Electronic Supplementary Information

Characterization of the piezoresistance in highly doped p-type 3C-SiC at cryogenic temperatures

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1. Fabrication process and schematic sketch of the pressure sensor

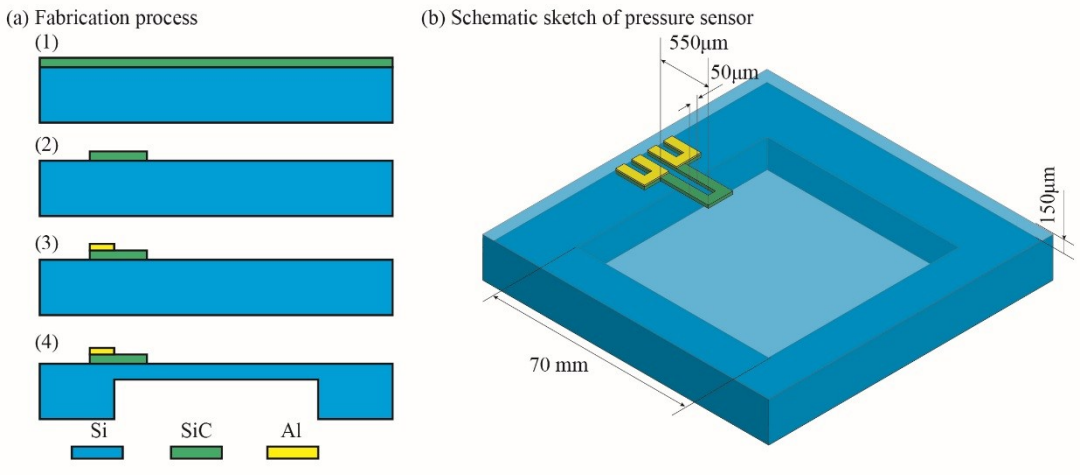

Figure S1. Fabrication process and concept of the pressure sensor

Figure S.1 (a) shows the fabrication process of the pressure sensors, starting from the SiC-on-Si platform. The SiC thin film was etched into U-shape micro resistor structures using ICP-etching with an etching rate of 100 nm/min. Subsequently, aluminum was sputtered and etched to form electrodes for SiC resistors. Finally the Si on the backside was removed using laser engraving with an etching rate of 16 μm/min, leaving a thin Si membrane with thickness of 150 μm. The surface roughness of the Si membrane was found to be approximately ±5%.

Figure S.1 (b) present the concept of the pressure sensors, in which the SiC resistor is located at near the center of one edge of a Si membrane. The thickness of the membrane was 150 μm, which is much thicker than the SiC layer. As a consequence, under an external pressure, the deflection of the Si membrane will induce a strain into the SiC layer.

In our simulation, the direction of the Si layer (along the longitudinal direction of the SiC resistor) was [110]. The Young's modulus of 3C-SiC was assumed to be isotropic (G=350GPa). This assumption does not significantly change the estimated strain since the elongation of the SiC follows the Si layer due to the large difference in the thickness of the two layers (380 nm in SiC and 150 μm in Si) [1][2].

2. The experimental setup to characterize the piezoresistive effect at cryogenic temperatures

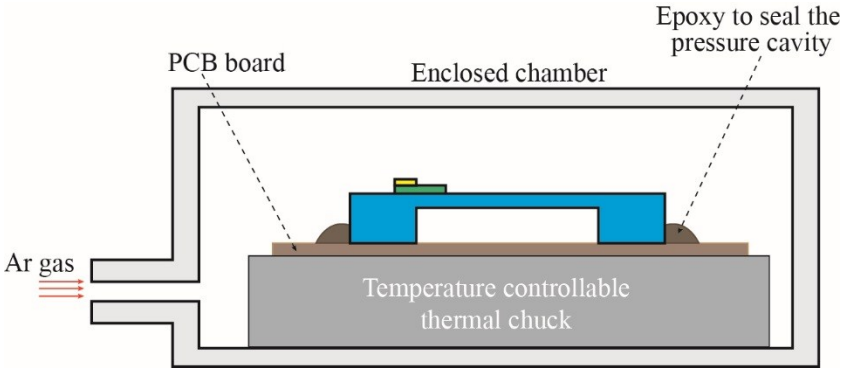

Figure S2. Schematic sketch of the experimental setup

Figure S2 shows the concept of the experimental setup. Epoxy was used to glue the siC-on-Si pressure sensor onto a PCB board, forming an enclosed cavity under the Si membrane.

The PCB board was placed on the surface of a temperature-controllable chuck using grease to enhance thermal conductivity. The temperature on the surface of the chip was monitored using a commercial thermos couple sensor.

The setup was placed inside an enclosed chamber (Linkam^{TM}), and external pressure was applied by pressurizing/de-pressurizing an inert gas (Ar).

Reference:

1. H.-P. Phan, D.V. Dao, P. Tanner, L. Wang, N.-T. Nguyen, Y. Zhu, and S. Dimitrijev, *Appl. Phys. Lett.*, 104(11), 111905 (2014).
2. X. Li, W. Y. Shih, I. A. Aksay, and W. H. Shih, *J. Am. Ceram. Soc.* 82(7), 1733 (1999).