

strange MATTER



Want to feel something really weird? Swish your gloved hands around in a vat of magneto-rheological fluid and feel it morph from fluid to solid at the touch of a button. Make a pool of magnetic ferrofluid "dance" and manipulate blobs of ferrofluid with rare-earth magnets.

Experience the interactive materials science exhibition:

Virginia Air & Space Center
Hampton, VA
May 29–September 6, 2004
www.vasc.org

Museum of Discovery and Science
Ft. Lauderdale, FL
June 11–September 6, 2004
www.mods.org

To volunteer for activities with the exhibition, contact

Kaveri Chaturvedi
Community Resources Coordinator
kaverisch@msn.com

Strange Matter is presented by the Materials Research Society. This exhibition and its tour are made possible by the generous support of the National Science Foundation, Alcan Inc., Dow, Ford Motor Company Fund, Intel Innovation In Education, and the 3M Foundation.



Materials
Research
Society



of the proper unset strand frees the right foot from the middle foothold, although it is still tethered to the left foot (state 2, Figure 1c). The addition of a set strand results in the right foot attaching to the right foothold (state 3, Figure 1d). The flexible linkers must be long enough to extend from the left to the right foothold, a gap of about 2 nm. Similar unset and set steps remove the left foot from the left foothold (state 4, Figure 1e) and attach it to the middle foothold (state 5, Figure 1f). The researchers verified each of the states by illuminating the structures with UV light, which resulted in covalent bonds between single-stranded DNA (due to the presence of the psoralen), and then performing polyacrylamide-gel electrophoresis.

Sherman and Seeman said that their device has precise bidirectional control and that a longer gait can be achieved with longer footpaths, which might also accommodate multiple, independently addressable bipeds and multipeds. They said that rotational motion can be achieved with circular footpaths. The researchers envision applications such as the transportation of loads and the winding or threading of polymers. In addition, Sherman and Seeman believe that "algorithmically generated set strands could drive a device on a 2D footpath so that the positions of the feet could represent the state of a DNA-computational machine."

STEVEN TROHALAKI

Bi₂O₃-Coated Zinc Oxide Nanoparticles Yield High-Quality Ceramics

Polycrystalline ceramic zinc oxide (ZnO) varistors, which include an intergranular bismuth-rich phase, are known to show excellent nonlinear current-voltage properties. These materials are typically made by sintering physically mixed precursors and thus often have poor microstructural uniformity and porosity. F. Yuan of the Chinese Academy of Sciences and the Korean Research Institute of Chemical Technology and H. Ryu, also of the Korean Research Institute, have found that sintering ZnO nanoparticles that have been uniformly coated with Bi₂O₃ results in ZnO ceramic varistors with perfect and homogenous ZnO grains, each of which is completely surrounded by a uniform Bi₂O₃ layer.

As described in the April issue of the *Journal of the American Ceramic Society* (p. 736), Yuan and Ryu used predesigned nanoparticles as precursors to prepare the ceramic varistors. The researchers precipitated a Bi(NO₃)₃ solution onto a slurry of basic carbonate-of-zinc and after calcination obtained ~30–50-nm-sized

ZnO nanoparticles with homogenous Bi₂O₃ coatings. These particles were then sintered at 1150°C for 1 h to obtain the ZnO ceramics.

Yuan said, "The major advantage of this process is that ZnO nanoparticles coated with Bi₂O₃ can give a uniform liquid phase environment for every ZnO particle." The ceramics prepared from these precursors exhibited uniform grain size ranging from 3–5 μm for samples with 1 wt% Bi₂O₃ to 8–10 μm for samples with 3 wt% or 5 wt% Bi₂O₃.

The eutectic temperature for the ZnO–Bi₂O₃ system is ~740°C; above this temperature, a liquid phase is formed. In using the preformed, coated particles, each ZnO particle is in a homogenous medium, thus the ZnO grains grow homogeneously and perfectly. The researchers observed that above 3 wt% of Bi₂O₃ there is a continuous skeleton of the bismuth-rich phase completely surrounding the perfectly formed ZnO grains. They also determined that the ZnO grains do not grow once the bismuth-rich phase has formed a continuous grain boundary surrounding the ZnO grains. The lack of porosity and good grain condition as well as the excellent grain-boundary properties are expected to have favorable effects on the varistor properties under high current.

SARBAJIT BANERJEE

Bandgap of Semiconducting Nanotubes Shrinks in High Magnetic Fields

A team of researchers headed by Richard Smalley at Rice University has discovered that the bandgap of semiconducting single-walled carbon nanotubes (SWNTs) shrinks monotonically as a function of magnetic flux densities up to 45 T (Figure 1). The findings confirm quantum mechanical theories offered more than four decades ago by Aharonov and Bohm. According to lead researcher Junichiro Kono, an assistant professor of electrical and computer engineering at Rice, the SWNTs will likely become metals at >100 T.

A magnetic flux passing through a mesoscopic ring structure modifies the quantum states and the dynamics of electrons in the ring. Quantum-interference effects, manifested, for example, as oscillations in magnetoresistance, occur when the phase coherence length exceeds the circumference. However, a magnetic flux passing through SWNTs interacts with them in a different fashion than would occur with a mesoscopic ring, because the SWNTs have a periodic lattice potential along the circumference of the nanotube.