Abstract

In recent years, carbon based nanostructured materials (e.g. carbon nanotubes, carbon nanofibers, and nanocomposites) hold great promise for potential applications in various fields, due to their several remarkable properties such as electrical properties. Electrical properties are intimately related to the structure of the carbon materials, which varies with the synthesis conditions and treatments. For that reason, in this thesis, different kinds of multi-walled carbon nanotubes (MWCNTs), carbon nanofibers (CNFs), and nanocomposites were synthesized. Consequently, their electrical properties were investigated.

MWCNTs were synthesized by aerosol assisted and fixed-bed chemical vapor deposition (CVD) techniques. The as-grown synthesized MWCNTs were purified by two different methods, namely chemical treatment and annealing at 2600 °C .On the other hand, two kinds of CNFs (platelets and herringbones) were synthesized by fixed-bed CVD. Some of these different kinds of MWCNTs and CNFs were embedded in polycarbonate and copper to form nanocomposite materials. In addition, MWCNTs were treated with different plasma environment (Ar, H_2 and N_2) at different treatment conditions (e.g. power, time) in order to functionalize their surfaces. Besides, the influence of plasma pretreatments on electroless plating with copper was investigated. The synthesized samples were characterized by using the following techniques: scanning electron microscopy (SEM), transmission electron microscopy (TEM), Raman spectroscopy, X-ray photoelectron spectroscopy (XPS), and X-ray diffractometer (XRD).

The aim of the present thesis is to gain a deeper understanding of electrical properties of different kinds of synthesized MWCNTs, CNFs, and nanocomposites materials. This study also addressed the influence of plasma-based surface modification of MWCNTs on their electrical properties and coatings of MWCNTs. Towards this goal, the electrical properties of different kinds of MWCNTs and CNFs have been investigated. The electrical measurements were separately carried out in two temperature ranges (4-294 K and 300-570 K) by four points probe technique. Moreover, the influence of synthesis conditions and post treatments on their electrical properties has been studied. The temperature dependence of the electrical properties was interpreted using Mott's variable range hopping (Mott's VRH) model and Arrhenius model.

It was found that the MWCNTs showed an improved electrical conductivity by annealing and subsequent acid treatments as compared to as-grown and acid treated MWCNTs. Moreover, the measured electrical properties gave a good fit to Mott's VRH model at low-temperature range. The conduction mechanism of the MWCNTs shows a crossover from 3D-VRH to 2D-VRH. In addition, different electrical properties have been calculated such as activation energy, density of states, hoping distance and hopping energy. Furthermore, the obtained results proved that nitrogen plasma treatment is more suitable for functionalization MWCNTs surface with superior electrical properties and the best copper growth was achieved at 180 W for 10 min.