Poster

SPM studies of SWCNTs decorated by Oligodeoxyribonucleotides

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The dispersion of Single Walled Carbon Nanotubes (SWCNT) is an important step often required for different applications in engineering and biology.[1-4] For engineering applications, the dispersion of SWCNTs in solvents has been reported.[5-8] For biological applications, Zheng and *et al*[9, 10] have shown DNA facilitates the dispersion of SWCNTs in aqueous solution. Molecular modeling suggests the mechanism for association is a non-covalent "wrapping" of the Oligodeoxyribonucleotide (ODN) around the nanotubes[9]. Yet the chemistry and strength of this association has not been investigated.

A series of studies utilizing different characterization techniques have been conducted to characterize the ODN:SWCNT hybrids.[11] After dispersing the SWCNTs with T30 ODN, Transmission Electron Microscopy (TEM) has shown different morphologies of ODN:SWCNT hybrids. The morphologies vary depending on the sonication time. Atomic force microscopy (AFM) studies confirm the TEM data and provided more detailed images. At higher sonication times (>90min), isolated SWCNTs decorated with features that are attributed to ODN are observed (Figure 1). These features have an average height of 1-2nm above the SWCNT agreeing with the approximate height of single stranded ODN. X-ray Photoemission Spectroscopy (XPS) showed two distinct peaks for P and N, two key elements in T30 ODN, and confirm the decorative features are ODN (Figure 2). Chemically oxidizing SWCNTs increases the number of ODN features decorating the nanotubes (Figure 3), suggesting the association of ODN to defects.

Continued studies are underway to chemically characterize the association of ODN with SWCNTs and to determine if SWCNTs can be selectively linked by combining complimentary base pairs.

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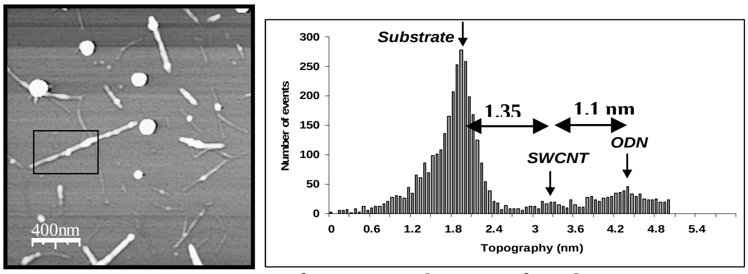
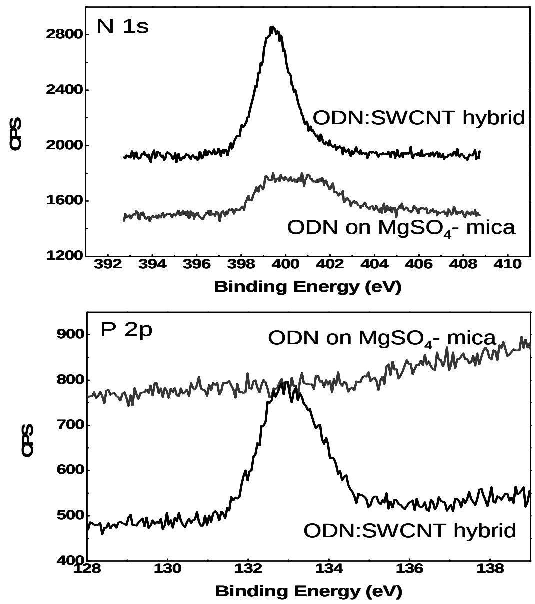


Figure 1: On left a non-contact SPM images of a mica substrate after depositing a T30:SWCNT solution that has been sonicated for 90 min. On right a topographic height histogram of the image inside the square shown in the image on left. The large peak at 1.95 nm is representative of the mica substrate and serves as a convenient baseline. A peak 1.35 nm above the substrate is a measure of the diameter (height) of the SWCNT. A second peak at 2.45 nm above the substrate measures the height of the T30 ODN feature.



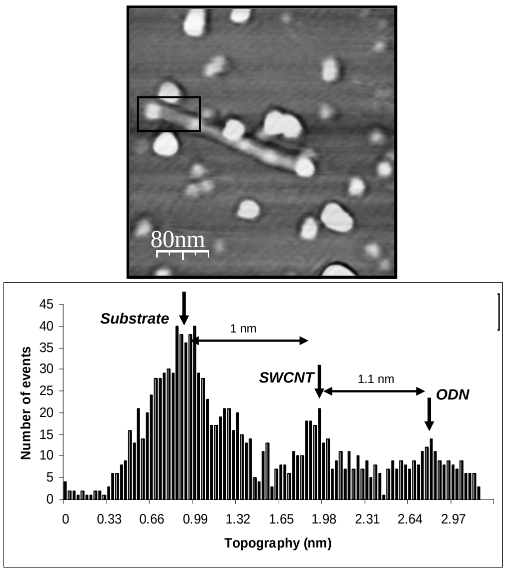


Figure 2: XPS data from ODN and ODN:SWCNT samples. On top the N1s XPS signal from ODN covered $MgSO_4$ treated mica is compared with the signal from SWCNT:ODN hybrid sample. The data indicate that the mica substrate contributes a small nitrogen signal. The nitrogen signal increases by factor of ~4 when ODN:SWCNTs are present. In bottom, the P2p XPS signal from ODN covered mica is compared with the signal from ODN:SWCNT hybrid sample. In this case, phosphorus is detected only when ODN:SWCNTs are present.

Figure 3: On top, a non-contact SPM image of $MgSO_4$ treated mica substrate after depositing SWCNTs that have been chemically oxidized before sonication with T30 ODN. In addition to the ~20 dot-like objects that are characteristic of all electric-arc samples, the image shows five localized features decorating the length of the SWCNT, which is ~250nm long. The separation between the features is ~50-70 nm. The bottom figure shows a topographic height histogram from a region of the image inside the box drawn in the top figure. The diameter of the SWCNT is ~1 nm. The feature attributed to ODN at the end of the SWCNT is ~1.1 nm above the SWCNT.