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Adjustment of Distance between Driving IDT and Reflector in SAW Motor

弾性表面波モータの駆動IDTと反射器の距離に関する調整

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1. Introduction

Interdigital transducers (IDTs) of a surface acoustic wave (SAW) motor are made of two unidirectional interdigital transducers (U-IDTs) including a driving IDTs (D-IDTs) and a reflector (R-IDTs)[1,2]. In attempt to evaluate the efficiency of the SAW motor, the recycle efficiency of the substrate has been defined[3]. In this paper, the distance between D-IDTs and R-IDTs will be adjusted to improve the recycle efficiency.

2. Motivation

The U-IDTs have been simulated by the improved cross field model[4,5]. Since the design aim is that the susceptance of the U-IDTs is 0, to achieve the impedance matching, the distance between D-IDTs and R-IDTs is adjusted, as shown in **Fig. 1**. When distance is too close, the design of the electrode is difficult. Also, the wave loss will be increased, when distance is too far. So, the previous distance was 878 μm.

However, when the distance is adjusted to 858.5 μm from 878 μm, the conductance of the U-IDTs is up to 16.8 mS from 12.5 mS. At the same time, the susceptance is still 0.

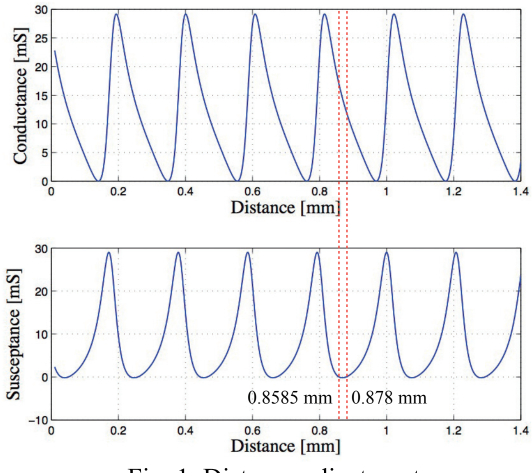

Fig. 1 Distance adjustment.

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Table I Parameters of U-IDTs.

Parameters	D-IDTs	R-IDTs
Periodic length (μm)	400	414
Strip-electrode pairs	21	32
Aperture (mm)	9	9
Bus bar (μm)	1750	1750
Gap (μm)	300	
Distance (μm)	858.5	
Metallization-ratio	0.5	

3. Fabrication

The parameters of U-IDTs was estimated as shown in **Table I**. To evaluate the performance of the novel U-IDTs, the substrate has been fabricated by basic semiconductor planar process, as shown in **Fig. 2**.

4. Measurements

At first, the admittance characteristic of the novel U-IDTs was measured by a precision impedance analyzer. In order to avoid the influence of the reflected waves, the absorber was covered in the front and back of the U-IDTs. As shown in **Fig. 3**, the measurement result was close to the previous simulation result. When the driving frequency was 9.61 MHz, the conductance of the U-IDTs was 17.5 mS. Also, the susceptance was 0.6 mS.

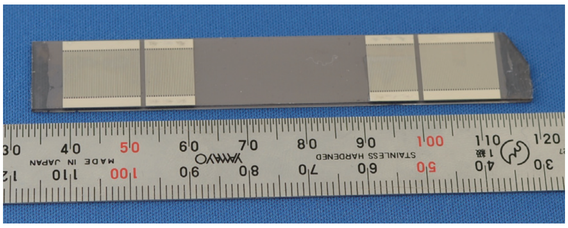

Fig. 2 Substrate product.

Then, the recycle efficiency of the novel substrate was measured. In order to achieve the impedance matching, 58 Ω recycle resistor was used in this measurement. Through the Input power P_{ein} and the recycle power Pe_{out}, the recycle efficiency η of the novel substrate can be calculated in equation 1.

$$\eta = \frac{Pe_{out}}{Pe_{in}} \tag{1}$$

The relationship between the input power and the recycle power is shown in **Fig. 4**. Through the measurement results, the recycle efficiency of the novel substrate was up to 78%. Compared with the previous recycle efficiency, 10% was increased by the distance adjustment.

