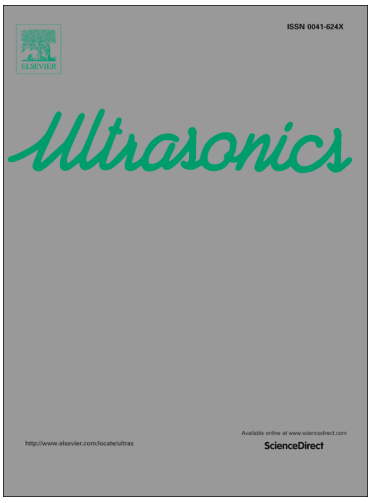

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Simulation of a Love Wave Device with ZnO Nanorods for High Mass Sensitivity

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Abstract

The paper presents 3D finite element simulation and analysis of Love wave resonator with different guiding layer materials and investigation of the coupled resonance effect with ZnO nanorods on the device surface. Analytical estimation of phase velocity and mass sensitivity of Love wave device with SiO_2, ZnO, gold, SU-8, and parylene-C as guiding layer materials is performed for comparative analysis. Simulations are carried out to study the variation in electromechanical coupling coefficient, displacement profile and frequency response of the Love wave resonator. SU-8 offers high mass sensitivity of 1044 m^2/kg while gold layer provides maximum K^2 of 8.6%. In comparison to SiO_2 and ZnO, polymers exhibit sharp rise and fall in K^2 within a narrow range of normalized layer thickness (0.03-0.1). ZnO nanorods of varying height and surface nanorod density are designed over the Love wave resonator with SiO_2 as the waveguiding layer. In the presence of coupled resonance, the nanorods and substrate vibrate in unison causing an increase in average stress and mass sensitivity but leads to decrease in the electromechanical coupling coefficient of the device. Surface nanorod packing density of 25 μm^{-2} offers high mass sensitivity of 1304 m^2/kg that is 20 times greater in comparison to the mass sensitivity of a plain Love wave device.

Keywords: Coupled resonance, $LiTaO_3$, Love Wave, Mass sensitivity, SAW, ZnO nanorod