Characteristics of surface acoustic wave propulsion system at 10 MHz

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1. Introduction

Swimmer using an ultrasonic transducer is easy to simple structure and small size, because the propulsion force of the swimmer can be obtained simply by a high frequency transducer[1-3]. In this research, characteristics of the propulsion system are reported in water using the surface acoustic wave(SAW) transducer.

2. Design

2.1 SAW transducer

The SAW transducer (128°Y-cut Lithium niobate) used in this research is shown in **Fig. 1**. The dimensions of the transducer were 16 mm in depth and 14 mm in width. The parameters of IDT used to excite the SAW is shown in **Table I**.

2.2 Admittance characteristics

Admittance characteristics were measured using an impedance analyzer in air. The measurement results and the calculation results derived from the IDT equivalent circuit are shown in **Fig. 2**. The measured and calculated impedance characteristics have a good fitting. The conductance of the SAW transducer in air and calculation result were 11.4 and 11.3 mS respectively.

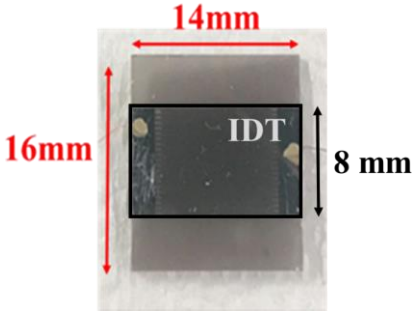

Fig. 1 SAW transducer.

Table I IDT parameters.

Frequency [MHz]	9.61
Aperture [mm]	9.0
Strip-electrode width [μm]	100
Strip-electrode gap [μm]	100
Strip-electrode pairs	20

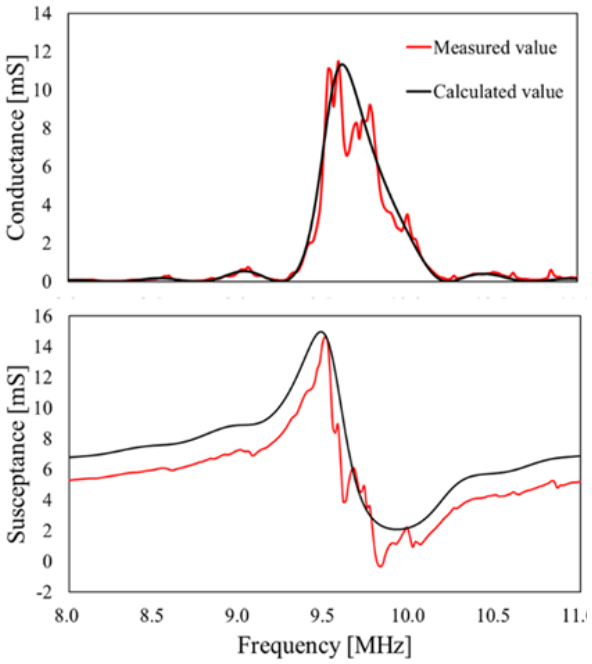

Fig. 2 Admittance characteristics.

3. Sound pressure

To investigate the force for the propulsion system, the sound pressure of the SAW transducer was measured with a hydrophone. Sound pressure was measured vertically to the strip-electrode. The dimensions of the transducer were 16 mm in width and the part of IDT was 4~12 mm. The sound pressure was measured near the transducer and 5mm from the transducer. Sound pressure was measured at 1 mm spot. The measurement results obtained at 5 V_{pp} and 9.61 MHz are shown in **Fig. 3**. Higher sound pressure was centralized in the IDT area. At 5 mm area, the highest sound pressure was observed at the edge of the IDT. The result was consistent with the theory.

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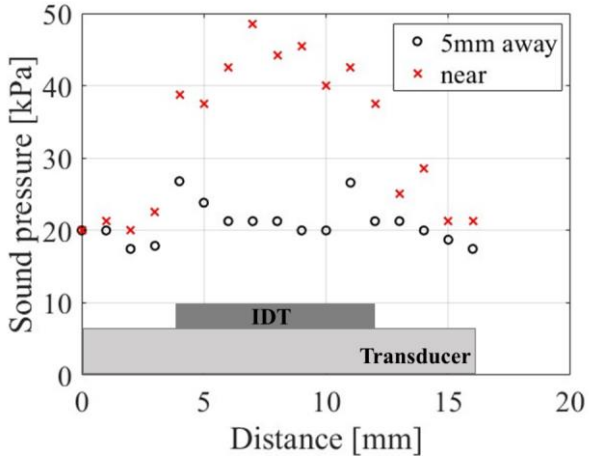

Fig. 3 Sound pressure of SAW transducer.

