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Spurious Responses Modeling with Multi-mode COM Model on $SiO_2/LiNbO_3$ Substrate

マルチモード COM モデルを用いた $SiO_2/LiNbO_3$ 基板の不要応答解析

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1. Abstract

TC-SAW (Temperature Compensated Surface Acoustic Wave) is widely studied to achieve the tight roll off characteristics required for the mobile communication systems. $LiNbO_3$ covered with SiO_2 film structure is proposed for one of the temperature compensation methods [1-6]. An issue to apply the $SiO_2/LiNbO_3$ substrate for the filter devices is the spurious responses prediction.

2. Multi-mode COM Model

Figure 1 shows cross sectional view of TC-SAW composed of $SiO_2/LiNbO_3$ substrate. One of the spurious responses on TC-SAW comes from the different propagation mode, in the case where the main mode is Rayleigh mode, SH (Shear Horizontal) mode appears as the spurious response near the pass band. These two modes exist very closely and are mutually coupled to each other.

COM model is widely used to simulate the SAW device design because of good simulation accuracy and its simple closed equation form. However, conventional COM model cannot catch the mutual coupling between SH and Rayleigh modes. In this paper, new multi-mode COM modeled the mutual coupling between SH and Rayleigh mode is proposed.

Figure 2 shows the simulated dispersion characteristics by FEMSDA [7-9] on dots and COM model on solid line. Modeled geometry is h=0.04λ, H=0.275λ here. SH and Rayleigh branches and the mutual coupling between them are observed on FEMSDA result. COM model can trace the Rayleigh branch well. However, SH branch and mutual coupling don't agree with that from FEMSDA. Figure 3 shows proposed multi-mode COM model results on solid line. The conventional COM model is composed by a pair of the differential equations. Multi-mode COM model equation can be derived by adding the pairs of differential equations to the single mode COM equations. On the multi-mode COM model, both

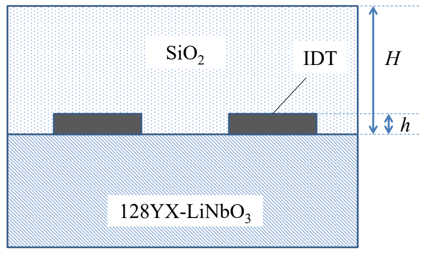

Figure 1 Cross sectional view of TC-SAW structure.

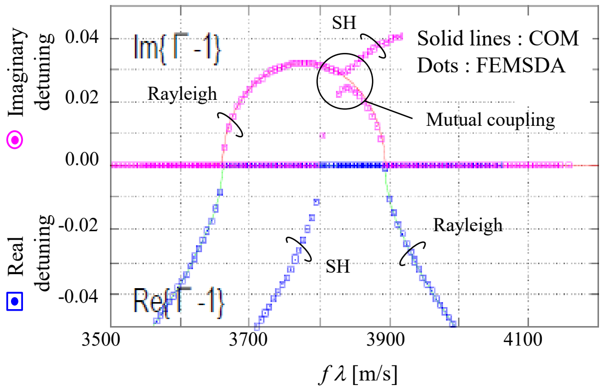

Figure 2 Dispersion characteristics with FEMSDA and single mode COM model.

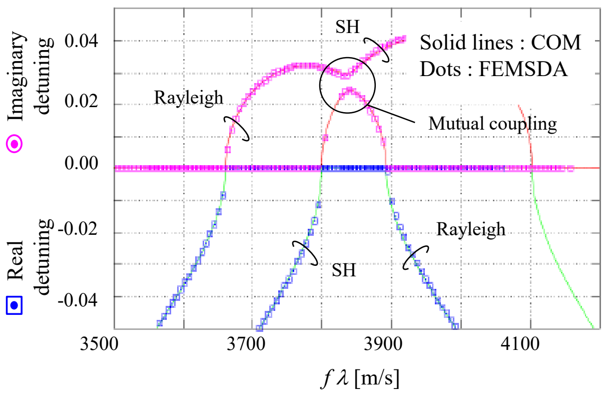

Figure 3 Dispersion characteristics with FEMSDA and multi-mode COM model.

Rayleigh and SH branches agree well and the mutual coupling also successfully modeled.

3. Verification by Experiment

To verify the proposed model, transmission characteristics simulation was performed and compared with the measurement. Figure 4 shows simulated result of single mode COM, which neglects mutual coupling between Rayleigh and SH mode. Measured result shows two spikes in the pass band, however the simulated result cannot predict them. Figure 5 shows the simulated result of multi-mode COM, which considers mutual coupling. The result shows good agreement with measurement. The mutual coupling between the Rayleigh and SH mode modeling is important for the accuracy of the spurious response prediction.

4. Conclusion

This paper proposed multi-mode COM model can consider the mutual coupling between Rayleigh and SH mode. Experimental verification indicates the mutual coupling modeling is important for the accuracy of the spurious response prediction.

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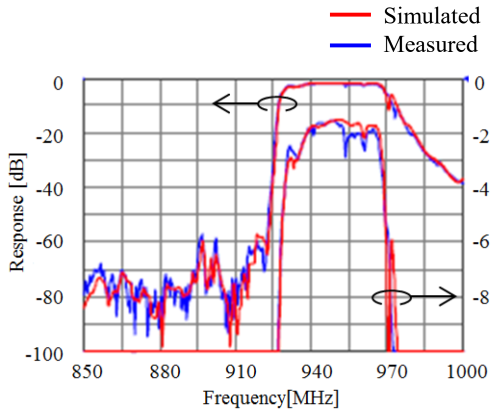

Figure 4 Measured transmission characteristics and simulation with single mode COM model.

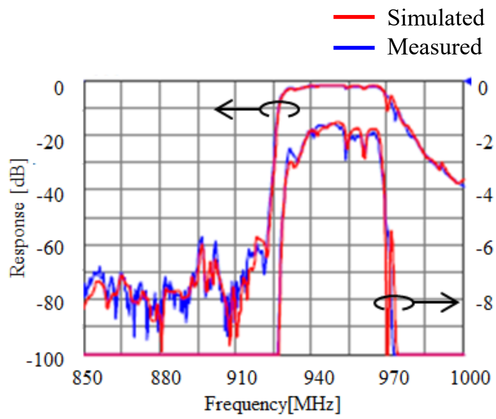

Figure 5 Measured transmission characteristics and simulation with multi-mode COM model.

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