FAST MOVING FRONTS - 2008

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Haoshen Zhou talks with *ScienceWatch.com* and answers a few questions about this month's Fast Moving Front in the field of Materials Science.

Article: Superhydrophobic perpendicular nanopin film by the bottom-up process
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SW: Why do you think your paper is highly cited?

Generally, the superhydrophobic surface was prepared by application of a rough surface based on nano- or macro-structures coated with the low-surface molecular energy molecular compound fluoroalkyltrimethoxysilane (FAS). These low-surface energy molecules such as FAS still have a hydrophobic surface with contact angle of water (CAW) in the range from 100o-108o. The traditional method is merely to increase the CAW from hydrophobic (CAW: 90o-120o) into the superhydrophobic range (CAW: 150o-180o).

It remains a challenge to increase the CAW from hydrophilic into superhydrophobic range, although it looks possible, according to Cassie's law, which explains how simply roughing up a surface increases the apparent surface angle. This paper achieved this result based on controlling the surface fraction ratio vs. the trapped air by using a perpendicular nanopin film with a pin diameter of 6.5nm by using the chemical-bath deposition (CBD) method. The CAW was increased from about 75o to 178o, which is nearly an ideal super-hydrophobic surface. It appears that this method should provide the possibility to design superhydrophobic surfaces from low-CAW materials. Such inorganic materials with low CAW will be interesting, not only for chemical and physical fundamental research, but also for industrial applications.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

It is the first time a hydrophilic surface with a CAW of 75o was transformed into a superhydrophobic surface with a CAW of 178o, while only utilizing a perpendicular nanopin structure film.

SW: Would you summarize the significance of your paper in layman's terms?

The hydrophilic surface can be changed into superhydrophobic only by modifying the roughness of the surface.

"Some other possible applications—such as LIB, SP, PEFC, DSSC, OWGS—are already being investigated by our group for solutions to the worldwide problems involving energy and the environment."

SW: How did you become involved in this research and were there any particular problems encountered along the way?

In our group, we synthesize various nanostructure functional materials in order to develop energy storage devices and environmental detectors, such as the lithium ion battery (LIB), super-capacitor (SP), polymer electrolyte fuel cell (PEFC), dye sensitized solar cell (DSSC), and optical waveguide gas sensor (OWGS).

At first, we developed a bottom-up approach to synthesize cobalt hydroxide nanosheets and nanopins under different processing conditions. At that time, we wanted to intercalate some molecular substances such as lauric acid into crystalline frame of d-spacing in order to fabricate organic/inorganic hybrid materials. In fact, we failed.

However, as we discovered the super-hydrophobic phenomenon purely by accident, we realized that this interesting phenomenon could be completely explained by Cassie's law and extended a new output for perpendicular nanopin films. As for practical applications, there are still some critical problems remaining, such as how to increase its mechanical strength.

SW: Where do you see your research leading in the future?

We have extended the nanopin-to-nanosheet and nanorod structures for super-hydrophobic surfaces, and cobalt hydroxide to other metal hydroxide or metal oxides. In the future, the concept described in this paper can be extended to cover several potential practical applications such as anti-sticking, anti-frost, anti-cloudy, anti-contamination, anti-snow stacking, self-cleaning, and minimizing flow resistance through a pipeline.

SW: Do you foresee any social or political implications for your research?

Currently, nanostructure surface modification has become one of the most efficient ways to fabricate functional surfaces for various applications. Super-hydrophobic technology is only one example.

Some other possible applications—such as LIB, SP, PEFC, DSSC, OWGS—are already being investigated by our group for solutions to the worldwide problems involving energy and the environment. Some of these investigations are being funded by the Japan Science and Technology Agency (JST), New Energy and Industrial Technology Development Organization (NEDO), and the Japan Society for the Promotion of Science (JSPS) and the National Institute of Advanced Industrial Science and Technology (AIST).

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Keywords: superhydrophobic surfaces, fluoroalkyltrimethoxysilane, hydrophobic surface with contact angle of water, chemical-bath deposition method, perpendicular nanopin structure film, synthesize various nanostructure functional materials, cobalt hydroxide nanosheets and nanopins, Cassie's law.

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