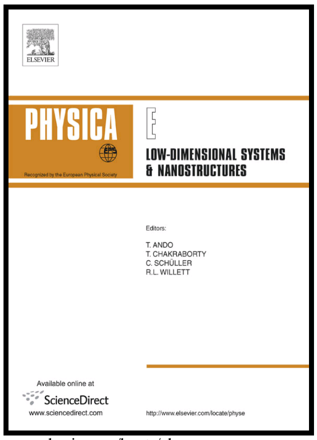

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Abstract

In this paper, we study the longitudinal linear and nonlinear free vibration response of a single walled carbon nanotube (CNT) embedded in an elastic medium subjected to different boundary conditions. This formulation is based on a large deformation analysis in which the linear and nonlinear von Kármán strains and their gradient are included in the expression of the strain energy and the velocity and its gradient are taken into account in the expression of the kinetic energy. Therefore, static and kinetic length scales associated with both energies are introduced to model size effects. The governing motion equation along with the boundary conditions are derived using Hamilton's principle. Closed-form solutions for the linear free vibration problem of the embedded CNT rod are first obtained. Then, the nonlinear free vibration response is investigated for various values of length scales using the method of multiple scales.

Keywords: Embedded carbon nanotube rod; Nonlinear von Kármán strain; Strain and velocity gradient theory; Linear and nonlinear free vibration; Method of Multiple Scales.

1 Introduction

Nanomaterials are materials used at the nanoscale with outstanding mechanical, chemical, electrical, optical and electronic properties. Examples of nanomaterials include carbon nanotubes, graphene sheet, zinc oxide (ZnO) nanowires, boron nitride (BN) nanotubes and nanosheets [1, 2, 3]. Carbon nanotubes (CNTs), discovered by [4], are layers of graphite that are wrapped up into cylinders with diameters of about one nanometer and lengths up to many micrometers. CNTs have received widespread interest of researchers from many disciplines, including material science, engineering, chemistry and physics. CNTs are being used in carbon nanotube composites [5] and environment resistant coatings made of carbon nanotube reinforced materials [6, 7].

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