Silicon Micro-islands and Nano-spikes Channel Water on Glass Slides

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(PhysOrg.com) -- Working at the nanoscale level, University of Arkansas engineering researchers have created stable superhydrophilic surfaces on a glass substrate. The surfaces, made of randomly placed and densely distributed micron-sized silicon islands with nano-sized spikes, allow water to quickly penetrate textures and spread over the surface.

The research will aid in the development of commercial products with superior self-cleaning and anti-fogging properties and could lead to the design of microfluidic chips with a network of tracks or channels to better control the flow of liquid.

Discovered in the mid-1990s, superhydrophilicity is the physical condition of a material such that when water is applied to the material, the water forms no contact angle and thus prevents beading.

“Superhydrophilic surfaces exhibit self-cleaning properties because the surface has a higher affinity to water than to oils and other contaminants,” said Min Zou, associate professor of mechanical engineering and author of the study published in the Nanotechnology. “The surfaces also exhibit anti-fogging properties because a thin, uniform film of water that does not scatter light forms on the surface.”

Zou and three students tested the wettability of glass substrates by texturing the slides through a process known as aluminum-induced crystallization of amorphous silicon.

“Aluminum-induced crystallization of amorphous silicon has been studied extensively to produce films for electronic and photovoltaic applications,” Zou said, “but it has never been investigated for increasing the wettability of solid substrates.”

The researchers deposited 100 nanometers of amorphous silicon on the glass slides and then a layer of aluminum on top of the amorphous silicon. They annealed the sample at 650 degrees Celsius for 10 minutes and then removed the residual aluminum through selective wet etching. The annealing - a process of heating and cooling - created the irregularly shaped micro-islands with nano-scale spikes.

“When a water droplet reached the silicon textures, particularly the nano-sized spikes, it quickly penetrated the textures and suffused the surface,” Zou said. “The stability of the islands and spikes ensured the stability of the superhydrophilicity.”

The researchers also discovered that the textured surface becomes superhydrophobic when treated with octafluorocyclobutane, a compound of carbon and fluorine used in the production and processing of semiconductor materials and devices. Hydrophobic describes the physical property of a molecule repelled from water. Superhydrophobicity refers to material surfaces that have a water contact angle greater than 150 degrees. In other words, they are materials with surfaces that are extremely difficult to wet.

Provided by University of Arkansas (news : web)