ficity can only be attributed to the presence of gold nanoparticles, according to the researchers, since there was no specificity when only the medium in which the gold particles were suspended was used. Furthermore, the researchers said, the nanoparticles enabled PCR amplification at lower annealing temperatures than current techniques allow without compromising specificity.

The single-stranded DNA binding protein SSB selectively binds to single-stranded DNA, but not to double-stranded DNA. The researchers said that the optimizing effect of gold nanoparticles is greater than that of SSB that is commercially available. Gold nanoparticles bind more strongly to single-stranded DNA than double-stranded DNA because double-stranded DNA has a higher surface charge density, and anionic DNA strands do not bind to the negatively charged surfaces of citrate-stabilized nanoparticles. The researchers also said that adenine, thymine, guanine, and cytosine—the bases of which DNA is composed—contain nitrogen atoms that display high affinities to gold. These bases are more exposed in single-stranded DNA than double-stranded DNA, which means that there is a higher interaction between the gold nanoparticles and the DNA bases, the researchers said. They furthermore reported that the rigidity of the double-stranded DNA prevents the DNA from wrapping around the nanoparticles, but the more bendable single-stranded DNA readily wraps around them. The researchers said that this technique may find application in many other PCRs that require high specificity or high yields.

MARÍA PÍA ROSSI

Cobalt-Adsorbed Polypyrrole Film on Carbon Nanoparticles Shows Promise as Non-Noble-Metal Catalyst

Billions of dollars per year are currently being invested in fuel cell research and development worldwide. Currently, several materials-related issues, such as an alternative to Pt catalysts, must be addressed before fuel cell technology is able to supplant natural resources like oil as primary energy sources. M. Yuasa, A. Yamaguchi, H. Itsuki, K. Tanaka, M. Yamamoto, and K. Oyaizu of the Tokyo University of Science in Japan have investigated carbon nanoparticles with cobalt polypyrrole coatings as non-noble-metal catalysts for fuel cell electrodes. According to their study, reported in the August 23 issue of *Chemistry of Materials* (p. 4278; DOI: 10.1021/cm050958z), the cobalt atoms are coordinated by four nitrogens and the structure is maintained even after heat treatment at 700°C. The researchers have found an increase in catalytic activity after the high-temperature heat treatments.

M. Yuasa and co-workers used fluid-bed electrolysis to deposit polypyrrole (PPy) coatings on high-surface-area carbon black particles (BET surface area, ~800 m^2/g). Carbon black (CB) is a common support used for platinum-based catalysts. The PPy-coated CB particles were then suspended in a solution of cobalt acetate in CH_3OH, which was then refluxed to allow formation of cobalt ions at the respective sites. Current–voltage measurements, extended x-ray absorption fine structure spectroscopy, x-ray diffraction, and x-ray photoelectron spectroscopy were used to measure the catalytic activity and structure of the CoPPy/CB composite.

A significant feature of the CoPPy/CB catalyst synthesized using this procedure is a positive shift in the O_2 reduction potential after annealing in an inert atmosphere up to 700°C without deposition of metallic cobalt. The researchers said that the difference in catalytic activity may be attributed to the mechanism in which the catalyst reduces O_2. Yuasa and co-workers said that the reduction of O_2 by the heat-treated catalyst occurs by a four-electron reduction involving the bridging of O_2 with two adjacent cobalt centers. Conversely, as-synthesized CoPPy/CB catalysts are believed to reduce O_2 by two electrons involving only a single cobalt center. The researchers said carbon nanoparticles with PPy-modified

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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

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