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Douglas BLEECHER, *et al*
Superhydrophobic Spray (" Neverwet ")

http://www.independent.co.uk/news/science/superhydrophobic-spray-neverwet-enters-us-market-in-a-20-can-8668784.html

Superhydrophobic spray NeverWet enters US market in a $20 can

Two step spray coating makes fabrics, wood, metals and plastic waterproof
by James Vincent

A spray on treatment that makes any object repel liquid has been launched into the US market. This is NeverWet, a superhydrobphobic coating that can be applied to nearly any surface.

Consumers can now buy the two cans (capable of treating 10 to 15 square feet) for $19.97 from Home Depot. Surfaces that the spray can be applied to include fabrics, wood, metal and plastics. The treatement consists of two coatings, each of which takes 30 minutes to dry.

NeverWet have not yet given official figures on how long the superhydrophobia will last in various situations, but claim that treatments have "remained under seawater for over a year and reemerged completely dry."

Unfortunately, when the treatment is applied to glass it causes the surface to become frosted, though the company behind the product promise that a clear-drying version is in development.

A demonstration video (below) shows NeverWet in action, including waterproofing an iPhone (something that instructions for NeverWet explicitly warns against), a toilet brush, a t-shirt and a pair of shoes.

Superhydrophobic surfaces works by increasing the contact angle between water droplets and the coated surface through creating a low surface chemistry and a smooth surface – essentially this changes whether each individual droplet remains a ball when it rests on a surface, or whether it spreads out.

Hydrophilic surfaces (surfaces that soak up water) have a contact angle of less than 90 degrees. Hydrophobic surfaces have a contact angle of above 90 degrees, but superhydrophobic surfaces have a contact angel of above 150 degrees.

NeverWet coatings creating a contact angle of between 160 and 175 degrees (by comparison, the non-stick coating on a Teflon pan is a 95 degrees contact angle). These are hard concepts to understand without talking about surface tension and why water molecules want to minimise their exposure to what is non-water.

For a great video explanation via MIT click here.

http://www.youtube.com/watch?v=PPJ0Khs7uWs&feature=youtu.be

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http://www.youtube.com/watch?v=7is6r6zXFDc?

Ross Nanotechnology's NeverWet superhydrophobic spray-on ...
1:04

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http://www.neverwet.com

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http://lancasteronline.com/article/local/438712_When-these-guys-say-NeverWet-----they-mean-it.htmlhttp://lancasteronline.com/article/local/438712_When-these-guys-say-NeverWet-----they-mean-it.html
Aug 14, 2011 // Jun 18, 2013

When these guys say NeverWet ... they mean it

By

CHAD UMBLE
Correspondent

For one Lancaster County company, necessity was indeed the mother of invention.

About three years ago, Ross Technology Corp. needed a better way to reduce corrosion on the steel products it makes here.

When they couldn't find a suitable one, they worked on creating something on their own.

And eventually they hit upon a slick product that's led to a whole new business.

That product is NeverWet, a silicon-based spray-on coating that repels water and heavy oils.

"When we started getting it to work, we realized it solved a lot of problems rather than just corrosion," said Andy Jones, who leads the new effort.

Jones is the president of Ross Nanotechnology, the subsidiary of Ross Technology Corp. that was formed to develop NeverWet.

The company now employs 12 scientists, chemists and engineers.

They work out of a lab at the Ross Technology headquarters in the Conestoga Valley Industrial Park.

In addition to fighting corrosion, NeverWet's nano-particle coating keeps things clean, dry and free of bacteria and ice.

Jones said that once they found a coating that worked on metal, they created different formulations that adhere better to other surfaces, including clothing, plastics and cookware.

The cookware formulation also was tweaked so it can better handle high temperatures.

"Anywhere you don't want corrosion, or ice or things to get wet, this works well," Jones said.

"When you start thinking about it, there are a lot of places where that's good."

Jones quickly mentioned a number of additional possibilities.

NeverWet could make ovens, toilet plungers and bed pans a cinch to clean, packaging resist water and white boards free of "ghost" images, he said.

Another application is safeguarding electronics.

"I sprayed my iPhone with NeverWet, submerged it in a foot of water for 30 minutes, took it out and it was good to go," Jones said.

Ross Nanotechnology isn't the only organization that likes what it sees in NeverWet.

In June, NeverWet won the top prize at InventHelp's INPEX trade show in Pittsburgh. NeverWet also won a gold medal in the science category.

