Novel Oscillator Using Langasite-Type Piezoelectric Single Crystal

Appropriate configuration of novel resonator using langasite-type piezoelectric single crystal was designed. The resonator is able to achieve lower impedance at low frequency range, faster start up time, and wider band performance as compared with conventional quartz resonator and to contribute to downsizing and low power consumption of on-board equipment.

Langasite-type single crystals are attractive materials for high-stability oscillators and filters as well as pressure sensors operating in high-temperature environments. Novel langasite-type single crystal was developed from a compound reducing scarce elements as compared to conventional one (Fig. 1) [1]. When applying the novel langasite-type single crystal to a resonator, it contributes to low power consumption of the instrument on board because of the properties such as low impedance at low frequency and fast start up time which are unachievable with quartz.

Fig.1 Novel langasite-type single crystal.

All electronic devices operate based on the reference signal called "clock signal". The resonator is one of the key devices generating the clock signal. Because the clock signal is generated based on the signal at the resonant frequency of the resonator, it is important to design the resonator without spurious signals around the resonant frequency for stable generation of the clock signal. The spurious appears depending on cut angle of the crystal, operating frequency, configuration of the crystal substrate (length, width, and thickness), shape of electrode, and so on.

In this report, appropriate configuration of the resonator without spurious around resonant frequency 8 MHz was investigated taking a rotated Y-cut substrate as specimen.

In theoretical consideration of the spurious, Mindlin's plane plate equation [2] and material constants determined were applied in the calculation. Resonator thickness h=0.185 mm and frequency constant C=1507 were used as calculation parameters for designing resonant frequency of 8 MHz. The result was shown in Fig. 2. The lateral axis is l_x/h, where l_x and h are length and thickness of resonator. The vertical axis is ω/ω_0, where ω is frequency and ω_0 is resonant frequency of infinite plate.

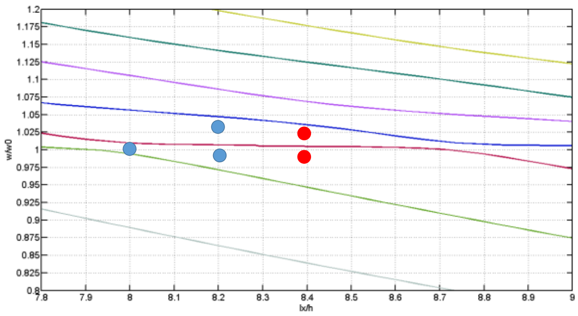

Fig. 2 Mode chart of resonator.

In Fig. 2, solid lines are the calculated results and dots indicate the results of main resonant and neighbor spurious components obtained from the experimental measurement. Difference between the calculated and measured results are considered to be the mass-loading effect of electrode. From the above results, l_x/h=8.3 is expected to be appropriate configuration for the resonator because there are no spurious components near the main resonance.

References

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Full Name: Andrey Medvedev (Fomos Materials)
E-mail: medvedev@imr.tohoku.ac.jp
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