1P4-1

Excitation of Rayleigh Wave with Sapphire-LiNbO3 Mechanical Integration for Surface Acoustic Wave Motor

サファイア基板へのニオブ酸リチウム素子の機械予圧によるレイリー波励振

Deqing Kong[1‡], Minoru Kuribayashi Kurosawa[1]
([1]Tokyo Institute of Technology)
孔　徳卿[1‡]，黒澤　実[1]（[1]東京工業大学）

1. Introduction

The durability of the surface acoustic wave (SAW) motor is a essential research topic due to the friction driving[1)]. Thus, the friction durability between the slider and the stator is required to study in depth. In an attempt to improve the durability of the stator in the SAW motor, a novel sapphire stator was studied in this research. The sapphire stator is more resistant than the current lithium niobate stator with the friction driving. In the novel sapphire stator, the SAW is generated by the lithium niobate interdigital transducer with the pure mechanical preload[2)], as shown in **Fig. 1**.

The novel sapphire stator was assembled. The admittance characteristics of the lithium niobate interdigital transducer was measured. Furthermore, the wave vibration amplitude, generated by the transducer, was measured in the sapphire substrate.

2. U-IDT Transducer

In the SAW motor, Rayleigh wave (RSAW) is generated by the unidirectional interdigital transducer (U-IDT) in the lithium niobate substrate, including a driving IDT (D-IDT) and a reflector IDT (R-IDT). The previous U-IDT transducer of the lithium niobate was utilized. The parameters of the U-IDT were determined and shown in **Fig. 2** and **Table I.**

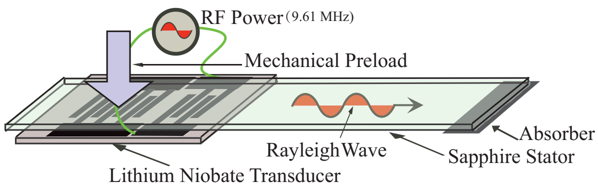
3. Fabrication and Measurements

To evaluate the performances of the sapphire stator, the U-IDT transducer was fabricated firstly. The substrate was 128° y-rotated x-propagation lithium niobate. For the U-IDT transducer, 400 nm Aluminum film was deposited by sputtering.

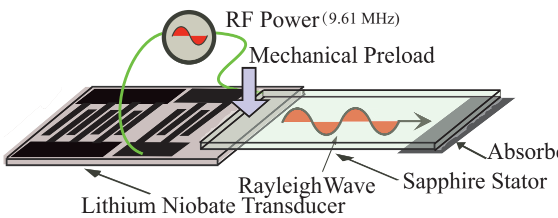
In the novel sapphire stator of the SAW motor, Rayleigh wave of the sapphire stator is generated by the U-IDT lithium niobate transducer with the normal mechanical preload, the mechanical design of the preload parts is significant. The key point of the preload parts is tension uniformity, to avoid the breakage of the U-IDT lithium niobate transducer. In the meantime, the sapphire is anisotropic material, the high parallelism of the U-IDT lithium niobate transducer and the sapphire stator is essential. Two types of the mechanical preload were investigated.

As shown in **Fig. 3**, compared with the admittance characteristics of the case of sapphire stator type II, the admittance characteristics of the sapphire stator type I fluctuated slightly, because the electrodes of the U-IDT transducer and sapphire substrate were integrated on the surface.

E-mail address: kong.d.aa@m.titech.ac.jp



(a) Type I, mechanical preload part is on the surface of the U-IDT transducer.



(b) Type II, mechanical preload part is on the front the U-IDT transducer.

Fig. 1 Schematic view of sapphire stator.

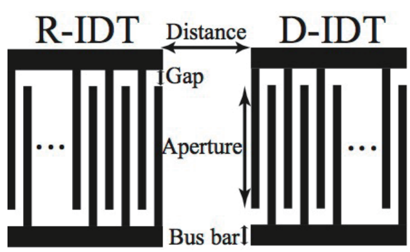


Fig. 2 Geometry of U-IDT.

Table I Parameters of U-IDT.

