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Nanoindentation Behavior of UV-Curable Epoxy/Multi-Walled Carbon Nanotubes Composites

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Abstract – The near-surface mechanical properties of photocurable epoxy-acrylate resin/multi-walled carbon nanotubes (MWCNT) nanocomposites has been investigated by a nanoindentation technique. The nanofillers were dispersed in the resin using sonication and thin films were prepared by curing with U.V. light. The Young´s modulus and hardness of neat resin and nanocomposites with two different MWCNT concentration (0.1 and 0.5 wt%) were then measured in a nanoindenter. It was observed that these properties are very sensible to the concentration of nanotubes. In addition, it is possible to notice a sharp increase on the measured properties near the surface of the films, which are related to cure process parameters and concentration of nanofillers.

Since their discovery, in the earlier 90´s, Carbon Nanotubes (CNTs) have been receiving much attention in the scientific community [1]. Due to their superior mechanical properties and very high thermal and electrical conductivities, many efforts have been made to prepare nanocomposites with small amounts of these nanofillers in order to obtain novel materials with better properties than the neat material. Very probably, due to the success of the high increases in the electrical conductivity in these nanocomposites, using polymeric matrices, similar results are expected in thermal and mechanical properties. Although, according to the literature, using small amounts up to 1% w/w of these nanofillers allows an increase around 50-100 % in the Young´s modulus. However, working with higher CNT concentrations is a hard task since the viscosity of the system increases several times, which makes the dispersion process of the nanofillers very difficult and generates nanocomposites with non-homogeneous dispersion and mechanical properties similar or inferior to the neat material .

In this work, thin films of a UV-Curable Epoxy/MultiWalled Carbon Nanotubes (MWCNT – BayTubes - Bayer) nanocomposite were prepared using sonication to disperse the filler in the resin. Later, by means of U.V. light, the nanocomposites and neat samples were cured. Two concentrations of MWCNTs, 0.10% and 0.50 wt%, were employed.

Nanoindentation was the chosen technique to measure Young´s modulus and hardness of the nanocomposites. Figures 1 and 2 show some of the results obtained in the presented work. It is observed that the surface modulus and hardness of the nanocomposites are significantly higher than those of the neat UV-curable epoxy resin. These properties strongly depend on the indentation depth and decrease for higher tip penetration depths inside the samples probably due to cure process parameters and concentration of nanofillers.

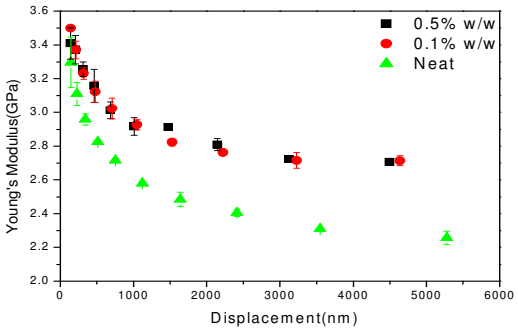

Figure 1: Young´s modulus of UV-Curable Epoxy/MWCNT nanocomposites.

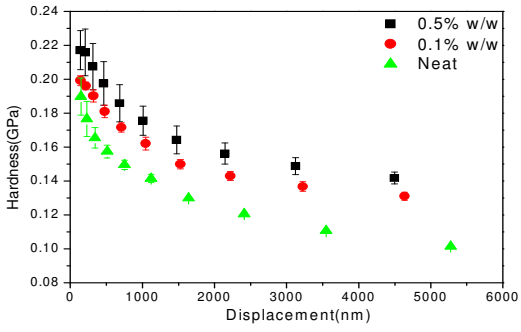

Figure 2: Hardness measurements of UV-Curable Epoxy/MWCNT nanocomposites.

[1] S. Iijima, Nature, **1991**, 354, 56.