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Sonochemical "in situ" polymerization and characterization of PMMA/MWCNT nanocomposites films

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Abstract:

Nanocomposites of multiwalled carbon nanotubes (MWCNT) in very small amounts dispersed into polymeric materials could have high potential applications whereupon conductivity (electrical and thermal), transparency, low specific weight, compromise between mechanical strength and flexibility are required. The building blocks of the nanocomposites are of the molecular scale, confinement effects result from the way these blocks intercalate. This is why nanocomposites show unique properties compared with bulk materials. Understanding the complex interactions between the building blocks is essential in nanotechnology to develop a new generation of advanced materials. In particular, the relative merits of polymer-carbon nanotube nanocomposites to conventional micro and macro-composites is the remarkable increases in properties using very low loadings levels of nanoscale substances. It is still a challenging to obtain the complete dispersion of nanoparticles into polymer matrix although many methods, including *in situ* polymerization, melt blending, and solution blending, have been studied in the literature. In this work, nanocomposites of Poly(methyl methacrylate) PMMA, a typical transparent amorphous polymer, and MWCNT (1 to 3 wt%) were synthetized by sonochemical *in situ* solution polymerization. Ultrasound cause cavitation in the reactive

solution and could improve nanoparticles dispersion into the polymeric matrix as well as chemical interactions between carbon nanotubes and polymer chains. A 2^3 factorial experimental design was used to study the effect of synthesis variables on the electrical resistance of PMMA/MWNCT thin films as: ultrasonic energy or amplitude of the sonotrode, ratio of monomer:initiator (MMA:AIBN) and kind of solvent (chloroform and chloroform/toluene). The results of sheet resistance measured by the four-points method range from 5.7 to 29.2 kΩ/sq; the lowest resistances were found at the high levels of energy (69.2 kJ), for chloroform, and at the low levels (34.6 kJ) for the chloroform/toluene mixture. It seems that sonochemical reactions between MMA and CNT are solvent dependent regarding to be organic or inorganic. FTIR-ATR analyses of PMMA/MWCNT films showed a new absorption band at 1601 cm^{-1}, characteristic of C=C bond. This new band is related to the PMMA-MWCNT interactions on the sonochemical polymerization with AIBN, which opens π bonds of both MMA and CNT. The nanocomposites morphology were analyzed by TEM showing nanotubes relatively well dispersed into PMMA, some interconnected which should decrease the electrical resistivity of the PMMA.