# ORNL super water repellent could cause big wave in market

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A water repellent developed by researchers at the Department of Energy's Oak Ridge National Laboratory outperforms nature at its best and could open a floodgate of commercial possibilities.

The super-water repellent (superhydrophobic) material, developed by John Simpson, is easy to fabricate and uses inexpensive base materials. The patent-pending process could lead to the creation of a new class of water repellant products, including windshields, eyewear, clothing, building materials, road surfaces, ship hulls and self-cleaning coatings. The list of likely applications is virtually endless.

"My goal was to make the best possible water repellent surface," Simpson said. "What I developed is a glass powder coating material with remarkable properties that cause water-based solutions to bounce off virtually any coated surface."

The ORNL nano-structured material maintains a microscopic layer of air on surfaces even when submerged in water, resulting in a profound change in the basic water-solid interface. Simpson likes to refer to this as the "Moses effect."

Traditionally, Simpson noted that superhydrophobic coatings were expensive, were of poor water repellent quality or lacked the durability to make them practical.

"Existing high-quality superhydrophobic materials are generally relegated to university research laboratories because they are difficult and expensive to produce, not scalable to large volumes and not amenable to being made into a commercially viable coating," Simpson said.

The process for making superhydrophobic glass powder is based on differentially etching of two glass phases from phase-separated glass. Simpson starts with borosilicate phase separating glass as the base material, which he heats to separate further. He then crushes this material into a powder and differentially etches the powder to completely remove the interconnected borate glass phase. Differential etching makes the powder porous and creates nanoscale sharpened features. Finally, Simpson treats the powder with a special hydrophobic solution to change the glass surface chemistry from hydrophilic to hydrophobic.

The powder's porosity and nanoscale sharpened features amplify the effect of water's surface tension and causes the powder to become "unwettable."

"Such a superhydrophobic powder has many features and advantages, some of which include ease of manufacturing, low cost and scalability," Simpson said. "The fact that the coral-like nanoscale features can be preserved as the powder grain size is reduced allows us to make very small superhydrophobic powder grains."

That translates into needing only a small amount of inexpensive superhydrophobic powder to coat a relatively large surface area.

Another feature of this powder is its thermal insulation characteristics. Water does not enter the grain pores because the powder grains are superhydrophobic. This results in a dry breathable coating with trapped insulating air throughout. And, because the powder consists almost entirely of porous amorphous silica, it also makes a very good electrical insulator. In addition, since the powder creates a layer of air between the coated substrate and any water on the surface, water-based corrosion of the substrate is greatly reduced or entirely eliminated.

Simpson believes the number of possible applications will continue to expand as more people become aware of this technology.

"Staying dry in a rainstorm may only have a small personal value," Simpson said, "but reducing the energy required to transport products by boat or barge or extending the life of bridges or buildings would have a great value to society and individuals alike."

UT-Battelle manages Oak Ridge National Laboratory for the Department of Energy. Simpson is a member of the Engineering Science and Technology Division. This research was funded by the Laboratory Directed Research and Development program.

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