STW resonator on (0°, 22°, 90°) cut of langasite with Al electrodes

Ayrat Galisultanov[1], Vladimir Kalinin[1], Sergey Volynkin[1], Victor Plessky[2]

[1] SAW devices Dept., Avangard JSC, St. Petersburg, Russia
[2]R&D, GVR Trade SA, Chez-le-Bart, Switzerland

Email: galisultanov@gmail.com

In this paper we present the results of measurements of the three types of Surface Transverse Waves (STW) resonators on langasite (0°, 22°, 90°) with aluminum electrodes. This STW cut of langasite provides temperature stable delay of STW with high coupling coefficient and potentially provide better Q-factor than standard SAW resonators[1], since pure shear vibrations in STW result in less loss than those of Rayleigh type waves with compression components. Thus the problem of obtaining high-Q STW resonator on langasite is relevant for both practical and theoretical points of view.

We fabricated resonators with λ = 6, 7.2, 9 μm; m/p = 0.5; W = 200 λ; N_{IDT}=130, N_r=400. Thickness of aluminum h_{Al} = 288 nm. The main results of the measurements are shown in the Table 1.

Table 1.

λ, μm	h/λ, %	F_{res}, MHz	Q_u	C_0, pF	V_{ph}, m/s
6	4.8	489.4	2000-3000	65	2936.2
7.2	4	408.4	1500-2400	83	2938.4
9	3.2	326.8	1000-2200	90	2941.2

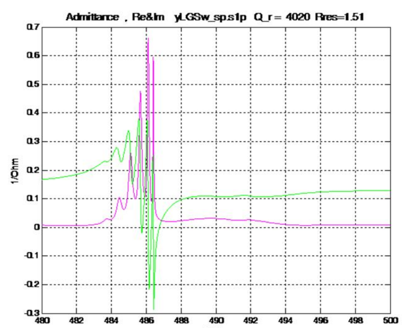

Fig. 1: Admittance of the test resonator (λ =6 μm).

Recent attempts to develop such resonators resulted in mediocre Q factors of the order of 1000 rather than the expected Q>10000 in the 434 MHz ISM frequency range[2]. Simulation in the FEMSAW program (Fig. 1) showed that the oscillations are related with a finite number of reflectors. The experimentally obtained values of Q <3000 is lower than the calculated ones and required explanation. Since the shear wave velocity in this cut of langasite smaller than the corresponding BAW velocity in aluminum, aluminum electrodes accelerate wave. This is a special case considered in article[3]. Bragg reflection, on the other hand, creates a "stop-bands", on the left edge of which the phase velocity of the wave decreases. That is the surface wave exists only due to the Bragg stopband phenomena. In the case of uniform Al layer there is no localized near surface shear wave (no Love wave with Al layer on LGS) and energy is lost in busbars, thereby reducing the quality factor.

[1] C.U. Kim, W. Wang, V.P. Plessky, V.I. Grigorievski, "High Q-factor STW-Resonators on AT-Cut of Quartz", IEEE Ultrasonics Symposium, 2007, pp.2582-2585

[2] V. Plessky, V. Yantchev, W. Daniau, S. Ballandras, V.Grigorievsky and W.-B. Wang, "Surface Transverse Wave (STW) resonators on langasite", Joint UFFC, EFTF and PFM Symposium, 2013, pp.263-266

[3] V. P. Plessky, J. Koskela & M. M. Salomaa, "Ghost surface transverse waves in periodic structures". IEEE In Ultrasonic Symposium, Proceedings., 1998, Vol. 1, pp. 131-134