Combating Friction and Stiction

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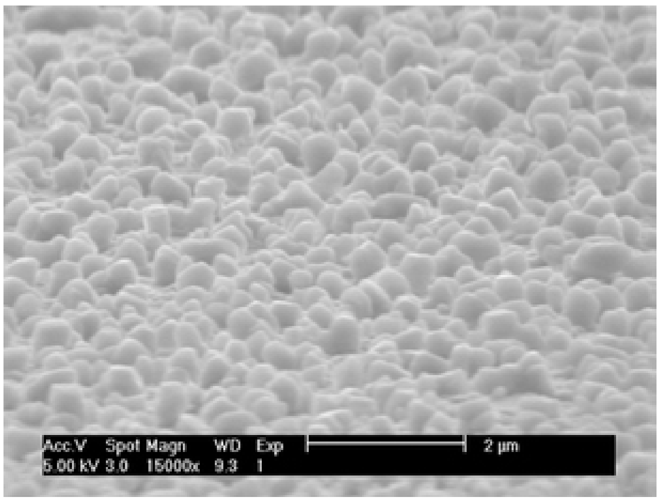

Nanoscale bumps.

Micro-electro-mechanical systems, popularly referred to as MEMS, in small electronic devices often fail because of adhesion and stiction – the attractive force between the surfaces of interacting parts. University of Arkansas researchers have developed a surface-topography engineering method that reduces these forces and will help microscopic parts interact and function smoothly.

“There are two approaches to address adhesion and stiction issues in MEMS devices,” said Min Zou, assistant professor of mechanical engineering. “One is chemistry – applying chemicals on surfaces to weaken the forces. The other is topography engineering. Our approach was simple – we engineered nanoscale bumps to reduce the contact area between surfaces."

Water contact angle.

The goal of the project was to create a hydrophobic surface. Determined by a popular engineering benchmark known as the water-contact angle, hydrophobicity describes the process of water "beading up" or turning into a ball, such as rain does on an automobile windshield that has been treated with chemicals.

The water-contact angle is the measurement used to describe the extent to which water beads. A water-contact angle greater than 90 degrees is considered hydrophobic, and any angle greater than 150 degrees is considered superhydrophobic. With a water-contact angle of approximately 180 degrees, beads represent a near-perfect sphere with only minimal contact on surfaces.

Using only topography-engineering methods, Zou's team achieved a water-contact angle as high as 137 degrees on silicon. No other researcher has achieved a higher water-contact angle without the use of chemicals. Zou's team also conducted a study that combined the surface-topography engineering method with chemicals. That study achieved a water-contact angle greater than 150 degrees, and thus produced a superhydrophobic surface.

Zou's team started with amorphous silicon – silicon that does not exhibit any crystalline form or shape. The researchers used aluminum to induce crystallization, which manifested as nano- or microcrystallites to form the textured surfaces. The researchers induced crystallization by annealing – a process of heating and cooling – the amorphous silicon in a conventional furnace.

"We demonstrated that the surface area covered by nanotextures can be controlled by changing annealing temperature and duration," Zou said.

In addition to electronic devices, the research applies to biomedical devices. It also advances the understanding of tribology, which is the study of friction, wear and lubrication of interacting surfaces in relative motion, such as gears, bearings and head-disk interfaces in computer hard drives.

Zou presented the research findings in January at the International Conference on Integration and Commercialization of Micro and Nano-systems organized by the American Society of Mechanical Engineers. The research was awarded the conference's best paper award.

Source: University of Arkansas, Fayetteville