Reduction of Transverse SAW leakage on the Resonator based on Al/42° YX-LiTaO₃ substrate structure

Tomoya Komatsu‡, Hiroyuki Nakamura, Hidekazu Nakanishi, Tetsuya Turunari, and Joji Fujiwara (Industrial Devices Company, Panasonic Corporation)

1. Introduction

The transverse SAW leakage toward the bus-bar causes the increased insertion loss (IL) in leaky SAW resonators on a 42° YX-LiTaO₃(42LT) substrate [1]. A narrow gap between the inter-digital electrode and the dummy electrode less than 0.25λ is effective to reduce the transverse SAW leakage [2]. However, it is difficult to realize such a narrow gap in the high frequency applications. This paper proposes the new resonator structure for the reduction of the transverse SAW leakage without narrowing the gap.

2. Reduction of Transverse SAW leakage

Fig.1 shows the schematic of the conventional SAW resonator structure, and the outline of SAW velocity on each region. Leaky SAW on a 42LT substrate has the waveguide in the faster velocity region. Regarding to the conventional structure, the SAW velocity on the gap and the bus-bar is faster than that on the inter-digital region. Therefore, the transverse SAW leakage occurs toward the bus-bar. Conversely, the transverse SAW leakage toward the bus-bar could be reduced by making the velocity on the bus-bar slower than that on the inter-digital region.

Fig.2 shows the schematic of the proposed SAW resonator structure, and the outline of SAW velocity on each region. The proposed SAW resonator consists of aluminum (Al) grating and deposited Ta₂O₅ film on the outside of the inter-digital region. Since the density of Ta₂O₅ is much higher than that of Al [3], the SAW velocity on the bus-bar could be slower than that on the inter-digital region.

The effect of Ta₂O₅ film for the structure was analyzed by FEMSDA [4]. Fig.3 shows the analytical results of variation of SAW velocity by Ta₂O₅ film thickness. In the analysis, the relative Al thickness was set at 9% and the metallization ratio was set at 0.5.

---

komatsu.tomoya@jp.panasonic.com
It was confirmed that the SAW velocity on the bus-bar could be made slower by deposited Ta$_2$O$_5$ film. This result suggests that Ta$_2$O$_5$ film thickness of 2% is enough to reduce the transverse SAW leakage toward the bus-bar. On the other hand, Ta$_2$O$_5$ film thickness of 7.5% is required to make the SAW velocity on the gap slower than that on the inter-digital region.

3. Experimental Results

The SAW resonators with the gap of 0.5λ and Ta$_2$O$_5$ film on the outside of the inter-digital region were fabricated on 42LT substrate. The design parameters are those shown in Table I. Fig. 4 shows the measured resonance characteristics by deposited Ta$_2$O$_5$ film. Here, Ta$_2$O$_5$ film thickness conditions are relative thickness of 3%, 2%, and without Ta$_2$O$_5$ film, respectively. It is confirmed that IL of the resonator without Ta$_2$O$_5$ film increases remarkably above the resonance frequency by the transverse SAW leakage. On the other hand, the increase of IL is reduced by deposited Ta$_2$O$_5$ film without narrowing the gap. As the result of deposited Ta$_2$O$_5$ film of 2%, IL is improved about 0.25 dB at \( f/f_r = 1.01 \). In addition, it should be noted here that the measured conductance characteristic of the resonators with relative Ta$_2$O$_5$ film thickness of 2% and 3% scarcely changes. This result suggests that the transverse SAW leakage toward the bus-bar could be suppressed by making the SAW velocity on the dummy electrode and the bus-bar slower than that on the inter-digital region.

Table I. Design parameters of fabricated resonators.

<table>
<thead>
<tr>
<th>Number of IDT</th>
<th>75 pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of reflector</td>
<td>15 pairs</td>
</tr>
<tr>
<td>Metallization ratio</td>
<td>0.5</td>
</tr>
<tr>
<td>Aperture</td>
<td>15λ</td>
</tr>
<tr>
<td>Gap</td>
<td>0.5λ</td>
</tr>
<tr>
<td>Dummy length</td>
<td>1.5λ</td>
</tr>
</tbody>
</table>

4. Conclusion

This paper proposed the new structure for reduction of the transverse SAW leakage toward the bus-bar in leaky SAW resonators on 42° YX-LiTaO$_3$ substrate without narrowing the gap. The transverse SAW leakage could be reduced by deposited Ta$_2$O$_5$ film on the outside of inter-digital region.

The analytical result suggested that the SAW velocity on the bus-bar could be made slower than that on the inter-digital region by deposited Ta$_2$O$_5$ film thickness of 2%.

Then the effect of the proposed structure was confirmed experimentally. The measured result showed that IL is improved about 0.25 dB at \( f/f_r = 1.01 \) by deposited Ta$_2$O$_5$ film thickness of 2%.

Acknowledgment

We would like to thank Prof. Ken-ya Hashimoto of Chiba University for FEMSDA.

References