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The influence of dispersion forces on the size-dependent pull-in instability of general cantilever nano-beams containing geometrical non-linearity

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Abstract

While, the effects of ground electrode architecture on the vibration response and instability of nano-switches have considered in a few studies, no attention has been paid to study the dispersion effects in these general nano-structures. Herein, the static and dynamic pull-in instability of a general beam-type nano-electromechanical system in the presence of quantum vacuum fluctuation (Casimir), intermolecular (van der Waals) and piecewise electrostatic attractions are investigated. To this aim, the impacts of size-dependent, fringing field, surface elasticity, residual surface stress, the geometrically nonlinear deformation as well as the location/length of the actuated substrate plate are also considered. The nonlinear governing equations of nano-cantilevers are derived using Hamilton's principle. After validation of the results by previous available numerical results, the pull-in voltages and fundamental natural frequencies of the actuated nano-beam are achieved numerically using the step-by-step linearization method. It is found that the fundamental natural frequency is enhanced significantly by increasing the surface elasticity, residual surface stress and length scale.