Synthesis and Characterization of Novel Carbon Nanotubes-Iron Oxide Nanoparticles Hybrids

A. P. Douvalis[1*], T. Tsoufis[2], D. Gournis[2], P. Trikalitis[3] and T. Bakas[1]

[1] *Physics Department, University of Ioannina, 45110, Ioannina*
[2] *Department of Materials Science and Engineering, University of Ioannina, 45110, Ioannina*
[3] *Department of Chemistry, University of Crete, Voutes 71003, Iraklio*

**adouval@cc.uoi.gr*

Magnetic nanoparticles (NPs) are important materials with a wide range of technological applications, like media for magnetic data storage [1], drug carriers, identifiers as also contrast and hyperthermia agents in biomedicine [2]. On the other hand carbon nanotubes (CNTs) are novel developed versatile materials with extraordinary structural, mechanical, electronic and magnetic properties and posses a high potential to be used in many aspects of modern technical implementations [3]. The joining of the properties of both categories of materials has given rise to new fields of research and dynamic future technological applications [3].

In this work we present a simple and versatile way to synthesize different CNTs-iron oxide NPs hybrid materials. Chemically functionalized CNTs (single- and multi-walled) were used as nanotemplates for the in-situ synthesis of a variety of ferrimagnetic and/or antiferromagnetic iron oxide NPs. The method involves the covalent functionalization of the CNTs, the subsequent adsorption of the nanoparticle precursor on the functionalized nanotube surface followed by the interaction of acetic acid vapors with the derived nanotube-precursor system. The various resulting CNTs-iron oxide NPs hybrid materials were prepared upon pyrolysis of the created iron acetate species under three different atmospheres: air, argon and oxygen.

The characterization of the final hybrid materials with Raman spectroscopy showed that in most cases during the calcinations process, carbon nanotubes retain their initial basic structural characteristics intact. In addition combined X-Ray diffraction, Mössbauer spectroscopy and magnetization measurements revealed that the atmosphere chosen during the thermal treatment affects significantly the nature of the resulting nanoparticles, which were found to be either ferrimagnetic maghemite (γ-Fe_2O_3), magnetite (Fe_3O_4) or antiferromagnetic hematite (α-Fe_2O_3). Transmission electron microscopy provides information on the formation, size and type of the synthesized iron oxide phases.

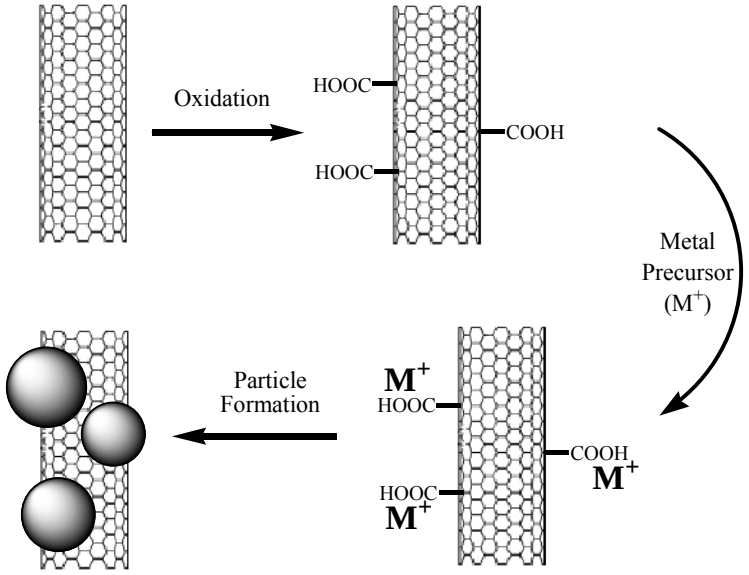

Figure 1. Scheme for the preparation of CNT-iron oxide nanoparticle nanohybrids

References

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