2P3-2

Study on Finding Range of Rotation Angle for Effective Transverse Mode Suppression Based on Using Dielectric Stripes Structure of Surface Acoustic Wave Resonators

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1. Introduction

Resent advance of surface acoustic wave (SAW) technology makes drastic enhancement of device performances such as quality factor (Q). One example is incredible high-performance (I.H.P.) SAW resonators employing very thin 42ºYX-$LiTaO_3$ (42-LT) layer bonded with a Si substrate with a SiO_2 interlayer[1-3]. Since Q enhancement makes spurious resonances apparent in the resonance characteristics, their suppression is always crucial.

Recently, the authors proposed a new structure for transverse mode suppression[4]. This new design uses dielectric stripes for the piston mode operation of SAW resonators to solve the limit of conventional “hammer-head” design in high MR in double busbar configuration.

This paper discusses applicability of this technique for the I.H.P. configuration with reduced LT rotation angle θ for the enhancement of the electromechanical coupling coefficient (k^2).

2. Variation of k^2 and slowness curve with θ

Fig. 1 shows a unit cell of the device used for the periodic 3D FEM analysis. The double busbar configuration[5] was applied for SAW energy confinement. Device parameters used for the simulation are taken from Ref. 4. The metallization ratio (MR) is fixed at 0.5 in the following calculation.

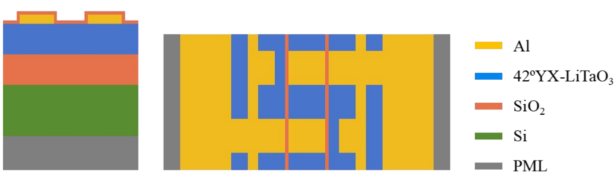

Fig. 1 I.H.P. SAW structure with SiO_2 stripes on the edges of IDT aperture.

Fig. 2 shows variation of k^2 in the structure with θ. It is seen k^2 can be increased by reducing θ. However, reduction of θ makes the SAW slowness curve more convex as shown in **Fig. 3**, and it makes suppression of transverse modes more difficult as long as the “hammer-head” is employed[6]. Note that the slowness curve can be flattened by setting MR small (0.35) as also shown in Fig. 3. The authors demonstrated good transverse mode suppression by the conventional “hammer-head” for I.H.P. SAW structure on 42-LT. In the case, MR is set at 0.35[7].

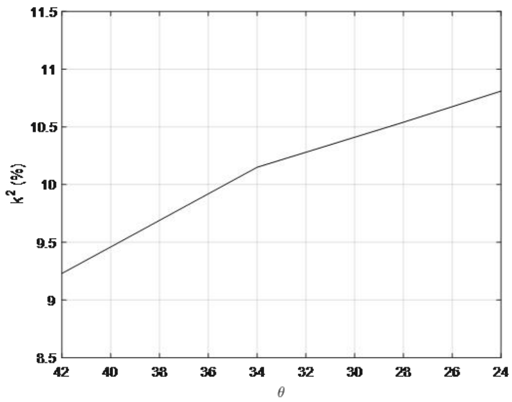

Fig. 2 Variations of k^2 with θ.

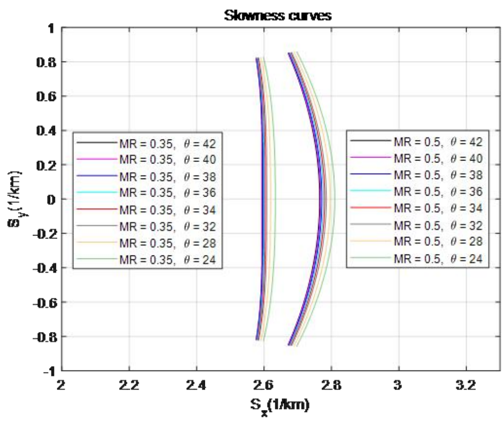

Fig. 3 Variations of slowness curves with θ.

