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# Reduction of Transverse SAW leakage on the Resonator based on Al/42° YX-$LiTaO_3$ substrate structure

$LiTaO_3$ 基板共振器の SAW 横方向漏洩の低減に関する検討

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## 1. Introduction

The transverse SAW leakage toward the bus-bar causes the increased insertion loss(IL) in leaky SAW resonators on a 42° YX-$LiTaO_3$(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.

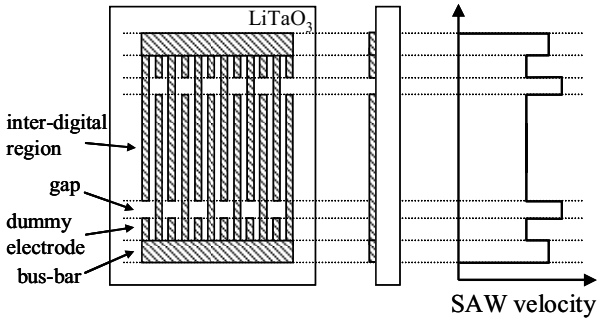


Fig.1 Conventional SAW resonator structure and the outline of SAW velocity on each region.

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 $Ta_2O_5$ film on the outside of the inter-digital region. Since the density of $Ta_2O_5$ 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.

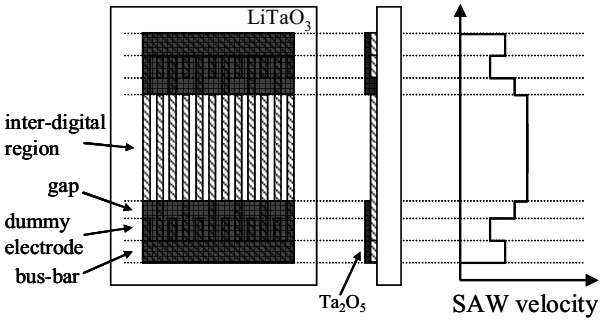


Fig.2 Proposed SAW resonator structure and the outline of SAW velocity on each region.

The effect of $Ta_2O_5$ film for the structure was analyzed by FEMSDA [4]. Fig.3 shows the analytical results of variation of SAW velocity by $Ta_2O_5$ film thickness. In the analysis, the relative Al thickness was set at 9% and the metallization ratio was set at 0.5.

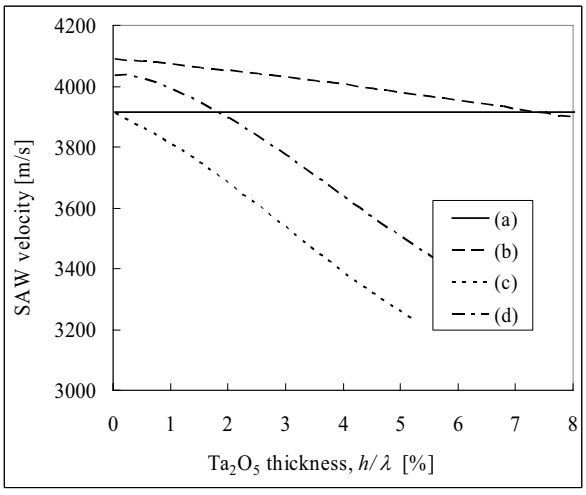


Fig.3 Variation of SAW velocity by $Ta_2O_5$ film thickness. (a) Inter-digital region, (b) Gap, (c) Dummy electrode, and (d) Bus-bar.

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It was confirmed that the SAW velocity on the bus-bar could be made slower by deposited $Ta_2O_5$ film. This result suggests that $Ta_2O_5$ film thickness of 2% is enough to reduce the transverse SAW leakage toward the bus-bar. On the other hand, $Ta_2O_5$ 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 $Ta_2O_5$ 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 $Ta_2O_5$ film. Here, $Ta_2O_5$ film thickness conditions are relative thickness of 3%, 2%, and without $Ta_2O_5$ film, respectively. It is confirmed that IL of the resonator without $Ta_2O_5$ film increases remarkably above the resonance frequency by the transverse SAW leakage. On the other hand, the increase of IL is reduced by deposited $Ta_2O_5$ film without narrowing the gap. As the result of deposited $Ta_2O_5$ 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 $Ta_2O_5$ 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.

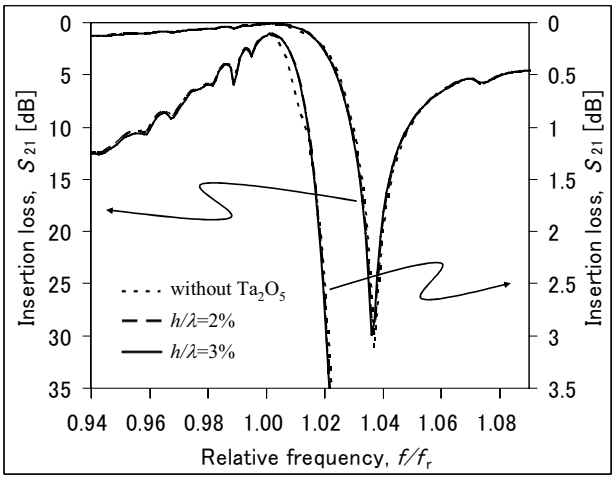
| | |
|---|---|
| Number of IDT | 75 pairs |
| Number of reflector | 15 pairs |
| Metallization ratio | 0.5 |
| Aperture | 15λ |
| Gap | 0.5λ |
| Dummy length | 1.5λ |

## 4. Conclusion

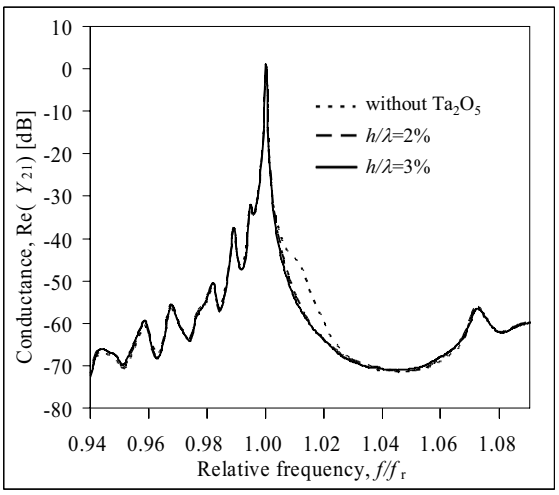
This paper proposed the new structure for reduction of the transverse SAW leakage toward the bus-bar in leaky SAW resonators on 42° YX-$LiTaO_3$ substrate without narrowing the gap. The transverse SAW leakage could be reduced by deposited $Ta_2O_5$ film on the outside of inter-digital region.

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 $Ta_2O_5$ 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 $Ta_2O_5$ film thickness of 2%.




(a) Insertion loss.




(b) Conductance characteristic.

Fig.4 Measured resonance characteristics by deposited $Ta_2O_5$ film.

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**References**

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