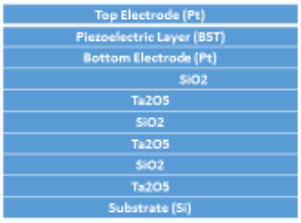
Finite Element Simulation of Switchable and Tunable Resonators

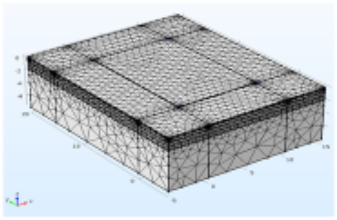
Daw Adersah[1] and T.S. Kalkur[1,*]
[1]Department of Electrical and Computer Engineering
University of Colorado Colorado Springs,
1420 Austin Bluffs Parkway, Colorado Springs CO 80918.
*Thottam Kalkur: tkalkur@uccs.edu

Piezo electric thin films such as Aluminum Nitride and Zinc oxide are widely studied for the fabrication of FBAR based resonators and filters for cell phones. Recently, Barium Strontium Titanate (BST) thin films have attracted the attention of many investigators because of their voltage induced piezoelectricity. The resonators and filters fabricated by BST are switchable and tunable. In this paper, we are presenting the results of finite element based simulation of BST based resonators to optimize their performance before fabrication.

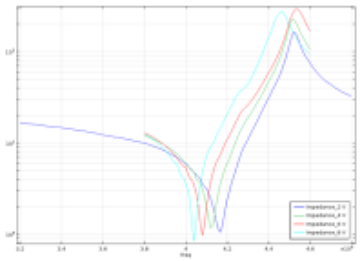
The simulations have been performed on FBAR based resonator structures routinely fabricated in our laboratory. These resonators use silicon dioxide/tantalum oxide based Bragg reflectors for acoustic isolation. Platinum thin film of thickness 100nm with 20nm of titanium adhesive layer was used as bottom electrode, 180 nm of BST and 100nm of platinum as top electrode. COMSOL finite element solver was used for finite element simulation of the resonators to obtain their impedance, series and parallel resonant frequency, quality factor and electromechanical coefficient and their variation with applied electric field. The variation resonator parameters were studied with variation in top electrode metal thickness. In addition, the effect of changing the BST composition ($Ba_xSr_{1-x}TiO_3$) on resonator characteristics are also simulated.



a



b



c

Fig.1 a) Cross-section of structure of simulated BST resonator structure with Bragg reflector, b) Triangulation used for simulating the structure, c) Simulated response of variation of impedance with frequency for various applied voltages.