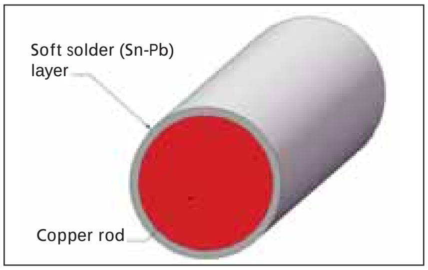

A **Solder-Covered Copper Rod or Wire** affords the benefit of high thermal conductivity of the copper and, when sufficiently cold, electrical superconductivity of the solder.

ever, the superconducting coil material is not suitable as such a link because electrically superconductive materials are typically poor thermal conductors.

The heterogeneous material construction makes it possible to solve both the electrical- and thermal-conductivity problems. The basic idea is to construct the coil as a skeleton made of a highly thermally conductive material (typically, annealed copper), then coat the skeleton with an electrically superconductive alloy (typically, a lead-tin solder) [see figure]. In operation, the copper skeleton provides the required thermally conductive connection to the cold source, while the electrically superconductive coating material shields against Johnson noise that originates in the copper skeleton.

This work was done by Inseob Hahn, Konstantin I. Penanen, and Byeong Ho Eom of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to NPO-45929, volume and number of this NASA Tech Briefs *issue, and the page number.*

Progress Toward Making Epoxy/Carbon-Nanotube Composites

Lyndon B. Johnson Space Center, Houston, Texas

A modicum of progress has been made in an effort to exploit single-walled carbon nanotubes as fibers in epoxy-matrix/fiber composite materials. Two main obstacles to such use of carbon nanotubes are the following: (1) bare nanotubes are not soluble in epoxy resins and so they tend to agglomerate instead of becoming dispersed as desired; and (2) because of lack of affinity between nanotubes and epoxy matrices, there is insufficient transfer of mechanical loads between the nanotubes and the matrices.

Part of the effort reported here was oriented toward (1) functionalization of single-walled carbon nanotubes with methyl methacrylate (MMA) to increase their dispersability in epoxy resins and increase transfer of mechanical loads and (2) ultrasonic dispersion of the functionalized nanotubes in tetrahydrofuran, which was used as an auxiliary solvent to aid in dispersing the functionalized nanotubes into a epoxy resin. In another part of this effort, poly(styrene sulfonic acid) was used as the dispersant and water as the auxiliary solvent. In one experiment, the strength of composite of epoxy with MMA-functionalized-nanotubes was found to be 29 percent greater than that of a similar composite of epoxy with the same proportion of untreated nanotubes.

This work was done by Thomas Tiano, Margaret Roylance, and John Gassner of Foster-Miller, Inc. and William Kyle (consultant) for Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-23278-1

Predicting Properties of Unidirectional-Nanofiber Composites

John H. Glenn Research Center, Cleveland, Ohio

A theory for predicting mechanical, thermal, electrical, and other properties of unidirectional-nanofiber/matrix composite materials is based on the prior theory of micromechanics of composite materials. In the development of the present theory, the prior theory of micromechanics was extended, through progressive substructuring, to the level of detail of a nanoscale slice of a nanofiber. All the governing equations were then formulated at this level.

The substructuring and the equations have been programmed in the ICAN/JAVA computer code, which was reported in "ICAN/JAVA: Integrated Composite Analyzer Recoded in Java" (LEW-17247), *NASA Tech Briefs*, Vol. 26, No. 12 (December 2002), page 36. In a demonstration, the theory as embodied in the computer code was applied to a graphite-nanofiber/epoxy laminate and used to predict 25 properties. Most of the properties were found to be distributed along the through-the-thickness direction. Matrix-dependent properties were found to have bimodal through-the-thickness distributions with discontinuous changes from mode to mode.

This work was done by Christos C. Chamis, Louis M. Handler, and Jane Manderscheid of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18366-1.