Postprint of an Euler-Bernoulli Beam Model for Single-Walled Carbon Nanotubes Based on Nonlinear Constitutive Relations

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Abstract

Recent mechanical experiments on graphene have revealed that its stress-strain constitutive relationship is nonlinear under finite deformation. Graphene can roll into carbon nanotubes, and theoretically, the stress-strain relationship of large-diameter single-walled carbon nanotubes is identical to that of graphene. In this study, based on the nonlinear constitutive relationship of graphene, a novel Euler-Bernoulli beam model for single-walled carbon nanotubes is developed. Subsequently, for the case of simply supported ends, the static bending and forced vibration of single-walled carbon nanotubes under uniformly distributed loads are investigated using the Galerkin method and multiscale method. The results show that in static bending, the nonlinear terms in the constitutive relationship induce a stiffness-softening effect on the carbon nanotubes. In forced vibration, the nonlinear terms modify the location of the amplitude bifurcation point. Therefore, the significant influence of the nonlinear terms in the constitutive relationship on the mechanical properties of carbon nanotubes cannot be overlooked.

Full Text

Preamble

The original text in this section contains extensive encoding errors and corrupted characters that cannot be meaningfully translated. All mathematical expressions, citations, and figure/table markers have been preserved in their original form where identifiable, but the surrounding content consists solely of document artifacts and fragmented data without coherent semantic structure.

Note: Figure translations are in progress. See original paper for figures.

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