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Poling degree Control of $Pb(Zr,Ti)O_3/Pb(Zr,Ti)O_3$

$Pb(Zr,Ti)O_3/Pb(Zr,Ti)O_3$ の分極度制御に関する研究

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1. Introduction

In recent years, to prepare for aging society, people take a growing interest in health problems. However, for going to the hospital and taking a doctor's diagnosis, and receiving medical treatments, it requires time and money. Therefore, home health monitoring, it requires less time and lower cost, has been desired. One example of home health monitoring is measurement using a chair. Measurement of biological signals by sitting on a chair with a sensor, it is possible to obtain stress-free heart rate variability without consciousness of the measurement itself. Moreover, since it is an act carried out on a daily basis, it leads to the early detection of illness and it is low cost. However, the signal to noise ratio (SNR) requirement of sensors is very demanded. Typical biological signal measurement, polyvinylidene difluoride (PVDF) sensors are used, even though SNR of PVDF is not high enough due to ringing effect. Development of new sensors for biological signal measurement has been desired.

Flexible sol-gel composite film sensor was developed for high temperature non-destructive testing applications.[1)] Sol-gel composite was made from the mixture of ferroelectric powders and dielectric sol-gel solution and flexibility was accomplished due to the porosity existed in the piezoelectric film. Sol-gel composite piezoelectric film sensor has high SNR and high sensitivity for movement so that it was expected that it was possible to measure biological signal. In the previous study, biological signal was measured by sitting on a chair with $Pb(Zr,Ti)O_3$ (PZT)/PZT piezoelectric film sensors, which were made by PZT powders and PZT sol-gel solution.[2)] However, measurement results in the past study, body movement noise was observed and canceling body movement noise was an issue.

In this study, to cancel the body movement noise, poling degree control of PZT/PZT was attempt. In detail, performance difference caused by different output poling voltages duriing poling process was investigated.

2. Sample fabrication

PZT/PZT sol-gel composite sensors ware made by sol-gel spray technique. **Fig. 1** shows fabrication processes of PZT/PZT piezoelectric film sensor. First, PZT powders and PZT sol-gel solutions were prepared. PZT sol-gel solutions ware self-manufactured. PZT powders was chosen because of raw material availability, high sensitivity, and poling facility.[2)] The mixture of PZT powders and PZT sol-gel solution was ball milled. Then, the mixture ware sprayed onto a stainless substrate by an automatic spray coating machine. The thickness of stainless substrate were 60μm. This substrate was chosen due to appropriate hardness and high temperature durability. Then, the spray coating was carried out in an automatic spray coating machine. After spray coating, drying at 80°C on a hot plate, 150°C in an oven and firing at 650°C in a furnace ware processed for 5 min each. Those spray coating process and thermal process ware repeated until target film thickness. Target film thickness was 90μm in this experiment. This target thickness was selected due to the balance of output voltage and fabrication time, since the thicker film produces higher output voltage and require longer fabrication time. Typical optical image of PZT/PZT piezoelectric film onto stainless substrate is shown in **Fig.2**. Area of PZT/PZT fim was 12mm by 40mm.

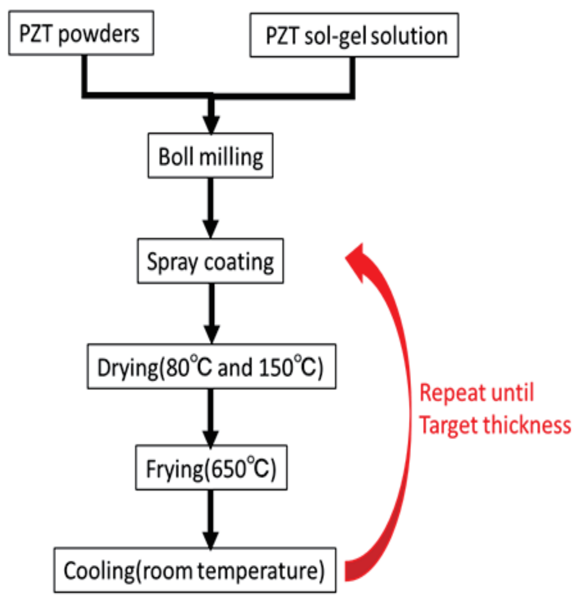

Fig. 1 PZT/PZT piezoelectric film sensor fabrication processes.

