fillers, in certain embodiments, are contemplated to be in the range of between 0.05 μm to 5.0 μm, but preferably between 0.1 μm and 0.25 μm. Some embodiments contemplate a variety of SiC shapes to reduce clumping together during mixing with the binder/s. Shapes can include spheres, nodules of random shape, cubes, cube-like, needles, platelets, fibers, flakes, for example. Some embodiments contemplate the introduction of a first size of SiC particles (for example having an average size of 0.08 μm and standard deviation of 0.02 μm in a Gaussian distribution) and a second size of SiC particles (for example having an average size of 0.15 μm and standard deviation of 0.02 μm in a Gaussian distribution). Other embodiments contemplate the first size being a first shape and the second size being a second shape. Yet other embodiments contemplate the first size and the second size being the same shape. Yet another embodiment contemplates a third size of SiC particles, etc. In practice, SiC may have other impurities along with the SiC, for example approximate bulk SiC may be 98% by weight, 0-0.1% Quartz, 0-.05% Cristobalite, etc. Though there are a number of sources that can provide SiC powder/s, Saint-Gobain Ceramics and Plastics Inc., of Worchester, MA. is one example of a provider.

[00015] Some embodiments contemplate a coating over the SiC paint to reduce clumping, improve dispersion in binder, improve dispersion regarding other fillers, create a more hostile surface to fouling creatures, etc. Some SiC particle embodiments are contemplated to possess charged polar coatings substantially covering the SiC particles used for the paints. The charge can ward off sea creatures, be designed to improve corrosion resistance, etc. Coatings can be metallic, polymers, ceramics. They can be applied a number of different ways, from Atomic Layer Deposition (ALD) processes to Chemical Vapor Deposition, etc., just to name a couple of examples.

[00016] SiC used herein can include multiple optional polymorphs of SiC, which are different structures of SiC (such as different crystalline or amorphous structures, e.g., Face-centered-cubic (FCC) diamond structure, hexagonal, rhombohedral, etc.). Some SiC polymorphs are the same structure in two dimensions but differ in a third dimension, for example. Other embodiments contemplate additional elements in a SiC structure, SiCx, such as SiCN, for example, that can function within the spirit and scope of the present invention.

[00017] SiC powder used in many embodiments herein is smaller than 5 microns, and more preferably under 1 micron generally speaking, and therefor does not contribute to the surface roughness of the paint appreciably. Though SiC is contemplated to be an abrasive surface to prevent slipping (non-slip) when people walk on the surface (or perhaps in sandpaper), the SiC used in an abrasive applications would have to have a large grain size, larger than that used in this application. Some applications of SiC paints may incorporate large +1 micron sized platelet powders (wherein the +1 micron size is the smallest dimension and the largest dimension in many microns) in paint to contemplate a surface finish that incorporate the flat SiC platelet surface to contribute to a smooth surface with hardness durability of the SiC (i.e., scales). Such paint relies on the flat surface of the SiC platelet to be exposed to the outer surface from the paint whereby those platelets are not completely encapsulated. This kind of platelet paint is intended for improving a slick surface that is different from paint used in conjunction with the SiC powders of sub 1 micron in size.

[00018] Pigments that can be used herein include both natural and synthetic pigments. Natural pigments can include various clays, calcium carbonate, mica silicas, and talcs, for example. Synthetic pigments can include engineered molecules, calcined clays, blanc fixe (barium sulfate), precipitated calcium carbonate, and synthetic pyrogenic silicas, for example. Other pigments include titanium dioxide, phthalocyanine blue, red iron oxide, and many others.

[00019] Additives can be used with the SiC paint embodiments to modify surface tension, improve flow properties, improve the finished appearance, increase wet edge, improve pigment stability, impart antifreeze properties, control foaming, control skinning, etc. Other types of additives include catalysts, thickeners, stabilizers, emulsifiers, texturizers, adhesion promoters, UV stabilizers, flatteners (de-glossing agents), biocides, etc. Additives some embodiments contemplate a SiC based paint that does not use additives whatsoever.

