

Structural and Compositional EELS Studies on Doped Carbon Nanostructures used as Cold Field Emitters

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Nowadays, more and more microscopes are equipped with cold field emission guns (C-FEG) due to their higher performance. For further improvement of C-FEGs, new emitter materials need to be explored. In this sense, carbon nanotube (CNTs) related materials are very promising candidates as cold field emitter [1]. However, more recently, carbon cone nanotips (CcNT) [2] have been considered as one of the most applicable form of carbon as field emitter, answering most of the technological problems of CNTs installation in a C-FEG [3,4]. For a higher performance of C-FEG, the electronic band structure of carbon nano-objects (tube or cones) can be modulated through the introduction of heteroatoms into the graphene lattice leading to a lower work function [5,6]. This work is devoted to the doping of these carbon nanostructures by nitrogen and/or boron, the deep study of their structure and atomic composition, and to the evaluation of their cold field emission characteristics. In this contribution, we will focus on our recent results related to doping of carbon nanotubes. HRTEM imaging, spatially-resolved EELS and X-ray photoelectron spectroscopy (XPS) studies have been developed on these NTs. After heating treatments, there is no significant structural modification in the CNTs (Fig.1). C-B and C-N bonds are identified at macro scale by XPS (Fig.2 (a)) and at local scale by EELS-STEM (Fig.2 (b), (c)). DFT calculations are also carried out and point out how the CNTs are affected by BN dopants. All these results will be discussed in depth in this contribution.

References:

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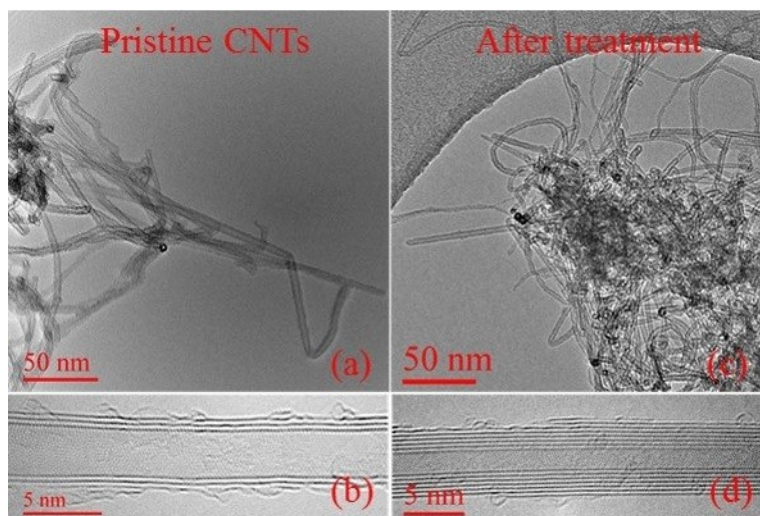


Fig 1. Structural comparison between pristine (a), (b) and doped CNTs (c), (d) at different magnification.

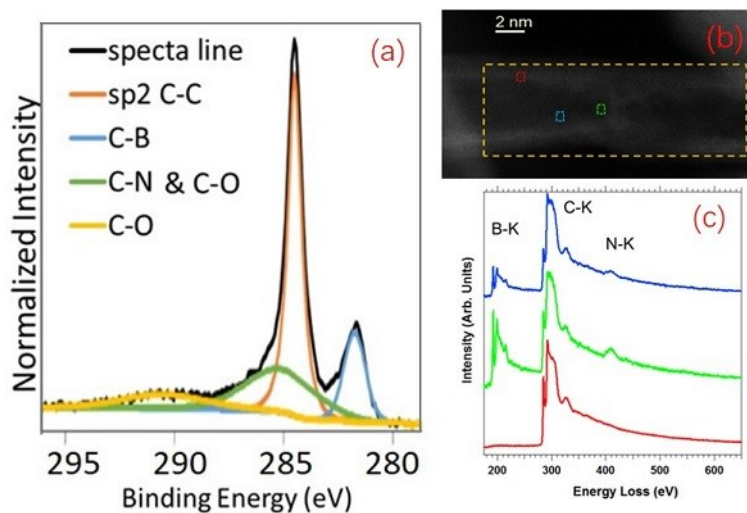


Figure 2. (a) XPS spectra of carbon C1s binding energy. (b) HAADF-STEM image of a doped CNT. (c) Selection of EEL spectra extracted from the spectrum-image recorded in the yellow marked area. (c) Blue, red and green spectra correspond to the sum of EEL spectra collected in the different areas highlighted in Fig. 2(b).