The event showcases new products and innovations that are available for business and industry to manufacture, license or distribute.

Jones said Ross Nanotechnology began licensing the NeverWet technology to other manufacturers about two years ago.

It has sold four licenses to date and has numerous deals under discussion with potential licensees who'd use it on the products they manufacture.

The decision is a time- and labor-intensive exercise.

"Everybody has their own processes, so it takes a year or more of testing (before they decide whether to use NeverWet)," Jones said.

"That's the painful part of this business."

Ross Nanotechnology is focusing on a handful of niche markets, he said.

Though declining to disclose Ross Nanotechnology's sales figures, Jones said the company is "small now but growing quickly."

And, Jones said he expects to see some significant product launches in early 2012.

These would include the first retail version of NeverWet for use by consumers.

During a recent visit to the company's headquarters, Jones showed off NeverWet's capabilities in what seemed like a series of magic tricks.

On hard surfaces such as glass and ceramic that were treated with NeverWet, water turned into nearly spherical balls that shot in all directions.

A cotton shirt shed water. A canvas shoe repelled chocolate syrup and was left perfectly white.

"Shoe people are all over us," eager to buy a NeverWet license. "If you pay $200 for a pair of shoes, you want them to stay clean," he said.

Ross Nanotechnology has yet to license NeverWet to a shoe manufacturer, though, Jones said.

What's the secret behind NeverWet?

NeverWet — which has 13 patents pending — works much as Scotchgard does in protecting furniture, carpets and other surfaces. That is, it creates a very high contact angle for water on a surface, Jones explained.

A drop of water that lies flat on a surface has a contact angle of zero percent, but if the droplet forms into a perfect circle, it has an angle of 180 degrees.

Human skin provides a surface angle of 75 to 90 degrees, Jones said. Car wax provides a surface angle of about 95 degrees. Scotchgard has an angle as high as 116 degrees.

In contrast, NeverWet has a contact angle as high as 165 degrees, which means water forms an almost perfect sphere.

Because of that shape, the water is repelled.

Materials scientist Vinod Sikka, Ross Nanotechnology's director of research and development, played a key role in inventing NeverWet, Jones said.

Sikka previously spent 34 years at Oak Ridge National Laboratory, where he became manager of research and technology development.

But having a superior product alone isn't enough to guarantee commercial success, Jones points out.

"It's challenging to break into the coatings market. People have been using the same stuff from the same suppliers for a long time," he said.

Jones sees lots of potential for NeverWet, though.

"It is very novel, and when you start thinking about it, you can think about how transformative the technology can be," Jones said. "You can use it everywhere."

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http://news.cnet.com/8301-17938_105-57323425-1/this-superhydrophobic-coating-is-truly-stunning/
November 11, 2011

This superhydrophobic coating is truly stunning

After reading this article, prepare to say to yourself, "I'm living in the future."

by

Christopher MacManus

A superhydrophobic spray-on coating set to launch next year could dramatically change our perception of the phrase "water resistant."

NeverWet is a patent-pending silicon-based covering that deflects nearly all liquids and heavy oils by creating a very high contact angle upon application. The angle is much higher than traditional substrates, such as car wax (90 degrees), Teflon (95 degrees), or Rain-X (110 degrees). Liquid literally glides off NeverWet's 160 degree to 175 degree angle in a way that almost seems like computer animation, as seen in the video below.

Left: Contact angles of various surfaces. Right: A droplet sitting on a the superhydrophobic surface of a lotus leaf, which is extremely difficult to get wet.
(Credit: Ross Nanotechnologies)

At first glance, the mind-bending NeverWet comes across as a liquid repellent, but it is much more than that. Surfaces that are sprayed with NeverWet repel ice, corrosion, and even bacteria. The company behind the product, Ross Nanotechnologies, says on its Web site that the material does not fade in strength from blasts of high pressure. In fact, it even states that NeverWet-infused materials "have remained under seawater for over a year and reemerged completely dry."

A dramatic video by the company also demonstrates something unbelievable: a waterproof iPhone. A video shows an iPhone covered in NeverWet, sitting in a bowl of water for 30 minutes, remaining fully functional the entire time it is submerged. Other potential applications include a variety of objects and places, such as shoes, electrical equipment, clothing, hospitals, bathroom products, and much more.

Lancaster Online has an informative interview with several of the people behind NeverWet, including co-inventor Vinod Sikka. He admits to the Pennsylvania newspaper, "It's challenging to break into the coatings market. People have been using the same stuff from the same suppliers for a long time. It is very novel, and when you start thinking about it, you can think about how transformative the technology can be," Jones said. "You can use it everywhere."

