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Development of Linear Array Piezoelectric Transducer using Sol-Gel Spray Technique

ゾルゲルスプレー技術を用いたリニアアレー圧電素子の開発

Shingo Koda[1†‡], Masayuki Tanabe[2], Makiko Kobayashi[2], and Masahiko Nishimoto[2]
([1]Grad. School Sci. Technol., Kumamoto Univ.; [2]Fac. Adv. Sci. Technol., Kumamoto Univ..)
幸田真吾[1†‡], 田邉将之[2], 小林牧子[2], 西本昌彦[2] ([1]熊本大院 自然科学研究科, [2]熊本大院 先端科学研究部)

1. Introduction

In medical ultrasound imaging, piezoelectric material is used as probe for emitting and receiving ultrasound. In fabrication process of the probe, the piezoelectric material is finely diced using dicing machine; then it takes long time and the diced element is easy to break. New Fabrication methods are suggested by some researchers to solve this problem[1-3]. As the alternative method of manufacture, sol-gel spray technique has been proposed. This technique has advantages: 1)easy to fabricate, 2) possible to fabricate on curved substrate[4]. In this study, a linear array piezoelectric transducer with a sol-gel spray technique has been developed and experiment with the piezoelectric transducer is performed.

2. Method

2-1. Fabrication of transducer

Piezoelectric transducer is fabricated using sol-gel spray technique. The composite of PZT sol-gel solution and MPT powder at the ratio of 3:2 is sprayed to a stainless steel substrate with 100 μm thickness using an airbrush. After the spraying, drying (150 ˚C) and firing (650 ˚C) are performed. Spraying process of the composite, drying, and firing are repeated until the film becomes the desired thickness. Consequently, the substrate is polarized. The fabrication process flowchart is illustrated in **Fig 1**.

To make top electrode layer, a mask is placed on the film, and colloidal silver is sprayed using an air brush. The design of the mask is illustrated in **Fig 2**.

2-2. Experimental conditions

The fabricated linear array transducer is shown in **Fig. 3**. To evaluate the fundamental performance of the transducer, pulse-echo experiment is conducted using a pulser/receiver (DPR300, JSR Ultrasonics) and a digital oscilloscope. The experimental setup is illustrated in **Fig 4**. The conditions of the pulse/receiver are listed in **Table. I**.

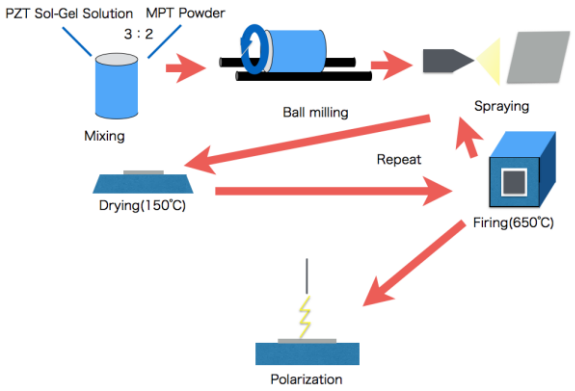


Fig 1. Fabrication process.

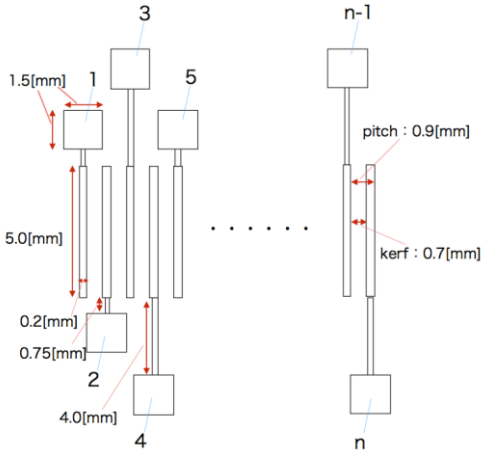


Fig. 2 Design of top electrode of linear array.

