

ELECTROLESS METAL DEPOSITION ON SELF-ASSEMBLED ORGANIC NANOTUBES: FROM FUNDAMENTAL STUDIES TO APPLICATIONS AS NANOWIRES

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Design and synthesis of molecular modules that can self-assemble into complex structures with desirable properties has been one of the most audacious challenges in supramolecular chemistry that gave rise to the blossom of the bottom up approach in nanotechnology. Conductivity is one of the most wanted properties for future nanoelectronics, which makes it possible for high aspect ratio nanostructures (rods, tubes, ribbons) to be used as electronic wires.

Two of the most popular methods to fabricate such structures consist of (a) incorporating a π -conjugated array along the main axis of 1D nanostructures and (b) coating or filling a nanostructure with reducible metal ions. The challenges of the first method are the generally low conductivity of organic material, and the problems associated with creating low-resistance metal-organic junctions. The second method requires the addition of an external reducing agent, which results in uneven metal cluster distribution along the nanostructure, and hence non-reproducible conductivity.

To alleviate the limitations associated with methods (a) and (b) we devised a strategy wherein the supramolecular organic nanostructure acts as a reducing agent for metal ions that deposit on its surface. Because of the homogenous distribution of the reducing elements, electron transfer is specific, evenly distributed on the surface, and results in templated metallic nanostructures with a homogeneous thickness and continuous metal distribution. To demonstrate this strategy we synthesized helical rosette nanotubes (HRN's) appended with formyl functional groups and shown their ability to form helical bundles (HBs) in water (Fig. 1). Reaction with Silver (I) diammonium complex (Tollen's reagent) yielded HRN's homogeneously coated with a thin layer of metallic silver (Fig. 2, 3). Scanning electron microscopy, transmission electron microscopy, atomic force microscopy, infrared spectroscopy, energy dispersive x-ray analysis, x-ray photoelectron spectroscopy, small angle x-ray scattering, infra red spectroscopy, and dynamic light scattering studies will be presented. The possible mechanisms for the bundles formation will be discussed.

References:

- [1] Fenniri H. et al. *Proc. Natl. Acad. Sci. USA*. **99** (2002) 6487
 [2] Braun E. et al. *Nature* **391**, (1998) 775.

Figures:

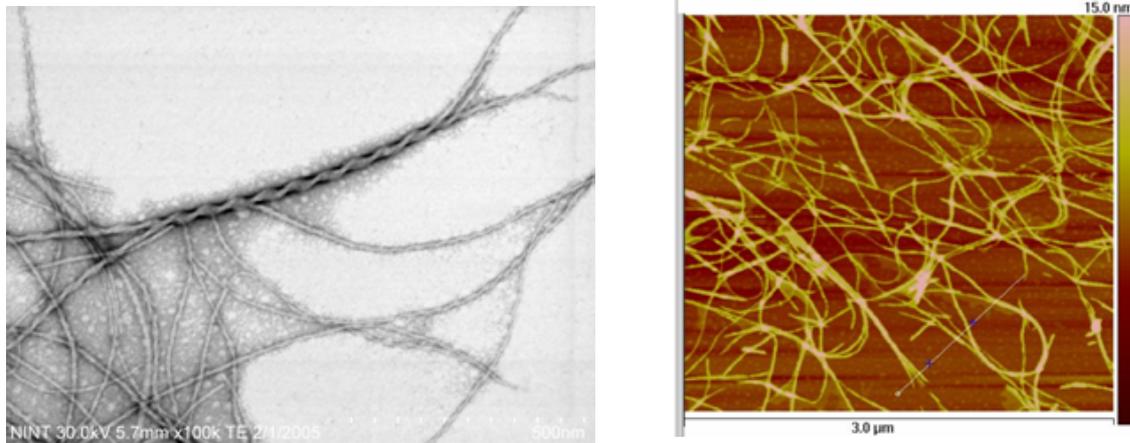


Figure 1. STEM image of stained with uranyl acetate helical bundles (HBs) (left), AFM of HBs (right)

