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Supporting Information

Geometry-Induced High Performance Ultraviolet Photodetectors in Kinked SnO_2 nanowires

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Experimental Section

Synthesis and characterization of SnO_2 nanowires: The SnO_2 nanowires were synthesized in LPCVD system with quartz tube of 30 mm outer diameter. In detail, a mixture of commercial SnO_2 and graphite powders (2:1, weight ratio) was loaded into an alumina boat located in the center of quartz tube and heating zone and single crystalline Si wafer deposited with a thin layer of Au nanoparticles was located at downstream as substrate for deposition. To expel the air sealed in system, high purity argon gas with flow rate of 600 sccm was introduced into system for at least 20 minutes. Then, the flow rate of Ar was turn to 100 sccm and pressure of the system was read as 210 Pa. After that, the mixture in tube was heated to 950 ^{o}C in 30 minutes and then the temperature was maintained during the following 60 minutes. After the reaction, the furnace was powered off and the whole system was cooled down to room temperature naturally. The fabricated SnO_2 samples were characterized with a scanning electron microscope (SEM, Hitachi S4800), an X-ray diffractometer (XRD, RINT 2200), and a transmission electron microscope (TEM, JEM-2010F) equipped with an X-ray EDS.

Device fabrication and photoconductive measurements: As-grown SnO_2 nanowires were dispersed in ethanol and then deposited randomly on SiO_2/Si substrates. After that, a standard E-beam lithography procedure was adopted to pattern and deposit Cr (10 nm)/Au (50 nm) electrodes on nanowires. The electronic characteristics of SnO_2 nanowire were collected with the aid of an Advantest Picoammeter R8340 and a DC voltage source R6144. To further evaluate the response rate of kinked nanowire photodetector, oscilloscope (Keysight DSO-X

3052A) and chopper were applied. The spectral response of SnO_2 nanowire under different incident light wavelengths was recorded using a xenon lamp (500 W). The light intensity was adjusted with an aperture and calibrated by using a UV-enhanced Si photodiode. The time responses of photodetectors to light illumination were traced by a current meter after shut off the light.

Electrical field simulation: The simulation of the electric field in the KNW SnO_2 device was performed by the software of COMSOL Multiphysics (electric static module) by using the finite element method. The simulated geometries are totally the same as those on the kinked part in resented in Fig.2 (b). Namely, the electrode distance is 2 μm , the size of the KNW is 50 nm, and the angle is 123° . In order to simplify the simulation, the KNW is considered as a conductor. One electrode is biased at 3 V, the other is grounded. The simulation boundaries are obtained from the experiments, such as the KNW is surrounded by air. The simulation is thus simplified by solving the Poisson Equation.

