Dissolution of Carbon Nanotubes in Aqueous Double-Stranded DNA Solution

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Although carbon nanotubes have been in the forefront of nanoscience and nanotechnology because of their many unique properties, chemical and biochemical approaches using this material have been very limited. Noncovalent sidewall-functionalized soluble carbon nanotubes are of interest,[1)] because the study would lead to the chemical and biochemical design to create functional carbon nanotubes in solution systems. The combination of carbon nanotubes and DNA is of interest to many chemical and biochemical areas in both fundamental and application. Recently Zheng and coauthors have reported the dissolution of SWNTs in a single-stranded DNA aqueous solution.[2)] At the same time, we have described that double-stranded DNA dissolves SWNTs in aqueous solutions. [3)] Here we present in detail about the dissolution of SWNTs in double-stranded DNA aqueous solutions.

SWNTs were obtained from Carbon Nanotechnologies Incorporated and were used as received. About 0.4 mg of SWNTs was placed in the DNA aqueous solution (5 mL) and then sonicated with a bath-type ultrasonifier at temperatures below 10 ˚C for 1 h. Centrifugation of the suspension at a given g-value was found to give a black-colored transparent supernatant aqueous dispersion/solution, which was collected and used for the measurements.

Atomic force microscope (AFM) was used to reveal the structure of SWNTs in the DNA solution. A sample for AFM measurements was prepared by dipping a freshly cleaved mica substrate into the DNA-SWNT aqueous solution and then air-dried. A typical AFM image for a SWNTs-DNA solution is shown in Figure 1. The heights of the images were mainly in the range of 1.5-2.8nm. It is evident that nanotubes are individually dissolved by the aid of DNA in water. Nanotube bundles that are formed from aggregation of several nanotubes were also seen in the AFM image.

Although the detailed mechanism for the dissolution of the nanotubes in a DNA aqueous solution and the fine structure of the obtained SWNTs-DNA in water are not clear at present, the importance of the weak interaction of the major (and/or minor) grooves of the DNA and the nanotubes may be suggested for the dissolution of the nanotubes in water.

DNA-SWNTs solutions obtained were characterized by TEM, UV-vis-NIR and Raman spectroscopies. Detailed results will be reported at the meeting.

References

[1] a) N. Nakashima, Y. Tomonari, H. Murakami, *Chem. Lett.* **2002**, 638. b) N. Nakashima, et al., *Chem. Phys. Lett.*, **378**, 481-485 (2003).
[2] M. Zheng et al., *Nature Materials*, **2**, 338 (2003).
[3] N. Nakashima et al., *Chem. Lett.*, **32**, 456-457 (2003).

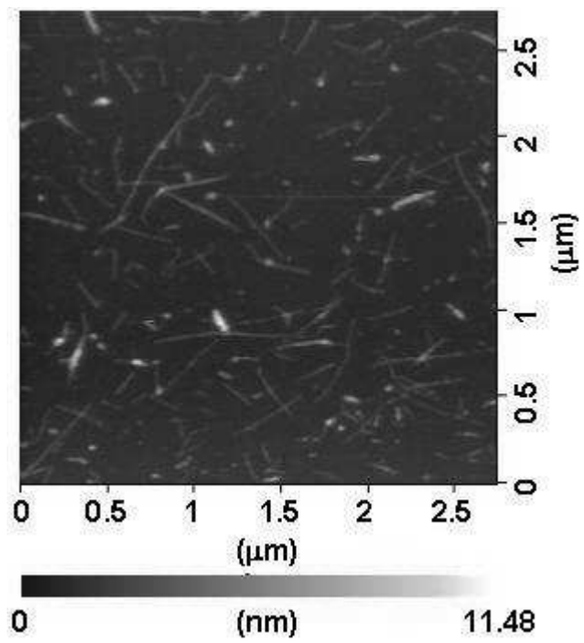

Figure1. A typical AFM image of a DNA/SWNTs aqueous solution on mica.