Keynote

NANOTUBE FILLING WITH SOLIDS, LIQUIDS AND GASES

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One may immediately realize that a nanotube (NT), seamless cylinder with a diameter of several nanometers or less, presents an ideal nanosize crucible for various metallurgical, chemical or physical operations on the nanoscale. Indeed, various metals, ceramics, gases and/or liquids may be put inside NTs on demand. Thus novel functional materials with the dimensions downsized by millions of times (as compared to those in use) are created. Herewith we report on the recent breakthroughs with respect to Carbon, Boron Nitride and novel inorganic NT filling with various media and intriguing functional properties of the novel composite nanomaterials thus created.

Firstly, a C NT filled with liquid Galium metal is analyzed in detail.[1,2] Electrical resistance of the nanostructure is found to be markedly different in Ga-filled and Ga-unfilled regions. This makes possible precise electrical calibration of a NT-based "thermometer" and/or making NT-based electrical switches.

Secondly, filling of a C NT with a ferromagnetic single-crystalline Fe-Co alloy (Figure 1) is addressed.[3] The resultant material exhibits much larger coercive field at room temperature (e.g. 900 Oe) than a FeCo bulky counterpart. The phenomenon is highly valuable for novel nanoscale magnetic sensors, spintronic and magnetic data storage devices.

Thirdly, a Magnesium peroxide filling of a BN NT is thoroughly discussed.[4,5] Under moderate heating, *e.g.* using an electron beam of a TEM instrument, unstable peroxide decomposes to stable magnesium oxide and molecular oxygen, all inside NT. Oxygen freely outflows from the NT due to its open-tip end. Therefore, nanoscale oxygen burner and/or generator may be awaited as the outcome of research.

Then, a Silicon Carbide nanowire inside a BN NT is presented (Figure 2).[6] Since a BN nanotube produces the perfectly insulating shield of a semiconducting wire encapsulated within, the synthesized material may properly serve as the element of a nanoscale Field-Effect transistor, as realized during *I-V* curve measurements on an individual composite nanostructure using an atomic force microscope. It is worth noting that this approach works well for other semiconductors put inside BN nanotubes.

Finally, other successful examples of various NT fillings obtained in the Lab, including hydrogen storage phenomena, and smart applications of the resultant structures are reviewed.[7,8,9]

References

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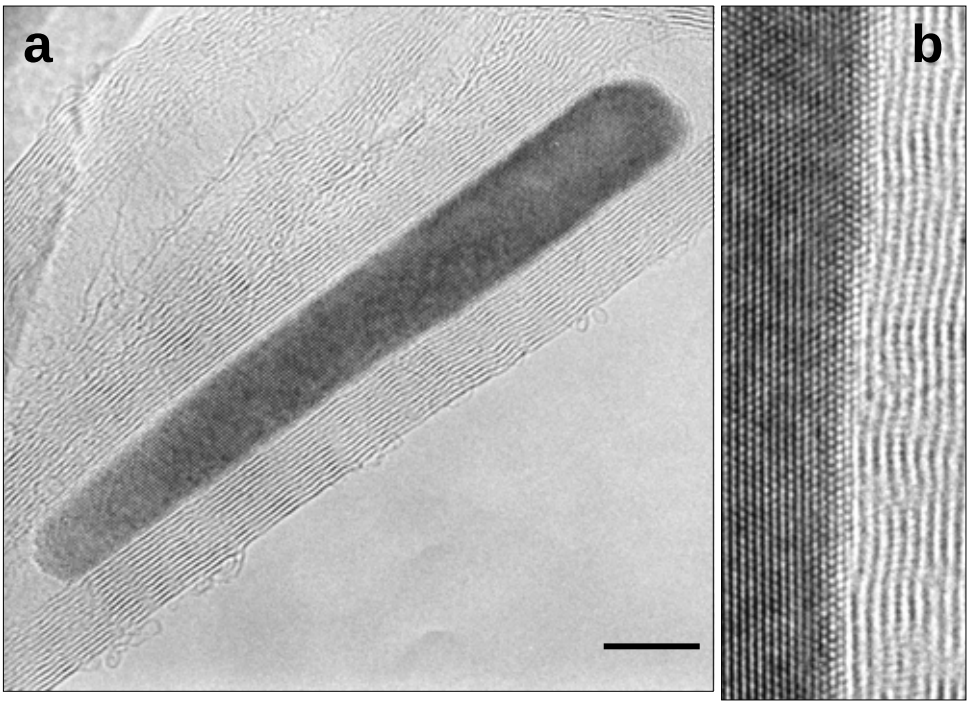

Figure 1. (a) HRTEM image of a C nanotube filled with a ferromagnetic FeCo alloy nanowre; and (b) enlarged view of the tube-filling interface displaying clear atomic steps on the filling. Scale bar in (a) is 5 nm.

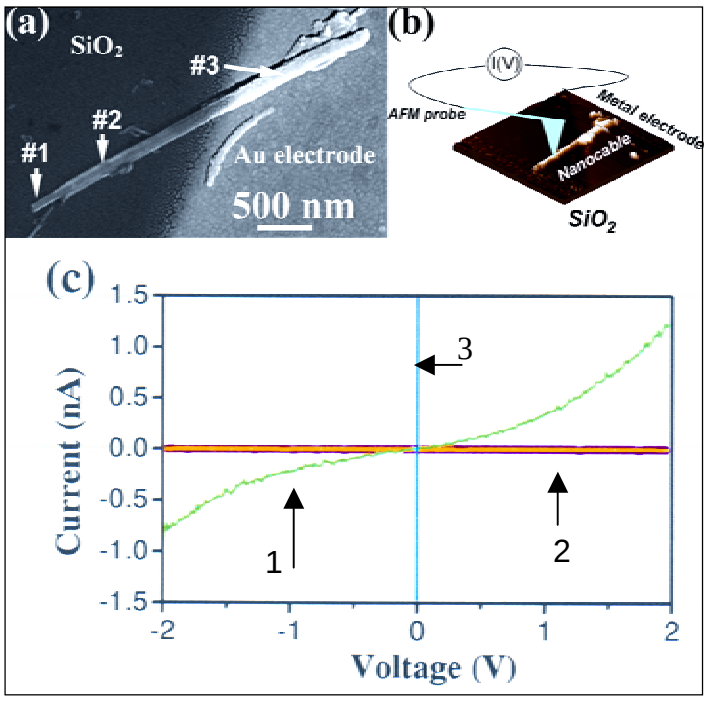

Figure 2. (a) SEM image of a semiconducting SiC nanowire protruding from an insulating BN nanotube; (b) AFM measurement set-up; (c) *I-V* curves taken at various spots: 1-SiC wire; 2-BN shielding tube; 3- Au electrode.