Selective excitation of a single mode in a multimode BAW resonator

Victor Plessky[1], Vladimir Pashchenko [2], Ventsislav Yantchev[3], Vladimir Kalinin[2]

[1]R&D, GVR Trade SA, Gorgier, Switzerland
[2]SAW devices Dept., Avangard Ltd, St. Petersburg, Russia
[3] Angstrom Lab., Uppsala University, Uppsala, Sweden
Email: victor.plessky@gvrtrade.com

Multimode high-overtone bulk acoustic wave resonators (HBAR) using low propagation loss materials, such as Lithium Niobate, Sapphire, YAG, show excellent $Q*f_{res}$ product values up to 10^{14} unachievable for SAW resonators. However, presence of numerous strong modes limits application of such device for the frequency stabilization purposes.

The metal electrodes of HBAR usually also decrease Q-factor and variation of their thickness influences the resonance frequencies. In this paper we propose a structure including the HBAR with no electrodes on its surface, but with a system of grooves or ridges with period 2p, and with IDT electrode structure suspended (with pitch equal to *p*) over the surface of HBAR (Fig.1). The MEMs technology must be sufficient nowadays to realize such a structure at GHz frequencies. Here the COMSOL simulations of this device is presented. The device works as follows. The electric fields created by the IDT excite SAW in bottom piezoelectric material in a narrow frequency band, when the frequency of excitation corresponds to $V_{SAW,piezo}/2p$. The excited SAW is scattered into the bulk of the piezoelectric in direction perpendicular to the surface by the periodic (λ=2p) grooves. If the frequency corresponds to the frequency of one of the bulk modes of the high-overtone BAW resonator only this mode is efficiently generated. The COMSOL simulations show that, in principle, this mechanism works. We observe often two peaks in admittance curve – the one corresponding to SAW and nearby another resonance corresponding to the BAW resonance excitation. For the IDT with finite number of electrodes, one could put on piezoelectric bulk resonator the reflectors with period *p* as synchronous continuation of transduction zone with period *2p*. In this case SAW<=>BAW transformation will be limited to the IDT region and reflector will return back SAW trying to escape from this region. High Q factor of the devices is provided due to a) no acoustic loss in metal – no acoustics there b) reduced resistive loss in the electrodes, which can be rather thick. Increase power handling is expected too.

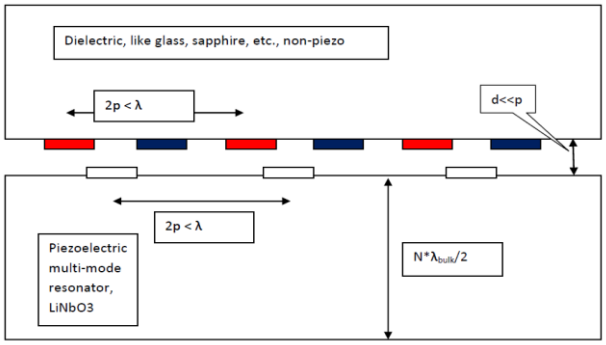

Fig. 1: Studied device geometry.

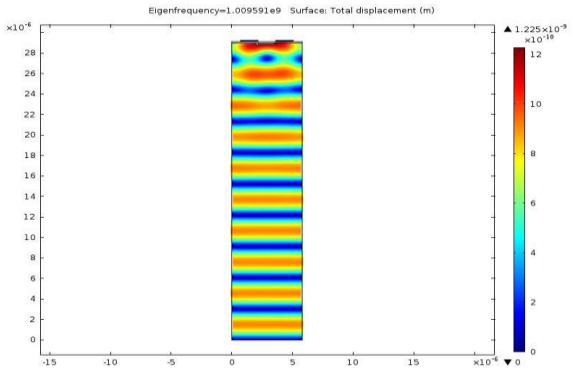

Fig.2 BAW excitation by suspended IDT