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Vibration characteristics of functionally graded graphene reinforced porous nanocomposite cylindrical shells with spinning motion

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Abstract

This paper is concerned with free vibration characteristics of the functionally graded graphene reinforced porous nanocomposite cylindrical shell with spinning motion. It is assumed that the graphene platelet (GPL) nanofillers and internal pores are randomly oriented and uniformly dispersed in each concentric cylindrical shell, and both the GPL weight fraction and the porosity coefficient vary continuously along the thickness direction. Effective material properties of the nanocomposite which are position-dependent are derived employing the modified Halpin-Tsai model and the rule of mixture. Three types of the GPL patterns and four types of the porosity distributions are considered. Frequencies of forward and backward travelling waves and critical spinning speeds are derived from the equations of motion which are established based on the first order shear deformation theory and the Hamilton's principle. Detailed parametric studies on dimensionless natural frequencies and critical spinning speeds of the GPL reinforced porous nanocomposite cylindrical shell are carried out, especially, effect of initial hoop tension on vibration characteristics of the spinning cylindrical shell is numerically discussed.

Keywords: Cylindrical shell, Graphene platelet, FG porous nanocomposites, Spinning motion, Initial hoop tension

1. Introduction

Graphene, firstly isolated by Novoselov et al. [1] in 2004s, is a two-dimensional single layer of carbon atoms with extraordinary mechanical, thermal and electrical properties [2]. Among all the carbon-based nanofillers, graphene and GPL have extremely high tensile strength (130GPa), Young's modulus (about 1TPa) and specific surface area ($2630 m^2/g$). In the past decades, carbonfilled polymer composites, such as multilayer GPL reinforced composites [3–6] and functionally graded (FG) carbon nanotube (CNT) reinforced composites [7–9] have been widely utilized

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