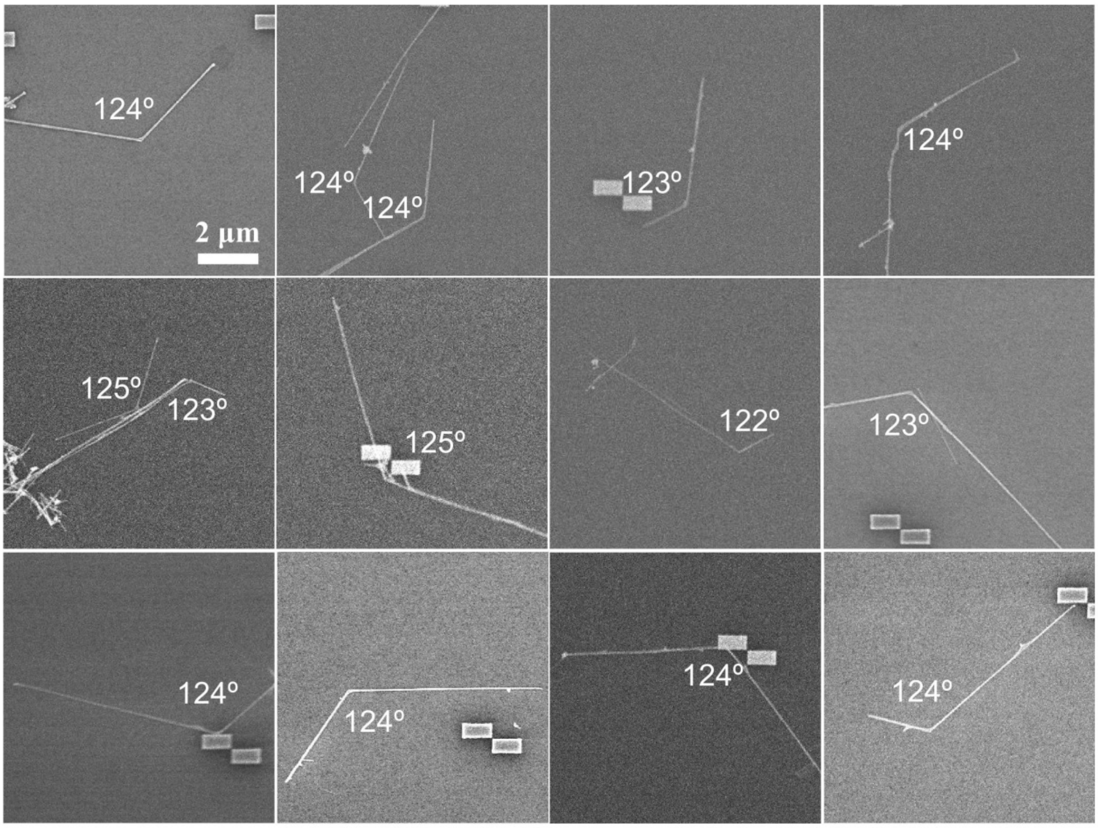

Figure S1. SEM images for kinked SnO_2 nanowires.

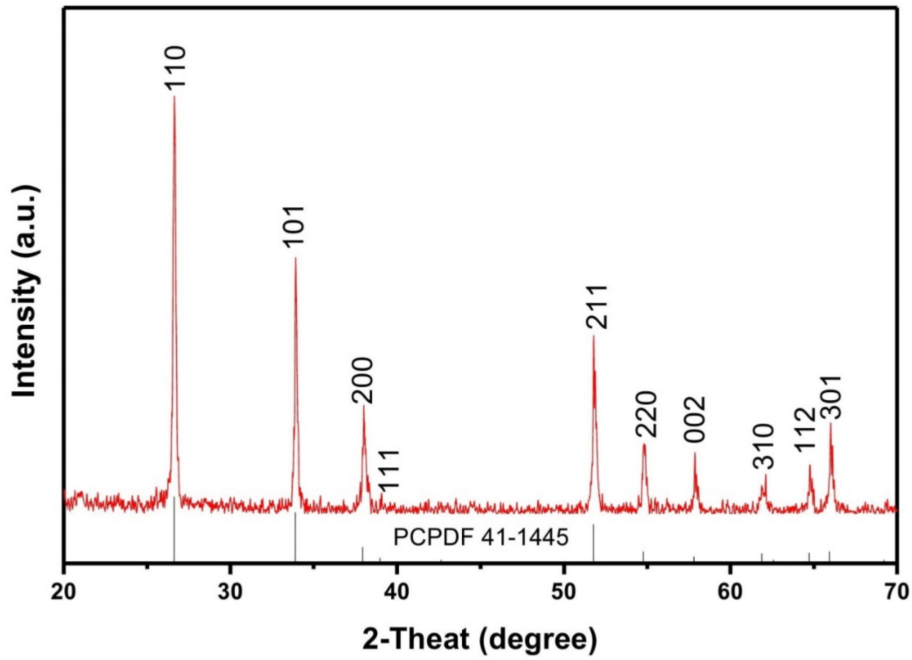

Figure S2. XRD spectrum for as-grown SnO_2 nanowires mixture film, including straight and kinked nanowires.