[00020] Generally speaking, adding up the pigments and fillers by volume is termed PVC for Pigment Volume Concentration. One embodiment contemplates a PVC of 30%-35% total of all the dry additives by volume. Other embodiments contemplate approximately one third of the PVC being SiC and two thirds of the PVC being other fillers, such as described above. Some embodiments contemplate between 10% and 50% of the PVC being SiC. Yet other embodiments contemplate the filler being exclusively SiC.

Some include an industrial silicon-carbide based paint comprising: paint binder; paint solvent; paint pigment; and silicon-carbide powder having an average grain size that does not exceed 1.0 micrometers, wherein said silicon-carbide powder is essentially completely encapsulated by said paint binder when said paint binder, said paint solvent, said pigment and said silicon-carbide powder are homogenously mixed together in said silicon-carbide based paint, wherein said paint is durable in a marine environment after said paint is cured. This industrial paint comprises embodiments wherein said silicon-carbide powder is essentially encapsulated in said paint when said paint is painted on a surface and cured. This industrial paint comprises embodiments wherein said silicon-carbide powder grain size has an average size of 0.08 micrometers or further wherein said silicon-carbide powder possesses a standard deviation of 0.02 micrometers. This industrial paint comprises embodiments wherein when said industrial silicon-carbide paint is cured on a flat surface it possesses an average roughness contribution of less than 50% of the paint binder alone without consideration to

said flat surface on which said paint is applied. This industrial paint comprises embodiments wherein the smallest dimension of said silicon-carbide powder is less than 0.1 micrometer in average. This industrial paint comprises embodiments wherein said silicon-carbide powder makes up a range of between 3 percent and 17 percent of said industrial silicon-carbide paint by volume. This industrial paint comprises embodiments wherein said silicon-carbide powder is not adapted as an abrasive for slip resistance when said industrial silicon-carbide based paint is cured. This industrial paint comprises embodiments wherein said industrial silicon-carbide based paint is adapted for marine environments. This industrial paint comprises embodiments wherein said silicon-carbide particles are coated with a different material. This industrial paint comprises embodiments wherein said industrial silicon-carbide based paint is adapted for outdoor environments, such as typical outdoor weather including heat, rain, salt water, cold, and general weather exposure found throughout Earth.

Other embodiment contemplate a method for applying an industrial silicon-carbide based paint, the method comprising: providing paint binder, paint solvent, paint pigment, and silicon-carbide powder; mixing said paint binder, said paint solvent, said paint pigment, and said silicon-carbide powder in a homogenous solution; applying said industrial silicon-carbide based paint on a surface; curing said industrial silicon-carbide based paint on said surface, wherein said silicon-carbide powder possesses a maximum size that when said industrial silicon-carbide based paint is cured, said silicon-carbide does not create a slip resistance texture and is non-soluble in water. This method further contemplates wherein said surface is an exterior surface exposed to salt water. This method further contemplates wherein said exterior surface is the surface of a sea vessel. This method further contemplates wherein said silicon-carbide powder is less than 0.2 micrometers in size. This method further contemplates wherein said silicon-carbide powder is in a range of between 3 percent and 18 percent of said industrial silicon-carbide based paint. This method further contemplates

wherein when said industrial silicon-carbide based paint is cured, said industrial silicon-carbide based paint possesses an average roughness of less than 50% of the roughness of the cured paint without the SiC without any contribution to the roughness from a surface on which said paint is painted.

[00021] An apparatus embodiment contemplated includes an industrial silicon-carbide based paint comprising: paint binder; paint solvent; paint pigment; and silicon-carbide powder in a range of between 3 percent and 18 percent of said industrial silicon-carbide based paint by volume, said paint binder, said paint solvent, said paint pigment and said silicon-carbide powder combined essentially homogenously, wherein when industrial silicon-carbide based paint is adapted to be cured on a surface that is exposed to water, said silicon-carbide powder has less than a 5 percent contribution to surface roughness of said industrial silicon-carbide paint. The apparatus further contemplates embodiments such as wherein said industrial silicon-carbide based paint is adapted to be painted on an outer surface of a marine vessel. The apparatus further contemplates embodiments such as wherein said silicon-carbide is platelet shaped. The apparatus further contemplates embodiments such as wherein said paint is not adapted to be subjected to heat above 300 degrees Fahrenheit.

