Supporting Information

Adjustable electrical characteristic in hybrid Si/PEDOT:PSS core/shell nanowire hetero-junctions

Wenhui Lu,*[a] Shuai Zhang,[a] Enqi Dai,[a] Bin Miao,[b] Yiran Peng,[c] Tao Pang,[a] Tiansheng Zhang,[a] Lei Yan,[c] Shuxin Zhang,[c] Jiadong Li,*[bd] Xingzhu Wang*[c]

[a] *Department of Applied Physics, College of Science, Huzhou University, Huzhou, Zhejiang 313000, P. R. China * E-mail: whlv2016@189.cn*

[b] *i-LAB, Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences, Suzhou, 215125, P. R. China. * E-mail: jdli2009@sinano.ac.cn*

[c] *Key Laboratory of Polymeric Materials & Application Technology of Hunan Province, College of Chemistry, Xiangtan University, Xiangtan, Hunan 411105, P. R. China * E-mail: xzwang@xtu.edu.cn* State Key Laboratory of Applied Optics,

[d] Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences, 130033 Changchun, P. R. China

* E-mail: xzwang@xtu.edu.cn

Supplementary Note 1. Preparation of the hybrid Si/PEDOT:PSS core/shell nanowire arrays.

Single-side polished p-type Si (100) wafer (0.5 Ω cm) and N-type Si (100) wafer (2 Ω cm) were used to prepare Si nanowire arrays. The starting Si wafers were cut with 2.5 x 2.0 cm^2 area, and then were firstly cleaned with standard RCA procedure. The cleaning Si wafers were immediately placed into an aqueous solution containing 5.0 M HF and 0.2 M $AgNO_3$ for 40 s to electroless the Ag nanoparticles. Subsequently, the uniform Ag nanoparticles layer covered Si wafers immersed in composed of 4.6 M HF and 0.8 M H_2O_2 aqueous solution for 5 min to form array structured Si nanowires. They were followed by washes with diluted HNO_3 at a volume ratio of 1:1, and then 5% HFaq. to remove Ag nanoparticles and silicon dioxide layer.

The hybrid Si/PEDOT:PSS nanowire hetero-junctions having the core/shell array

structure were prepared by employing a PEDOT:PSS solution filling and drying method. The PEDOT:PSS solutions were purchased from Aldrich Co. (No. 768642). A drop of one third volume ratio of ethanol is added to commercial PEDOT:PSS water solution and applied to the Si nanowire arrays. The solution can be used to achieve good wettability, and to fill into the Si nanowire arrays. Then, the sample was dried at 120 ℃ for 10 min. to form the hybrid core/shell nanowire hetero-junctions.

Supplementary Note 2. The electric potential distribution in hybrid n-type Si/PEDOT:PSS hetero-junction.

Given that Si nanowire was an infinitely long cylinder with charge density ρ, dielectric constant $\varepsilon_o\varepsilon_r$ and radius r_o. Because of the cylinder symmetry, the electric field in Si nanowire was to be dependent on the radius r. A cylinder with radius r and length L was chosen to define the Gauss's surface. By applying Gauss's law, the electric field was as described by the following equation:

$$2\pi rLE = \frac{\rho\pi r^2 L}{\varepsilon_0\varepsilon_r} \qquad \text{(S1)}$$

if the Si nanowire in hybrid n-type Si/PEDOT:PSS hetero-junction was just at full depletion, the ρ equals approximately to qN_D, where N_D was doping concentration of Si and q is the elementary charge. Then the electric field in the Si nanowire cylinder equals:

$$E = \frac{qN_D}{2\varepsilon_0\varepsilon_r} r \qquad \text{(S2)}$$

Consider the electric potential was zero at the centre of Si nanowire cylinder. The electric potential in the Si nanowire cylinder equals:

$$V = -\int_0^r E dr = -\frac{qN_D}{4\varepsilon_0\varepsilon_r} r^2 \qquad \text{(S3)}$$