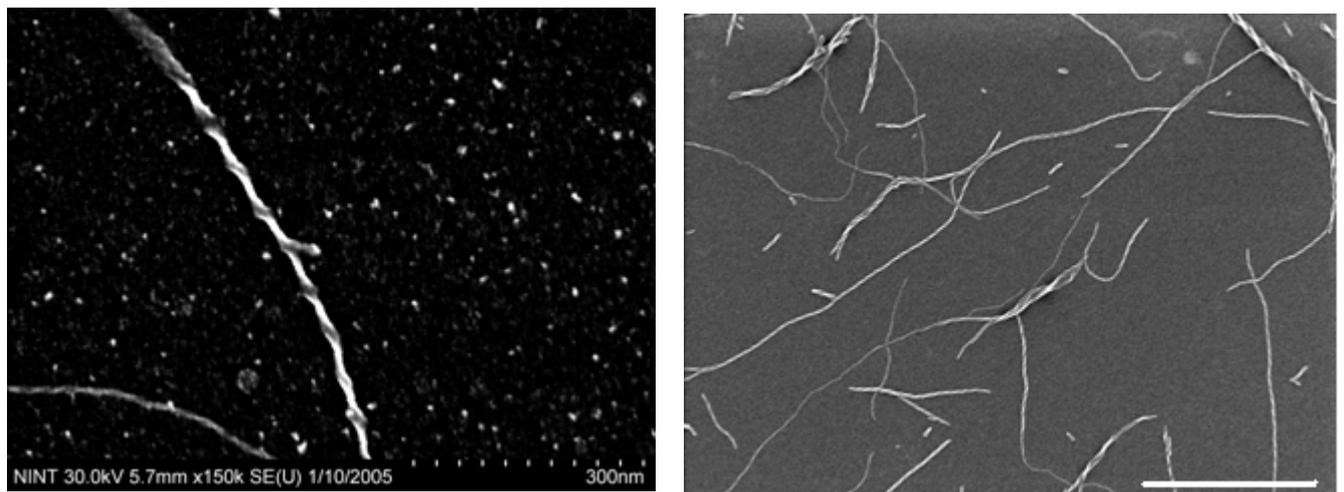


Figure 2. SEM images of HBs coated with silver. Scale bar is 500 nm on the left picture.

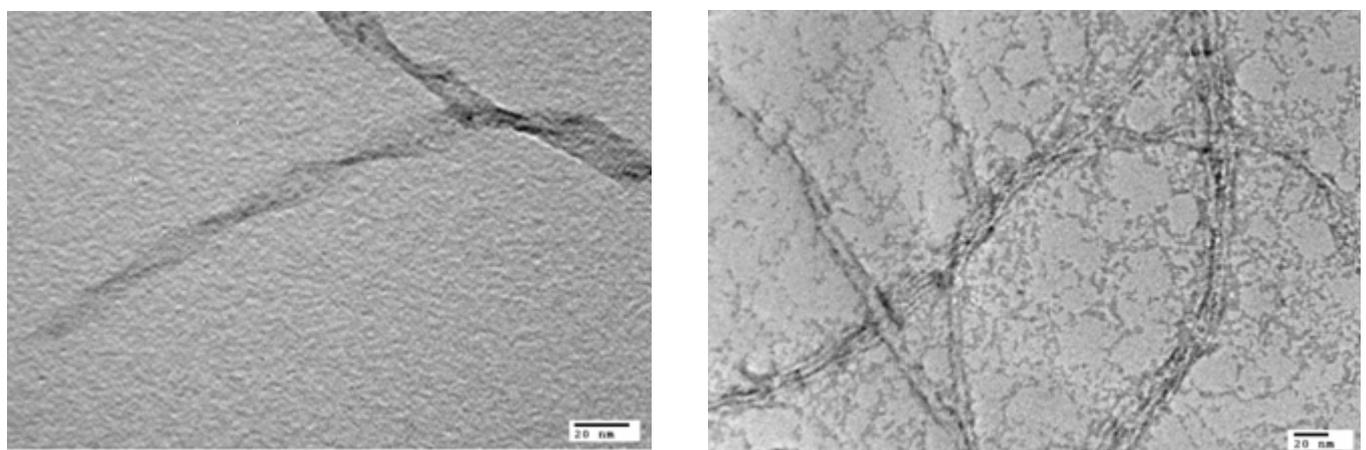


Figure 3. TEM images of HBs coated with silver unstained (left), HBs stained with uranyl acetate (right) showing single tubes within a helical bundle.