Influence of Electrode Arrangement in Surface Acoustic Wave Device for UltraSonic welding by using PZT substrate

PZT 基板を用いた超音波溶着用弾性表面波素子における電極配置による影響

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1. Introduction

We have carried out ultrasonic Au Foil joining by using 2.5 MHz of surface acoustic wave (SAW) device by mean of $LiNbO_3$ substrate.[1)-2)]The aim of this study is applying ultrasonic joining method to flip chip bonding. The advantage of usage of SAW device for joining are follows: Damages of joined parts can be avoided and positioning accuracy becomes higher, because displacement of vibration of joining tool can be small at higher frequencies. Therefore, it is thought that it is suitable for Au Foil joining. On the other hand, it is very difficult to get wider area of joining part by using conventionally used longitudinal-mode transducer system at higher frequencies. By using SAW joining system, however, we can get a wider work area on the SAW device.

On the other, $LiNbO_3$ substrate cracks easily by static load in SAW joining. Therefore, we tried using PZT substrate, because PZT substrate is very harder than $LiNbO_3$ substrate. We succeeded in plastic joining in the precedent study by SAW power accumulator.[3)] However, joint strength was very low. In order to achieve stronger bonding, Therefore, it is necessary to design to obtain larger amplitude.

In this study, we solve the design problem caused by isotropy, aim at obtaining larger amplitude, verify the arrangement of the reflector, and carry out the simulation analysis.

2. Simulation analysis by finite element method

Fig.1 illustrates Simulation was carried out by the finite element method using Murata software's CAE software Femtet. We simulated by ordinary OMSA reflector model and model of Spread out like an OMSA reflector fan-shape.

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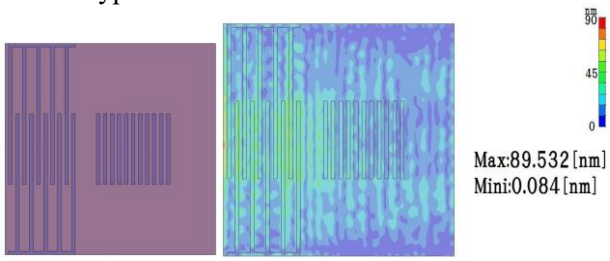
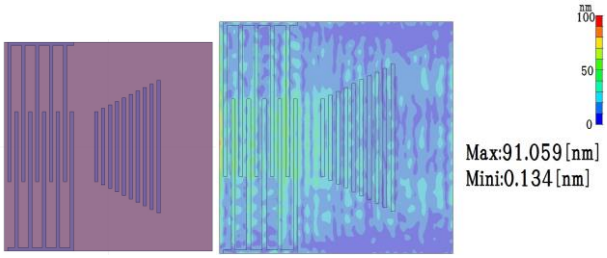
The aim is to investigate the influence of spreading the reflector in a fan shape in order to improve the reflection efficiency by effectively using the space in the octagonal power combining type SAW. And as a comparison, we simulated ordinary reflectors. The size of substrate is a width of 3 mm and depth of 3 mm and a thickness of 0.2 mm were simulated. We designed IDT 5 pairs and OMSA reflector 10As a result, it is considered that the reflection efficiency is improved because the fan type reflector slightly improves the maximum displacement amount of 2 nm with respect to the normal type.



(a) Ordinary OMSA reflector



(b) Fan-Shape OMSA reflector

Fig.1 Simulated by Femtet

3. Construction of SAW device

From the simulation results, we design SAW devise and examined the actual influence. Fig.2 illustrates the SAW device that used in this study. The substrate of the SAW device used PZT (Model : C-213 FUJICERAMICS). The size of substrate is a width of 100 mm and depth of 30 mm

and a thickness of 10 mm. we designed a 2.5 MHz SAW resonator[4]. The sound velocity of SAW substrate is 1988 m/s and a wavelength is 0.8 mm . Therefore, the width of every electrode finger and gap width between electrode fingers were both as 0.2 mm. These SAW devices were designed IDT 14 pairs and OMSA reflector 30. (a) is ordinary OMSA model and (b)is Fan-Shape OMSA reflector.

4. Electrical characteristic of SAW device

Fig.3 shows a frequency characteristics of two devices were measured. As a result of the measurement, it was confirmed that the two elements have similar characteristics. Moreover, showed higher |Y| value in the model in which the reflector was widened. Because the result of improvement in reflection efficiency. As a result of measurement, the resonant frequency of both elements was 2.58 MHz.

