Tunable reflector of SAW based on induced piezoeffect in ferroelectrics

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Periodic domain structures in piezoelectric and ferroelectric materials are very attractive for researchers. There are various acousto-optics and laser devices based on periodic domains[1,2].

A report dedicated to tunable SAW filters based on phononic crystals (PC) with periodic domains has been published[3]. Major disadvantages of these PC are laser-induced tunability and using a high voltage source. It this paper we propose a novel type of SAW PC based on an electric field induced piezoelectric effect in the ferroelectric materials[4]. Tuning of the proposed PC is achieved by applying the voltage magnitudes from 1V to 15V.

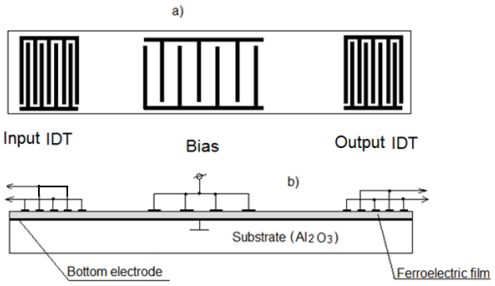

Fig. 1. Electric field tunable phononic crystal.
a) Top view. b) Side view

Considered here PC structure (Fig. 1) is realized as a SAW delay line design and consists of substrate with deposited ferroelectric film and series of interdigital transducers (IDT) atop of the ferroelectric film. Input and Output IDTs excite and receive SAW. DC control voltage apply to the bias IDT located between the Input IDT and Output IDT, and having the same geometric period as the input/output IDTs, but its electrodes are connected in parallel. Ferroelectric film thickness is about 0.5 to 1μm. Using so small values of the film thickness, we can obtain a high electric field in ferroelectric film in areas between the bias IDT electrodes and the bottom electrode. The periodic structure of domains with changed piezoelectric, elastic and permittivity properties is created under the Bias IDT due to the induced piezoeffect.

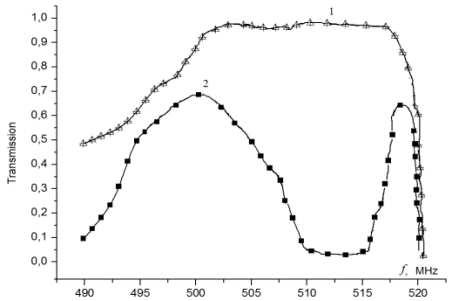

Fig.2 SAW transmission versus frequency.
1 – Bias 0 V. 2 – Bias 15 V.

The COMSOL simulations of transmission coefficient of (Fig. 2) shows that by changing the bias voltage we can tune the reflectivity in a wide range.

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[3] A. V. Golenishchev-Kutuzov et al, "Induced domains and periodic domain structures in electrically and magnetically ordered materials". Physics-Uspekhi, vol. 170, p. 697–712, 2000.

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