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An engineered directional nanofilm mimics nature's curious feats

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(PhysOrg.com) -- In nature, textured surfaces provide some plants the ability to trap insects and pollen, certain insects the ability to walk on water, and the gecko the ability to climb walls. Being able to mimic these features at a larger scale would spur new advances in renewable energy and medicine. In a paper published in the October 10 issue of *Nature*

Materials, a team of researchers from Penn State, the Naval Research Laboratory, and Harvard Medical School report on the development of an engineered thin film that mimics the natural abilities of water striding insects to walk on the surface of water, and for butterflies to shed water from their wings.

Although superhydrophobic self-cleaning surfaces are an active area of research, this development marks an engineering breakthrough in the ability to control the directionality of liquid transport. Using an array of poly(p-xylylene) nanorods synthesized by a bottom-up vapor-phase technique, the researchers were able to pin water droplets in one direction with enormous adhesive forces proportional to the number of nanorods and the surface tension, while releasing droplets in the opposite direction.

The differential between the pin and release force is 80 micronewtons, over ten times the values reported in other engineered surfaces with ratchet-like features, and the first such surface to be engineered at the nanoscale. Recently, the authors also demonstrated directional adhesion and friction of these surfaces, similar to the way a gecko can climb a wall (*J. Applied Physics*, 2010). Gecko's feet contain approximately 4 million hairs per square millimeter, whereas polymer nanorods can be deposited at 40 million rods per square millimeter.

The nanofilm produced by this technique, called oblique angle deposition, provides a microscale smooth surface for the transport of small water droplets without pumps or optical waves and with minimal deformation for self-powered microfluidic devices for medicine and for microassembly.

In work sponsored by the U.S. Navy, the nanofilm is envisioned for use as a coating that would reduce drag on the hull of vessels and retard fouling. Potential industrial and energy related uses are as directional syringes and fluid diodes, pump-free digital fluidic devices, increased efficiency of thermal cooling for microchips, coatings for tires, and even in energy production from rain drops.

The lead on the Penn State team, Melik Demirel, associate professor of engineering science and mechanics and corresponding author on the report, believes that the current laboratory based vapor phase technique, which although relatively simple still requires a vacuum, can be replaced by a liquid phase technique, which would allow for scaling the production of their material to industry size. “The major impact of our method is that for the first time we can create a controlled directional surface at the nanoscale,” Demirel concludes.

More information: The paper, “An engineered anisotropic nanofilm with unidirectional wetting properties,” is available at www.nature.com/nmat/journal/va … nt/abs/nmat2864.html .

Provided by Pennsylvania State University

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