Opto-Mechanical coupling in polymer based carbon nanotube composites.

B. Fragneaud[(1)*] and J.W. Kysar[(1)]

B Fragneaud. and J.W. Kysar.
Mechanical Engineering Department / Columbia University,
220 S. W. Mudd Building, 500 West 120th Street, New York, NY 10027 USA.

email: bf2204@columbia.edu
* Corresponding author.

Abstract

Recent work has demonstrated that polymer / Multiwalled Carbon Nanotubes (MWNT) composites have an opto-mechanical coupling when the material is exposed to visible light. In this study we synthesized poly(dymethyl siloxane) (PDMS) based composites with two types of carbon nanotubes: pure carbon MWNTs and nitrogen doped MWNTs. The composites were prepared by dispersing MCNTs in a solvent with sonication after which the polymer matrix was added to the mixture. The composites were dried in a vacuum oven in order to completely remove residual solvent. Various composites with different CNTs concentration were prepared (0 vol. % to 2.5 vol. %). When the composites were exposed to a visible white light, they tended to contract or expand depending on the prestrain applied to the specimen. This phenomenon reaches an optimum for about 1% concentration, which may indicate the concentration of total light absorption. The composites that contain pure carbon MWNTs and the composites that contain nitrogen-doped MWNTs exhibit a similar behavior, but the magnitude of the effect is larger for the nitrogen-doped MWNTs.

The composites were characterized by various experimental methods such as coupled opto-resistive mechanical analyses, Raman spectroscopy, AFM among others. The goal of the research is to correlate the MWNTs electronic structure to the opto-mechanical coupling properties.

From experimental result, we were able to develop an analytical model, which permits to describe the opto-mechanical coupling of composites. This model takes into account the effect of nanotube alignment when the composite is under tensile stress, as well as the thermal expansion of the matrix.