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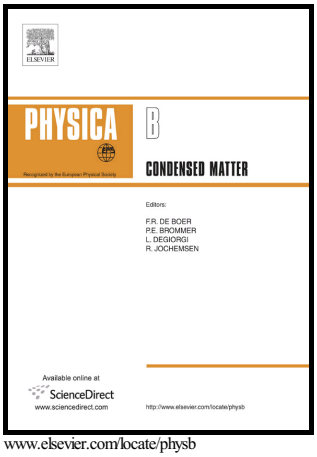

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Vibration, buckling and smart control of microtubules using piezoelectric nanoshells under electric voltage in thermal environment

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Abstract

Piezoelectric nanomaterials such as zinc oxide (ZnO) are of low toxicity and have many biomedical applications including optical imaging, drug delivery, biosensing and harvesting biomechanical energy using hybrid nanogenerators. In this paper, the vibration, buckling and smart control of microtubules (MTs) embedded in an elastic medium in thermal environment using a piezoelectric nanoshell (PNS) are investigated. The MT and PNS are considered to be coupled by a filament network. The PNS is subjected to thermal loads and an external electric voltage which operates to control the mechanical behavior of the MT. Using the nonlocal continuum mechanics, the governing differential equations are derived. An exact solution is presented for simply supported boundary conditions. The differential quadrature method is also used to solve the governing equations for other boundary conditions. A detailed parametric study is conducted to investigate the effects of the elastic constants of surrounding medium and internal filament matrix, scale coefficient, electric voltage, the radius-to-thickness ratio of PNSs