Nonlinear tuning of microresonators for dynamic range enhancement

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Abstract

This talk investigates the application of continuation methods to the design of micromechanical devices, specifically a novel formulation for the nonlinear tuning of nano/microresonators. Path-following techniques are employed to explore the dependence of the resonator dynamic range on system parameters, with emphasis on the geometry of bilayer microbeams. The analysis relies on a combination of the Matlab-based Computational Continuation Core (COCO) with a finite-element discretization of a geometrically exact, nonlinear mechanical model of the transverse and longitudinal dynamics of multilayer microbeams, which also takes into account rotary inertia effects. The system performance is here characterized by the resonator's response to distributed harmonic excitation in the presence of nonlinearities. Second-order perturbation analysis is used to verify the computational scheme for free vibrations of a single-layer model, confirming the presence of a zeroth-order-in-amplitude frequency shift with expected order of convergence. An inverse problem is then proposed for the continuation of the critical amplitude at which the transition to nonlinear response characteristics occurs. COCO's task embedding paradigm enables an efficient approximation of the corresponding cusp bifurcation of limit cycles in terms of three coupled periodic-orbit continuation problems.

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