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Electronic Supplementary Information

Highly Sensitive Piezoresistance Behaviors of *n*-type *3C*-SiC Nanowires

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Characterization of SiC Nanowires:

The as-synt hesized *n*-type 3C-SiC nanowires was characterized by TEM (JEM-2100F, JEOL, Japan). Fig. S1(a) shows a typical TEM image of the nanowires, suggesting their smooth and clean surface with a uniform size in diameter. Fig. S1(b) presents the selected area electron diffraction (SAED) pattern of the SiC nanowires recorded from the marked area of A in Fig. S1(a), which can be indexed to the 3*C*-SiC (JCPDS Card No. 41-0360). The SAED pattern is identical over the entire nanowire, disclosing its high crystallinity and single-crystalline nature. Fig. S1(c) is the corresponding HRTEM image of the n-type SiC nanowire. The lattice fringes with a separated spacing of 0.25 nm correspond to the planes of 3C-SiC. Both the SAED pattern and the HRTEM image suggest that the nanowires grow along [111] direction with a top surface of $(1\bar{1}0)$, which is schematically shown in Fig. S1(d).

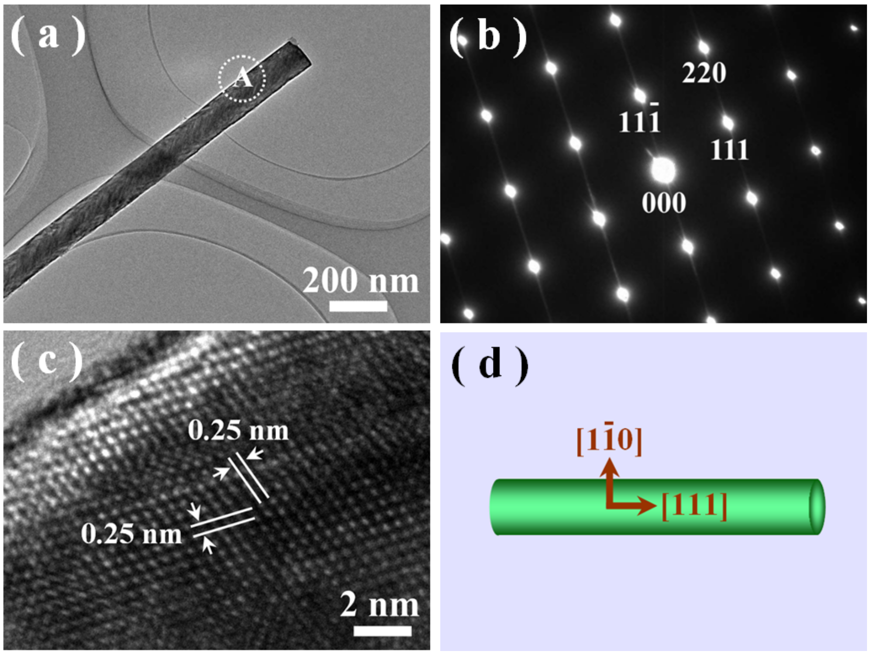

Fig. S1 (a) A typical TEM image of *n*-type 3C-SiC nanowires. (b) SAED pattern of the SiC nanowire recorded from the marked are of A in (a). (c) Corresponding HRTEM image of the SiC nanowire. (d) A schematic illustration for the crystal growth habit of *n*-type 3C-SiC nanowire.

Calculation of the Piezoresistance Coefficient:

When a semiconductor crystal is subjected to strain, the change in resistance is referred to the piezoresistance effect. [1] In semiconductors, particularly in the ones with indirect band gap, mechanical strain affects the electronic band structure, thus modifying the effective electron mass, the mobility, and the resistivity. The change of the resistance induced by the external strain fixed on the $(1\bar{1}0)$ surface of the SiC nanowire can be given by:

$$\pi_{[1\bar{1}0]} = \frac{\Delta R}{R_0 \sigma} \quad \text{.......................... (1)}$$

where ΔR is the resistance change between those with and without an external force; $\pi_{[1\bar{1}0]}$ is the piezoresistance coefficient; R_0 is the resistance under zero force; σ is the stress ($\sigma = F/S$, where F is the force applied over the area of S). The contact area between the spherical AFM tip and nanowire can be approximately considered as an ellipse with a major axis of $2a$ along the nanowire and a minor axis of $2b$ along the transverse direction, which can be present as below: [2]

$$a = \sqrt{2\Delta h \cdot r_{tip}} \quad \text{..........................(2)}$$

$$b = \sqrt{\frac{2\Delta h \cdot r_{tip} r_{nanowire}}{r_{tip} + r_{nanowire}}} \quad \text{.......................... (3)}$$

where r_{tip}=20 nm and $r_{nanowire}$=115 nm are the respective radius of the AFM tip (provided by the manufacturer) and SiC nanowire (Figure 1(b)), and Δh is the deformation of SiC nanowire along the transverse direction. According to the Hertz model [2] used for a cylinder in contact with a spherical tip, Δh can be expressed as:

