Synthesis and characterization of carbon nanotube/iron oxide hybrids

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Developing renewable and non-polluting energy sources is one of major challenges of this century. Solar energy has many advantages; it's renewable, abundant and it can be converted to heat or electricity, or to generate chemical fuels, such as hydrogen (H_2). We propose to use thin films of carbon nanotubes (CNTs) decorated with hematite nanoparticles as photoanodes for H_2 generation by the photo-electrochemical splitting of water molecules. Hematite has several advantages as a semiconductor material for this end. With a band gap around 2.0 eV, it is sensitive to large fraction of the solar spectrum. It has good chemical stability in aqueous environment and the position of its valence band is appropriate for oxygen evolution. However, hematite has shown poor charge transport properties, which are associated with high recombination losses in photoanodes [1]. In this scenario, CNTs could be used to minimize recombination losses by capturing the photo-generated electrons and transporting them to external circuit.

In this work, the synthesis of CNT/hematite hybrids was investigated. The method consists on the solvothermal treatment (140 °C) of a mixture of multi-walled CNTs (produced by chemical vapor deposition) and iron chloride in ethanol. A systematic study exploring different reaction parameters such as CNT functionalization, reaction duration, and iron concentration was performed. Scanning and transmission electron microscopy characterization demonstrates that the CNTs were decorated with flower-like nanostructures having diameters in the 100-500 nm range. The size of the nanoparticles could be controlled by the reaction time. X-ray diffraction and energy dispersive analysis confirm that the nanoparticles have the α-Fe_2O_3, hematite, phase. In addition, thin films of the hybrid material were deposited on indium-tin oxide substrates by electrophoretic deposition. It was observed that hybrid materials based on the functionalized CNTs were more easily dispersed and produced more homogeneous films. An example of the produced films is shown in Figure 1. On-going studies are directed to the photo-electrochemical characterization of the produced films

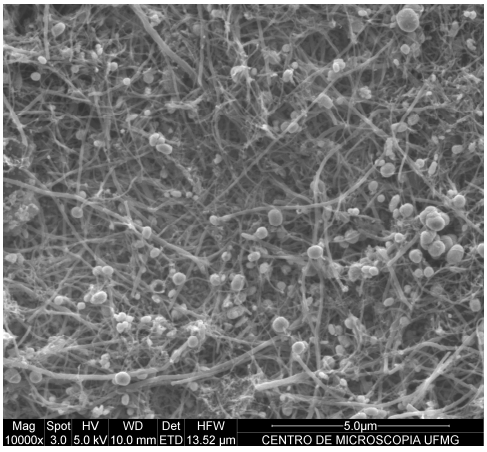

Fig1. SEM image of a thin film of CNT/hematite hybrid.

Keywords: Hematite, carbon nanotube, photo-electrochemistry, hydrogen, solar energy.
Work supported by CNPq, Fapemig, Capes. SEM and TEM images were performed at Centro de Microsocpia da UFMG.

[1] T. Lindgren et al., Solar Energy Materials & Solar Cells **71**, 231(2002)

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