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Investigating of surface effects of clamped partially effected nano-beams under electrostatic excitation using modified couple stress theory

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Abstract

The aim of this paper is to develop a new general Euler-Bernoulli model of clamped Nano-beam taking into account the small scale effects, which is ignored in classical theories. In order to correct previous models and establishing a model based on the fact that many issues will be included, it is assumed the substrate electrode is shorter than the movable electrode. In this model, the non-classical modified couple stress theory is used to investigating of effects of position and length of substrate electrode, electrostatic forces, intermolecular forces, capillary force, size effect and surface effects. Governing equations of clamped nano-beam motion and the corresponding boundary conditions are derived by using Hamilton's principle. Considering von-Karman strain, non-linear equations of mid-plain stretching are added to governing equations. Numerical finite element method is utilized to solve the non-linear governing equations. In order to investigate the accuracy of present method, the obtained results are compared with the results available in literature and found in very good agreement. The results demonstrate that the decrease of the substrate electrode length leads to the increase of the required pull-in voltage and the ultimate intermolecular forces and capillary force and decrease of pull-in deflection. Moreover, increasing of size effect and axial force parameters, decreases the pull-in voltage parameter.

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