In addition, to evaluate the vibration amplitude of Rayleigh wave, generated by the U-IDTs, in the front of driving U-IDTs, ten spots was scanned in a line at the same driving power. Since aperture of U-IDTs is 9 mm, the interval of each spot was 1 mm.

The vibration amplitude results were compared as shown in **Fig. 5**. In the previous research, when input power was 6.3 W, the vibration amplitude was 8.5 nm. And, the vibration amplitude of the novel U-IDTs was up to 10 nm. Consequently, 18% vibration amplitude have been increased at the same input power.

5. Conclusions

In this research, the distance between D-IDTs and R-IDTs, in the U-IDTs, was adjusted, for improving the efficiency of the substrate in the SAW motor.

When the distance was adjusted to 858.5 µm, the conductance of the U-IDTs is up to 16.8 mS, when the driving frequency was 9.61 MHz. Also, the measurement value was 17.5 mS, when the susceptance was close to 0.

Through some measurement experiments, the recycle efficiency of the novel substrate was up to 78%. At the same time, the vibration amplitude of the novel U-IDTs was improved.

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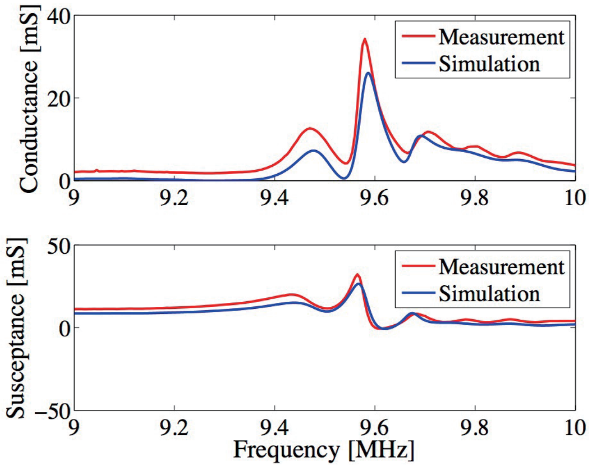

Fig. 3 Admittance characteristic.

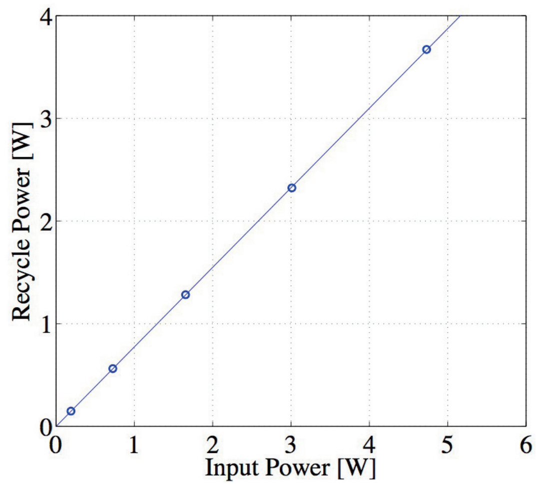

Fig. 4 Recycle efficiency.

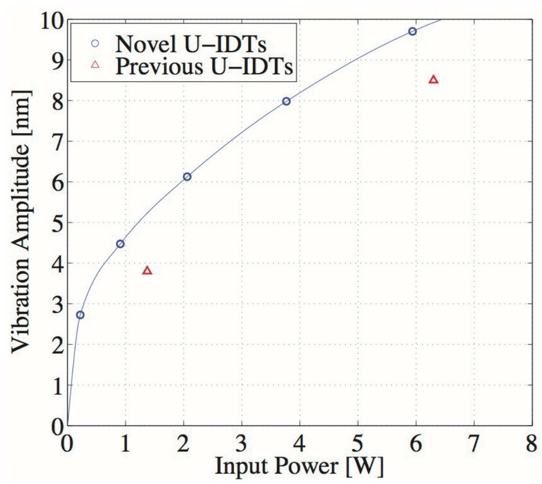

Fig. 5 Vibration amplitude.