$$\Delta h = \left(\frac{9F^2}{16Y_{eff}^2 r_{tip}}\right)^{1/3} Q(r_{tip}) \quad \text{..........................(4)}$$

where E_{eff} is the effective Young's modulus, and Q is the geometric factor. Combining *Eq.* (1-4), the piezoresistance coefficient of $\pi_{1\bar{1}0}$ can be given by:

$$\pi_{[1\bar{1}0]} = \frac{2\pi r_{tip} \Delta R \sqrt{r_{nanowire}}}{FR\sqrt{r_{tip} + r_{nanowire}}} \left(\frac{9F^2}{16Y_{eff}^2 r_{tip}}\right)^{1/3} Q(r_{tip}) \quad \text{……………………(5)}$$

With the E_{eff} of SiC nanowires being of ~600 GPa, [3] *Eq.* (5) can be simplified as:

$$\pi_{[1\bar{1}0]} = k\frac{\Delta R}{F^{1/3}R} \quad \text{……………………………(6)}$$

where k is a constant of *ca.* 4.82×10^{-13}. Consequently, the piezoresistance coefficient $\pi_{[1\bar{1}0]}$ of the nanowire can be calculated out, which falls in the range of 0.75 to 7.7×10^{-11} Pa^{-1} under the applied loading forces from 25.59 to 153.56 nN.

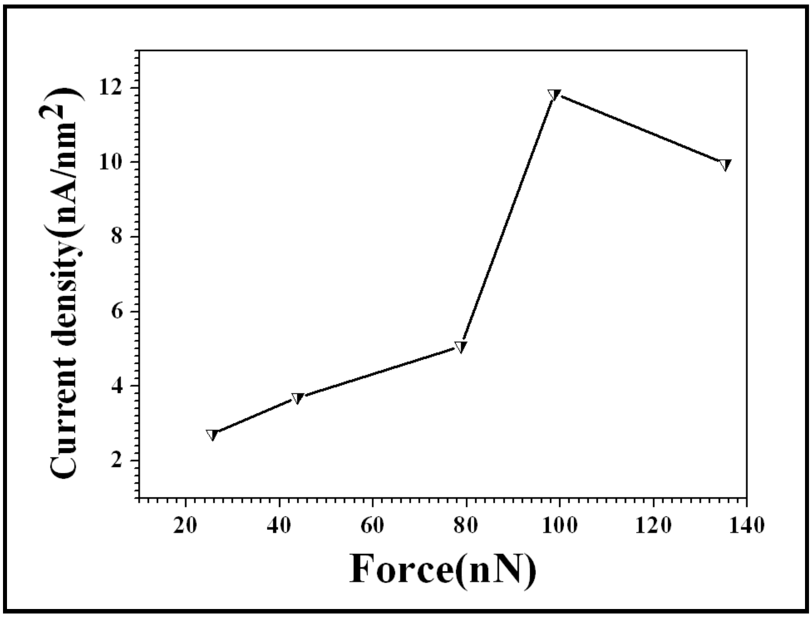

Fig. S2. The relationship between the loaded force and the current density under the voltage of -7 V.

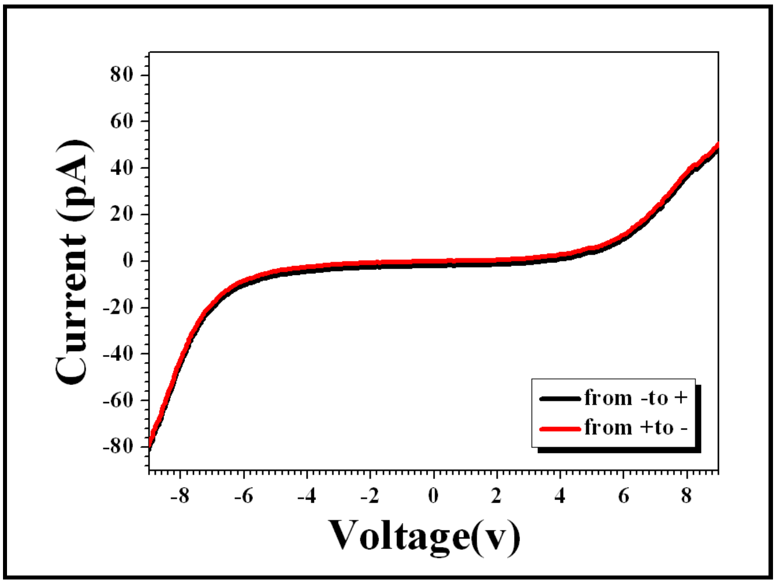

Fig. S3. The *I-V* characteristics of the nanowire with bias voltage sweeping from negative to positive values and in turn under the applied force of 43.87 nN.

References:

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