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| Description | |

# Local electronic transport through a junction of SWNT bundles

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**Abstract**

We have measured local electronic transport through a junction of single-wall carbon nanotube (SWNT) bundles by Atomic force microscopy (AFM)/Scanning tunneling spectroscopy (STS) dual probe method. We found that 1)the sudden decrease in current near the junction of SWNT bundles 2)the current actually flow through the junction of SWNT bundles. From the observed topographic current image, we can expect our method will be a powerful technique for investigation of functions of the devices in the nanometer scale.

*Key words:* Carbon nanotubes, AFM, STS
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Since the discovery of carbon nanotubes (NTs)[1], they have attracted great attention as a very interesting electronic material because of the one-dimensional tubular network structure in the nanometer scale. Actually, the findings of many properties of NTs opened up a route towards nanoscale electronic devices. Measurement techniques in nanometer resolution have been also developed under progress of nanotechnology [2]. Up to now, however, fields in evaluation of nanoscale function, namely, spatial variation of electronic states in nanometer scale, still remains to be explored. Here, we report investigation of local electronic transport through the junction of single-wall carbon nanotube bundles by means of atomic-force-microscopy (AFM)/scanning-tunneling-spectroscopy (STS) dual-probe method (DPM).

The soot containing single-wall carbon nanotube (SWNT) bundles was prepared by a laser ablation of carbon rod including Ni-Co catalyst. The obtained soot was purified by oxidation in $H_2O_2$ solution for two hours[3]. A circuit consisting of SWNT bundles and tungsten (W) electrode is prepared by electron lithography method[4,5]. The principle of AFM/STS-DPM is that a metal-coated conducting AFM tip monitor the electrically connected nanometer-sized circuit on the insulating substrate with applying the bias voltage during the conventional AFM measurement as shown in Fig. 1.

Figure 2 shows simultaneously observed topographic AFM image and topographic current image (TCI) with a bias voltage of 0.6 V around the junction of SWNT bundles. We confirmed that one side of a SWNT bundle (NT #1) is connected to the W electrode and another SWNT bundle (NT #2) is not connected to the electrode but to the NT #1. Current flowing on the NT #1 from the electrode suddenly decreases before the junction. On the other hand, no clear change in current is observed at the junction: current actually flow through the junction of SWNT bundles. Although the reason of sudden decrease in current near the junction is not clear, it is interesting to examin it in a viewpoint of effects of reflection and/or rectification of current at the junction. More detailed measurements and analyses will clarify the electronic properties and functions of the junction of SWNT bundles. In addition, TCI can provide information of local transport properties in nanometer scale resolution. Therefore, we believe that this method is very effective for evaluation of nanoscale devices.

In conclusion, we have investigated local electronic transport properties around the junction of SWNT bundles. We found that 1)the sudden decrease in current near the junction of SWNT bundles 2)the current actually flow through the junction of SWNT bundles. Our results show that this new approach has high potential for the detection of nanoscale electronic functions.

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## References


[1] S. Iijima, Nature (London) **354** (1991) 56.

[2] M. Freitag *et al.*, Phys. Rev. B **62** (2000) R2307.

[3] H. Kataura *et al.*, Carbon **38** (2000) 1691.

[4] A. Fujiwara *et al.*, Phys. Rev. B **60** (1999) 13492.

[5] A. Fujiwara *et al.*, Physica B **298** (2001) 541.

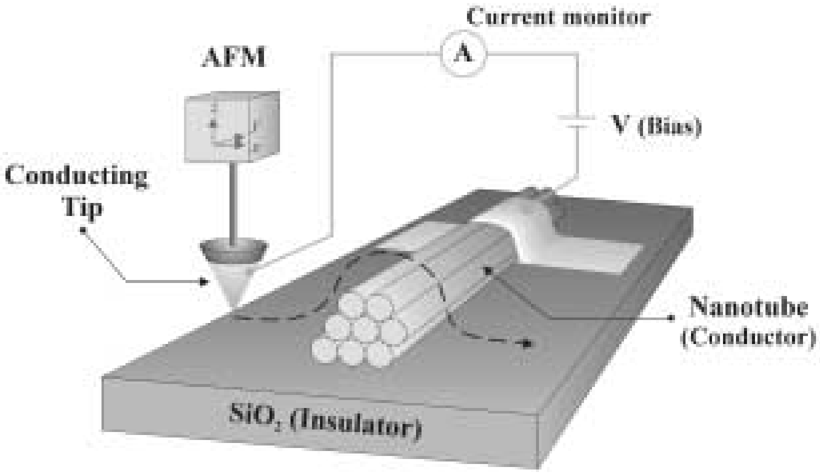


Fig. 1. Schematic illustration of the AFM/STS dual probe method.

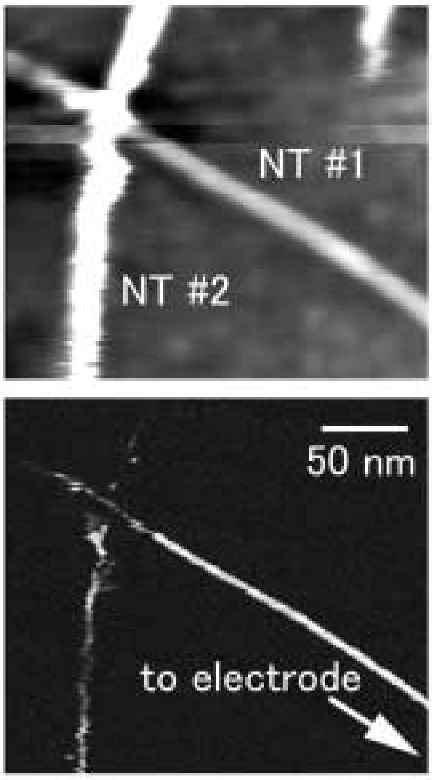


Fig. 2. Topographic AFM image (upper panel) and TCI with a bias voltage of 0.6 V (lower panel) around the junction of SWNT bundles.