WO2013090939
COMPOSITION AND COATING FOR SUPERHYDROPHOBIC PERFORMANCE

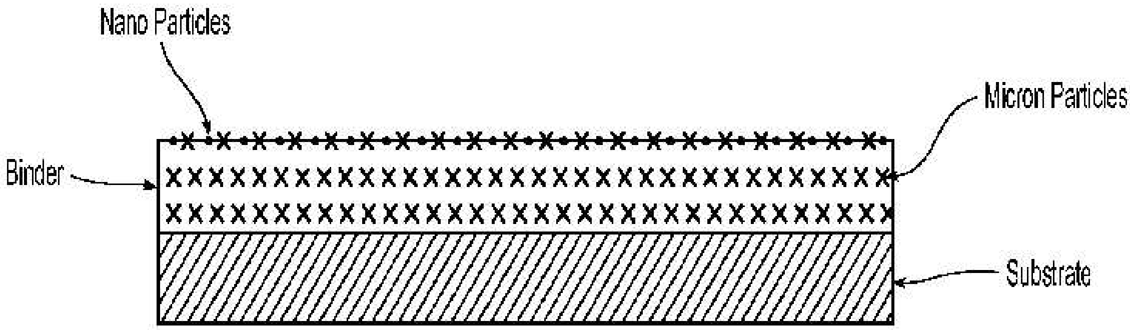
Inventor: SIKKA VINOD // HURLEY MICHAEL
Applicant: ROSS TECHNOLOGY CORP

IPC: C09D5/00

The present disclosure describes compositions comprising an acrylic polymer binder and nano-particles less than about 100nm that provide a hydrophobic or superhydrophobic coating that may also display oleophobicity. The coating composition may advantageously be prepared using VOC exempt compounds that are compatible with a variety of surface materials including many electronic components. In addition, the coating composition may also be rapidly dried rendering it useful for the rapid preparation of coated objects and surfaces in manufacturing/assembly line environments.

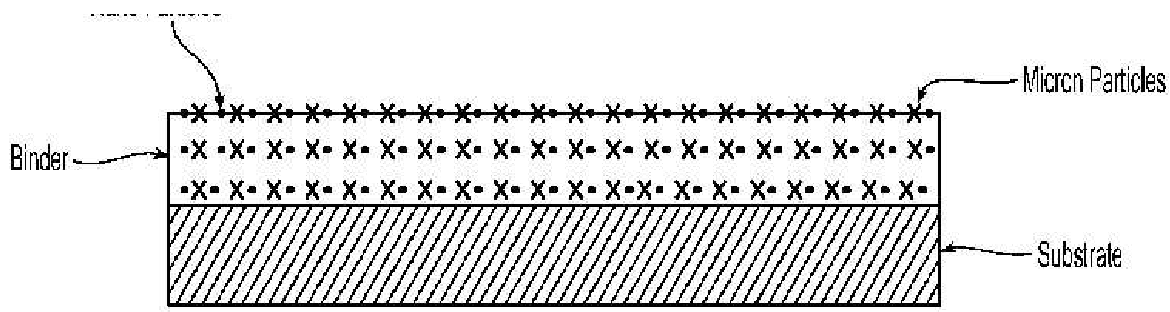
Excerpts :

WO2012115986
SUPERHYDROPHOBIC AND OLEOPHOBIC COATINGS WITH LOW VOC BINDER SYSTEMS



(a) One-Step with Bayhydrols without sodium sulfinate (Bayhuydrols 124, 122, 110 and A145)

Nano Particles



(b) One-Step with Bayhydrols 140AQ

Figure 2: Schematic showing the effect of different BAYHYDROL®s in distribution of TS720 nano particles across the coating thickness.

Inventor: GESFORD JOSH // HURLEY PHILIP

Coating compositions for the preparation of superhydrophobic (SH) and/or oleophobic (OP) surfaces that employ low amounts of volatile organic compounds are described. Also described are the resulting coatings/coated surfaces and methods of their preparation. Such coatings/surfaces have a variety of uses, including their ability to prevent or resist water, dirt and/or ice from attaching to a surface.

