CYTONIX

FREQUENTLY ASKED QUESTIONS

What is a hydrophobic coating?

A hydrophobic surface is a "water-fearing surface". Upon contact with a hydrophobic surface water recedes to reduce contact with the surface. By receding, the amount of water in contact with the surface is reduced to a minimum. The surface repels the water, causing droplets to form. The angle formed between the solid surface and the tangent to the curve of the liquid droplet is referred to as the contact angle. The greater the difference between the surface energy of the substrate and the surface tension of the liquid, the greater the contact angle and the easier it is to repel liquid droplets. By definition a hydrophobic surface has a contact angle to water that is greater than 90 degrees.

What is a superhydrophobic surface?

A super-hydrophobic surface has a contact angle to water that is >150 degrees. The contact angle for water on smooth solids cannot exceed approximately 130°, which is the limit for chemical hydrophobicity. To alter a hydrophobic surface to create a one that is super-hydrophobic, the surface must be roughened by the addition of micro or nano particles. Two criteria define super hydrophobicity: 1. The surface has a very high-water contact angle (>150°) and 2. The surface is micro or nano structured.

Creation of a surface with a greater than 150° contact angle to water is due to the air entrapment in the gaps of the rough structure. It is important to remember a super-hydrophobic surface is therefore a composite structure of air and solid in combination with the presence of low surface energy components on the roughened surface.

What is the history of super-hydrophobic surfaces?

The theoretical effect of surface roughness on the contact angle of a liquid was described by Wenzel and Cassie-Baxter in mathematical models formulated in the 1940s. However, it was not until 1964 that Dettre and Johnson measured the wettability of hydrophobic rough surfaces

8000 Virginia Manor Rd, #130
Beltsville, MD 20705, USA
www.cytonix.com
business@cytonix.com
301.470.6267

over an extremely wide range of surface roughness using glass beads coated with paraffin or a fluorine telomer. In 1977 Barthlott and Neinhuis, investigated the surfaces of the lotus leaf plants using electron microscopy. They showed that two scales of waxy surface texture gave rise to water bridges over the surface roughness in a Cassie–Baxter wetting state allowing water to roll off easily and remove any debris from the surface. They coined the term the "lotus effect". In the 1980s Cytonix developed some of the earliest commercial super-hydrophobic fluorinated coatings for biologics, communications, and architectural surfaces. Since 2000, super-hydrophobic surfaces have attracted considerable scientific interest as evidenced by the number of research papers published on super-hydrophobicity.

What are the benefits of a super-hydrophobic coating?

The phenomenon of super-hydrophobicity and related wetting mechanisms are attractive scientifically, but also from the industrial point of view, where extreme water repellency is desired. Articles with super-hydrophobic surfaces shed water very efficiently, carrying with it readily dissolved and wetted particulates. Another advantage of a super-hydrophobic surface is that it dramatically lowers the resistance to water flow at that surface. As the affinity of the surface for air or other gas is much higher than for water, the resistance to water flow can be primarily defined by the viscosity of the water with air or other gas rather than the solid surface. In this way a super-hydrophobic coating lowers the coefficient of friction or the drag. In addition, a very important property of a super-hydrophobic coating is increased ice and snow repellency.

What are the limitations of super-hydrophobic coatings?

In spite of numerous scientific papers on super-hydrophobic coatings most of the commercial super-hydrophobic surfaces have their limitations. Since a super-hydrophobic surface is a composite structure of air and solid in combination with the presence of low surface energy components on the roughened surface, this type of surface can be damaged due to abrasive forces which in turn reduce the level of hydrophobicity, limiting many commercial applications of super-hydrophobic coatings.

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Do I really need a super-hydrophobic coating?

Just comparing the contact angles of water to hydrophobic and super-hydrophobic surfaces you would easily think that having a super-hydrophobic surface would be better than a hydrophobic surface. However, there are other types of properties that need to be considered in deciding between a super-hydrophobic and hydrophobic surface such as abrasion resistance, durability, and transparency. Sometimes an abrasion resistant hydrophobic coating can offer more protection from water and moisture than a super-hydrophobic coating. If transparency is desired to protect against moisture, then a hydrophobic coating is generally more robust and less expensive.

What is an oleophobic coating?

An oleophobic surface repels oil. An oleophobic coating generally has a contact angle to oil that is greater than 60 degrees. Oil and oily substances like fingerprints and grease are less likely to adhere to an oleophobic surface. Therefore, oleophobic surfaces are sometimes called anti-fingerprint or easy to clean surfaces. Most cell phones and touchscreens now come with an oleophobic surface. These surfaces not only repel fingerprints they also have a slippery surface, this is due to the low coefficient of friction of the surface.

What are some applications for oleophobic surfaces?

Since oleophobic coatings repel fingerprints they are widely used on all types of portable electronic that utilize touch screens, such as smart phones, tablets, and laptops. While some devices come with a factory applied oleophobic coating, these coatings may need to be reapplied after extensive use. Membranes that repel both water and oil, such as venting membranes require an oleophobic coating.

What is an icephobic surface?

Roughened and particle containing super-hydrophobic surfaces effectively repel water but do not always repel ice. The problem is the mechanism of action of super-hydrophobic coatings. In

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humid and cold conditions, water droplets can form within the rough super-hydrophobic coating by condensation. After condensation, water droplet nuclei create water-loving and ice-loving patches. In high humidity cold conditions super-hydrophobic surfaces can lose their hydrophobic and icephobic properties.

A surface that has ice adhesion strength of less than 100kPa is considered icephobic or anti-icing. Unfortunately, ice adheres very strongly to many structural materials – aluminum, for example, has ice adhesion strength of 1600kPa. Since ice is frozen water, a great deal of research has been conducted on making icephobic coatings by increasing water repellency. Newer approaches based on interfacial cavitation using rubbery elastomers have been shown to create more durable icephobic materials. Even a small amount of force can deform the rubbery surface, breaking the solid free.

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