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Nanoparticle Coating Keeps Glass Fog-free

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COURTESY OF MICHAEL RUBNER

A CLEAR DIFFERENCE
Rubner and Cohen steamed up coated and uncoated glass slides and compared them atop a picture of a lotus flower. The slide on the left (with a taped top) has the antifog coating, while the slide on the right does not.

Michael F. Rubner and Robert E. Cohen may have just robbed Hollywood horror filmmakers of one of their most beloved clichés--the threatening note furtively traced in the fog of a bathroom mirror. That's because the MIT professors, in the departments of materials science and of chemical engineering, respectively, have developed a new superhydrophilic polymer coating that permanently eliminates fog from bathroom mirrors as well as windshields, eyeglasses, and camera lenses.

Rubner and Cohen make their coating from alternating layers of silica nanoparticles that are about 10 nm across and polyallylamine hydrochloride. The charged nanoparticles make the coating superhydrophilic so that when water droplets accumulate on the coated surface, they do so with a small contact angle, effectively forming a thin sheet of water. This eliminates fogging, which occurs when tiny water droplets condense on glass and randomly scatter light.

"Not only is the coating antifogging, but it's also antireflective," Rubner said. This, he explained, means that the coated glass is more transparent than uncoated glass. According t Rubner, regular, uncoated glass allows about 92% of light through and reflects the other 8%. Glass treated with the superhydrophilic coating lets 99.7% of light through.

The antifogging material grew out of an effort to mimic the superhydrophobic properties of lotus leaves (C&EN, June 7, 2004, page 30). In that work, Rubner and Cohen imitated the lotus leaf's characteristic micro- and nanoscale roughness by creating micrometer-sized pore in a polyelectrolyte film and then dotting this polymer with silica nanoparticles. A final treatment of waxy semifluorinated silane made the material hydrophobic.

Rubner and Cohen noticed that if they didn't apply that final hydrophobic layer, water would b instantaneously drawn into the structure. The researchers wondered what would happen if they put the polyelectrolyte and nanoparticle film onto glass rather than the opaque substrate they were using to mimic the lotus leaves. "We got these beautifully transparent films," Rubne recalled.

Rubner noted that there's a critical coating thickness required to achieve both the antifogging and antiflective properties. He said applying between 10 and 20 alternating layers gives the desired properties. He also pointed out that several aspects of the coating make it attractive t industry. Both the polymer and the silica nanoparticles are relatively inexpensive, and the layers are applied from a water-based solution. The coating process is based upon charge, h explained, with electrostatic forces holding negatively charged layers of silica together with th positively charged polyallylamine hydrochloride.

Both the military and automotive industries have already expressed interest in the coating, Rubner said. He and Cohen are currently preparing a paper on the work.

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