A Suspended Lithium Niobate Resonator with Buried Electrodes at 3.3 GHz

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With the advent of the 5G standard, there has been increasing demand for acoustic RF filters that provide large fractional bandwidths (FBW) above 3 GHz with low loss (e.g. for 5G-FR1 bands). Recently, resonators based on shear modes (A1 Lamb wave[1,2], SH0[3,4]) in thin suspended plates of lithium niobate (LNO) have been investigated as alternatives to established solutions based on either surface or bulk acoustic waves (SAW, BAW).

Shear mode devices with LNO have shown promise for wideband filtering due to their large electromechanical coupling (k^2_{eff}). These modes are commonly excited by interdigital transducer (IDT) electrodes deposited on the surface of the LNO plate. For SH0 resonators, the resonance frequency is inversely proportional to the electrode pitch like SAW devices[3]. However, with increasing frequency and consequently narrower electrode pitches, the electric field generated by conventional, surface-type IDTs becomes increasingly non-uniform which leads to a loss in k^2_{eff}.

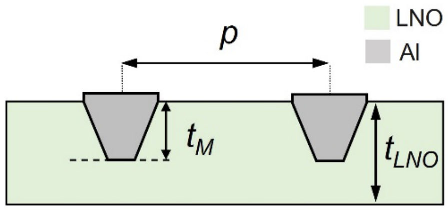

Fig. 1: Structure of a unit cell of a buried IDT

This paper reports on the design and fabrication of an acoustic resonator on a suspended plate of LNO with a novel buried IDT. In contrast to conventional IDT, the electrode metal in buried IDT is embedded in the piezoelectric layer (Fig. 1) which allows for a uniform, horizontal electric field and thus large k^2_{eff} even with extremely narrow pitches and high resonance frequencies.

Fig. 2 shows first experimental results of a SH0 resonator at 3.3 GHz with large k^2_{eff} of 33.4% enabled by buried IDT. The resonator consists of a YX36°-cut LNO plate (t_{LNO} = 300 nm) with buried Al electrodes (t_M = 150 nm) in an array of 70 finger pairs with a pitch of p = 550 nm. The demonstrated capability to deliver more than 700 MHz of separation between resonance and anti-resonance at > 3 GHz makes these devices promising for a n77 or n78 band filtering application.

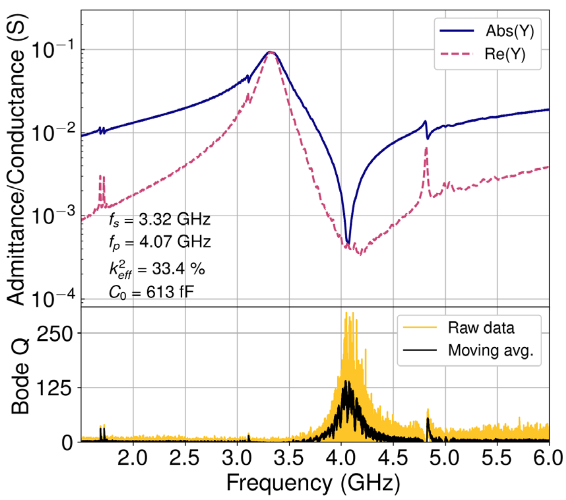

Fig. 2: Measured admittance response and Bode Q of a fabricated device.

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[2] R. Lu et al., *J. Microelectromech. Syst*, 29 (2020), pp. 313-319.
[3] S. Stettler and L.G. Villanueva, *J. Microelectromech. Syst*, 32 (2023), pp. 279-289.
[4] S. Wu et al., *IEEE Trans. Electron Devices,* 70 (2023), pp. 4829-4836