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Electrical conductivity of a copper-metallic carbon nanotube composite

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NASA is investing in advanced aviation propulsion technology that includes greater electrification of the power train. Increased electrical conductivity of power transmission wires is a technology that can substantially improve future aircraft. Both higher electrical conductivity and lower densities compared to copper and aluminum are needed. Carbon nanotubes (CNT) are being considered as a composite component to improve the electrical properties of Cu and Al. Electrical conductivity, density, and chemistry were measured for dilute Cu-CNT composites. CNT electrical conductivity depends on structure, or its chirality. All commercially available CNT consist of a mixture of approximately 66% CNT with structures that result in conductivities characteristic of semiconductors and 33% with conductivities more like metals. The average electrical conductivity of this mixture of CNT is not high enough to benefit Cu or Al. In this work composites with Cu were made using no CNT, mixed CNT, and sorted metallic only CNT. For composte wire fabrication, carbon nanotubes were coated with Cu and sealed in an evacuated pure Cu 0.25 in. diameter tube; sealed tube assemblies were hot isostatically pressed and mechanically worked into 1 mm diameter wires. The conductivity of both mixed and sorted CNT composites was 10 to 25% lower than Cu. The decrease in electrical conductivity of the composites was large compared to a bounding estimate of introducing equivalent void fractions and this suggests multiple factors were affecting the conductivity. Detailed analysis of the factors will be presented and will provide insight into future options for improving conductivity.

Biography

Henry C de Groh received his B.S. in Metallurgical Engineering from the University of Arizona in 1985, and his M.S. in Materials Sci. & Eng. from Case Western Reserve University in 1988 and has been at NASA for 32 years. de Groh is currently working on Oxide Dispersion Strengthened alloys for high temperature engines; Cu and Al carbon nanotube composites for wire; and high strength textile fibers through incorporation of CNT into silk. Mr. de Groh is married with two sons in college and likes to sail, plays guitar and sings in a band, and is a competitive Olympic weightlifter at the international level.

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