TEM CHARACTERIZATION OF METAL MATRIX NANOCOMPOSITES

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Since their discovery, carbon nanotubes (CNTs) became an interesting research spot due to their unique features revealed depending on their atomic distribution. According to their chirality, these carbon arrangements have shown evidence for diverse structural, mechanical, thermal and electronic properties, which elucidates the reason why the scientific community accomplishes great efforts on the synthesis and characterization of them. [1,2] Considering these key properties, one of their applications points up a possibility of incorporating CNTs in metallic, polymeric and ceramic materials to modify their features and reinforce them. Specifically, we call attention to incorporating pyrolytically grown carbon nanotubes into different metal matrixes with the purpose of modifying their properties endeavoring as well a dispersion control throughout the material. This is a fact to be carefully considered as properties efficiency of CNTs in composite applications depends strongly on the uniform dispersion of CNTs throughout the matrix without destroying the integrity of nanotubes.[3] Hence, it is important to characterize the nanotubes as an initial stage. In order to produce the nanotubes we employ a spray pyrolysis method that demonstrates it is possible to obtain bulk amounts of CNTs by spraying a ferrocene 2%wt in toluene solution through a quartz tube furnace working at 800-900^{o}C. Throughout the experimental procedure we employ fine low melting point metallic precursors that tend to form clusters incorporating the pyrolytically grown carbon nanotubes within.

Electron dispersion spectroscopy (EDS) studies are employed in order to inspect the chemical composition in the matrix as well as in former stages where only the CNTs spatial distribution prior to the inclusion is sought. With this approach, we are set to follow what models have tried to clarify about the role of metal catalysts during the SWNT and MWNT formation as well as the spatial distributions of metal atoms during the process.

Characterizing CNTs aims to reveal the shape distribution of the tubes according to the sample preparation and dispersion processes. To perform sample characterization, a JEOL 2010 Transmission Electron Microscope has been used under 200kV accelerating voltage. Conventional diffraction contrast and phase contrast mode are used. The first combined with selected area diffraction patterns allows one to visualize overall CNTs distribution, shape and format together with the detection of defects over a wide range of magnifications. The second is a necessary condition to obtain high resolution images with lattice information. With High Resolution Transmission Electron microscopy the basic morphology of the tubes can simply be interpreted. As observed on figure 1a, the Bright Field BF image shows the overall width of distribution of nanotubes and fibers as well as how their flexibility allows their twist and bending. Tubes defects are also revealed as observed on image 2. One perceives on figure 1b how the Dark Field Image contrast provides information on the strain fields and effects incorporated in the fibers. From this centered DF image arise reflections from contaminant catalytic seed nanoparticles. The BF/DF pair shown on Fig 3a,b corresponds to the boxed area on 1b. Its EDS spectrum shown in Fig 3c corroborates its nature as Fe catalytic seed.

References:

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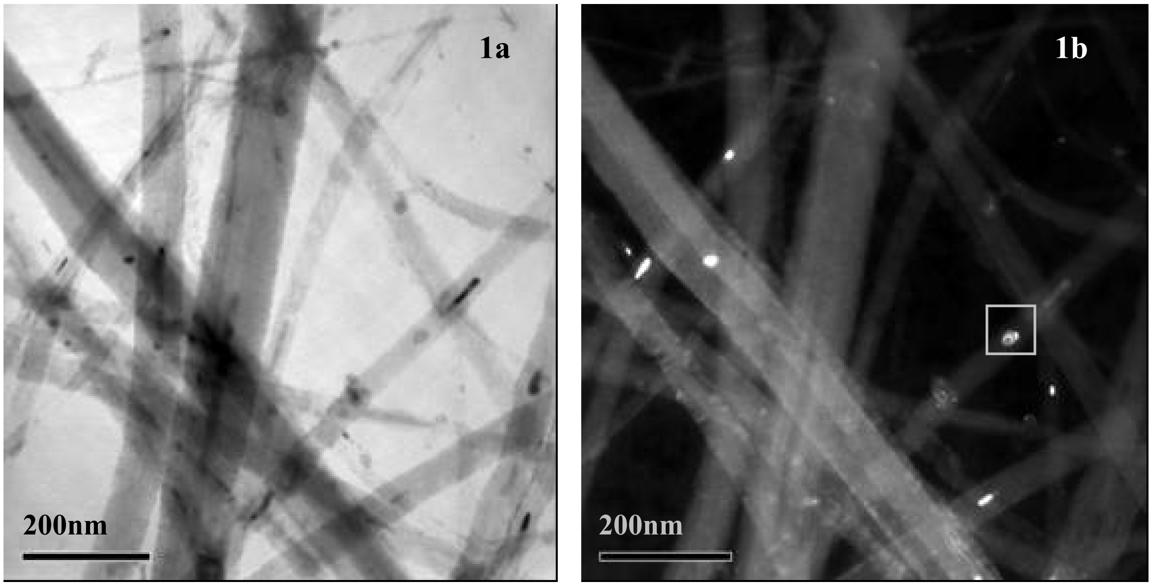