	D-IDT	R-IDT
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	

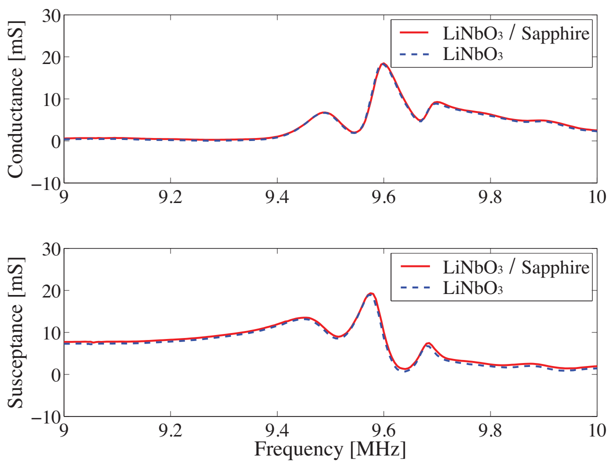
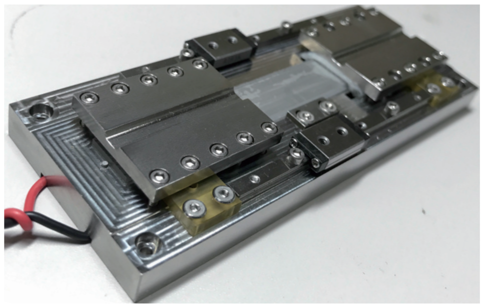


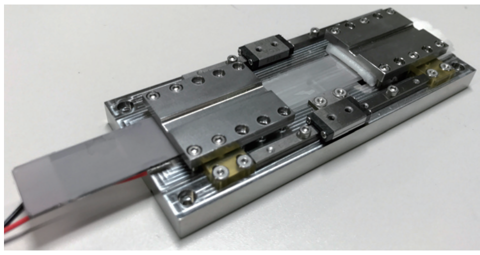
Fig. 3 Admittance characteristic of U-IDT transducer.

Consequently, the previous 9.61 MHz driving frequency is maintained in the sapphire stator type I and type II.

To generate Rayleigh wave in the sapphire substrate efficiently, the mechanical design of the novel sapphire stator is shown in **Fig. 4**. The surface of the sapphire stator was scanned with a laser Doppler vibrometer to measure the vibration amplitude of Rayleigh wave. Additionally, since the Fresnel effect occurred at the front of the U-IDT transducer, the distance between the mechanical preload part and scanned spots was 1 mm. Also, to avoid the interference of the reflected wave, the other part of the sapphire stator was covered by the absorber. As shown in **Fig. 5**, the vibration amplitudes of RSAW were scanned for the five different values of the input voltage. Compared with the pure previous lithium niobate stator, the normal vibration amplitudes was down to 4.4 nm and 4.7 nm from 9.5nm in case of the sapphire stator, type I and type II, when the input voltage was 20.5 V. The vibration amplitudes of the sapphire stator type I was lower than the type II. Also, the power loss were investigated in case of



(a) Type I, mechanical preload part is on the surface of the U-IDT transducer.



(b) Type II, mechanical preload part is on the front the U-IDT transducer.

Fig. 4 Measurement device of novel sapphire stator.

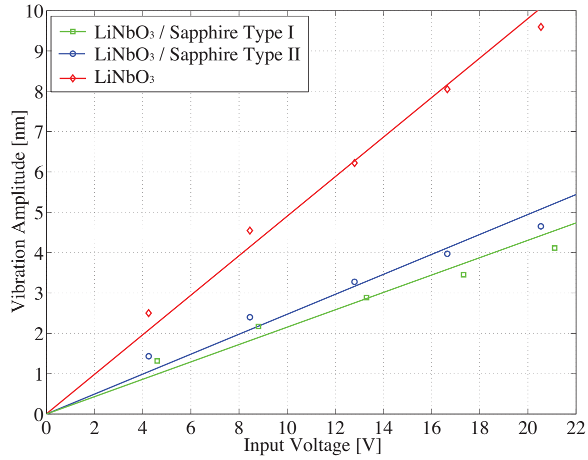


Fig. 5 Vibration amplitude in the sapphire stator.

the sapphire stator type I and type II.

4. Conclusions

The novel sapphire stator was studied. Rayleigh wave was generated in the sapphire stator by the lithium niobate transducer with the normal mechanical preload. Because the wave vibration are decreased, the power loss will be described for detailing the power flow in future.

References

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2. D. Kong and M. K. Kurosawa: Proc. of IEEE Ultrasonics Symposium (2016) p. 1-4.