turned off. The researchers noted several possible improvements to the system, including optimization of the zeolite chemistry and the use of more sophisticated optical reflection measurement techniques.

COLIN MCCORMICK

Highly Ordered Isoporous Membranes Fabricated from Nanocomposites

Isoporous films, which have application in photonics, biotechnology, and biomedical devices, have previously been formed by the incorporation of inorganic nanoparticles into an organic polymer matrix. However, the properties of this class of nanocomposite materials are adversely affected by nanoparticle aggregation. In general, attachment of polymer chains to nanoparticles increases their dispersion and results in improved mechanical properties and thermal stability. Recently, D. Nystrom and colleagues from KTH, together with M. Whittaker from the University of Queensland, grafted polymers onto silica nanoparticles and used them to fabricate isoporous membranes.

As reported in *Macromolecular Rapid Communications* **26** (p. 524; DOI: 10.1002/marc.200400617), KTH researcher A. Hult and colleagues used atom-transfer radical polymerization to graft polystyrene (PS) onto functionalized silica nanoparticles. Infrared spectroscopy confirmed the PS grafts, which had a molecular weight of 23,400 g/mol. The researchers cast films on a glass substrate from a mixture of hybrid nanoparticles, CS_2, and linear PS under humid conditions. A temperature decrease resulting from solvent evaporation caused water to condense onto the film surface. Stabilized water droplets were then formed when hybrid nanoparticles precipitated at the water–solvent interface. An opaque film formed when all solvent evaporated, with the final membrane containing 10 wt% silica. The researchers, using an optical microscope and atomic force microscopy to analyze the membrane structure, observed a hexagonal array of pores, that is, a honeycomb structure, with an average pore diameter of 2.5 µm, a nearly monodisperse pore size distribution, and a pore depth varying from 0.8–1.5 µm. By changing the humidity and the rate of air flow, the researchers were able to vary the pore size from 2 µm to 8 µm.

Hult and co-researchers said that their method is applicable to a broad range of materials and that the large surface areas, open pore structure, and isoporous nature of the films make them very attractive for membrane applications.

Hult said, "We can also make nanocomposites in which copolymers are grafted to the silicon microstructure."

STEVEN TROHALAKI

Ice Used As Resist for Patterning Nanostructures

G.M. King and researchers at Harvard University have recently demonstrated the use of frozen water as a resist for electron-beam lithography. They patterned chromium lines as narrow as 17 nm and lines of local surface chemical transformations as narrow as 5 nm, as reported in the June 8 issue of *NanoLetters* (p. 1157; DOI: 10.1021/nl050405n).

The researchers cooled a silicon substrate in a scanning electron microscope chamber to 128 K before leaking in water vapor to grow a stable ice film. They patterned the ice film using the electron beam (1–30 keV, 30–150 pA, ~5 nm diameter) and performed a lift-off process by sput-

CNT Arrays Encapsulated into Freely Suspended Flexible Films

Carbon nanotubes (CNTs), with their mechanical strength and electrical properties, are excellent candidates for multifunctional membrane sensors requiring high electrical conductivity and extreme robustness. However, it is hard to obtain long-living, freestanding, organized micro- and nanostructured membranes composed of nanowires and nanotubes due to their extreme fragility. Recently, H. Ko and a group of researchers at Iowa State University introduced a method to fabricate freestanding microarrays of CNTs by encapsulating them into robust, albeit compliant, polymeric nanofilms.

As reported in the May 17 issue of *Chemistry of Materials* (p. 2490; DOI: 10.1021/cm050495x), the researchers encapsulated CNT microarrays into freely suspended layer-by-layer (LbL) membranes by using spin-assisted LbL (SA-LbL) assembly and microcontact printing by sacrificial polymer patterning. The experimental procedure for patterned arrays of CNTs is outlined schematically in Figure 1. The CNT layer was ~5 nm thick with a density of ~18 bundles/µm^2. Raman spectra at the CNT area confirmed that neither the oxidation process nor deposition routine significantly affected the microstructure of the CNTs encapsulated into the LbL membranes. High optical contrast caused by the alternating layers into the LbL membrane creates an efficient Raman grating with a variation of G-band intensity of 1:1000 and higher.