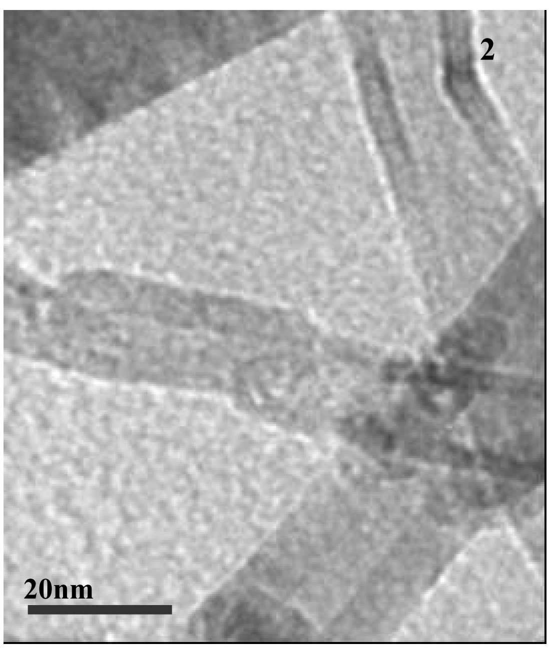

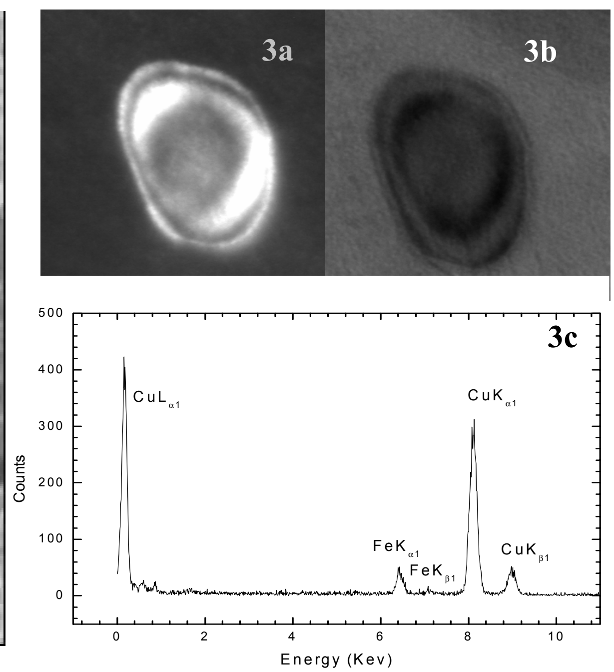

Figure 1 (a,b) Low magnification bright field BF/dark field DF pair of images showing overall width, distribution, twist and bending of CNTs.

Figure 2 High magnification image revealing structural defects of CNTs

Figure 3(a,b,c) Catalytic seed attached to tubes from boxed area on fig 1b and EDS spectrum revealing its nature.