

Nanoengineered Surfaces

Self-cleaning Coatings

...superhydrophobic surfaces

Lotus Effect

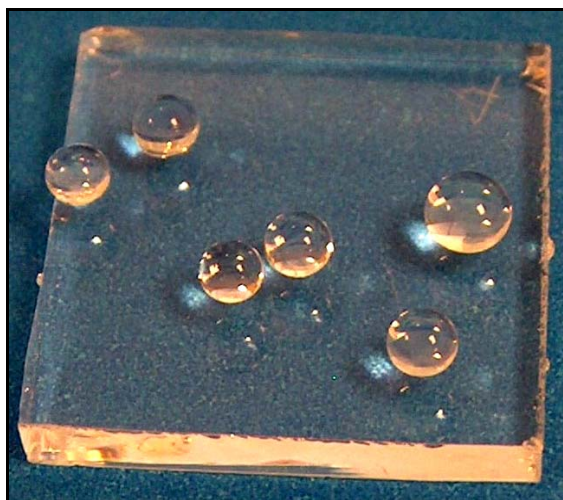
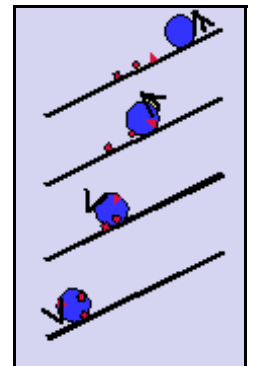
The development of superhydrophobic self-cleaning surfaces was first inspired by the observation of natural cleanness of lotus leaves and other plant leaves. Studies of lotus leaves by scanning electron microscopy (SEM) revealed that the key features of the lotus leaf are a microscopically rough surface consisting of an array of randomly distributed micropapillae with diameters ranging from 5 to 10 μm . These micropapillae are covered with waxy hierarchical structures in the form of branch-like nanostructures with average diameters of about 125 nm. The water contact angle on a lotus leaf is higher than 160° with a rolling angle of about 2° , which would be considered a high performance superhydrophobic self-cleaning surface. For reference, the droplet shown above at left has a contact angle of greater than 165° .

Example Markets for Self-cleaning Surfaces

- Architectural glass
- Building materials
- Auto glass
- Shower doors
- Solar panel glass covers
- Traffic signs/signals
- Greenhouses
- Optical components and sensors

Self-cleaning

Water droplets coming in contact with a superhydrophobic surface (contact angle $>150^\circ$) form nearly spherical beads. The contaminants, either inorganic or organic, on such surfaces are picked up by water droplets or adhere to the water droplet and are removed from the surface when the water droplets roll off, as illustrated to the right. The combination of low surface energy and micro- and/or nano-structured features, which can certainly reduce the contact area between the surface and water droplets, form superhydrophobic surfaces.



nGimat Coatings

nGimat has developed self-cleaning surfaces using its Combustion Chemical Vapor Deposition (CCVD) process to deposit thin films. The sample at left illustrates one such coated surface produced under a DOE-funded project. The water droplets are nearly perfect spheres sitting on the coated glass surface. The substrate is borosilicate glass and the water contact angle is $>165^\circ$ while the rolling angle is $<5^\circ$. Additional data is presented on the back of this page.

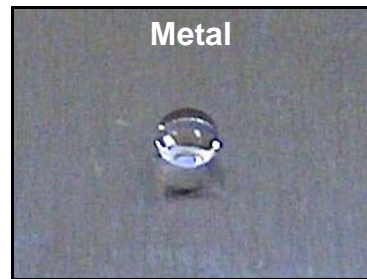
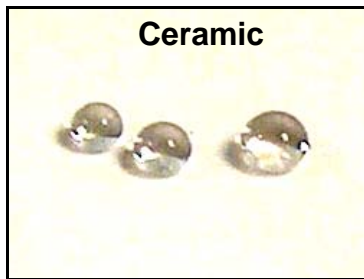
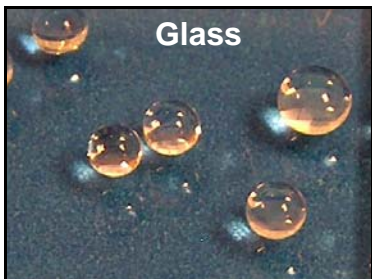
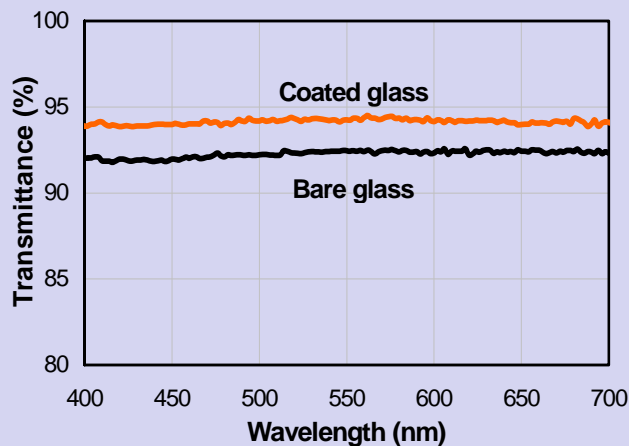
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nanoEngineered Materials™

