ABSTRACT

Effect of surface modification on the electronic properties and solubility of carbon-based nanostructured materials

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In the first part of this dissertation, the effect of surface organic functionalization on the electronic structure and physicochemical properties of graphenes was studied. Towards this aim, graphene oxide (an oxidized form of graphene) was used as pristine material that was further functionalized through ring opening reactions with amine derivatives bearing various functional groups (thiol, carboxyl and amine groups).The purpose was to compare the electronic and magnetic properties of graphene through 'chemically' adjustment of the interlayer distance between the sheets of nanomaterial. Hybrid materials were characterized by a combination of experimental techniques including X-ray diffraction, infrared and μ-Raman spectroscopies as well as thermal analysis. Particular emphasis was given to the study of electronic structure and magnetic properties of the final hybrid materials with Electron Paramagnetic Resonance spectroscopy. Results showed that the organic functionalization of graphene allows a control of interlayer distance, which in turn modulates the interlayer anisotropy/and strength of spin-spin interactions.

In the second part, we present a study of the solubilization effect of Humic Acids on carbon nanotubes (CNTs).As the production and applications of CNTs expand the introduction of CNTs into the environment increases continuously. Natural surface-active materials, such as humic acids (HA) are widely distributed in the environment and may adsorb onto individual CNTs, and thus alter their surface physicochemical properties and enhance their stabilization in water. Here, the

solubilization effect of well characterized synthetic Humic Acids on Multi-Walled CNTs (MWCNTs) was followed with Attenuated Total Reflection (ATR) FTIR spectroscopy. A well characterized Humic Acid Like Polycondensate (HALP) produced with no-use of a catalyst shows remarkable capability for solubilisation of - otherwise water-insoluble - MWCNTs. FTIR data showed that CNTs cause specific changes in the spectral features of humic acids. These spectral changes are sensitive to pH, indicating that deprotonable groups of the humics are involved in the interaction with the MWCNTs. Finally, while MWCNTs are not soluble in water, the presence of HALP forms non-precipitating colloid suspensions which are practically unaltered for at least two weeks.