Large-Scale Implementation of Nanostructured Superhydrophobic (SH) Powders for Breakthrough Energy Savings

Pioneering Advanced Materials and Systems for Energy Savings

Sponsor: DOE, Office of Energy Efficiency and Renewable Energy, Industrial Technologies Program.

Features:
- Nanostructured superhydrophobic powders, coatings, and surfaces.
- Extremely water repellant.
- Antifouling behavior.
- Anticorrosion behavior.

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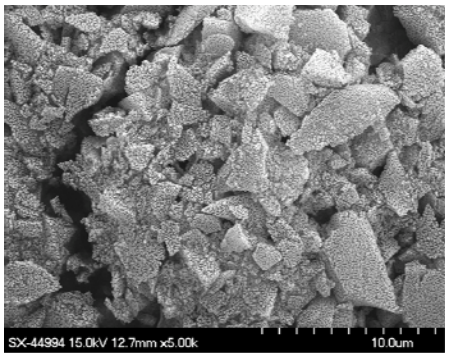
Researchers at the Department of Energy's (DOE's) Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee, have developed a set of highly water repellent materials and related surface treatments that can be applied to a large range of substrates and materials. These substrates include metals, glass, plastics, wood, and fiberglass and other composites.

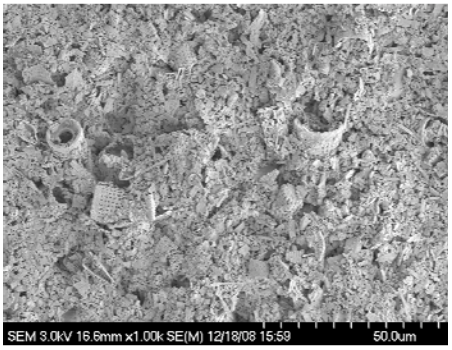
DOE's Industrial Technologies Program is currently funding and supporting a joint collaboration between ORNL and ROSS Technology, Inc., to explore the use of these SH powders in various energy saving applications. For example, the application of these SH powders could result in a substantial reduction in energy used to transport water through pipes and impede the growth of algae on the surface of water transport systems.

Large-scale implementation of nanostructured SH powders into industrial, transportation, and consumer products could lead to breakthrough energy savings and related carbon, economic, and environmental benefits.

The key to developing commercially viable highly water repellent, or "superhydrophobic," coatings is the creation of nanostructured powders, where each powder grain contains nanoscale texturing that produces an amplification of surface tension effects. These powders are treated with a water repellent chemical, and can be bonded to a wide range of substrates to produce some of the most highly water repellent surfaces known.

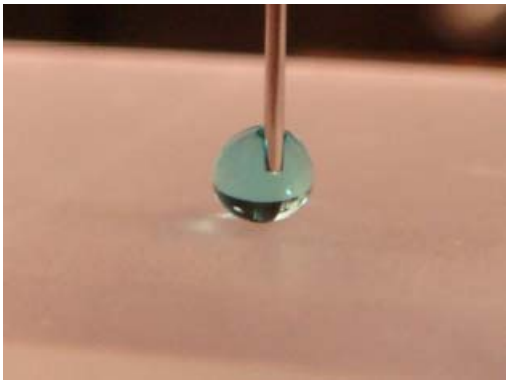


Highly water repellent nanotextured glass powder.



Milled and treated SH diatomaceous earth powder.

Coated toy boat (lower) sits substantially higher in the water than the uncoated boat (upper) due to a layer of air pinned to the coating surface.



Water drop sitting on SH powder coated surface.

ORNL researchers are exploring the use of solvents and bonding materials to produce surfaces that are not only highly water repellent, but also strongly bonded to the substrate surface and, consequently, very durable. These are powder-based treatments and can be applied to very large surface areas using conventional spray coating and painting techniques.

Further, one of these coatings is based on a commonly available, inexpensive material, diatomaceous earth, which is easily mined and is presently used in a number of agricultural and food-based products. This material is formed from the silica skeletal remains of fresh water diatoms that lived many millions of years ago. The size of these structures ranges from around 5 to 50 microns, but they contain nanometer sized surface features which produce superhydrophobic behavior after treatment to change the surface chemistry from hydrophilic to hydrophobic. The uses of extremely water repellent, robust, inexpensive coatings that can be applied to large-scale structures are vast. Examples include boat hulls, bridges, decks, and almost any exposed structure that requires protection to prevent possible damage from exposure to water and moisture.

The above image is an example of using SH powder coatings as corrosion inhibitors. The magnesium (Mg) part on the right was coated with SH powder, while the Mg part on the left was not coated. Both parts were subjected to the same corrosive (salt spray) conditions. The coated piece was completely protected, while the one on the left was not.

SH coated areas spell out "ORNL" by dramatically repelling water.