e-mail: koda@st.cs.kumamoto-u.ac.jp

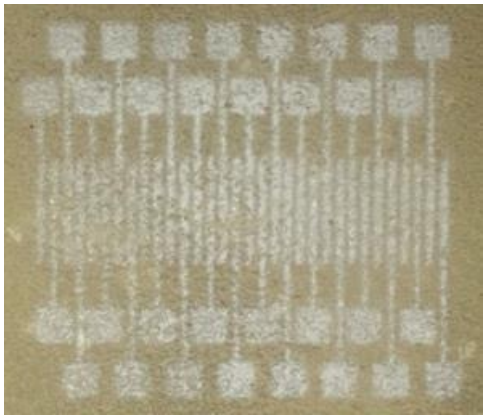


Fig. 3 Photo of fabricated linear array transducer.

Table. I Conditions of pulser/receiver.

Transmitter	Pulse Amplitude	9
	Pulse Energy	LOW 1
	Damping	16
Receiver	Gain [dB]	59
	HP Filter [MHz]	2.5
	LP Filter [MHz]	7.5

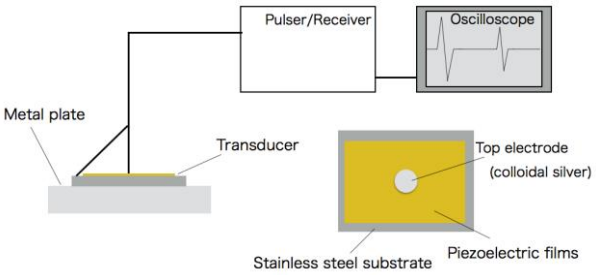
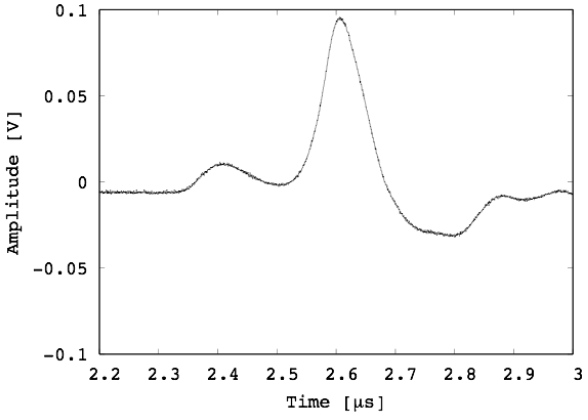


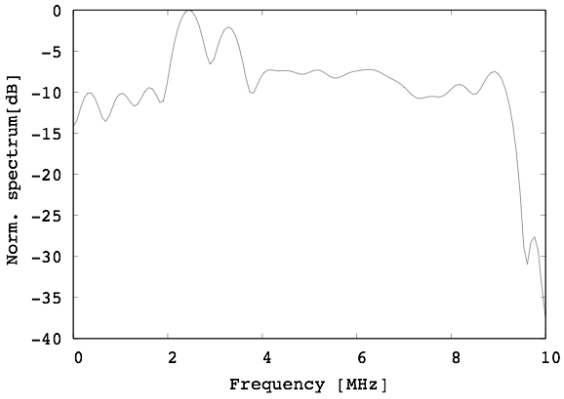
Fig. 4 Setup of pulse-echo experiment.

3. Result

The obtained echo from the bottom of the metal plate is shown in **Fig. 5**. The peak amplitude of the obtained echo is 0.095V. The center frequency is 2.4MHz and its -6 dB frequency bandwidth is 0.8MHz (2.1-2.9 MHz).



(a)



(b)

Fig. 5 Echo signal from metal plate in pulse-echo experiment in (a)time and (b) frequency domains.

4. Conclusion

In this study, the linear array transducer with sol-gel composite spray technique has been developed and pulse-echo experiment was conducted.

As a future work, the improvement of the quality of piezoelectric film will be planned, and detail examination of performance of linear array element will be given.

References

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