Public Abstract

First Name:Damola
Middle Name:Martins
Last Name:Ajiboye
Adviser's First Name:Matthew
Adviser's Last Name:Maschmann
Co-Adviser's First Name:
Co-Adviser's Last Name:

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Title:Mechanical Analysis of a Growing Carbon Nanotube Forest

The rediscovery of carbon nanotubes in 1991 heralded a new dawn in the material science field. This is largely due to the exceptional thermal, mechanical, optical and electronic properties exhibited by carbon nanotubes. In spite of these highly lauded properties, their transfer to fabricated devices have been problematic. This work seeks to elucidate the complex interactions that occur in a carbon nanotube forest and provide insight to harnessing their tremendous properties.

Mechanical analysis and parametric study of an actively growing carbon nanotube forest are undertaken with the help of two and three dimensional finite element models. Carbon nanotube forest parameters like nanotube growth rate distribution, orientation angle, and diameter are varied to examine their effects on the resulting forest morphology. Herein, individual nanotubes are modeled as linear frame elements that are connected at adjacent nodes. The prevalent van der Waals interaction between carbon nanotubes is modeled as bar elements. The modeling results show that the fastest-growing carbon nanotube is inhibited by neighboring nanotubes, therefore generating compressive force that is transmitted to the substrate of the forest. On the other hand, the slowest growing carbon nanotube transmits tensile forces to the substrate. The resulting forest morphology exhibits a strong consistency with observed carbon nanotube forests whilst maintaining mechanical phenomena like buckling, translation and rotation as seen in electron micrographs. This modeling approach is a paradigm shift in the study of carbon nanotube forest growth mechanics and establishes a framework for further thermal and electrical analyses.

Keywords: Carbon nanotubes, mechanics, modeling, finite element.