BACKGROUND

The superhydrophobic (SH) and superoleophobic surfaces are defined as those where water or oil droplet contact angles exceed 150[deg.]. Such surfaces have a variety of uses, including their ability to prevent or resist water, dirt and/or ice from attaching to a surface. A variety of hydrophobic and oleophobic surface coating compositions have been described that employ high amounts of volatile organic compounds (VOCs) including those that participate in atmospheric photochemical reactions. Those contrast with the coating compositions described herein that utilize water and/or VOC- exempt organic solvents that have been found to undergo limited amounts of atmospheric photochemical reactions and lower amounts of photochemically active VOCs.

SUMMARY

This disclosure sets forth coating compositions that employ water-based binder systems that have a low VOC content and/or low non-exempt VOC content, thereby providing a variety of environmental benefits in their application. The coating compositions described herein remain substantially hydrophobic/oleophobic even when abraded, and have increased durability and/or life span when subjected to normal wear and tear compared to coatings where hydrophobic and/or oleophobic components are restricted to the coating's surfaces.

DETAILED DESCRIPTION:

LOW VOC COATINGS

Compositions for forming hydrophobic and/or oleophobic coatings described in this disclosure include one-step compositions that employ water-based polyurethanes (or combinations of water based polyurethanes) as a binder in combination with one or more types of second particles. The compositions set forth in this disclosure may optionally include one or more types of first particles in addition to third particles.

The low VOC coating compositions described herein provide coatings that do not lose hydrophobicity and/or oleophobicity when their surface is abraded. As the coatings do not lose hydrophobicity and/or oleophobicity when abraded, the coatings permit thickness to be used as the basis to increase the abrasion resistance and durability.

1. Binders

To reduce the amount of VOC's, particularly non-exempt VOC's, that are released from coating compositions used to prepare hydrophobic and/or oleophobic coatings, water-based (also denoted as waterborne) binders may be used to prepare coating compositions that result in SH and/or OP coatings, including water-based polyurethanes (e.g., water-based polyurethane dispersions (PUDs), emulsions, and/or suspension).

In addition to low volatile organic compound content, water-based polyurethanes permit the formation of hydrophobic and/or oleophobic coatings that remain substantially hydrophobic and/or oleophobic even after substantial surface abrasion. Moreover, water-based polyurethanes offer mechanical flexibility, size/dimensional stability of the dried and cured coating, and they can resist embrittlement due to heat and/or light exposure. UV curable versions of water-based polyurethanes (e.g., PUDs) are also available that avoid the need to heat cure coatings, which is economically and environmentally desirable due to reduced energy expenditure associated with light cureable coating applications relative to those requiring or whose curing is enhanced by heating.

1.1 Water-Based Polyurethanes As Binders

A wide variety of water-based polyurethanes (polyurethane coating compositions comprising more than insubstantial amounts of water as a solvent and/or diluent) may be used to prepare hydrophobic and/or oleophobic coatings described herein. Polyurethanes are polymers consisting of a chain of organic units joined by urethane (carbamate) linkages. Polyurethane polymers are typically formed through polymerization of at least one type of monomer containing at least two isocyanate functional groups with at least one other monomer containing at least two hydroxyl (alcohol) groups. A catalyst may be employed to speed the polymerization reaction. Other components may be present in the polyurethane coating compositions to impart desirable properties including, but not limited to, surfactants and other additives that bring about the carbamate forming reaction(s) yielding a coating of the desired properties in a desired cure time.

In some embodiments, the polyurethane employed in the durable coatings may be formed from a polyisocyanate and a mixture of -OH (hydroxyl) and NH (amine) terminated monomers. In such systems the polyisocyanate can be a trimer or homopolymer of hexamethylene diisocyanate (HDI).

HDI Trimer Polyalcohol Polyurethane

Some solvents compatible with such systems include water, n-butyl acetate, toluene, xylene, ethyl benzene, cyclohexanone, isopropyl acetate, N-methyl pyrrolidone, and methyl isobutyl ketone and mixtures thereof; although not all of these solvents are VOC-exempt.

A variety of water-based (waterborne) polyurethane compositions may be employed for the preparation of hydrophobic, SH and/or oleophobic surfaces may be employed. Among the commercial water-based polyurethanes that may be employed in the preparation of SH and OP surfaces are those that comprise polycarbonate, polyester, polyethers and/or polyacrylic urethanes, and their aliphatic counterparts (aliphatic polyester urethane resins, aliphatic polycarbonate urethane resins, and/or aliphatic acrylic urethanes. The structures of some examples of polyacrylic urethanes, polyester urethanes, and polycarbonate urethanes are provided below...