4. Particle velocity

The particle velocity was measured by the SAW transducer. The SAW transducer was driven at a driving frequency of 9.61 MHz and an input voltage of 8.0~27.6 V_{pp} with particles in water. The motion of the particles was captured by a high-speed camera, and the particle velocity was analyzed. The particle velocity measurement results obtained at various driving voltages and the maximum particle velocity versus input voltages were shown in **Figs. 4** and **5**, respectively. For an input voltage of 27.6 V_{pp}, the maximum particle velocity was 69.1 mm/s.

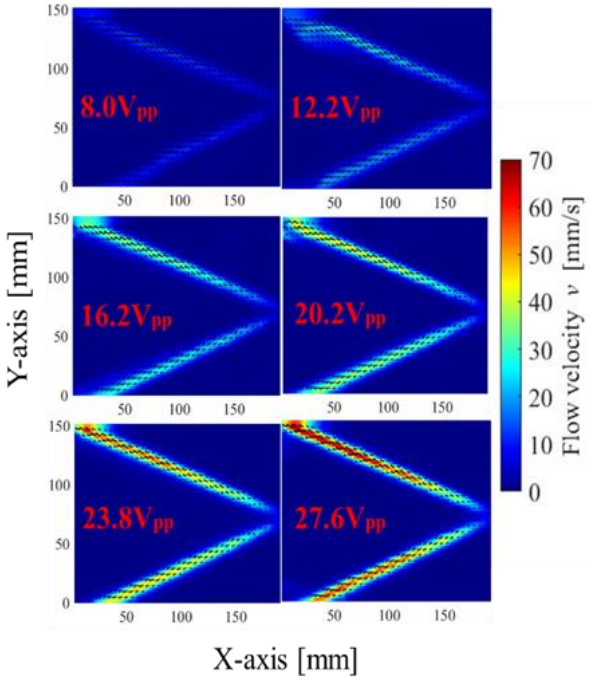

Fig. 4 Particle velocity of SAW transducer by diverse voltages in water.

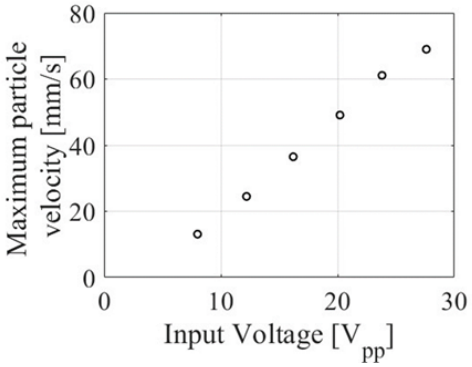

Fig. 5 Maximum particle velocity of by diverse voltages in water.

5. Propulsion

To investigate the force for the propulsion system, the propulsion of the SAW transducer was measured with a force sensor. The propulsion measurement results obtained at various driving voltages are shown in **Fig. 6**. For an input voltage of 72.5 V_{pp}, the highest propulsion of 3.6 mN was measured in water.

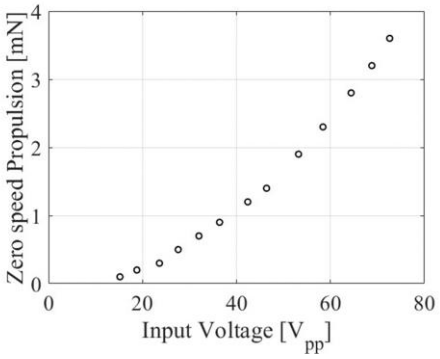

Fig. 6 Zero speed propulsion.

6. Conclusion

In this study, the characteristics of the SAW propulsion system at 9.61 MHz were evaluated. The admittance characteristics, sound pressure, particle velocity, and zero-speed propulsion of the SAW transducer were measured and reported.

Acknowledgment

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References

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