

only to amorphous networks. The researchers confirmed a well-defined, ordered mesostructure by scanning and transmission electron microscopy studies. They also found that the solid monoliths obtained in this way were transparent but birefringent when observed between crossed polarizers.

Saravanamuttu and Andrews proposed a model based on bicontinuous microemulsions to explain the unusual submicrometer periodicity of the composites. Microemulsions are ternary systems composed of organic, H₂O, and surfactant phases. The researchers said that in their system, a microemulsion forms upon generation of amphiphilic oligosiloxanes through condensation reactions of alkoxy-silanes. Because they possess relatively short organic chains, sterical limitations, and non-ionic head groups, these oligomers cannot form micellar structures. Instead, they are likely to self-assemble into minimal-energy, amphiphilic monolayers with low curvature and bending rigidity that occupy the interfaces between immiscible organic (alkoxysilane) and H₂O phases. According to the researchers, this could lead to a thermodynamically stable bicontinuous microemulsion in which the oligosiloxane monolayers partition organic and aqueous phases into discrete volumes. This microstructure could then be "frozen" by photopolymerization of the acrylate moieties, they said.

ANDREI A. ELISEEV

Phases of Surface-Parallel Molecules Discovered in Hg-Supported Langmuir Monolayers

Langmuir monolayers (LMs) are formed by amphiphilic molecules like alcohols and fatty acids on a liquid surface. The structure and properties of these monolayers strongly depend on the architecture of the constituent molecules and their inter- and intramolecular interactions. Until recently, however, LMs were studied on aqueous subphases, where the hydrophobic repulsion aligns the molecules normal to the surface. In the November 15 issue of *Science*, researchers from Bar-Ilan University, Israel; Brookhaven National Laboratory; and Harvard University have reported angstrom resolution x-ray measurements of the coverage dependence of the structure of LMs formed by stearic acid on a liquid Hg subphase.

M. Deutsch of Bar-Ilan and co-workers said that the resolution is possible because the high surface tension of Hg results in a very low surface roughness (~1 Å). Under the combined action of the alkyl chain-Hg attraction and the weak but important carboxyl head group-Hg subphase bond (~1.5 kJ/mol), a small change in the coverage induces a drastic change in the orientation of the molecules relative to the surface. At high coverage, from 19.5 Å²/molecule to ~25 Å²/molecule, a monolayer showing two phases of surface-normal molecules was found, similar to those found on water. At low coverage, from 57 Å²/molecule to 120 Å²/molecule, two hitherto unobserved phases of single and double layers of surface-parallel molecules were found. These flat-lying phases consist of molecular dimers packed side by side to form stripes. Long-range in-plane order is found to exist in the direction normal to the stripes, but no order is found in the dimer ordering along the stripe. This one-dimensional order in a two-dimensional layer is, in effect, a two-dimensional smectic-like phase. X-ray reflectivity and grazing incidence diffraction were used for measuring the structure of the monolayer normal and parallel to the surface, respectively. Bragg rod measurements detected the molecular tilt magnitude and direction.

The researchers said that this understanding of the interactions is important in the emerging fields of nanofabrication and biometallic interfaces.

MAXIM NIKIFOROV

Single DNA Molecules Detected by Nanopore Technology

The development of nanopore-based biomolecule detection techniques has been impeded by the difficulty of nanopore manufacture and poor nanopore stability. Physics professor Lydia Sohn and graduate student Omar Saleh in the Department of Physics at Princeton University have described the microfabrication of a stable nanopore-sensing device achieved by well-established techniques. The device consists of two 5-µm-deep reservoirs connected by a 3-µm-long, 200-nm-diameter pore micro-molded into poly(dimethylsiloxane) (PDMS). The nanopore sensor detected single λ-phase DNA molecules by monitoring the electric current produced by the flow of analyte solution through the pore. The microfabrication procedure can also be

used to create sensors for proteins and peptides, as well as sensors that distinguish between different surface functionalities of an analyte molecule. According to Sohn, this nanopore-sensing device represents a "first step toward a host of single-molecule sensing applications."

As described in the January issue of *Nano Letters*, the researchers used electron-beam and photolithography techniques to pattern negative masters of the pore and reservoirs, respectively, as polystyrene structures onto a silica substrate. PDMS was then poured over the master and allowed to harden. The master was then removed and the PDMS slab sealed to a glass cover slip. The master for the mold is very durable and can be used to fabricate a large number of nanopore sensors, according to Sohn and Saleh.

Analyte solution was driven through the sensing nanopore by electrophoresis or by applying pressure to one of the reservoirs. The electric current that accompanied the flow was measured using platinum electrodes on the cover slip. The current through the pore was lower when a large molecule obstructed the flow of solvent. The drop in the current was proportional to the size of the molecule and allowed for coarse sizing of the DNA. The drop in the current was also lower for larger pores, and could not be reliably measured for pores >300 nm in diameter.

The researchers said that this device can be used to detect smaller biomolecules by reducing the pore size. They said the pore can also be functionalized with various molecular species to change the retention time, and current profile, of the analyte. This chemical interaction can also be used to distinguish between two similarly sized but differently functionalized analyte molecules, they said. The Sohn research group is currently investigating the manufacture of nanopore array devices for detection of multiple analytes, as well as devices that allow optical and electric screening of samples.

GREG KHITROV

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News of MRS Members/Materials Researchers

Ibon Azkona of the Basque Technology Centre has received an award from the **European Powder Metallurgy Association** for the **best European doctoral thesis on powder metallurgy in 2002**. The result

of the research carried out by Azkona has been the production of ultrahard materials based on transition-metal borides through a feasible route at industrial scale. The award was announced on October 8

during the EPMA conference held in Lausanne, Switzerland.

Camden R. Hubbard (Oak Ridge National Laboratory) has received the **2002 McMurdie Award** for contributions to the