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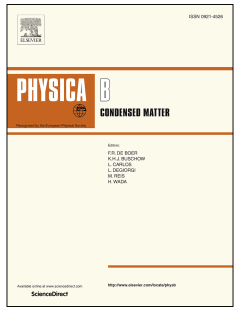

Size-dependent transverse vibration of viscoelastic nanoplates including high-order surface stress effect

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Size-dependent transverse vibration of viscoelastic nanoplates including high-order surface stress effect

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Abstract

The general governing equation for size-dependent transverse vibration of viscoelastic rectangular nanoplate with high-order surface stress effect is formulated. Using the Navier' method, the closed form solutions for vibrational frequencies of the nanoplate with simply supported boundary conditions are obtained. The small size effect and the influences of high-order surface stress and viscoelastic structural damping on the damped frequency of the nanoplate are discussed. It is demonstrated that the damped frequency and the damping ratio of the nanoplate are significantly dependent upon the small size and high-order surface stress effects. The effects of the high-order surface stress on the damped frequency and the damping ratio of the nanoplate are much more significant than those of the conventional surface stress. Moreover, the damped frequency and damping ratio are related to the viscoelastic structural damping.

Keywords: Transverse vibration; Viscoelastic nanoplate; Structural damping; Size-dependence; High-order surface stress effect

1. Introduction

In the past two decades, lots of attention has been paid to nanoscale structures used in many branches of science. Due to the superior physical performances compared with the conventional structural elements, a large number of structures at small scale are being applied to micro/nano electromechanical systems (MEMS/NEMS). As a kind of nanoscale structure, nanoplates have various potential applications, such as nanosheet resonators, paddle-like resonators, thin display screens, and other thin film elements [1–3].

As the ratio of surface area to volume is very large at the nanoscale, the surface effects on the mechanical behavior of nanoplates are found to be significant [4,5]. To take account of the surface effects of nanoplates, many numerical simulation approaches such as the molecular dynamics simulation and finite element simulation methods have been proposed [6–11]. However, it should be pointed out that these numerical simulation methods are computationally expensive as they cost

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