[00022] It is to be understood that even though numerous characteristics and advantages of various embodiments of the present invention have been set forth in the foregoing description, together with the details of the structure and function of various embodiments of the invention, this disclosure is illustrative only, and changes may be made in detail, especially in matters of structure and arrangement of parts within the principles of the present invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed. For example, a variety of combinations of paint binders, additives, pigments, solvent, fillers could be used with SiC based structures while still maintaining advantageous functionality over copper based paints without departing from

the scope and spirit of the claimed invention. Another example can include using multiple polymorphs of SiC or SiCx powders while still maintaining improved functionality over present day antifouling paints without departing from the scope and spirit of the claimed invention. Finally, although the preferred embodiments described herein are directed to marine paint applications, and related technology, it will be appreciated by those skilled in the art that the claimed invention can be applied to other technologies, without departing from the spirit and scope of the present invention.

[00023] It will be clear that the claimed invention is well adapted to attain the ends and advantages mentioned as well as those inherent therein. While presently preferred embodiments have been described for purposes of this disclosure, numerous changes may be made which readily suggest themselves to those skilled in the art and which are encompassed in the spirit of the claimed invention disclosed and as defined in the appended claims. Accordingly, it is to be understood that even though numerous characteristics and advantages of various aspects have been set forth in the foregoing description, together with details of the structure and function, this disclosure is illustrative only, and changes may be made in detail, especially in matters of structure and arrangement to the full extent indicated by the broad general meaning of the terms in which the embodiments below are expressed.

CLAIMS:

1. An industrial silicon-carbide based paint comprising:

   paint binder;

   paint solvent;

   paint pigment;

   silicon-carbide powder having an average grain size that does not exceed 1.0 micrometers, wherein said silicon-carbide powder is essentially completely encapsulated by said paint binder when said paint binder, said paint solvent, said pigment and said silicon-carbide powder are homogenously mixed together in said silicon-carbide based paint, wherein said paint is durable in a marine environment after said paint is cured.

2. The industrial silicon-carbide based paint of claim 1 wherein said silicon-carbide powder is essentially encapsulated in said paint when said paint is painted on a surface and cured.

3. The industrial silicon-carbide based paint of claim 1 wherein said silicon-carbide powder grain size has an average size of 0.08 micrometers.

4. The industrial silicon-carbide based paint of claim 3 wherein said silicon-carbide powder possesses a standard deviation of 0.02 micrometers.

5. The industrial silicon-carbide based paint of claim 1 wherein when said industrial silicon-carbide paint is cured on a flat surface it possesses an average roughness contribution of less than 50% from said paint binder alone.

6. The industrial silicon-carbide based paint of claim 1 wherein the smallest dimension of said silicon-carbide powder is less than 0.1 micrometer in average.

7. The industrial silicon-carbide based paint of claim 1 wherein said silicon-carbide powder makes up a range of between 3 percent and 17 percent of said industrial silicon-carbide paint by volume.

8. The industrial silicon-carbide based paint of claim 1 wherein said silicon-carbide powder does not contribute to slip resistance when said industrial silicon-carbide based paint is cured.

9. The industrial silicon-carbide based paint of claim 1 wherein said industrial silicon-carbide based paint is adapted for marine environments.

10. The industrial silicon-carbide based paint of claim 1 wherein said silicon-carbide particles are coated with a different material.

11. The industrial silicon-carbide based paint of claim 1 wherein said industrial silicon-carbide based paint is adapted for outdoor environments.

12. A method for applying an industrial silicon-carbide based paint, the method comprising:

providing paint binder, paint solvent, paint pigment, and silicon-carbide powder;

mixing said paint binder, said paint solvent, said paint pigment, and said silicon-carbide powder in a homogenous solution;

applying said industrial silicon-carbide based paint on a surface;

curing said industrial silicon-carbide based paint on said surface, wherein said silicon-carbide powder possesses a maximum size that when said industrial silicon-carbide based paint is cured, said silicon-carbide does not create a slip resistance texture and is non-soluble in water.

13. The method claim 12 wherein said surface is an exterior surface exposed to salt water.

14. The method of claim 13 wherein said exterior surface is the surface of a sea vessel.

15. The method of claim 12 wherein said silicon-carbide powder is less than 0.2 micrometers in size.

16. The method of claim 12 wherein said silicon-carbide powder is in a range of between 3 percent and 18 percent of said industrial silicon-carbide based paint.