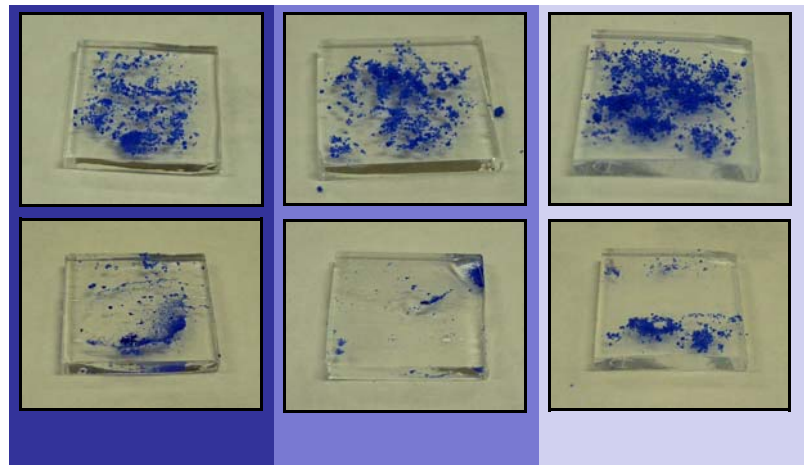
Self-cleaning Coatings

Recent developments have expanded *nGimat*'s self-cleaning coating technology to a wide variety of substrates and applications, but the initial development began on glass substrates for applications ranging from architectural to solar cell cover glass. For self-cleaning coatings, applications that require optical clarity present a challenge, since the coating must be rough enough for self-cleaning purposes but not scatter light. *nGimat* has engineered nanocoatings that meet this challenge. The graph at right shows that transmittance of the coated glass is actually improved with respect to the bare substrate due to the anti-reflective nature of the coating. This property provides additional benefit to applications, such as solar cells. The photograph at right illustrates the visual clarity of CCVD-coated glass compared to the clarity of bare glass.



As mentioned previously, *nGimat* has expanded the self-cleaning coating technology from glass to a wide variety of substrates. Examples of superhydrophobic surfaces are provided at left.

Self-cleaning properties of superhydrophobic surfaces are illustrated to the right. The three upper photos show bare, fluorinated, and fluorinated + CCVD-coated substrates, respectively, with blue powder sprinkled on the surface. The three lower photos show these same samples after a drop of water was rolled across them. Much of the powder is still spread across the bare substrate after cleaning. The fluorinated surface (which is hydrophobic) shows much better cleaning, but some powder still remains spread on the surface. The path of the water droplet is quite obvious on the fluorinated + CCVD-coated surface (which is superhydrophobic); no leftover powder is visible along the path.



The Company. *nGimat*, located inside the perimeter of Atlanta, is an intellectual property and manufacturing company that engineers nanopowders, thin films, and devices. Our facilities are equipped with instrumentation to perform cutting edge materials research, development, and manufacturing. The scientists and engineers at *nGimat* bring backgrounds in materials science, chemistry, physics, mechanical/chemical/electrical engineering, and biochemistry to the challenges of engineering nanomaterials. In addition, our analytical personnel provide rapid turn-around times and state-of-the-art materials analysis to support our materials development.

We at *nGimat* Co. would like to discuss your self-cleaning surface needs with you.

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