Finite Element Model of Surface Acoustic Wave Scattering with High-Aspect-Ratio Irregularities

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Abstract

The design of surface acoustic wave (SAW) devices needs the accurate study of the scattering fields, arising from the interaction of SAW with periodic irregularities placed on a surface of crystal to form interdigital transducers or reflective structures (RS). To solve this problem, the finite element methods are very perspective, because they allow to take into account the actual geometry of the electrodes and bulk scattering, in contrast to analytical methods.
This work describes results of finite element calculation in COMSOL Multiphysics® software of 2D SAW scattering fields in reflective delay line made on a LiNbO3 substrate with RS formed by projections or grooves. The properly defined reflection, transmission and scattering coefficients were numerically evaluated as functions of the reflector's thickness, from infinitively small to comparable with wavelength.
It was shown that these dependencies for projections are quasi-periodic and related to excitation of Eigen resonance modes in array of reflectors. In contrast to projections scattering from deep grooves does not have periodic behavior and with the depth's growth SAW scattering into volume increases while reflection coefficient doesn't reach more than 40%. The calculation of the 2D pattern of the scattered fields makes it possible to estimate the RS efficiency and clearly shows the range of the parameters for which an intensive SAW-energy radiation into the bulk occurs (Figure 1).
The obtained data was applied to developing RSs of various configurations, e.g., in designing SAW-based RFID tags for the 2.44 and 6 GHz frequency bands, where SAW wavelength becomes comparable to the height of electrode's structures.

Figures used in the abstract

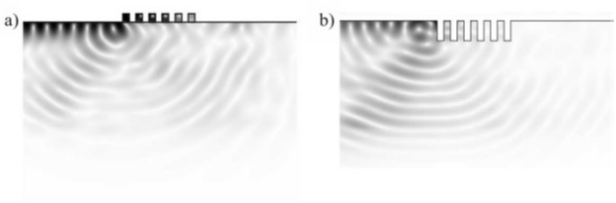

Figure 1: SAW scattering from projections and grooves.