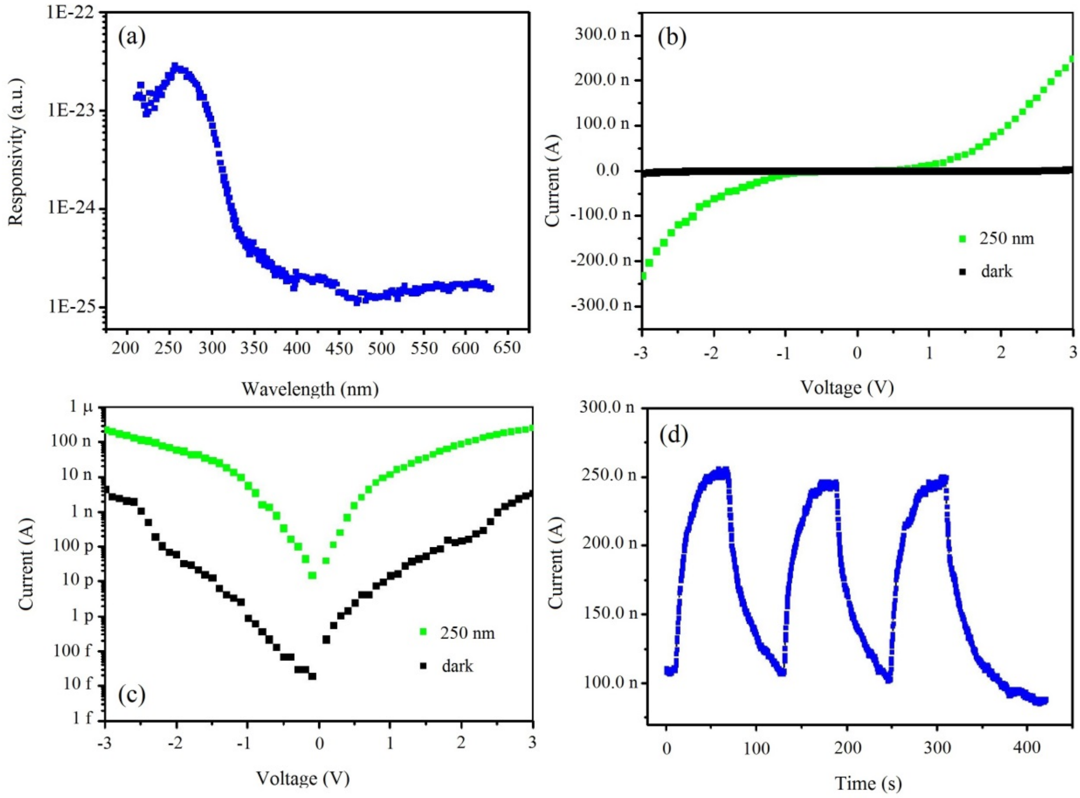

Figure S3. a) Spectral photoresponse measured on the straight nanowire device (Source-Drain2) at a bias of 3 V. b) The comparison of photocurrent on the straight nanowire device under 250-nm-wavelength incident light illumination and dark device. c) Plot the data in (b) with logarithmic format. d) On/off switching test upon 250 nm incident light illumination at a bias of 3 V for the straight nanowire device.

