Crystallographic and chemical modification of carbon nanowalls by radical oxidation

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Carbon nanowalls (CNW) are one of carbon nanomaterials, such as graphene sheets, carbon nanotube and so forth. Each CNW consists of nanographite domains and stands vertically on a substrate, which forms a maze-like structure. To establish nanoelectronics application of CNWs, their crystallographic and chemical controls are necessary. Recently, we have investigated radical oxidation of CNWs synthesized using C$_2$F$_6$/H$_2$ plasma (CF-CNWs) as one of post-growth modification techniques [1,2]. In this study, comparing with CNWs synthesized using CH$_4$/H$_2$ plasma (CH-CNWs), we studied radical oxidation effects on nanostructures in the CNWs.

The CH-CNWs were fabricated on Si substrates by a plasma-enhanced chemical vapor deposition using a CH$_4$ gas with hydrogen (H) radical injection. After the growth of the CNWs, they are treated with oxygen (O) radicals generated in a inductively-coupled O$_2$ plasma at the temperature of 700°C for 5 min.

Figure 1 shows the Raman spectra for CF- and CH-CNWs. It should be noted that the larger peak width of G-band and much smaller relative intensity of 2D-band in the spectrum for the CH-CNWs indicate a significant lower graphitization degree. Figure 2 shows the cross-sectional and top-view scanning electron microscope (SEM) images of the CH-CNWs before and after the O radical treatment. The etch rate in height was about 100 nm/min which is more than three times faster than that of the CF-CNWs. In addition, many carbonous residues were found after the treatment. Such kind of residues has not been observed in the case of CF-CNWs [1]. These results indicate that O oxidation on the CNWs surfaces are significantly depending on edge and defect structures, and impurities of nanographene domains in CNWs.


![Fig. 1 Raman spectra for CF- and CH-CNWs.](image1)

![Fig. 2 SEM images of CH-CNWs (a) before and (b) after O radical treatment.](image2)