Characterization of Plasma-Functionalized Buckypapers

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Applications based on the properties of individual carbon nanotubes (CNT), such as electronic devices, involve highly demanding separation and assembly processing [1-3]. Nevertheless, for many other less challenging applications, overall statistical properties of nanotube assemblies provide interesting alternatives and may lead to materials of superior performance, especially in the field of electrochemically based applications, energy storage, and sensor devices [4-6]. "Buckypapers" [7,8] are a special form of CNT assemblies, comprising of statistical networks of carbon nanotubes in sheet-like form, typically some tens of microns in thickness, made by filtration of CNT dispersions. Post-processing, functionalization, and integration into different kind of devices is relatively easy.

In this communication we present details of the preparation of buckypapers from single-walled HiPco CNTs, and their subsequent surface treatment using a proprietary nitrogen and oxygen cold-plasma process. We report on the characterization of the obtained and treated buckypapers using scanning electron microscopy (SEM), micro-Raman spectroscopy at three different excitation wavelengths (514.5, 532 and 785 nm), and Fourier-transform Raman spectroscopy at 1064 nm. Additionally, surface four-probe conductivity measurements were carried out.

The entangled network structure of the as-prepared buckypapers can be easily observed by SEM. However, the plasma treated side of the buckypapers shows significant modifications of the surface, *Figure 1*, with the generation of an apparently bead-like morphology. Initial conductivity values of about 50 S cm^{-1} measured for the as-produced buckypapers were found to decrease only slightly in the plasma treated buckypapers. Raman spectroscopy reveals good sample homogeneity for the buckypapers analysed. In the plasma treated buckypapers an enhanced D-band (disorded carbon) intensity and a lower G/D-band ratio is observed. Furthermore, the plasma-treated buckypapers show interesting variations in the low frequency radial breathing modes (RBM) as well as a systematically lower Raman response, *Figure 2*.

The observations will be discussed in terms of the modification of the resonance conditions in the plasma-modified samples, as a function of the different laser wavelengths, and its relation with type and degree of aggregation of the CNTs at the Buckypaper surface, and the nature of the oxygen or nitrogen functionalization induced by the plasma.

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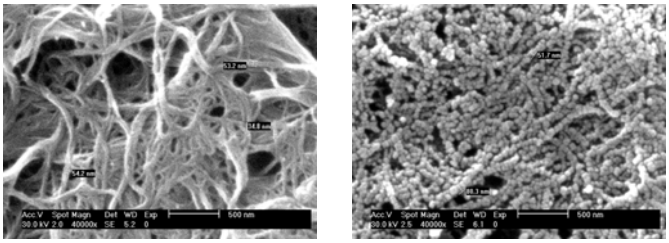
Figures:

Figure 1: SEM of buckypapers (scale bar = 500 μm)



As-prepared buckypaper

O_2 plasma treated buckypaper

Figure 2: Raman spectra (λ_{ex} = 514.5 nm) of buckypapers (inset = expanded RBM region)