By using interferometry, the researchers also studied how the encapsulation of the CNT arrays affects elastic properties of the freely suspended films. The result confirms that the filler-toughening mechanism effectively enhances the elastic properties of the patterned nanomembranes similarly to that demonstrated for thick homogeneous LbL films.

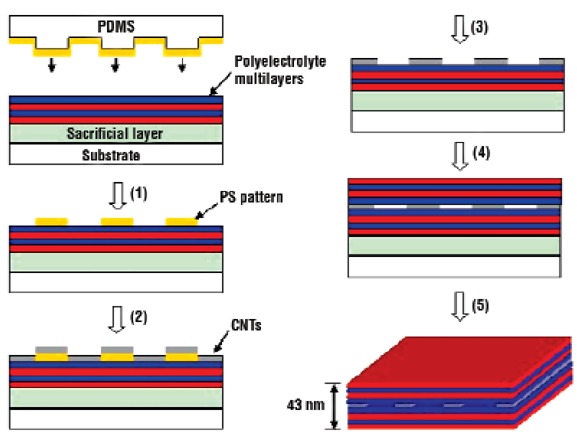


Figure 1. Schematic illustration of the procedure for fabricating freely suspended carbon nanotube arrays: (1) microcontact printing of polystyrene (PS) onto polyelectrolyte multilayers; (2) deposition of carbon nanotubes on the patterned substrates; (3) removal of PS layers; (4) formation of topmost polyelectrolyte multilayers by layer-by-layer assembly; and (5) release of carbon nanotube arrays by rinsing away the supporting sacrificial film. PDMS is poly(dimethylsiloxane). Reprinted in part with permission from Chem. Mater. ***17*** *(May 17, 2005) p. 2490. ©2005 American Chemical Society.*

The researchers said that the excellent mechanical properties of CNTs can be retained and finely tuned by embedding freely suspended carbon nanotube arrays in nanoscale polymer films. New anisotropic properties such as optical (Raman) gratings and potentially directional conductivity can be introduced. These new anisotropic properties have prospective applications for directional sensing and anisotropic electrical conduction.

TAO XU

tering the pattern with chromium in an adjacent chamber followed by a rinse in isopropanol to remove the ice and excess chromium. The ice can also be removed by sublimation. When no chromium was deposited, the researchers observed that a thin layer of material had grown in the patterned areas. The group posits that the material is a silicon oxide formed by a beam-induced reaction between the silicon substrate and the ice.

The potential advantages of an ice resist include the simplicity and purity of the process: The resist is deposited *in situ* under vacuum, there is little residue, and no harsh solvents are required. In comparison to the commonly used resist poly(methyl methacrylate) (PMMA), the researchers said that ice results in finer lines under typical exposure conditions and that ice does not suffer from the same proximity effects as PMMA due to a noncumulative effect of back-scattered electrons. A downside of the ice resist is that it requires an area dose of 8.8×10^5 μC/cm^2 to clear a 75 nm layer of ice, which is three orders of magnitude greater than that required for PMMA; however, the use of a focused ion beam results in faster writing speeds. The researchers said that further investigations are needed to minimize the dose as well as to probe the resolution limit and explore the use of other condensed gas species—both noble gases to prevent surface reactions and reactive gases to produce novel materials for nanoscale devices.

AMANDA GIERMANN

CNTs Used to Produce Multi-Beam Scanning Field-Emission X-Ray Source

Researchers J. Zhang of the University of North Carolina–Chapel Hill and Y. Cheng at Xintek Inc., Research Triangle Park, North Carolina, and their colleagues have reported a multi-beam field-emission x-ray source that can generate a scanning x-ray beam to image an object from multiple projection angles without mechanical motion. Details of their work appear in the May 2 issue of *Applied Physics Letters* (184104; DOI: 10.1063/1.1923750).

