Abstract Title

Carbon Nanotube-Reinforced Nanocomposites

Symposium Track

5 (Bellucci)

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Abstract body

Due to the high stiffness and strength, as well as their ability to act as conductors, carbon nanotubes are under intense investigation as fillers in polymeric materials [e.g., 1-2]. The nature of the carbon nanotube/polymer bonding and the curvature of the carbon nanotubes within the polymer have arisen as particular factors in the efficacy of the carbon nanotubes to actually provide any enhanced stiffness or strength to the nanocomposite. When the interfacial adhesion between the phases is weak, the nanotubes behave as holes or nanostructured flaws, inducing local stress concentrations, and the benefits of the CNTs properties are lost. As a consequence, despite some encouraging results have been reported [3], there are many experiments that demonstrate only modest improvement in the strength and stiffness after CNTs incorporation into polymers [e.g., 4-6].

Here the effects of carbon nanotube curvature and interface interaction with the matrix on the nanocomposite stiffness are investigated using nanomechanical analyses. A previously-developed nonlinear structural mechanics procedure for modeling mechanical behavior of carbon nanotubes is used [7-11]. The approach realize the extreme computational savings necessary to effectively model CNTs inside the matrix without losing significant accuracy with respect to atomistic methods. This new nonlinear structural mechanics based approach for modeling CNTs was verified by comparison with MD simulations and high-resolution micrographs available in the literature. Several RVE (Representative Volume Element), where the randomly distributed nature of the CNTs dispersion is simplified to a regular distributed form of staggered arrays, have been considered. Two categories of micromechanical models with different interfacial adhesion between the phases have been considered. We recognize and acknowledge that in many experiments available in literature poor bond (weak van der Walls interaction) and thus poor shear lag load transfer to the CNT is present. Our simulation shows that in these cases composite stiffness enhancement can be achieved through the bending energy of the CNT rather than through the axial stiffness of the CNTs. Subsequently nanocomposites were perfect bonding is present at the carbon nanotube/polymer interface are studied. Stronger bonds are often realized through acid treatment of the CNTs, here an innovative processing technique has been developed to produce novel composites where the CNTs are covalently bonded to the polymer matrix.

Keywords

Carbon Nanotube, Composite Materials, Nanomechanical Analysis, Nanotechnology.

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