Free vibrations of bi-stable pressurized FG plate-type MEMS

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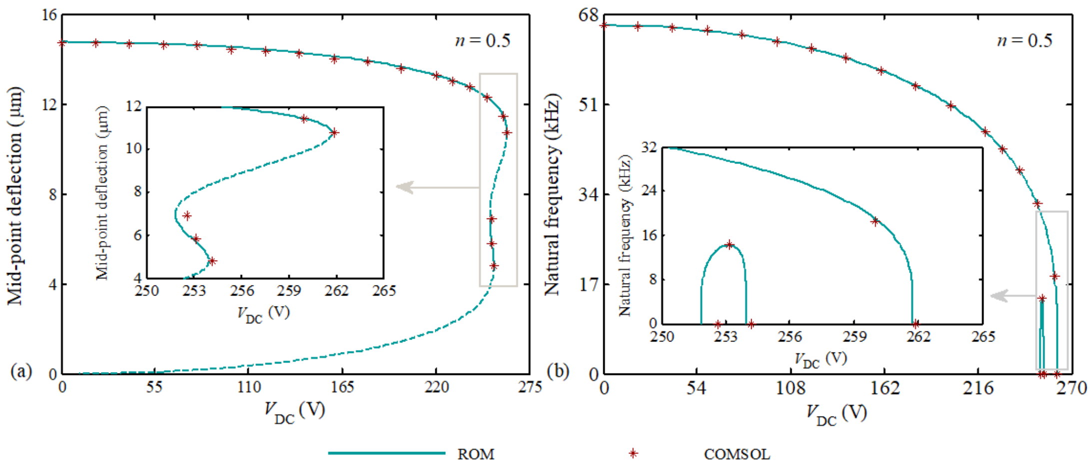
Recently, it has been shown that besides initially curved micro-plates, pressurized flat ones can also experience bi-stable behavior that enjoys many potential applications in designing high sensitive MEMS sensors [1]. In the sequence of ref. [1], the present work aims to investigate free vibrations of pressurized electrically actuated thin micro-plates made of FGM. To this end, the geometric nonlinear in-plane and out-of-plane governing equations of motion are obtained using the Hamilton principle and reduced to an initial value problem associated with the first transversal eigenmode of the structure through a multi-term Galerkin projection method. Having the reduced equation of motion, the eigenvalue equation governing the free vibrations of the micro-plate around its equilibrium configuration is then obtained. Afterward, the oscillatory behavior of pressurized plate-type MEMS is studied. It has been observed that the fundamental frequency of the system suddenly drops to zero when the micro-plate faces the limit points in its equilibrium path. The present findings are compared and successfully validated by 3D FE simulations carried out in COMSOL Multiphysics commercial software for a Silicon-Copper graded micro-plate with dimensions as same as the case studied in ref. [1], the power-law index is set to $n = 0.5$, and the micro-plate is assumed to be subjected to 3kPa differential pressure in the opposite direction of the electrical attraction.



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References

[1] A.R. Askari, "Bi-stability of pressurized electrically actuated flat micro-plates", Int. J. Solids Struct., 178-179, 167 - 179 (2019).