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Abstract

In this paper, the dynamic pull-in instability and bifurcation characteristics of circular nanoplate subjected to electrostatic and Casimir forces are studied. Surface effect originates from high surface/volume ratio of nanostructures, where atoms at a free surface experience distinct local environments with respect to those in the bulk material. Thus, the surface free energy being negligible in classical elastic theory, becomes significant in dynamic behaviors of nanostructures. Based on Eringen's nonlocal elasticity and Gurtin-Murdoch surface model, the nonlinear governing equation of electrically actuated circular nanoplate is derived in polar coordinate. The closed-form solution of dynamic frequency and electrostatic voltage is obtained by utilizing the homotopy perturbation method (HPM). Furthermore, the coupling effects of nonlocal parameter and surface characteristics on the dynamic pull-in instability of circular nanoplate are investigated, and the nonlinear dynamics behaviors, time histories and phase diagrams of electrically actuated circular nanoplate are discussed. Some new results obtained in this work could be helpful in design of 2-D circular nanoplate-type actuator considering size-dependency and quantum vacuum fluctuation effects.

Keywords

Dynamic pull-in, Circular nanoplate, Bifurcation, Small scale effect, Surface behaviors, Homotopy perturbation method