Next, we drove test an SAW device by power amplifier. The power amplifier used is ENI 240L RF Power Amplifier. When as a result of outputting with 50 dB amplification with amplifier input 1$V_{P\text{-}P}$, In the case of a fan shape reflector, it was 39 $V_{P\text{-}P}$ with respect to that of a normal reflector 68 $V_{P\text{-}P}$, and the load voltage was only half. This is Conceivable to be due to a decrease in load coefficient due was longer in cross finger width.

5. Conclusions

The Influence of electrode arrangement in SAW device for ultrasonic welding was studied. As a result, it was confirmed that the reflection efficiency improved when the cross finger width was widened. However, since the amplitude decreases due to the applied voltage during use under high load, it is necessary to consider not only the reflection efficiency but also the influence of the load in order to use for ultrasonic welding. We will examine how much the actual amplitude will be affected and consider more efficient placement

6. Reference

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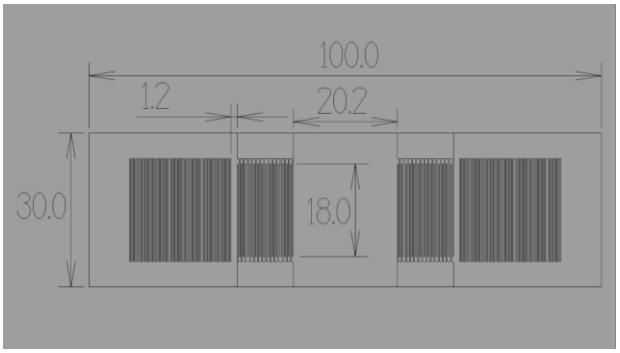
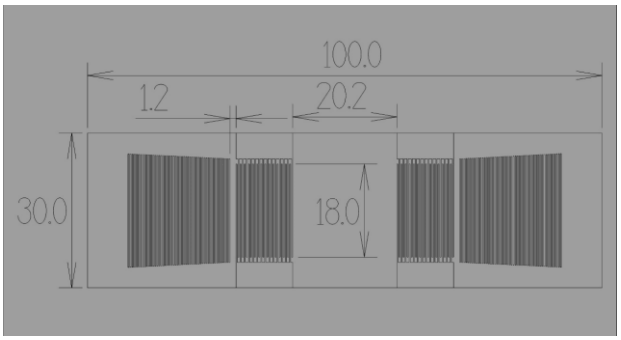
4) T. Kojima : Doctoral Dissertation, Tohoku Univ. 1988[in Japanese]

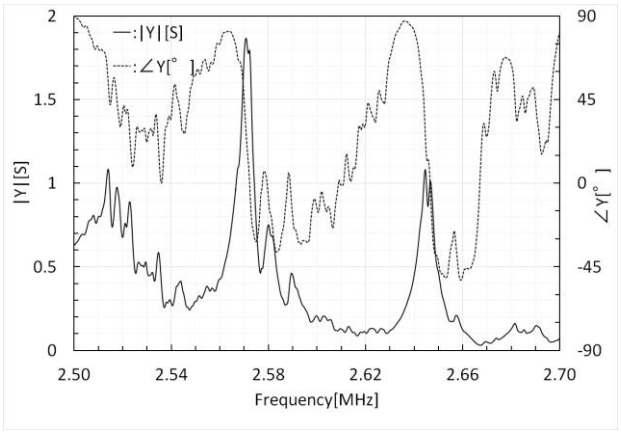


(a) Ordinary OMSA reflector

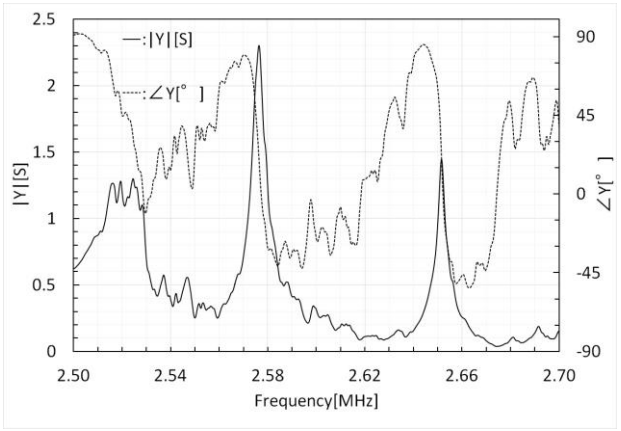


(b) Fan-Shape OMSA reflector

Fig.2 Construction of SAW device (Unit : mm)



(a) Ordinary OMSA reflector



(b) Fan-Shape OMSA reflector

Fig.3 Frequency characteristic of the SAW device