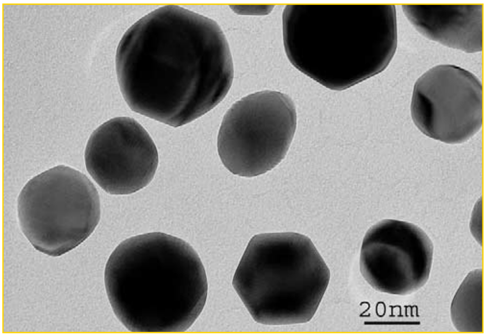
Solution for synthesizing NiBi nanostructures

NANOTECHNOLOGY



β-BiNi nanoparticles, showing hexagonal shape. (© 2005 American Chemical Society.)

Bi nanostructures exhibit a variety of interesting optical, electronic, magnetic, and thermoelectric properties. Furthermore, alloying Bi with other transition metals can improve its properties. For example, alloying with ferromagnetic elements can lead to high-performance materials for magnetic data storage, high-temperature soldering, and superconductors.

However, NiBi alloy synthesis normally uses methods such as evaporation or arc melting, which preclude production of nanoparticles. Researchers at Rice University, the Institut National des Sciences Appliquées, France, and the Max-Planck-Institut für Kohlenforschung, Germany have synthesized NiBi nanoparticles and nanowires via a mild wet-chemical process [Ould-Ely *et al.*, *Chem. Mater.* (2005) 17 (18), 4750].

Simultaneous decomposition of the organometallic precursors bis(cyclooctadiene)nickel (0) [$Ni(COD)_2$] and tetraphenyldibismuthine [Bi_2Ph_4] in tetrahydrofuran yields NiBi nanoparticles of hexagonal β-NiAs structure with an average diameter of 8-10 nm. The particles are superparamagnetic above 45 K and show antiferromagnetic dipolar interactions owing to their high concentration and the absence of a stabilizing agent.

NiBi nanowires can be formed by adding a stabilizer (trioctylamine and oleic acid) and decomposing at 200°C.

Rice's Kenton H. Whitmire says the method may yield a general approach for synthesizing nanowires of low-melting-point alloys. The team aims to make BiMn nanowires or nanofibers, which are anticorrosive and strongly magnetic and, hence, useful for data storage. The process may also be applicable to Bi/Sb compounds, Whitmire adds.

Mark Telford

Strong, transparent carbon nanotube sheets

NANOTECHNOLOGY

A team at University of Texas at Dallas and Australia's Commonwealth Scientific and Industrial Research Organization has assembled carbon nanotubes into 5 cm wide, 1 m long transparent sheets drawn at commercially usable rates of over 7 m per minute [Zhang *et al.*, *Science* (2005) **309**, 1215].

Starting with chemically grown, vertically oriented multiwalled nanotube arrays (forests), the sheets are drawn from the sidewall of a 245 μm high forest. The sheets are lightweight, highly flexible, highly electrically conductive, and stronger than same-weight steel sheets. Such properties are important for space and aerospace applications. For example, 1 km^2 of solar sail made from the sheets would weigh just 30 kg.

While sheets normally have much lower strength than fibers or yarns, the strength in the nanotube alignment direction already approaches the highest reported values for polymer-free nanotube yarns. The sheets generate little electronic noise and have an exceptionally low dependence of electronic conductivity on temperature, suggesting possible application as high-quality sensors.

Demonstrated applications of the transparent sheets include electrodes for organic light-emitting diodes in flexible displays, solar cells for light harvesting, high-stroke artificial muscles (which require electrodes that can be reversibly deformed over 100% without losing electrical conductivity), conducting appliqués, and broad-band polarized light sources that are switchable in 100 ns.

Since the nanotube sheets strongly absorb microwave radiation, they could be used to weld together plexiglass plates in a kitchen microwave oven. Neither the electrical conductivity nor the transparency is affected, suggesting the sheets could be used in transparent heating elements and antennas for car windows.

Mark Telford

Macroscale nanotube separation

NANOTECHNOLOGY

Single-walled carbon nanotubes (SWNTs) have potential application in next-generation electronic devices. However, a major hurdle is that no existing synthesis method can determine whether the produced SWNTs are semiconducting or metallic. Semiconducting and metallic nanotubes have very large differences in polarizability and can be separated by dielectrophoresis. But, until now, this has only been done using a micron-sized electrode system, yielding a small amount of metallic nanotubes.

Now, Thierry Lutz and Kevin J. Donovan at Queen Mary, University of London, UK have demonstrated the feasibility of using a macroscopic electrode system [Lutz and Donovan, *Carbon* (2005) **43** (12), 2508].

Theory suggests that much stronger field gradients than those in the macroscopic cells would be needed to separate spherical dielectric objects. The process works for SWNTs because of their large aspect ratio and their physical properties, especially the very large dielectric constants of metallic SWNTs.

So far, using Raman spectroscopy to show the effect of dielectrophoretic forces on the SWNTs, the researchers have identified enrichment only in the metallic nanotubes, possibly because of the high proportion of bundles left in the solution even after processing.

They suggest that this could be overcome, and high-purity samples obtained, by finding a better dispersion method or performing multiple separations in cascade. The process needs more fundamental study to fully understand it. In particular, the influence of electric field parameters on separation efficiency needs to be understood.

Mark Telford