Electronic Supplementary Information

3C-SiC on Glass: an Ideal Platform for Temperature Sensors under Visible Light Illumination

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1. Characteristics of grown 3C-SiC on Si substrate

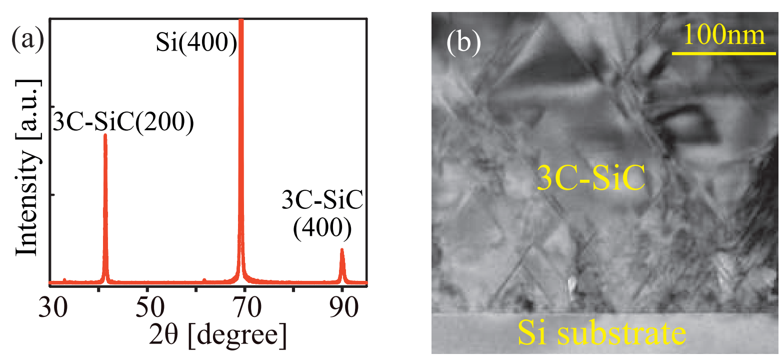

Figure 1: Characteristics of p-3C-SiC grown on Si (100)- (a) XRD graph and (b) TEM image

Fig. 1(a) depicts crystalline SiC film epitaxially grown on Si(100) substrate and TEM image shows good crystalline quality of the grown film (Fig. 1(b)).[1]

2. Formation of I-shaped 3C-SiC resistors on Si

First, Al-doped 3C-SiC film was grown on Si(100) substrate using a Low-Pressure Chemical Vapor Deposition (LPCVD) process,[2,3] Fig. 2(a). Next, the photoresist was coated and then a

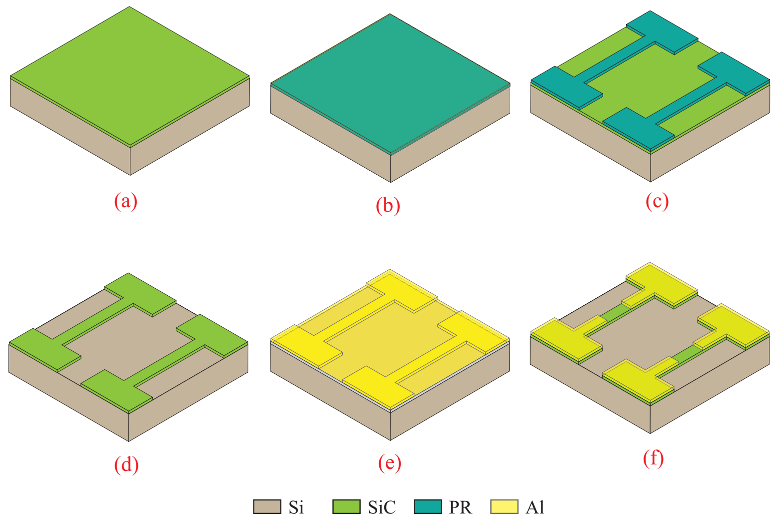

Figure 2: Formation of 3C-SiC resistors on Si substrate (not to scale)

mask was used to pattern the resistors (Fig. 2(b), and (c), respectively). HCl and O_2 gases were employed to remove the SiC (Fig. 2(d)). Then an Al layer was deposited (Fig. 2(e)) and it was then patterned and etched to form electrodes on 3C-SiC resistors, Fig. 2(f).

3. Experimental setup

Fig. 3 shows a schematic diagram of the experimental setup which was used to characterize the thermoresistive effect of the samples. The sample was placed on the hotplate (RT Stiring, Thermo Scientific) and a K-type thermocouple (resolution $\pm$1K) was used to measure the surface temperature of the sample. Two laser sources of 488nm and 635nm (THORLAB S3FC488, S1FC635, respectively) were utilized for light exposure with a laser intensity of 0.01 to 2.0 mW/cm^2. Light intensity on the samples surface was measured by using a photodiode power sensor (THORLAB S120C (resolution: $\pm$1nW)).