The key component of the device is a gated carbon nanotube (CNT) field-emission cathode comprising an array of five electron-emitting CNT pixels that are individually addressable by a metal oxide semiconductor field-effect transistor (MOSFET)-based electrical circuit. A pixel is activated when a voltage signal is applied to a corresponding MOSFET circuit. Under appropriate conditions, electrons are emitted from this activated pixel and are accelerated and focused on an area on a molybdenum target to produce an x-ray beam. Electrons from different pixels lead to x-ray emissions from different areas on the target. To generate a scanning x-ray beam, a pulsed controlling signal with a predetermined pulse width is swept across individual MOSFETs to generate a pulsed electron beam from each pixel, producing x-ray radiation from the corresponding focal point on the target. The controlling electrical circuit automatically compensates for cathode current intensities across the pixels. By using a digital area x-ray detector, images of an object from different angles of projection were recorded without moving the object or the x-ray source.

"This is a first step towards experimental realization of a multi-beam field-emission x-ray source," the researchers said. "The device can potentially lead to a fast acquisition rate for laminography and tomosynthesis with simplified experimental set-up."

SHIMING WU

News of MRS Members/Materials Researchers

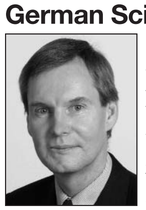
Mildred S. Dresselhaus Honored with Heinz Award

Mildred S. Dresselhaus

Mildred S. Dresselhaus of the Massachusetts Institute of Technology received the 11th Heinz Award for Technology, the Economy, and Employment in recognition of her contributions as a scientist, researcher, educator, and trailblazer for women in the sciences. An MIT professor and researcher for more than four decades, Dresselhaus is recognized by the Heinz Award as one of the United States' foremost experts in the multifaceted field of condensed matter and materials physics. Her investigations into the electronic properties of graphite, the structure and properties of novel forms of carbon, thermoelectricity, and the new physics at the nanometer scale have significantly advanced these fields, while at the same time, she has worked to break down stereotypes and expand opportunities for women in science. She has lectured around the world, written extensively about her research and served in prominent leadership roles, including as director of the Office of Science at the U.S. Department of Energy and as president of the American Physical Society and the American Association for the Advancement of Science, among other high-profile posts. She is a recipient of the National Medal of Science.

Presented by the Heinz Family Foundation of Pittsburgh since 1994, the $250,000 Heinz Awards, among the largest individual achievement prizes in the world, recognize profound contributions across a spectrum of activity—from the arts and the environment to technology and public policy. The award is named for the late Sen. John Heinz (R-Pa.). The Heinz Award was presented to Dresselhaus at a private ceremony in Washington, D.C., on May 24.

Eduard Arzt Receives 2005 German Science Prize



Eduard Arzt

Eduard Arzt, director of the Max Planck Institute for Metals Research and a professor of physical metallurgy/metal physics at the University of Stuttgart, has been named the 2005 recipient of the German Science Prize, awarded by the Stifterverband für die Deutsche Wissenschaft. This industrial foundation supports applied research in Germany. The prize recognizes Arzt's interdisciplinary team of materials scientists and biologists for their studies of artificial mechanical attachment systems based on biological attachment in flies, spiders, and geckos. The €50,000 research award was presented to Arzt at the Annual Max Planck Society meeting on June 23 in Rostock, Germany.

Ian W. Boyd Awarded the John Yarwood Memorial Medal and Senior Prize

Ian W. Boyd of the Department of Electronic and Electrical Engineering and London Centre for Nanotechnology at University College London has received the John Yarwood Memorial Medal and Senior Prize for "outstanding pioneering contributions to thin-film growth technology applied to microelectronics." The Medal and Prize are awarded by the British Vacuum Council, whose constituent bodies include the Institute of Physics and the Royal Society of Chemistry, and which is a full member of the International Union for Vacuum Science and Application (IUVSTA). The award will be presented to Boyd by Sir David King at the annual conference in September 2005.

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