17. The method of claim 12 wherein when said industrial silicon-carbide based paint is cured, said industrial silicon-carbide based paint possesses an average roughness contribution of less than 20% from said paint binder alone.

18. An industrial silicon-carbide based paint comprising:

paint binder;

paint solvent;

paint pigment;

silicon-carbide powder in a range of between 3 percent and 18 percent of said industrial silicon-carbide based paint by volume, said paint binder, said paint solvent, said paint pigment and said silicon-carbide powder combined essentially homogenously, wherein when industrial silicon-carbide based paint is adapted to be cured on a surface that is exposed to water, said silicon-carbide powder has less than a 5 percent contribution to surface roughness of said industrial silicon-carbide paint.

19. The industrial silicon-carbide based paint of claim 18 wherein said industrial silicon-carbide based paint is adapted to be painted on an outer surface of a marine vessel.

20. The industrial silicon-carbide based paint of claim 18 wherein said silicon-carbide is platelet shaped.

21. The industrial silicon-carbide based paint of claim 18 wherein said paint is not adapted to be subjected to heat above 200 degrees Fahrenheit.

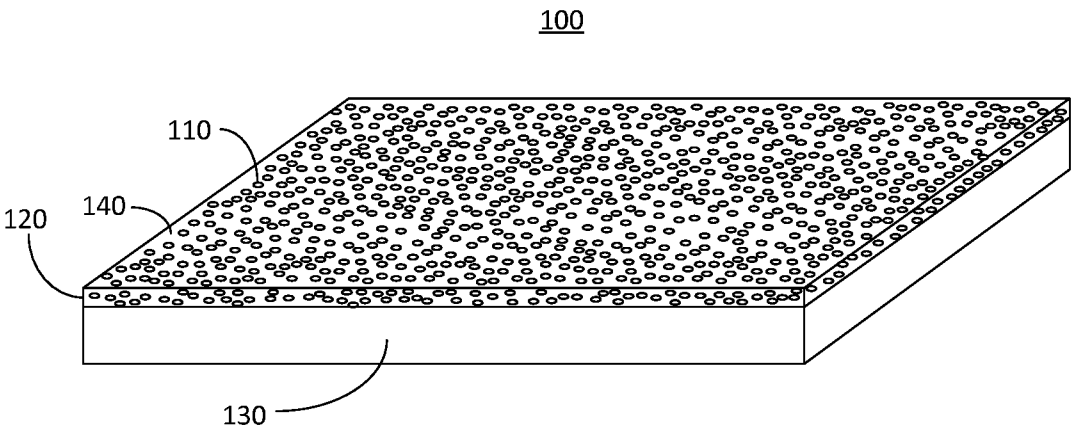

FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2015/051381

A. CLASSIFICATION OF SUBJECT MATTER

C09D 7/12(2006.01)i, C09D 201/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C09D 7/12; C09D 143/04; C08L 31/00; B05D 1/10; B05D 7/14; C08L 43/04; B32B 5/16; H01B 1/04; C08L 31/02; C09D 5/16; C09D 201/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: antifouling, fouling, paint, coating, erosion, corrosion, silicon carbide, SiC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 00-77102 A1 (J.C. HEMPEL`S SKIBSFARVE-FABRIK A/S) 21 December 2000 See claims 1, 11, 13; page 1, lines 6-9; page 3, lines 3-5; page 15, line 29 ; page 20, lines 27-34; page 29, lines 23-28, 30-33; page 30, lines 28-30; p age 35, lines 23-28; page 36, lines 8-10; page 39, lines 11-15.	1-21
Y	US 2011-0039093 A1 (FUKUMURA, N) 17 February 2011 See abstract; claims 1, 2; paragraph [0051].	1-21
A	US 5436284 A (HONDA, Y. et al.) 25 July 1995 See abstract; claim 1.	1-21
A	US 5116611 A (MASUOKA, S. et al.) 26 May 1992 See abstract; claim 1.	1-21
A	US 2009-0297720 A1 (RAMGOPAL, T. et al.) 03 December 2009 See abstract; claim 1.	1-21

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
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Date of the actual completion of the international search	Date of mailing of the international search report
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