4. Effect of temperature and light on low and highly doped Si

Fig. 4 depicts that the resistance of low doped Si decreases with increasing temperature, whereas the opposite phenomenon was observed for highly doped Si. The reason is that for low doped material, the resistance depends mainly on the variation of carrier concentration with temperature change, while the mobility becomes dominant in highly doped material.[4,5]

As observed in Fig. 5, the resistivity of low doped Si decreases with the increase of light

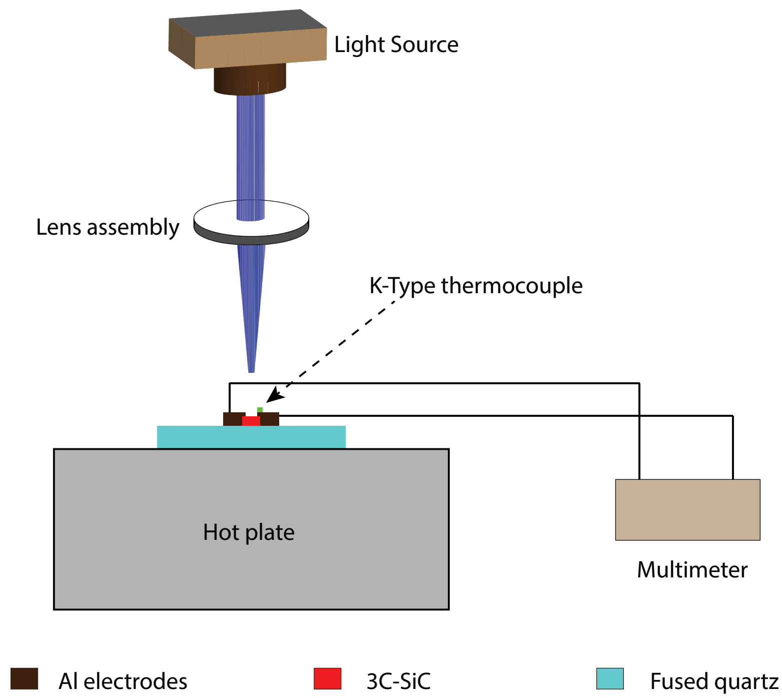

Figure 3: Schematic diagram of the experimental setup (not to scale).

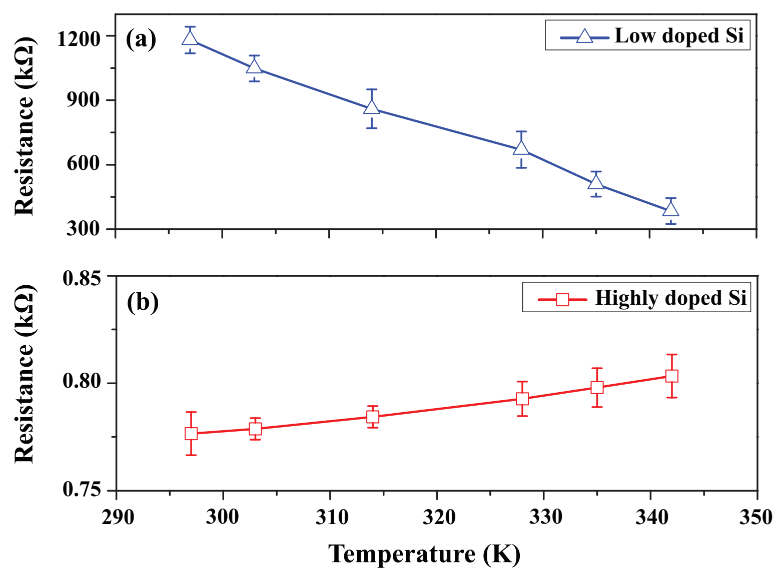

Figure 4: Temperature effect on the electrical resistance of (a) low and (b) highly doped Si.

intensity due to generation of additional charge carriers, however the variation in resistance of highly doped Si remains nearly constant as the impurities are almost fully ionized at room temperature.

