Superhydrophobic Thin Film Coatings

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Technology Summary

Exploiting its expertise with thin films and superhydrophobic materials, ORNL has developed a simple, inexpensive way to apply and reliably bond superhydrophobic powder to various substrates, creating coatings that are both transparent and water repellant.

Because of their many advantages and applications, numerous efforts have been made to develop superhydrophobic (water repellant) surfaces, including applying superhydrophobic coatings to hydrophilic surfaces. Most of the resulting processes have been extremely costly, are not broadly applicable, or produce coatings that are poorly bonded to the substrate or exhibit low quality superhydrophobic behavior and/or poor optical transparency. By contrast, surfaces coated using the ORNL process exhibit the following properties.

- Superhydrophobicity (droplet contact angle 160° to 175°)
- Optical transparency (> 95%) over the 400 nm to 700 nm optical regime
- UV radiation scattering/blocking
- Reflectance < 1%
- Durability [abrasion resistance, temperature cycle tolerance (–40°C to 150°C), and UV radiation tolerance]

The ORNL technique involves (1) making high quality superhydrophobic powder grains with sizes much smaller than the wavelength of light so that no significant amount of light gets scattered by the coating; (2) adequately dispersing the grains in a carrier fluid and maintaining dispersal throughout coating, bonding, and drying; and (3) adequately bonding the powder grains to the substrate without changing the powder grain nanostructure or surface chemistry, which could impact hydrophobicity.

The starting material can be any high quality superhydrophobic powder, including silanated aerogels and ORNL's superhydrophobic spinodal glass. Grain size is reduced to a diameter below 200 nm during agitation in a fluorinated solvent like FC-40, which also aids in dispersing the powder. Finally, amorphous fluorinated Teflon is used to bond the superhydrophobic powder to the substrate, increase hydrophobicity, and improve optical clarity; however, other bonding agents may be used.

Advantages

- Inexpensive, abundant base materials
- Flexible, scalable, materials independent process
- May be applied to a broad range of substrates
- Cost-effective

Potential Applications

- Optical devices subject to the elements (e.g., windshields, windows)
- Eye glasses, sports goggles, camera lenses
- Durable, water repellant coatings
- Self-cleaning coatings

Patent

John T. Simpson and Linda A. Lewis. *Composition for Forming an Optically Transparent, superhydrophobic Coating,* U.S. Patent Application 12/938,044, filed November 2, 2010.

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Related Technology

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