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Transfer Methods of Ultrathin Piezoelectric Strain Sensor to Flexible Printed Circuits

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Abstract

This paper presents a novel sensor sheet fabrication process using a stamping transfer method. By using this technique, not only the ultrathin micro sensors, but also MCU and amplifier chips required for configuration of the sensor devices can be mounted. We succeeded very fragile 5 mm long, 100 μm wide, 5 μm thick high aspect ratio ultrathin strain sensors to be transferred on flexible printed circuits. Since a large P-E hysteresis loop obtained even after transfer process, it was confirmed that this transfer technique could be transferred to the flexible substrate without damaging the ultrathin sensor.

1. Introduction

Currently, an accident due to the damage and aging infrastructure that was in place in the period of rapid economic growth has been frequently. To go from effectively maintains the infrastructure in the future, likely visualize the state of infrastructure utilizing such as a piezoelectric strain sensor is valid has been reported [1,2]. We have proposed a flexible sensor sheet which is disposed a sensor array capable of easily performing the distribution measurement of the strain leads to damage such as cracks. However, in order to detect micro strain with high sensitivity, it is necessary to use an ultrathin and high aspect ratio strain sensor chip having a thickness of about 5 μm. Therefore, development of a technique for mounting such a fragile ultrathin sensor on a flexible sheet is indispensable.

In this study, using a stamping transfer method, we attempt to mounting of ultrathin and high aspect ratio sensor chips. We prepare 5 mm long, 100 μm wide, 5 μm thick, and 1 mm long, 200 μm wide, 5 μm thick piezoelectric strain sensor chips, and these are mounted by transferring on a flexible printed circuits. Then, by measuring the electrical characteristics of the chip, we consider that the applicability of the strain sensor sheet.

2. Ultrathin Piezoelectric Strain Sensor Fabrication

To a transferable structures on a flexible sheet, we fabricated a ultrathin piezoelectric strain sensors in a state of being slightly supported on the handle layer of the SOI wafer (Fig. 1). First, we prepared a 1.9 μm thick piezoelectric structure sandwiched between the 100 nm thick upper and lower Pt/Ti electrodes using a MEMS process on the 3 μm

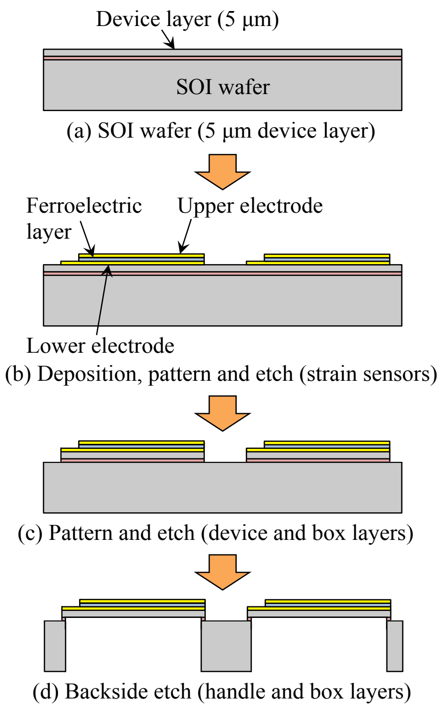

Fig. 1 Fabrication process of ultrathin piezoelectric strain sensors.

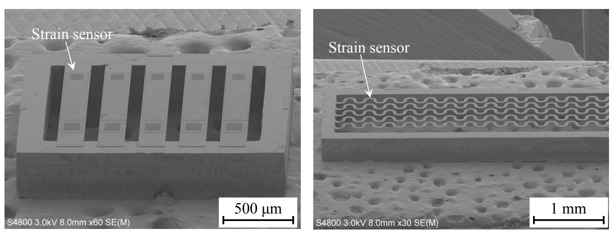

Fig. 2 Processed ultrathin piezoelectric strain sensors.

