EFFECTS OF CURVATURE ON THE ELASTIC MODULUS OF CARBON NANOTUBE-REINFORCED POLYMERS

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(individual submission)

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In this study we will investigate the effects of nanotube curvature on the elastic modulus of carbon nanotube-reinforced polymers. Recent experimental results suggest that substantial increases in the modulus of reinforced polymers can be attained through the addition of very small amounts (as low as 1% weight fraction) of carbon nanotubes as a reinforcing phase[1]. This suggests exciting new possibilities for extremely lightweight polymer materials with mechanical properties similar to those of composites obtained using larger-sized reinforcement phases such as carbon fibers.

In order to facilitate the development and use of such materials it will be necessary to develop models that can accurately predict their mechanical response. Microscopic images of nanotubes dispersed within a polymer matrix show that the nanotubes tend to exhibit significant curvature, particularly in the case of single-walled carbon nanotubes. Because of the size of the nanotubes, it is impractical to believe that curvature can be controlled during the fabrication of such materials, making it even more important to develop analytical models that account for the effects of curvature on the mechanical response of the system.

The goal of this work is to develop a model that will allow curvature effects to be incorporated into micromechanical analyses of carbon nanotube-reinforced polymer materials. An analytical model describing the decrease in effective reinforcement as a function of nanotube curvature will be developed. This model will be compared to the results of a finite element analysis parametric study that will relate the moduli of straight and curved nanotubes. Finally, these results will be used to compare micromechanical predictions of the effective Young's modulus of nanotube-reinforced polymers, based on TEM images showing actual nanotube geometry, with experimentally obtained data.

References

1. Qian, D., E. Dickey, R. Andrews, *et al.*, Load transfer and deformation mechanisms in carbon nanotube-polystyrene composites. Applied Physics Letters, 2000. **76**(20): p. 2868-2870.