Opto-Mechanical coupling in carbon nanotube: from experiment to model.

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Abstract

Among different coupling properties, it has been recently proposed that carbon nanotubes can undergo some dimensions transformation when exposed to visible light [1]. The authors concluded that they observed distinct movements of the single walled nanotubes without precising the dimension of the mechanical actuation. Finally they addressed the nature of the opto-mechanical coupling to the highly coupled thermal, electrical, optical and mechanical properties of this peculiar material. Few evidence of nanotube opto-mechanical actuation has been reported in the literature since then [2]. More recent papers have shown that when the carbon nanotubes are dispersed in a polymer matrix the composite material is able to expand or contract depending on the pre-stress applied to the material [3]. In order to explain the composite material deflection the nanotube actuation has been assumed to be equivalent to an isotropic compression along the nanotube longitudinal axis on an uncompressible material. However there is no experimental evidence of such a phenomenon. In this work we expose a direct observation of the opto-mechanical coupling in carbon nanotube by using a nano-indenter as a displacement sensor. Then we explored the impact of different parameters such as the nanotube length, light intensity or tube dispersion.

Finally we also propose a mechanism to explain this phenomenon and perform calculus by using density functional theory (DFT). It appears that the variations of the electron population densities between the valence band and the conductive band induced due to photon absorption results in carbon nanotube actuation mechanical contraction.

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[2] Lu, S. X. and B. Panchapakesan (2005). Nanotechnology, **16**(11): 2548-2554.

[3] Lu, S. X. and B. Panchapakesan (2007). Nanotechnology, **18**(30): 8.