Passive Wireless SAW - MEMS Microphone

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Wireless sensors based on surface acoustic waves (SAW) are very promising devices for various application areas. SAW sensors do not require an on-board power source. Sensor receives energy from interrogation radio frequency pulse which is an information channel simultaneously.

Commonly SAW sensor operation based on direct physical impacts (pressure, elastic deformation, acceleration etc.) on the SAW structure leading to variation of the device parameters like frequency or delay time. Disadvantage of this operation principle is low sensitivity of SAW sensors.

In this paper we propose a SAW - MEMS microphone which operation principle based on electrical field distortion of SAW. The electromechanical coupling coefficient for SAW defined as $k^2 = (V_0 - Vm)/V_0$, where V_0 and Vm are SAW velocity on free and metallization surface of piezoelectric respectively. Energy of the SAW concentrated near the piezoelectric surface. If on the SAW propagation path the metallized plate is placed, the electrical potential of SAW becomes zero and $V = V_m$. Lifting the metallized plate over the piezoelectric surface leads to change velocity V_0. Maximal variation of delay, thus, can be of the order of 10^{-2}, which is 2 orders higher than variation achievable by direct effect of crystal deformation.

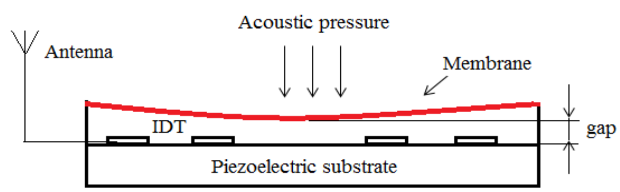

Fig. 1: SAW – MEMS microphone geometry

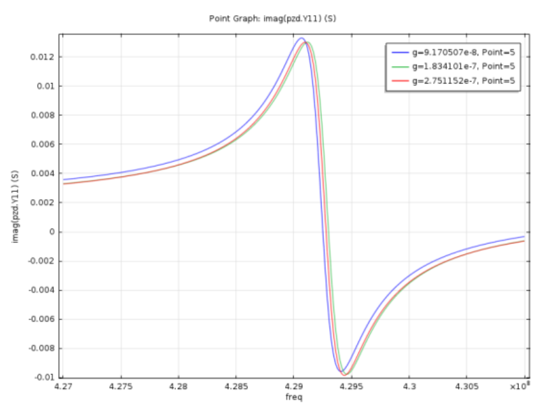

Fig.2: Shift the SAW resonance frequency

The device works as follows. The SAW resonator (Fig. 1) receives the RF signal through an antenna. The metallized membrane suspended above the piezoelectric substrate to the distance about 1% to 10% of SAW wavelength (depending on the dielectric permittivity of used substrate). The membrane bends under impact of the acoustic pressure (we use the cantilever amplification effect) and changes a gap between the substrate surface that leads to change the SAW velocity on free surface and as a consequence shift the resonance frequency of SAW resonator.

The COMSOL simulations of resonance shifting are presented in Figure 2. The membrane displacement on 90 nanometers under 1 Pa sound pressure results about 20 kHz resonance frequency shift that is more than enough to speech transmission. The central frequency of simulated SAW resonator is 430 MHz.

Proposed SAW - MEMS microphone also can be used as a wireless passive accelerometer and pressure sensor.