Title: Phononic-FBAR sensor for bio-detection

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Abstract

MEMS technology is widely used for biological applications as reliable systems and non-optical detectors. Thin-Film Bulk Acoustic Resonator (FBAR) is composed of a piezoelectric material sandwiched by two metal electrodes. It's a high-quality factor resonator of which the resonating frequency is determined by the total film thickness and material property. When mass is loaded to the surface of FBAR, its resonating frequency will shift. It has been multiple times for biological molecules detection. In this Multiphysics simulation, a Phononic pillar structure is integrated in the FBAR to reduce the total energy losses and preserve the energy in the micro-well. The presence of the nano-resonators like metal pillars, which are indeed resonators storing mechanical energy, certifies new features including a strongly confined spatial distribution of the energy and a new coupling polarization that is not found in classical FBAR structure. Thus, it will increase the quality factor of regular FBAR. In the simulation model we will be using unit cell of periodic pillars, where only one side of the simulation domain is bounded along the z-axis –semi-infinite structure. This will require the design of perfectly matched layers (PML) for mixed solid fluid structures. Since it is a periodic structure, we will be applying periodic conditions, using the Flocquet-Bloch theorem, and it will enable us to calculate the band diagrams. The aim of this simulation is to investigate the performance of single unit cell of P-FBAR in presence of DNA molecules. The model composed of thin zinc oxide layer, with piezoelectric physics properties, a metal nickel pillar surrounded by liquid. The simulation will study the eigen values of the system in perfect conditions. Thus, it will anticipate the performance of P-FBAR in presence of liquid. We anticipate that the nano-pillar will increase the quality factor of the system and reduce the losses. The proposed design will enable a better bio-detection at lower cost and higher resolution.