STM/STS studies on Europium nanowires encapsulated in carbon nanotubes

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The discovery of carbon nanotubes (CNTs) and their fascinating properties have ignited intense research interests on one-dimensional nanosystems. Although ultrathin atomic wires are one of the ideal one-dimensional systems, preparation of the ultrathin wires with diameters of 1~several nanometers has been difficult. Previously, we have reported the synthesis and characterization of ultrathin metal nanowires encapsulated in CNTs.[1][2] Here, we present the preparation and investigation of spatially-resolved electronic structure of Eu nanowires encapsulated in CNT (EuNW@CNT) by scanning tunneling microscopy/spectroscopy (STM/STS).

EuNW@CNT was synthesized by the direct nano-filling method[1] and deposited on Au(111) surface by the pulsed-jet deposition technique.[3] Figure 1 shows a STS spectrum of EuNW@CNT, where a new peak due to a localized density of states (DOS) of the encapsulated Eu nanowire can be seen. Figure 2 shows a d*I*/d*V* mapping observed at a bias voltage of -0.4 V, which corresponds to the voltage where the new DOS peak was observed. The bright region in the d*I*/d*V* map corresponds to the position where the encapsulated Eu nanowire locates. Spatially-resolved STS spectra reveal the position of Eu atoms in EuNW@CNT directly, which leads to a precise assignment of the STS peak and the interaction between Eu nanowires and CNTs.

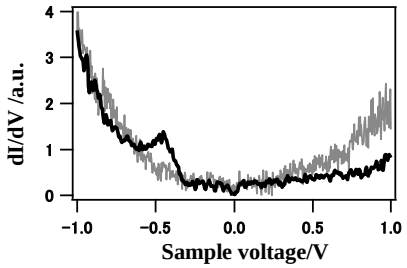

Fig.1 STS spectra of EuNW@CNT. Black curve is taken at Eu encapsulated point and gray curve is taken at empty area on the same CNT.

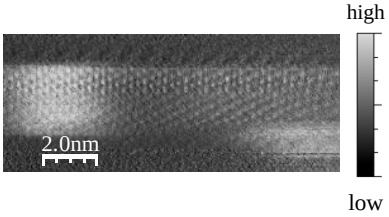

Fig.2 dI/dV mapping at -0.4 V. A bright spot on the left side of image is high localized density of state point where europium nanowire is encapsulated.

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[3] N. Fukui *et al*. J. Nanosci. Nanotechnol. **7**, 4267 (2007).

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