Controlling the growth of organic single crystals

ELECTRONIC MATERIALS

Single crystals of organic semiconductors can have mobilities as high as 20 cm^2/Vs and are promising for organic thin-film transistors. But it is difficult to make good electrical contacts to single crystals and, most challenging of all, their fragility makes them difficult to handle. One way around the handling problem would be to grow the single crystals directly on selected areas of a device structure. Researchers from the University of California, Los Angeles, Stanford University, and Lucent Technologies have grown oriented, large single crystals of anthracene on patterned self-assembled monolayers (SAMs). The group has demonstrated the potential of the work by fabricating functional transistors [Briseno *et al.*, *J. Am. Chem. Soc.* (2005) 127 (35), 12164].

Single crystals of anthracene grown on patterned 100 μm x 100 μm squares of 3P SAMs. (Courtesy of Alejandro L. Briseno.)

"The ability to control various aspects of crystal growth in one system provides a powerful technique for the bottom-up fabrication of organic single-crystal semiconductor devices," explains Alejandro L. Briseno. "We also show that functional transistors can be fabricated which exhibit performances exceeding those of conventional fabrication methods."

SAMs on a Au substrate were used to control the crystallization of anthracene. The team tried a number of different SAMs, including alkanethiols with various end groups as well as oligophenylene thiols. The best results were obtained with terphenylthiol (3P), where the anthracene crystals always had the same orientation. This is because the orientation and packing of the 3P SAM matches the orientation and lattice spacing of the molecules in the crystal. Microcontact printing was used to create patterns of 3P SAMs. These substrates showed highly localized growth of anthracene crystals on the 3P regions. The team was able to grow large single crystals 100 μm x 100 μm in size in this way. Briseno and colleagues are now working to optimize conditions to achieve patterned growth of single crystals over large areas for devices.

Jonathan Wood

Superhydrophobic polymers cast from lotus leaves

FABRICATION & PROCESSING

Hang Ji and colleagues at Peking University in China and the Ecole Normale Supérieure in Paris, France have created a superhydrophobic polymer structure by directly replicating the surface of a lotus leaf [Sun *et al.*, *Langmuir* (2005) doi: 10.1021/la050316q].

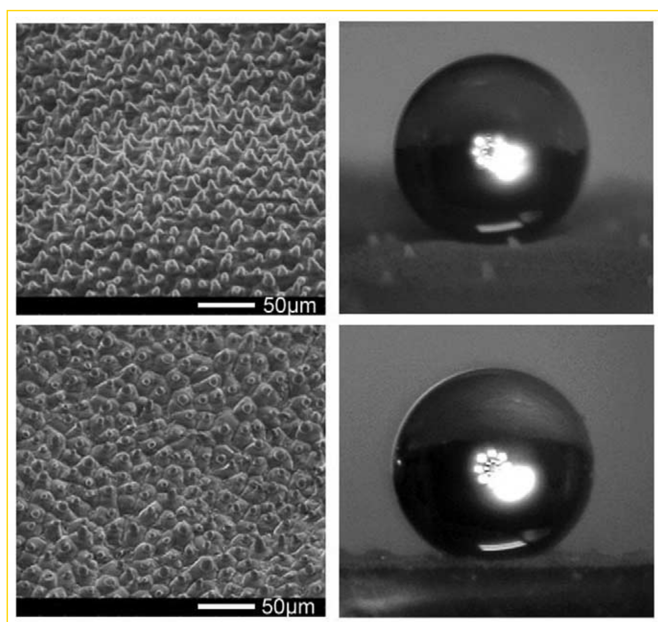
Lotus leaves are well known for their superhydrophobicity. Their textured surface with hierarchical micro- and nanoscale structures leads water drops to roll off the leaf and carry away dust particles and debris.

Self-cleaning and water-resistant synthetic mimics of the lotus plant could have applications as coatings for vehicles in water and for friction reduction of microchannels in microfluidics, explains Ji.

A number of methods have been used to simulate the surface of a lotus leaf, but they have typically involved many steps and processes or chemical treatments. In contrast, the soft-lithography method of the Chinese researchers is simple, easy to control, and faithful. Furthermore, it allows mass replication of the intricate surface topography of the lotus leaf.

Poly(dimethylsiloxane), or PDMS, was used to replicate the lotus leaf structure. The leaf is used as a template to cast a complementary PDMS layer. An antistick layer is added to the PDMS, which is then used as a negative template for a second PDMS casting step. The second PDMS layer is then a positive image of the lotus leaf. The complex lotus surface patterns are transferred with high fidelity.

The artificial PDMS lotus leaf has the same water contact angles and very low water roll-off angle as the natural lotus.



Both the lotus leaf (top) and replicated polymer structure (bottom) have the same superhydrophobic behavior. (© 2005 American Chemical Society.)

"The replicated textured surface shows the same superhydrophobic behaviour as the lotus and remains stable for long periods in humid environments," says Ji. "Remarkably, replication from a natural template allows one to reproduce complex topographic patterns simply, when it is often difficult to simulate practically and accurately," says Ji.

Jonathan Wood