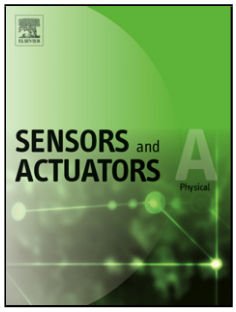

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A closed-form approach for the resonant frequency analysis of clamped rectangular microplates under distributed electrostatic force

Zhikang Li[1,2,3], Libo Zhao[1,2,3,*], Zhuangde Jiang[1,2,3], Yihe Zhao[1,2,3], Jie Li[1,2,3], Jiawang Zhang[1,2,3], Yulong Zhao[1,2,3], and Liwei Lin[4]

[1]State Key Laboratory for Manufacturing Systems Engineering, International Joint Laboratory for Micro/Nano Manufacturing and Measurement Technologies, Collaborative Innovation Center of SuzhouNano Science and Technology, Xi'an Jiaotong University, Xi'an, 710049, China
[2]School of Mechanical Engineering, Xi'an Jiaotong University, Xi'an, 710049, China
[3]Xi'an Jiaotong University Suzhou Academy, Suzhou, 215123, China
[4]Department of Mechanical Engineering, University of California at Berkeley, Berkeley, CA 94720, USA

[*] Corresponding author. Tel.:+86 029 82668616; libozhao@mail.xjtu.edu.cn (Libo Zhao[*])

Highlights of our paper

- A fast-converged reduced-order model was proposed for electrostatic microplates.
- Closed-form expressions were established for the resonant frequency analysis.
- The expressions were well validated using FEM and experimental results.
- 4. The expressions has generality for different dimensions of electrostatic microplates.
- 5. The expressions are applicable to single-layer plates as well as multilayer plates.

Abstract

This paper proposes a fast-converged reduced-order model for small vibrations of electrostatically actuated rectangular microplates around their deformed states. On this foundation, one-mode analysis method and thus closed-form analytical expressions are developed for the fundamental resonant frequency analysis. Numerical multi-mode analysis is conducted to investigate the convergence. It is concluded that the one-mode analysis method can give a converged solution, which demonstrates that the proposed model has a faster convergence than previous models where multi modes are needed. The directly calculated resonant frequencies by the closed-form expressions are in good agreement with the numerical results by FEM simulations with less than 5% variation before pull-in. Parametric study shows the closed-form expressions are applicable to the cases in which the thickness is less than 1/20 of the length and width under a nominal length to width ratio of 1~2.5, and the gap distance is less than or equal to the thickness of the microplate. Additionally, a kind of electrostatic configurations based on multilayer microplates, capacitive micromachined ultrasonic transducers (CMUTs), were used to experimentally validate the closed-form expressions and good agreement was