3. Impact of SiO_2 stripes for transverse mode suppression

Fig. 4(a) shows variation of calculated admittance Y and conductance G of I.H.P. SAW configuration shown in Fig. 1 structure with θ when the SiO_2 stripes are not given. Series of resonance peaks are seen above the resonance frequency. They are due to the transverse mode when the slowness

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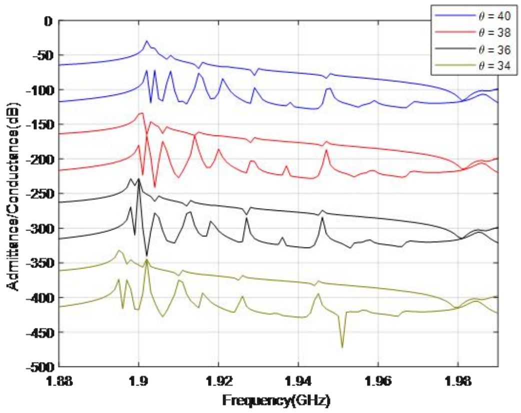
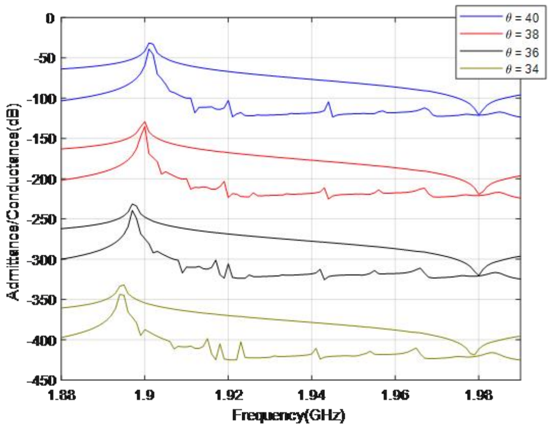
curve is convex. A low Q peak is seen slightly above the anti-resonance frequency. This is due to the "gap mode" caused by the secondary gap in the double busbar structure[7].



(a) Without SiO_2 stripes.



(b) With SiO_2 stripes.

Fig. 4 Calculated Y and G of I.H.P. SAW with the double busbar configuration when θ = 40º - 34º.

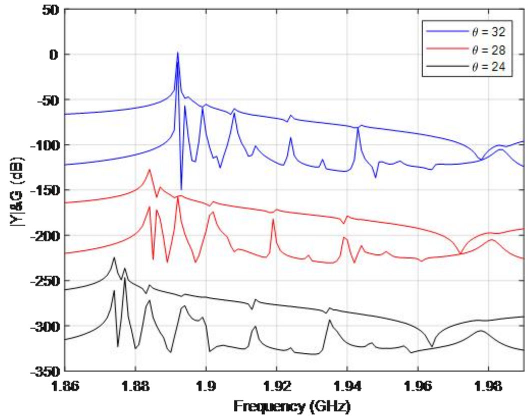
Fig. 4(b) shows variation of calculated Y and G with θ when the SiO_2 stripes are given. Note that SiO_2 height, stripe width and length were adjusted for each θ to offer good transverse mode suppression. It is seen that transverse mode resonances are well suppressed under appropriate settings even when θ is small.

Fig. 5 shows the results when θ is further reduced. Although transverse mode resonances are suppressed in some extent for these cases, they still remain. Furthermore, energy leakage may occur near the main resonance.

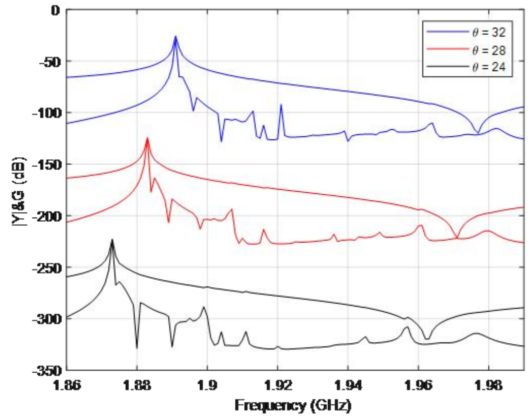
4. Conclusion

This paper discussed transverse suppression in the I.H.P. SAW structure with small θ using dielectric stripes.

Excellent transverse mode suppression was realized for θ larger than 34º even when MR=0.5. When θ is smaller than 34º, some transverse mode resonances remained and energy leakage occurred.



(a) Without SiO_2 stripes.



(b) With SiO_2 stripes.

Fig. 5 Calculated Y and G of I.H.P. SAW with the double busbar configuration when θ = 32º - 24º.

Acknowledgment

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