18a-E14-7

Fabrication of SiC/Si Hybrid Accelerometer for High Temperature Applications

東北大工 [1], 東北大 AIMR[2]　チャンド ラケ-ス [1], 江刺 正喜 [2], 田中 秀治 [1]

Tohoku Univ.[1]　Rakesh Chand[1], Masayoshi Esashi[2], Shuji Tanaka[1]

E-mail: rakeshchand@mems.mech.tohoku.ac.jp

High temperature sensing has a lot of applications such as plant monitoring, engine control and natural resource excavation. For acceleration/gravity sensing above 400ºC, we are developing a SiC/Si hybid capacitive sensor and its readout circuit illustrated in Fig. 1. In the previous study [1], we have demonstrated that a SiC diode bridge circuit could be used for reading out a differential capacitive sensor at 400~600ºC. In this study, a differential capacitive accelerometer was fabricated using SiC thin films on a Si substrate.

The schematic structure of the SiC/Si hybrid 1-axis accelerometer is shown in Fig. 2. A Si mass is supported by SiC beams, and differential capacitive gaps are formed by double side wafer bonding. In design, it must be noted that even intrinsic Si is electrically conductive at high temperature, and that parasitic capacitance between the wafers should be minimized. SiC is thermally more stable than Si at high temperature, and thus used for the movable supporting beams. Heteroepitaxial, polycrystalline and amorphous SiC can be used on Si, and thermal stability is better in this order. However, amorphous SiC deposited by plasma-enhanced chemical vapor deposition (PECVD) is used in this study, because amorphous SiC still shows fair stability up to 600ºC, and can be easily deposited at relatively low temperature (e.g. 400ºC) with controlled film stress.

5 μm thick amorphous SiC is deposited on both side of a 200 μm thick Si substrate simultaneously using a laboratory-made PECVD tool with polycarbosilane (PCS) as a precursor [2]. The SiC film is patterned by reactive ion etching (RIE) with SF_6 and O_2 using a 750 nm thick Ni mask. Ni is also used as metal electrodes, and patterned by wet etching using diluted nitric acid at 45ºC. The Si mass is released by a combination of deep RIE and following wet etching using TMAH. Figure 3 shows the Si mass supported by the released SiC beams. Double side wafer bonding is based on Au-Au diffusion bonding, which should stand up to 600ºC. Three processed Si substrates are aligned together in two steps, and bonded simultaneously at 300ºC in vacuum. The fabricated device will be tested at high temperature after connected with the SiC diode bridge circuit.

This study was partly supported by Creation of Innovation Centers for Advanced Interdisciplinary Research Areas Program.

References

[1] R. Chand *et al.*, “Silicon Carbide Diode Bridge Circuit for Capacitive Sensor Readout in High Temperature (673K) Environment”, Transducers 2013, pp. 1020-1023.

[2] 鈴木康久 他, “ポリカルボシランを用いた炭化珪素の両面 PECVD”, 第 29 回「センサ・マイクロマシンと応用システム」, 2012, pp. 121-126.

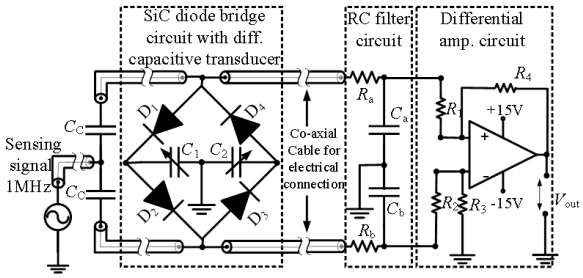

Fig. 1 Concept of high temperature sensor system using SiC/Si hybrid differential capacitive sensor and SiC bridge circuit

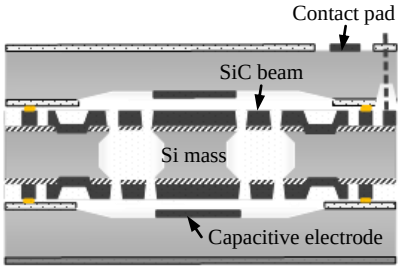

Fig. 2 Schematic structure of SiC/Si hybrid capacitive accelerometer

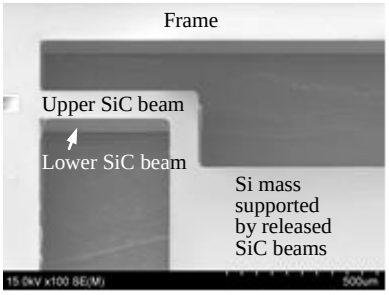

Fig. 3 Si mass supported by released SiC beams