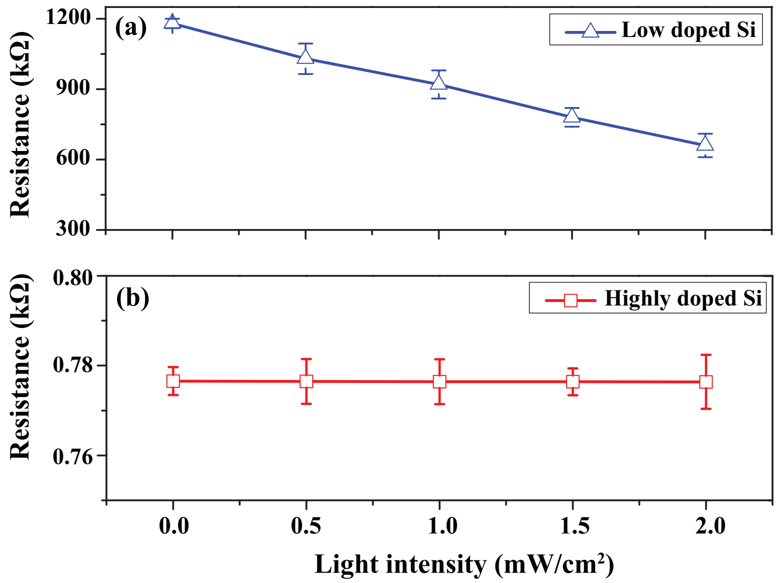

Figure 5: Light dependent electrical resistance of (a) low and (b) highly doped Si.

5. Influence of light on TCR of Si

Fig. 6(a) shows, the measured temperature coefficient of resistance (TCR) of low doped Si varied from -17,379 to -13,491 ppmK^{-1} for the temperature range of 297 to 343K. However, a positive temperature coefficient (PTC) of resistance was found for highly doped Si, Fig. 6(b), with the TCR value varying between 587 and 785 ppmK^{-1}. Fig. 6(a), also indicates that the

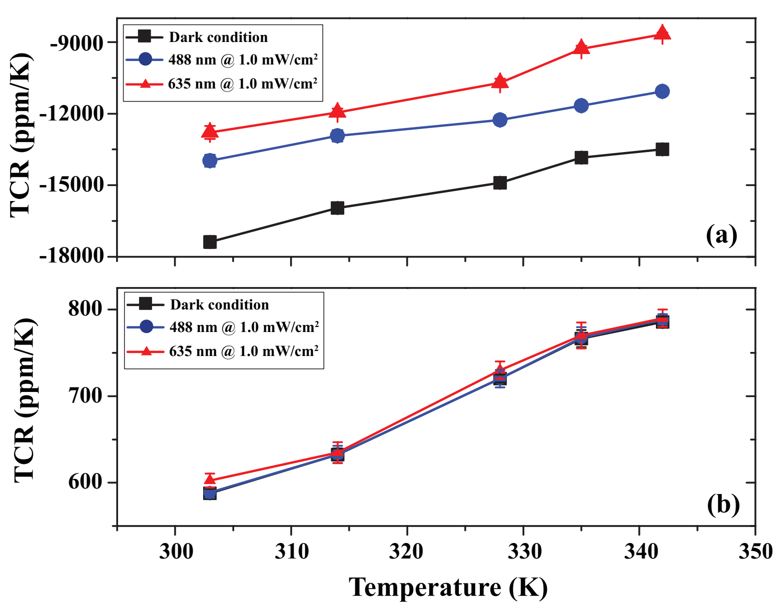

Figure 6: Light dependent electrical resistance of (a) low and (b) highly doped Si.

change in wavelength of incident photon had a significant influence on TCR of low doped Si. As depicted in Fig. 6(a), when an illumination of 488nm @1.0mW/cm^2 was applied, the TCR of low doped Si decreased from -17,379 to -13,975 ppmK^{-1} at 303K due to generation of additional carriers with the incidence of light.

References

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