Polystyrene grafting of CN\textsubscript{x} nanotubes  
for the elaboration of polystyrene-based nanocomposites

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Abstract

This thesis is concerned to the development of novel engineered surface materials using nitrogen-doped carbon nanotubes (CN\textsubscript{x}) that were grafted with polystyrene (PS) chains using \textit{in situ} radical polymerization controlled by nitroxides. The chemically modified carbon nanotubes were used in the preparation of polymer-nanotube composites with the aim of improving the dispersion of nanotubes within the matrix, but also the interfacial adhesion between them.

The \textit{in situ} polymerization method to graft polymer chains over CN\textsubscript{x} nanotubes involved the radical attachment of a system initiator-controller that could follow a Nitroxide Mediated Radical Polymerization (NMRP) in solution. This technique take advantage of the enhance reactivity of CN\textsubscript{x} nanotubes, and their electrical and mechanical properties, producing low structural damage. An extensive characterization was performed on the obtained modified nanotubes in order to evaluate the covalent polymer-grafting, as well as the material structural changes and physico-chemical properties. Some of the used techniques mainly involved microscopy, spectroscopy and physico-chemical methods, among them SEM, HRTEM and allied techniques, FTIR, Raman spectroscopy, ESR, TGA, etc. The polymer-grafted nanotubes were produced at several reaction conditions, and compared to materials physically mixed.

The produced polymer-grafted CN\textsubscript{x} nanotubes were used as nanofillers to prepared polymer nanocomposites using several kinds of matrices (amorphous PS, semicrystalline polyethylene oxide (PEO) and immiscible blends PS-PEO). The structural and physical differences observed due to changes in dispersion and interactions were described for each polymer matrix. In addition, the polymer nanocomposites prepared with polymer-grafted CN\textsubscript{x} nanotubes were compared with sonicated MWNT and CN\textsubscript{x} nanotubes. The nanocomposite characterization involved morphogical, thermal, electrical and mechanical properties using microscopy, TGA, DSC, dielectric spectroscopy and DMA. Interesting results were obtained, as elastic modulus enhancement and conductivity at low loadings in PS matrices. In other cases, a preparation challenges were found when producing PEO and PS-PEO, due to solution technique and immiscibility of the materials.