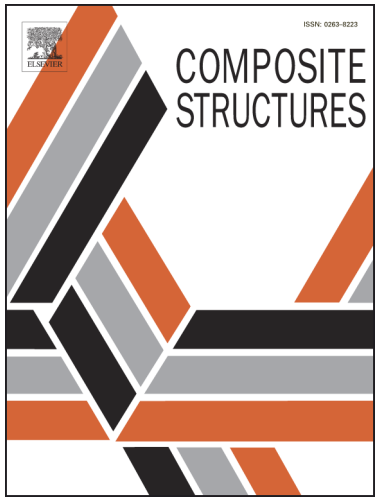

Nonlocal Timoshenko beam model for considering shear effect of van der Waals interactions on free vibration of multilayer graphene nanoribbons

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Nonlocal Timoshenko beam model for considering shear effect of van der Waals interactions on free vibration of multilayer graphene nanoribbons

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Abstract

In this study, shear effect of van der Waals (vdWs) interactions on free vibration of cantilever multi-layer graphene nanoribbons (MLGNRs) is investigated by using nonlocal Timoshenko beam model and molecular dynamics (MD) simulations. To this end, it is assumed that GNR layers of MLGNRs are perfectly bonded that no delamination will occur in layers interfaces. To calibrate the small scale parameter of the nonlocal Timoshenko model, the first two frequencies of armchair type cantilever MLGNRs with various layers and lengths are extracted using MD simulations and matched with those of the nonlocal Timoshenko theory. Comparing frequencies obtained by the MD simulation and the Timoshenko model shows that if values of the bending rigidity and the interlayer shear modulus (or equivalent shear modulus of Timoshenko theory) are taken as 1.20 eV and 3.01 GPa, respectively, then it will be possible to use the Timoshenko model for the free vibration analysis of MLGNRs. Moreover, it is observed that the calibrated nonlocal parameter is dependent on the number of MLGNR layers, and its calibrated value increases by increasing the number of GNR layers. This study helps researchers to analyze the mechanical behavior of MLGNRs in which the interlayer shear has apparent impact.

Keywords: Interlayer shear effect, Multi-layer graphene nanoribbon, Nonlocal Timoshenko model, MD simulations, free vibration.

1. Introduction

Graphene has attracted significant attention due to its extraordinary mechanical, electrical, optical, and thermal properties [1-4]. Graphenes are promising candidates for the design and development of nanoelectromechanical systems (NEMS), such as mass and gas sensors, nanocomposites, transistors and semiconducting devices [5-8].

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