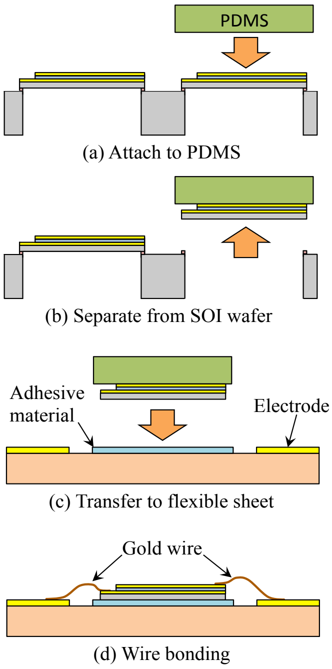

Fig. 3 Transfer process of the ultrathin piezoelectric strain sensor.

thick device layer. Then, we fabricated the device layer deposited on the piezoelectric structure in a state of being slightly supported on the handle layer by etching the device, box, and handle layers. By using such a state, it is possible to separate from the handle layer to adhere to the sensor using an adhesive rubber. Figure 2 shows SEM images of the ultrathin piezoelectric strain sensors.

3. Transfer to Flexible Substrates

We transferred the ultrathin strain sensor to flexible substrate from the SOI wafer, and evaluated the characteristics of the sensor by connecting the electrode using wire bonding. The transfer process is schematically shown in Fig. 3. Figure 4 shows photos of ultrathin piezoelectric strain sensors that are transferred to polydimethylsiloxane (PDMS). Figure 5 shows a photo of ultrathin piezoelectric strain sensor that is transferred from the PDMS on a flexible substrate. Since a large P-V hysteresis loop obtained even after transfer process, it was confirmed that this transfer technique could be transferred to the flexible substrate without damaging the sensor. (Fig. 6).

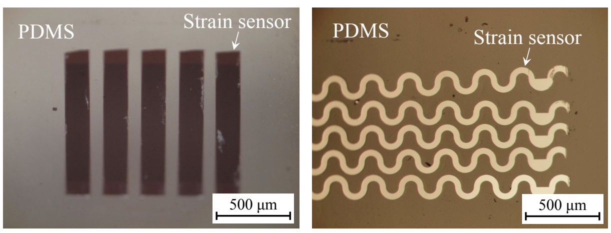

Fig. 4 Transfer of the ultrathin piezoelectric strain sensor to a tiny piece of PDMS.

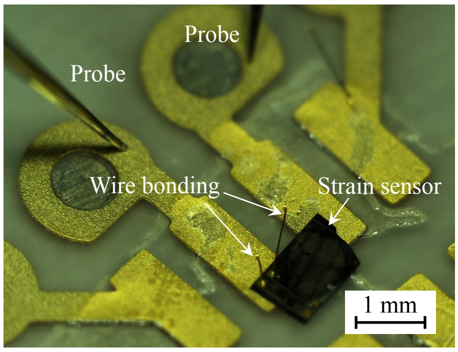

Fig. 5 Transfer of the ultrathin piezoelectric strain sensor to a flexible substrate.

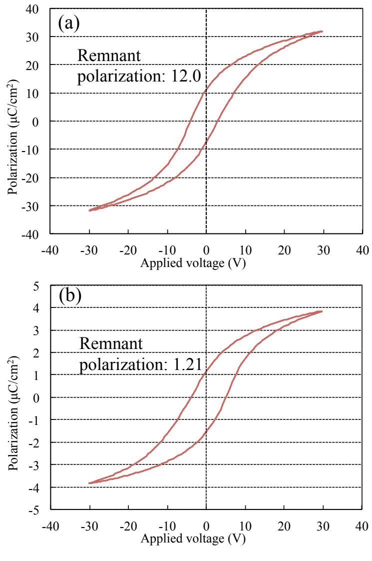

Fig. 6 Ferroelectric P-V hysteresis loops of (a) 1mm long and (b) 5 mm lomg ultrathin piezoelectric strain sensors.

4. Summary

We developed novel transfer methods for ultrathin piezoelectric strain sensors to flexible substrates. We succeeded very fragile 5 mm long, 100 μm wide, 5 μm thick high aspect ratio ultrathin strain sensors to be transferred on flexible substrates. Since large ferroelectric P-V hysteresis loops obtained even after transfer process, it was confirmed that the applicability of these transfer techniques to fabrication process of flexible strain sensor sheets.

Acknowledgements

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References

[1] J. Sirohi and I. Chopra, J. Intell. Mater. Syst. Struct. **11** (2000) 246.

[2] G. Song *et al.*, Smart Mater. Struct. **16** (2009) 959.