CARBON NANOTUBES ENCAPSULATING SUPERCONDUCTING SINGLE-CRYSTALLINE TIN NANOWIRES

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Superconducting low dimensional systems are the natural choice for fast and sensitive infrared detection, because of their quantum nature and the low-noise, cryogenic operation environment. On the other hand, monochromatic and coherent electron beams, emitted from superconductors and carbon-based nanostructured materials, respectively, are significant for the development of electron optical systems such as electron microscopes and electron-beam nanofabrication systems.

Here we describe a simple and reproducible method which yields individual µm-long carbon nanotubes filled with highly pure, single crystalline, superconducting tin nanowires [1]. For the first time the catalytic chemical vapour deposition (CCVD) method over solid tin dioxide has been employed to yield carbon nanotubes encapsulating single crystalline superconducting metallic tin nanowires. The surrounding carbon nanotube, consisting of only a few graphite layers (4–5 nm), is closed in both ends and protects the tin nanowire, and thus is protected against atmospheric oxidation. The superconducting tin nanowires, with diameters 15-35 nm, are covered with well-graphitized carbon walls parallel to the tube axis and show, due to their reduced diameters, a critical magnetic field (H_c) more than 30 times higher than the value of bulk metallic tin. Indeed, magnetization measurements show a slight increase in the superconducting temperature and a considerable increase of the critical magnetic field ($H_c = 0.6$ T) compared to bulk metallic tin (0.021 T). Various analytical techniques including HRTEM and SQUID measurements were used to characterize the final product.

References:

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