Title:

Synthesis and electrical characterization of monocrystalline nickel nanorods and Ni-CNT composites

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Abstract:

Aerospace vessels require electrically conductive, light weight frames to minimize damage from electromagnetic radiation, electrostatic discharge and lightning strikes while economizing fuel. Nickel nanowires and hybrid nickel-carbon nanotube materials are suitable nanostructures to ensure high conductivity at low mass loading.

Monocrystalline nickel structures have even better conduction properties than the polycrystalline equivalent due to possessing less particle-particle junctions. We have developed a solution-based method that produces monocrystalline nickel nanowires *via* the decomposition of metal-organic precursors in the presence of self-assembled surfactants. The resulting wires are approximately 20 nm wide by 1.5 µm in length. These wires have a morphology consisting of semi-flattened rods with pyramidal ends. Despite the changing dimensions between the nanorod body and its head, there was no disruption in the crystallographic orientation, as observed with HRTEM and diffraction patterns.

The nickel nanostructures were exposed to air for several weeks, but no oxidation was detectable by magnetic measurement, *i.e.* the saturation magnetization corresponds to Ni^0 and no bias is observed in the hysteresis loops. It seems that the long alkyl chain amine surfactant, in addition to being a structuration agent, remains at the surface of the Ni wires after washing and acts as a protective layer. The magnetic field around Ni nanowires was imaged using electron holography. Each Ni wire is a magnetic monodomain.

Routes to prepare hybrid nickel-CNT materials were explored using chemical vapor deposition in a fluidized bed, solution chemistry and dry preparation in a Fisher-Porter reactor. Different nickel compositions and material morphologies resulted, depending on the preparation technique.

The nickel nanorods and hybrid materials were incorporated into carbon fiber-reinforced polymer composites. The electrical conductivity as a function of wt% loading was measured, showing promise for these materials in discharging electrostatic charges.

Figure. Anisotropic monocrystalline nickel nanorod