surfaces provide a simple means of immobilizing Co ions for enhanced electrocatalytic activity.

JEREMIAH T. ABIADE

Suspended Carbon Nanotubes Display Negative Differential Conductance

The conductance of single-walled carbon nanotubes (SWNTs) and other one-dimensional nanomaterials is fundamentally important to a wide variety of electronic applications. It is well known that metallic SWNTs can carry tens of microamperes of current, achieving current densities two orders of magnitude higher than those possible with copper. Although it is generally true that the surrounding environment of such materials may substantially affect their electrical properties, only recently has a study been conducted on suspended SWNTs in native, unperturbed states. Researchers from the Department of Chemistry and Laboratory for Advanced Materials and the Department of Mechanical Engineering and Thermal Sciences at Stanford University have discovered that freely suspended metallic SWNTs display electrical properties that are drastically different from those observed in SWNTs on substrates.

As reported in the October 7 issue of *Physical Review Letters* (#155505; DOI: 10.1103/PhysRevLett.95.155505), researchers E. Pop, D. Mann, and J. Cao in Hongjie Dai's group at Stanford have found that the current-carrying ability of suspended SWNTs is reduced by up to an order of magnitude compared with SWNTs on substrates. In addition, the researchers found that suspended SWNTs display negative differential conductance at relatively low electric fields (200 V/cm), that is, the current starts decreasing with applied bias beyond ~0.2 V for 10-μm-long nanotubes. The researchers obtained suspended SWNTs with Pt electrical contacts by direct growth across pre-formed trenches 0.6–10 μm wide, and also, for comparison, fabricated similar SWNT devices lying on silicon nitride. The test article consisted of a silicon wafer with an oxide layer covered by a layer of silicon nitride and a series of Pt electrical contacts. The trenches were formed by removing the top silicon nitride layer and part of the oxide layer between some of the Pt contacts. The SWNTs grown on this test article spanned the silicon nitride in some regions and spanned trenches in other regions. Atomic force microscopy and scanning electron microscopy were used to characterize the devices. Current was measured as a function of voltage in vacuum at room temperature.

The researchers' theoretical analysis showed that the lack of a substrate allows significant self-heating in current-carrying suspended SWNTs. In addition, their unperturbed state enables a large population of nonequilibrium phonons with long lifetimes to build up, contributing to electron scattering and reduced current flow. By contrast, substrate–nanotube interactions aid both in heat dissipation and phonon relaxation, allowing higher currents, except, recent literature suggests, for nanotubes at biases greater than 1 V, where self-heating and hot phonons are thought to exist.

"This," the researchers said, "raises the interesting possibility that SWNTs on substrates may be engineered to deliver higher currents than previously thought possible (for a given tube length) through rational interface design for optimized heat dissipation and phonon relaxation." The discovery, they said, "may have general implications for high-current applications of quasi-1D materials." The researchers also said that their discovery may lead to new device applications consisting of suspended SWNTs.

STEVEN TROHALAKI

Reversible Guest Exchange Demonstrates Robustness of Zinc-Porphyrin–Based 3D Coordination Networks

Porous crystalline solids with a controlled pore size are attractive candidates for use in gas storage and separation, specific sorption, ion exchange, and catalysis. Three-dimensional porous crystalline materials are often assembled from precursors known as tectons—molecules whose interactions are predominantly dominated by forces that induce their self-assembly into organized architectures. In the August 8 issue of *Chemical Communications* (p. 3906; DOI 10.1039/b508135c), E. Deiters, V. Bulach, and M.W. Hosseini from Louis Pasteur University in Strasbourg have reported the synthesis of a novel zinc porphyrin tecton, which assembles into a robust crystalline network.

The tecton consists of a metalloporphyrin core with two meso positions of the porphyrin core functionalized with pyridine groups. The zinc core and the two oppositely oriented pyridines are available for further coordination; thus, this self-complementary molecule can assemble into an infinite three-dimensional coordination network. The coordination geometry around the Zn center leads to the formation of hexagonal channels in the network.

The researchers found that the voids in the hexagonal networks were filled with solvent molecules. These solvent molecules could be easily removed from the channels under a vacuum. Furthermore, the solvent molecules (methanol or ethanol) were reintroduced into the channels upon exposure to solvent vapor, or could even be replaced by other molecules such as cyclohexane, while still preserving the hexagonal channel structure. Thus, guest exchange between different solvents in the channels of the network occurs by a single-crystal-to-single-crystal transformation, retaining the structural integrity of the framework at all times. The researchers said that many crystalline porous solids collapse upon removal of included guests; thus they found remarkable the robustness of the three-dimensional framework achieved with this tecton.

SARBAJIT BANERJEE

Rare "Triple Coincidence" of Optical Nonlinearities for Use in Quantum Encryption and Teleportation Engineered in Periodically Poled KTP

One of the strangest aspects of quantum mechanics is the phenomenon of entanglement. Entangled particles share identical or complementary properties, such as energy, spin, or momentum, even when the values of those properties are undefined for the individual particles. Entanglement can also exist between different electromagnetic-field modes of bright (many-photon) laser beams. This area, known as continuous variable (CV) entanglement, has become a major focus of interest for quantum encryption and

https://doi.org/10.1557/mrs2005.229 Published online by Cambridge University Press