Electronic Supplementary Information

Piezoresistance Behaviors of *p*-type 6*H*-SiC Nanowires

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Experimental Procedure:

p-type 6*H*-SiC nanowires were synthesized by using catalyst-assisted pyrolysis of polymeric precursors as described in our previous work.[1] The used precursors were obtained by reaction of polyureamethylvinylsilazane (Ceraset, Kion Corporation, USA) and aluminum isopropoxide (AIP, Beijing Bei Hua Fine Chemicals Company, Beijing, China) with a weight ratio of Ceraset:AIP = 98:2. The AIP used here is to introduce the Al atoms for doping SiC naowires. The obtained polyaluminasilazanes, which were liquid as synthesized, were then solidified by heat-treatment at 260ºC for 0.5 hour in N_2. The solids were crushed into fine powders by high-energy ball milling for 24 hours, with 3wt% of $FeCl_2$ powder (analytical purity: 99.99%, Beijing Bei Hua Fine Chemicals Company, Beijing, China) additive as the catalyst. The powder mixtures were pyrolyzed in a conventional furnace with a graphite resistance under flowing ultra-high purity Ar (99.99%) of 0.1 MPa. The pyrolysis was carried out at 1450ºC for 2 hours followed by furnace-cool to ambient temperature.

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The obtained products were characterized by using field emission scanning electron microscopy (FESEM, S-4800, Hitachi, Japan), and transmission electron microscopy (TEM, JEM-2010, JEOL, Japan). The optical absorption of the nanowires was measured using a UV-3101 double channel spectrometer operated at room temperature (RT). Electronmechanical measurements were performed using a conductive atomic force microscopy (C-AFM, Nanoscope V, Veeco, USA) with Pt/Ir-coated tips (force constant: 0.2 N/m) at RT.

Calculation of the Piezoresistance Coefficient:

When a uniaxial stress is applied on the SiC nanowire with a top surface of (010), the changes in the resistance of the wire can be given as:

$$\frac{\Delta R}{R} = (1 + 2\nu + \pi_{[010]} Y)\frac{F}{SY} \qquad (1)$$

where R is the resistance under zero stress, ν is the Poisson ratio, $\pi_{[010]}$ is the piezoresistance coefficient along the transverse direction for SiC nanowire lying on the graphite substrate, Y is the Young's modulus of SiC nanowire, F is the loading force applied by the AFM tip, and S is the contact area between the spherical AFM tip and the nanowire. For semiconductor, the resistance changes resulted from dimensional deformation (*i.e.* $1+2v$ item in Eq. (1)) can be ignored. Thus, the Eq. (1) can be simplified as bellow:

$$\pi_{[010]} = \frac{S\Delta R}{RF} \qquad (2)$$

Due to the contact area between the spherical AFM tip and nanowire is approximately an ellipse with the major axis $2a$ along the nanowire and its minor axis $2b$ along the transverse direction, the a and b can be presented as below:[2]

$$a = \sqrt{2\Delta h \cdot r_{tip}} \qquad (3)$$

$$b = \sqrt{\frac{2\Delta h \cdot r_{tip} r_{nanowire}}{r_{tip} + r_{nanowire}}} \qquad (4)$$

where r_{tip}=20 nm and r_{nanowire}=170 nm are the respective radius of the AFM tip and SiC nanowire, and Δh is the deformation of SiC nanowire along the transverse direction. By using the results of the Hertz model[2] for a cylinder in contact with a spherical tip, the deformation Δh for SiC nanowire along the transverse direction can be expressed as:

$$\Delta h = (\frac{9F^2}{16Y_{eff}^2 r_{tip}})^{1/3} Q(r_{tip}) \qquad (5)$$

where E_{eff} is the effective Young modulus, and Q is the geometric factor. Combining Eq. (1-5), the piezoresistance coefficient $\pi_{[010]}$ can be given as:

$$\pi_{[010]} = \frac{2\pi r_{tip} \Delta R \sqrt{r_{nanowire}}}{FR\sqrt{r_{tip} + r_{nanowire}}} (\frac{9F^2}{16Y_{eff}^2 r_{tip}})^{1/3} Q(r_{tip}) \qquad (6)$$

Where the E_{eff} of SiC nanowires is ~50 GPa.[3] Put the value of the constants into Eq. (6), we obtain the final result:

$$\pi_{[010]} = k\frac{\Delta R}{F^{1/3} R} \qquad (7)$$

where k is a constant of *ca.* 7.94×10^{-9}. Consequently, the piezoresistance coefficient $\pi_{[010]}$ of the nanowire can be calculated out, which falls in the range of 51.2 to 159.5×10^{-11} Pa^{-1}.

References:

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3. Z. Wang, Z. Dai, R. P. Gao, Z. Bai and J. L. Gole, *Appl. Phys. Lett.,* 2000, *77*, 3349.