Surface Phononic Gratings as building blocks of Transducers and Reflectors with complete bandgap characteristics

Ventsislav Yantchev[1]

[1]Dept. Engineering Sciences, Uppsala University, Uppsala, Sweden
Email: ventsi.yantchev@gmail.com

The main contribution of this study is towards the development of a new generation of SAW resonators (for filters, sensors, etc.) extending the current SAW design technology through introduction of an orthogonal design concept. The fundamental idea is to benefit from the SAW propagation properties in periodic structures of higher space dimensions. State-of-the-art SAW resonators today make use of 1D periodic structures, i.e., the transducers and reflectors are represented by periodic arrays of surface strips. On the other hand, periodic structures of higher dimensions referred to as phononic crystals allow the definition of complete bandgaps. Experiments have shown promising results regarding the acoustic isolation demonstrated by surface phononic crystals formed by a periodic array of scattering inclusions, air holes or pillars. These structures, however, do not permit easy integration between the transducing and the reflecting blocks of the SAW device which is a prerequisite for eliminating the acoustic wave scattering in to the bulk substrate. On the other hand, classical 1D SAW resonators alleviate this problem by using transducers and reflectors of the same topology. It has recently been shown[1] that the above approach is applicable to a specific type of surface phononic crystal consisting of 1D aluminum strips on which a 2D array of low profile masses is superimposed. In an independent study a specific design employing 2D array of hexagonal symmetry has been proven to demonstrate complete bandgap characteristics while keeping the thickness of the heavy masses below 5% of the acoustic wavelength[2] (i.e the structure remains compatible with the planar SAW technology).

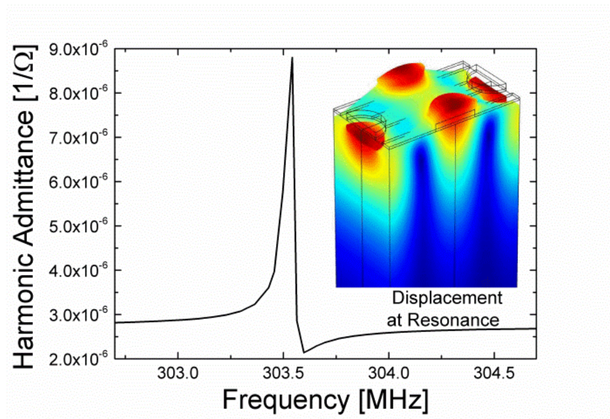

Fig. 1: Theoretical harmonic admittance of the transversely coupled phononic SAW transducer on AlN substrate. The electric potential is applied orthogonally to the SAW excitation direction

In this invited talk I will review the most recent theoretical and experimental results regarding the design and fabrication of phononic SAW resonant devices by means of the planar technology. Initially, three types of phononic IDT topologies will be theoretically described in terms of their propagation and excitation characteristics. These are the M-mode IDT, the K-mode IDT and the transversely coupled IDT[3] (see FIG. 1). Experimental verification of the proposed structures and principles will be demonstrated by test structures fabricated on a 128° YX $LiNbO_3$ crystal.

[1] M. Solal, J. Gratier, T. Kook, IEEE Trans. on UFFC, vol. 57, p. 30-37, 2010.

[2] V. Yantchev and V. Plessky, J. Appl. Phys., vol. 114, Issue 7, art.no. 074902, 2013.

[3] V. Yantchev, Appl. Phys. Lett., "A transversely coupled phononic surface acoustic wave transducer," in print, 2014.