Surface and shear energy effects on vibrations of magnetically affected beam-like nanostructures carrying direct currents

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Surface and shear energy effects on vibrations of magnetically affected beam-like nanostructures carrying direct currents

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Abstract

Free vibration of current-carrying nano-scaled beams immersed in a magnetic field is of huge interest. To bridge this scientific gap, Rayleigh, Timoshenko, and higher-order beam models accounting for the surface energy are employed and their equations of motion are established appropriately. For spatial discretization of the deformations fields, a meshless approach is exploited. The effects of surface and shear deformation, electric current, magnetic field strength, and geometric parameters of the nanobeam on the first ten natural frequencies are examined and discussed. The critical values of slenderness ratio, nanobeam's diameter, electric current, and magnetic field strength, which are corresponding to the dynamically unstable nanobeams, are graphically identified. The obtained results indicate that the discrepancies between the frequencies by considering the surface effect and those evaluated without consideration of the surface energy swould increase notably at the above-mentioned critical values.

Keywords: Nanobeams; Transverse vibrations; Direct electric current; Surface energy effect; Shear deformable beam theories; Reproducing kernel particle method.

1. Introduction

Ballistically carrier nanowires (NWs) are one-dimensional beam-like nanostructures for safe conveying of electrical currents. Metallic NWs are a major subgroup of such NWs which

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