EXAMPLE 3: VARIATION ON SECOND PARTICLE CONTENT IN A ONE-STEP COATINGS PREPARED WITH BAYHYDROL(R) 140AQ/CLEAR 700T BINDER AND CAB-O-SIL(R) TS720 RANGING FROM 11-20%

A 60:40 mixture of BAYHYDROL(R) 1.40AQ and clear POLANE(R) 700T (F63V521) by volume was prepared using those products as distributed by their ma ufacturers. TO 40 g amounts of each mixture was added 4.4, 6.0, and 8.0 g (i.e., 11%, 15%, and 20%) of CAB-O-SIL TS720. Also added to each mixture was 20-g (50%) water. All percentages are calculated and based on 100 g of 60:40 mixture. The compositions were each mixed using steel balls or a low impact mixer.

Each mixture was sprayed (using an air gun) on 4x 4-in square steel plates at five different thicknesses. All of the plates were air-dried for 30 niin prior to drying in an oven at 200[deg.]F for 30-40 min. Each plate was subjected to thickness measurement, surface roughness measurement (Ra and Rz values), and wear resistance using a Taber abrader (Taber abrasion). All Taber abrasion measurements were obtained using 250-g load and CS10 wheels. Data are summarized in Table 5 and plotted in Figs. 6-8. Figures 6 and shows the plot of surface roughness, Ra and Rz values respectively. Figure 8 shows Taber data as a function of coating thickness.

EXAMPLE 9: A ONE-STEP COATING COMPOSITION YIELDING SUPERHYDROPHOBIC AND OLEOPHOBIC COATINGS

A coating composition comprising:
BAYHYDROL(R) 124 - 24.0 grams
POLANE(R) 700T (white) - 16.0 grams
M5T = 9.0 grams (Cab-o-Sil M5 silica treated with (3,3,4,4,5,5,6,6,6-Nonafluorohexyl)trichlorosilane (SIN 6597.6) as described below)
Corvel Black - 2.8 grams and
H20 - 20.0 grams
was prepared by blending the components as follows:
BAYHYDROL(R) 124 (24.0 grams) and POLANE(R) 700T (16.0 grams) were blended together for 20 minutes. The addition of M5T (9.0 grams, M5 silica treated with (3, 3,4,4,5,5,6,6, 6-Nonafluorohexyl)trichlorosilane (SIN 6597.6)) to the solution was followed by mixing in a ball mill for 30 minutes. Addition of Corvel Black (2.8 grams) and H20 (20.0 grams) to the solution was followed by an additional 30 minutes of mixing in a ball mill.
The coating was applied using a Central Pneumatic spray gun with the nozzle size of 0.020-0.025 inches. A coating thickness of 1.2-1.4 mils was applied to a 4 x 4 inch Al-plate. The plate was cured at room temperature for 30 minutes followed by curing at 200F for 1-2 hours. After curing, the plates were tested for superhydrophobicity, oleophobicity, Taber abrasion

resistance, and shower resistance to loss of superhydrophobicity. The results of the tests show the coating displays superhydrophobicity (contact angle = 167.33, after Taber abrasion testing = (155.23). The coatings also display oleophobic/superoleophobic behavior (contact angle = 153.67). The coating lost its superhydrophobicity after 500 Taber abrasion cycles with a 250gram load. Superhydrophobicity is lost after 55-60 minutes in shower testing (described above); however, superhydrophobicity returns after drying.

US2012045954
HIGHLY DURABLE SUPERHYDROPHOBIC, OLEOPHOBIC AND ANTI-ICING COATINGS AND METHODS AND COMPOSITIONS FOR THEIR PREPARATION

Inventor: BLEECHER DOUGLAS // HARSH PHILIP

US2010314575
ANTI-ICING SUPERHYDROPHOBIC COATINGS

Inventor: GAO DI // JONES ANDREW

SUPERHYDROPHOBIC COATING OF A POLYMER NONWOVEN, IN PARTICULAR A POLYPROPYLENE NONWOVEN
WO2007048630

Inventor(s): BROCH-NIELSEN THOMAS [DK]; BONDERGAARD JENS [DK]; BESENBACHER FLEMMING [DK]; KINGSHOTT PETER [DK]; MOELGAARD SOEREN [DK] +

Also published as: DE102005051550 (A1) US2009227164 (A1) DE112006002245 (A5)

Abstract

The invention relates to a superhydrophic coating of a nonwoven. According to the invention, the nonwoven material is coated with a sponge-type net structure in the micro and nano range.