Fig. 2 Typical optical image of PZT/PZT piezoelectric film

After film fabrication, poling was performed by positive corona discharge at room temperature. In order to control poling degree, different output poling voltage was used in this time. Output poling voltage of sample 1 and sample 2 were 40kV and 10kV, respectively. After these processes, thin silver top electrodes were manufactured using silver paste. Area of top electrodes for sample 2 was small such as 5mm diameter just to confirm piezoelectric performance existence.

3. Experiment Results

The piezoelectric constant d_{33} was measured by piezo d33 meter and the measurement results of sample 1 and sample 2 was 96.4 and 5.4 pC/N, respectively. Sample 2 value of d_{33} of was much lower than d_{33} of sample 1. From this result, it can be confirmed that poling degree control by changing the poling output voltage was successfully operated.

Fig. 3 shows typical measurement result obtained by sample 1. The measurement was performed by measuring the voltage when a pressure was applied to the piezoelectric film. The pressure was applied by dropping an alumina ball with about 2g weight onto the piezoelectric film from 0.8cm height. From Fig. 3, peak-to-peak voltage of about 2.75V was observed.

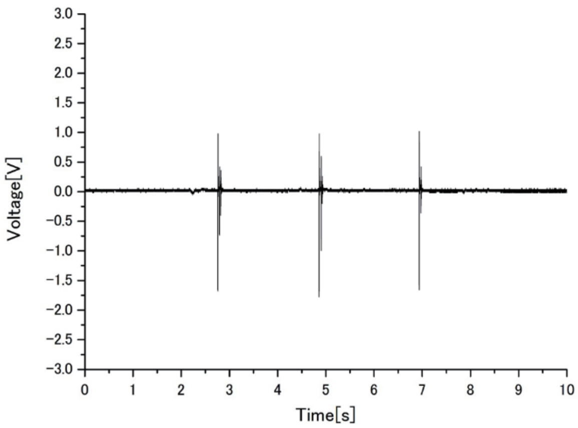

Fig. 3 Typical measurement result by sample 1

Fig. 4 shows typical measurement result obtained by sample 2. Sample 2 was also measured under the same conditions, but the waveform could not be observed. Therefore, measurement was performed by bending the piezoelectric film by hand. As a result, peak-to-peak voltage of about 0.075V was observed. From these results, it was confirmed that sample 2 was less sensitive than sample 1 and it also showed successful poling degree control.

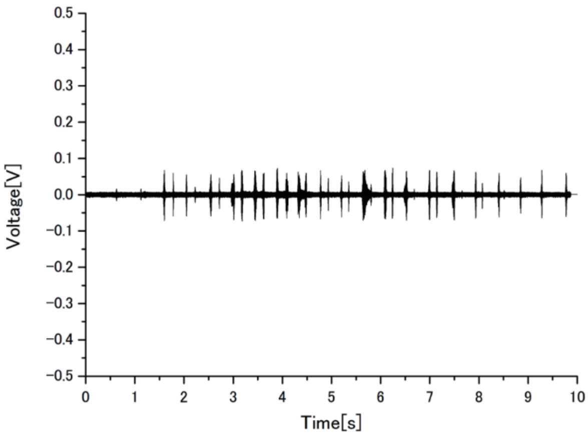

Fig. 4 Typical measurement result by sample 2.

4. Conclusion

90μm thick PZT/PZT piezoelectric film was fabricated on a 60μm thick stainless substrate. The piezoelectric constant d_{33} of sample 1 and sample 2 was 96.4 and 5.4pC/N, respectively. Corona discharge poling was performed for sample 1 by 40kV output voltage and for sample 2 by 10kV. The voltage was measured when a pressure was applied to the piezoelectric film. Peak-to-peak voltage of sample 1 was about 2.75V. Sample 2 was also measured under the same conditions, but the waveform could not be observed. Therefore, measurement was performed by bending of the piezoelectric film by hand. Peak-to-peak voltage of sample 2 was about 0.075V. From this study, it was found that the poling degree of the piezoelectric film can be controlled by controlling the poling voltage.

References

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