Organic Layers Pave Way for Next Generation of Biosensors and Solar Cells

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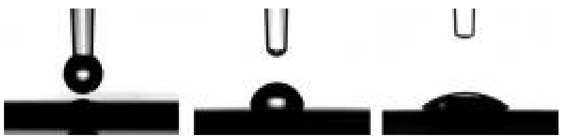

First frame: A droplet of water is about to be dropped onto a silicon surface. Second frame: On the original surface the droplet is tall, exhibiting minimal contact with the surface. Final frame: After modification, the surface has become more hydrophilic, an indication of progress toward researchers' goal of creating a silicon surface that will bond with organic molecules.

(PhysOrg.com) -- UT Dallas researchers have laid the groundwork for attaching virtually any organic molecule to silicon, a technological feat that promises to greatly improve semiconductor devices' performance in health care and solar power applications in particular.

"This is very exciting to have been able to go beyond what was thought to be possible," said Dr. Yves Chabal, principal investigator in the project and head of the Materials Science and Engineering Department at UT Dallas.

His team's accomplishments were reported in two articles in the October 2009 and February 2010 issues of the journal *Nature Materials.*

For semiconductors such as silicon to interact with the environment - as a biosensor that detects cancer-marker proteins, for example - it would be necessary to have an organic layer that interacts with those proteins. That interaction would then be detected by traditional circuitry underneath.

A critical challenge for fabricating biosensors and photovoltaic solar cells is to attach functional organic molecules without introducing electronic defects at the semiconductor surface. Up until now, biosensor devices were made using oxidized silicon, resulting in poor stability. And photovoltaic devices were limited due to what are known as interface traps, resulting in less-efficient energy transfer.

Nearly 20 years ago, Chabal and co-workers at Bell Labs devised a method to prepare oxide-free silicon surfaces perfectly terminated with a layer of hydrogen atoms. Recently, methods to attach organic molecules to that surface have been developed, but the number of molecules that can be attached is very limited, restricting the value of these methods for most applications, such as biosensors, microelectronics, optoelectronics and solar receptors. If oxidized surfaces are used instead, poor stability results, limiting performance and eliminating widespread use.

Chabal's latest effort took five years, culminating in several breakthroughs that enable two novel ways to make hydrogen-terminated silicon surfaces more reactive with organic molecules. The key to these processes is the ability to nanopattern these silicon surfaces in a very controlled fashion.

"We persisted primarily because of the excitement of the scientific discovery," he said, "but also because I could see that such fundamental knowledge could have a big impact on industrial applications."

In addition to enabling biosensors that detect minute quantities of substances such as cancer-marker proteins, the new technology promises a new generation of higher-efficiency solar cells, which have long languished at efficiency of less than 50 percent. Such higher-efficiency photovoltaic cells would incorporate sunlight-sensitive biomolecules, nanoparticles or quantum dots that capture photons and transfer the energy to the electronic substrate.

Chabal, who also holds the Texas Instruments Distinguished University Chair in Nanoelectronics at UT Dallas, believes the findings of his team's results could find their place in commercial applications within five to 10 years.

More information: www.nature.com/nmat/index.html

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