Journal of Acoustical Engineering Society of Iran, Vol. 6, No. 2, 2019

Design and performance analysis of a seismic grade resonance nano accelerometer

M. Rahmati Ahmadabadi[1], S. Esmaeelzadeh Khadem[*2], M. Rasekh[2]
1. Nanomaterials Group, Engineering Department, Tarbiat Modares University
2. Department of Mechanical Engineering, Tarbiat Modares University

Abstract

In this paper, design and performance analysis of a resonance nanosensor for earthquake low frequency geoacoustic 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 cosidered as a clamped-clamped nanoresonator actuated electrostartically. The induced accelaration 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 frequncy. Measuring the frequncy shift of the resonator, could lead to the estimation of the applied accelaration to the proof mass. Furthermore, the nanobeam is laminated between two piezoelectric layers wich applying voltage to them could improve the perfomance of the nanosensor. Governing equations are obtained using Hamilonian'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 charactersitics including the device dynamic response, resolution, sensitivity, bandwidth, dynamic range and the structural resitance. The results show that the proposed nano accelerometer could have a better performance compared the existing micro and macro earthquake detection devices measuring geoacoustic infrasonic and low frequency waves.

Keywords: Nanosensor, Earthquake detection, Nonliear dynamics, Resonator, Multiple time scales method, Infrasonic, Geoacoustic.

pp. 46-59 (In Persian)

[DOR: 20.1001.1.23455748.1397.6.2.2.5]

* Corresponding author E-mail: khadem@modares.ac.ir