

Design and performance analysis of a seismic grade resonance nano accelerometer

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Abstract

In this paper, design and performance analysis of a resonance nanosensor for earthquake low frequency geoaoustic waves detection is proposed. The model comprises of a proof mass suspended to the substrate, and a nanobeam attached to the intersection of the proof mass to the substrate. The nanobeam could be considered as a clamped-clamped nanoresonator actuated electrostatically. The induced acceleration to the proof mass could lead to an axial tensile or compression force in the nanoresonator. The axial induced force could change the system stored potential energy and result in the shift of the resonator natural frequency. Measuring the frequency shift of the resonator, could lead to the estimation of the applied acceleration to the proof mass. Furthermore, the nanobeam is laminated between two piezoelectric layers which applying voltage to them could improve the performance of the nanosensor. Governing equations are obtained using Hamiltonian's principle that considers the main sources of nonlinearity including electrostatic fringing field effect, piezoelectric and Casimir force, and stretching effect. The equations are solved using numerical and analytical methods. The simulation results are being used to investigate the nanosensor performance characteristics including the device dynamic response, resolution, sensitivity, bandwidth, dynamic range and the structural resistance. The results show that the proposed nano accelerometer could have a better performance compared the existing micro and macro earthquake detection devices measuring geoaoustic infrasonic and low frequency waves.

Keywords: Nanosensor, Earthquake detection, Nonlinear dynamics, Resonator, Multiple time scales method, Infrasonic, Geoaoustic.

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