Template-Grown Ni-Cu Nanowires Show High Magnetization and Enhanced Coercivities

Magnetic nanoparticles and their potential applications have received increasing attention in recent years. Nanoscale particles of ferromagnetic elements are the size of single magnetic domains and exhibit high coercivities relative to the bulk metals, making them candidates for use in memory devices. However, current methods of assembling ordered arrays of nanoparticles for inclusion in devices are not cost-effective. As reported in the February 11 issue of *Chemistry of Materials*, a group of researchers at the Chinese Academy of Sciences has prepared an ordered array of Ni-Cu composite nanowires by using a facile template-based method. The nanowires exhibit the same desirable properties as arrays of simple nanoparticles.

Yu-Guo Guo and co-workers used anodic aluminum oxide (AAO) membranes with well-defined arrays of columnar pores as templates for nanowire growth. The templates were immersed in a solution of copper sulfate and nickel sulfate, and the plating potential was pulsed in order to fill the pores with alternating layers of Ni and Cu. The AAO membrane was then dissolved, leaving behind an ordered array of nanowires, as confirmed by transmission electron microscopy.

Magnetic force microscopy revealed that each Ni segment behaved as a single magnetic domain, and that the magnetization direction was the same for all segments in the wire. The coercivity for an array of nanowires was found by superconducting quantum-interference device measurements to be ~490 Oe, compared with 0.7 Oe for bulk Ni. The researchers said that the saturation magnetization was comparable to that of the bulk metal.

Arrays of magnetic nanowires had previously been grown within AAO membranes, but the single-domain structure seen in nanoparticles was lost, and the coercivity was accordingly much lower. The researchers concluded that alternating segments of ferromagnetic Ni with nonferromagnetic Cu within the nanowire preserves the enhanced coercivities found in nanoparticles while allowing for a simple method of preparation. The group said that these features make composite nanowires suitable for use in high-density recording media or in other technological applications.

CATHERINE OERTEL

In Situ Soldering Attaches Nanotubes to Electrodes

In order to exploit the mechanical and electrical properties of carbon nanotubes (CNTs) in nanodevices, several attachment methods have been developed. These methods rely on lithographic techniques, involve electrical connections, or depend on the particular nanocomponents involved. Recently, however, a team of researchers from the Microelectronik Center (MIC) at the Technical University of Denmark and the catalyst company Haldor Topsøe A/S in Lyngby, Denmark, has developed a general, *in situ* soldering method for attachment of CNTs to microelectrodes by using a highly conductive gold–carbon composite. This method allows three-dimensional nanostructure assembly without many of the limitations of those previously developed.

As reported in the January issue of *Nano Letters*, Technical University of Denmark researcher P. Bøggild and co-workers performed the soldering by locally decomposing dimethylacetylacetonate gold(III) (which has a vapor pressure of 1 Pa at 25°C) with an electron beam. The organometallic compound is placed in a container with a narrow bore tube to control the diffusion of vapor onto the sample. At room temperature, a growth rate of 500 nm/min was obtained with a 0.8-mm-diameter, 2-mm-long tube. Soldering bonds with lengths >10 μm were grown without a conspicuous decrease in the growth rate.

Two cantilever microelectrodes on a silicon chip, positioned with a nanomanipulator stage, were connected to a dc voltage source. Freestanding multiwalled CNTs were prepared by chemical vapor deposition and shown by transmission electron microscopy (TEM) to be >20 μm long and 80–120 nm wide. In an environmental scanning electron microscope, a microelectrode pair was manipulated so that a nanotube extending from the sample traversed and contacted the electrodes. Two cross-shaped, gold–carbon soldering bonds were then formed by slowly scanning the beam across the nanotube at the point of contact to one of the electrodes. In addition, a set of protective bonds near the edge of the electrode were deposited so that the nanotube section extending past the electrode could be broken off without affecting the soldering bonds.

Review Articles

The January 2003 issue of *Reviews of Modern Physics* **75** (1) (partial issue) contains the following review articles: W.G. van der Wiel, S. De Franceschi, J.M. Elzerman, T. Fujisawa, S. Tarucha, and L.P. Kouwenhoven, "Electron Transport through Double Quantum Dots," p. 1; and J.R. Banavar and A. Maritan, "Colloquium: Geometrical Approach to Protein Folding: A Tube Picture," p. 23.

The *Journal of Applied Physics* **93** (2) (2003) contains D.G. Cahill, W.K. Ford, K.E. Goodson, G.D. Mahan, A. Majumdar, H.J. Maris, R. Merlin, and S.R. Phillpot, "Nanoscale Thermal Transport," p. 793.

The *Annals of Biomedical Engineering* **31** (1) (2003) contains A.C. Shieh and K.A. Athanasiou, "Principles of Cell Mechanics for Cartilage Tissue Engineering," p. 1.

Microelectronics Reliability **43** (1) (2003) contains M. Ruprecht, G. Benstetter, and D. Hunt, "A Review of ULSI Failure Analysis Techniques for DRAMs. Part II: Defect Isolation and Visualization," p. 17.

Advanced Materials **15** (1) (2003) contains S.M. O'Flaherty, S.V. Hold, M.J. Cook, T. Torres, Y. Chen, M. Hanack, and W.J. Blau, "Molecular Engineering of Peripherally and Axially Modified Phthalocyanines for Optical Limiting and Nonlinear Optics," p. 19.

Reviews of Scientific Instruments **73** (12) (2002) contains J.F. Power, "Inverse Problem Theory in the Optical Depth Profilometry of Thin Films," p. 4057.

AIAA Journal **40** (11) (2002) contains I. Chopra, "Review of State of Art of Smart Structures and Integrated Systems," p. 2145.

Advanced Engineering Materials **4** (12) (2002) contains F. Christin, "Design, Fabrication, and Application of Thermostructural Composites (TSC) like C/C, C/SiC, and SiC/SiC Composites," p. 903.

Proteomics **2** (12) (2002) contains B. Seliger and R. Kellner, "Design of Proteome-Based Studies in Combination with Serology for the Identification of Biomarkers and Novel Targets," p. 1641.

The International Journal of Quantum Chemistry **91** (3) (2003) contains the proceedings of the Ninth International Conference on the Application of the Density Functional Theory to Chemistry and Physics—Part II.

The November 2002 issue of the *Journal of Vacuum Science and Technology B* contains papers from the Third Low Energy Electron/Microscopy Photoemission Electron Microscopy Workshop and papers from the 46th International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication.

The October 2002 issue of the *Journal of Biomedical Optics* features a special section on "Tools for Biomolecular and Cellular Analysis."

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