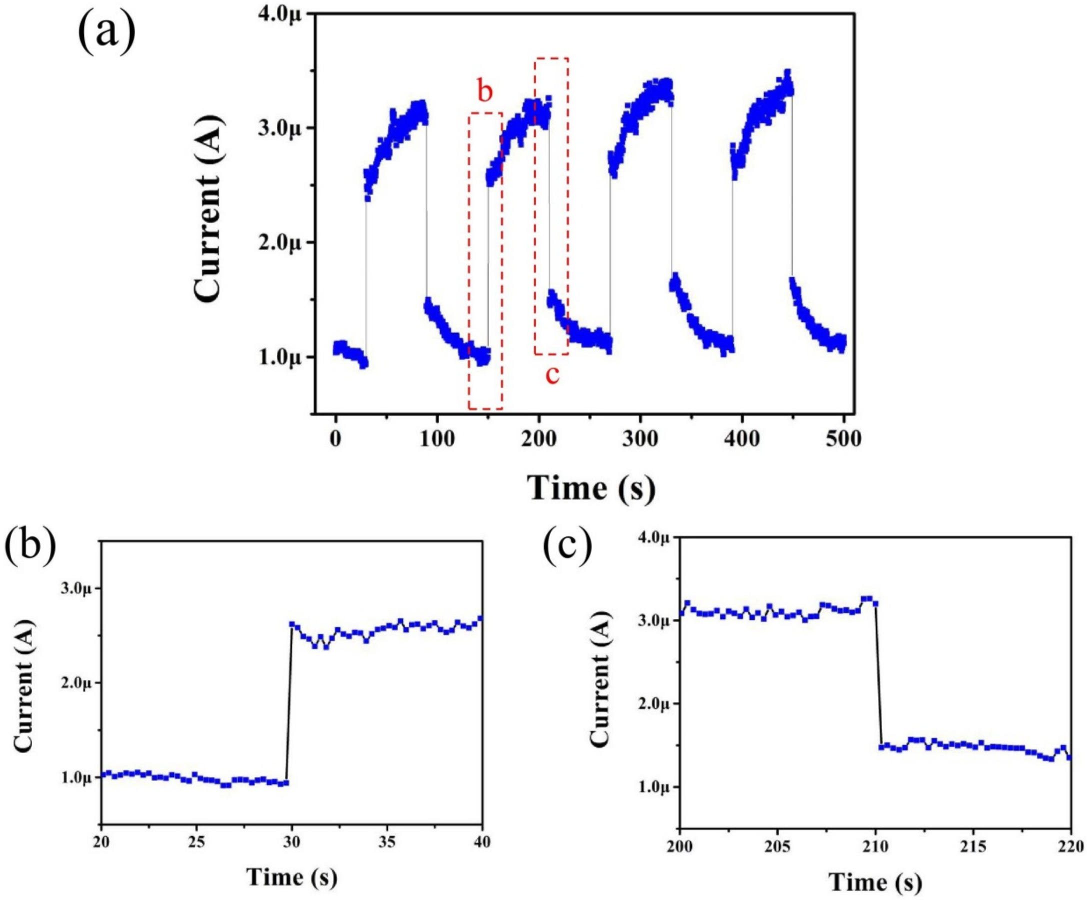

Figure S4. a) Time-dependent photoresponse measurement for the KNW device. b, c) Fast photoresponse speed for light on and off, respectively.

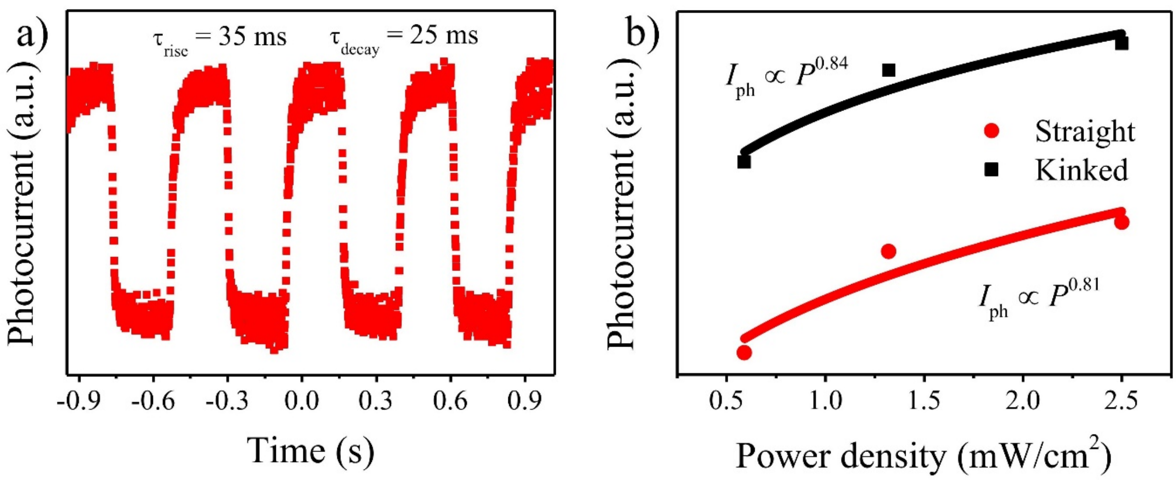

Figure S5. a) A much faster photoresponse measurement has been recorded by oscilloscope; b) Comparison of kinked and straight photodetector, photocurrent vs. power densities. The fitting of both kinds of nanowire were well matched with power law, suggesting that the dependence of photocurrent on power density didn't alter by kinked structure.

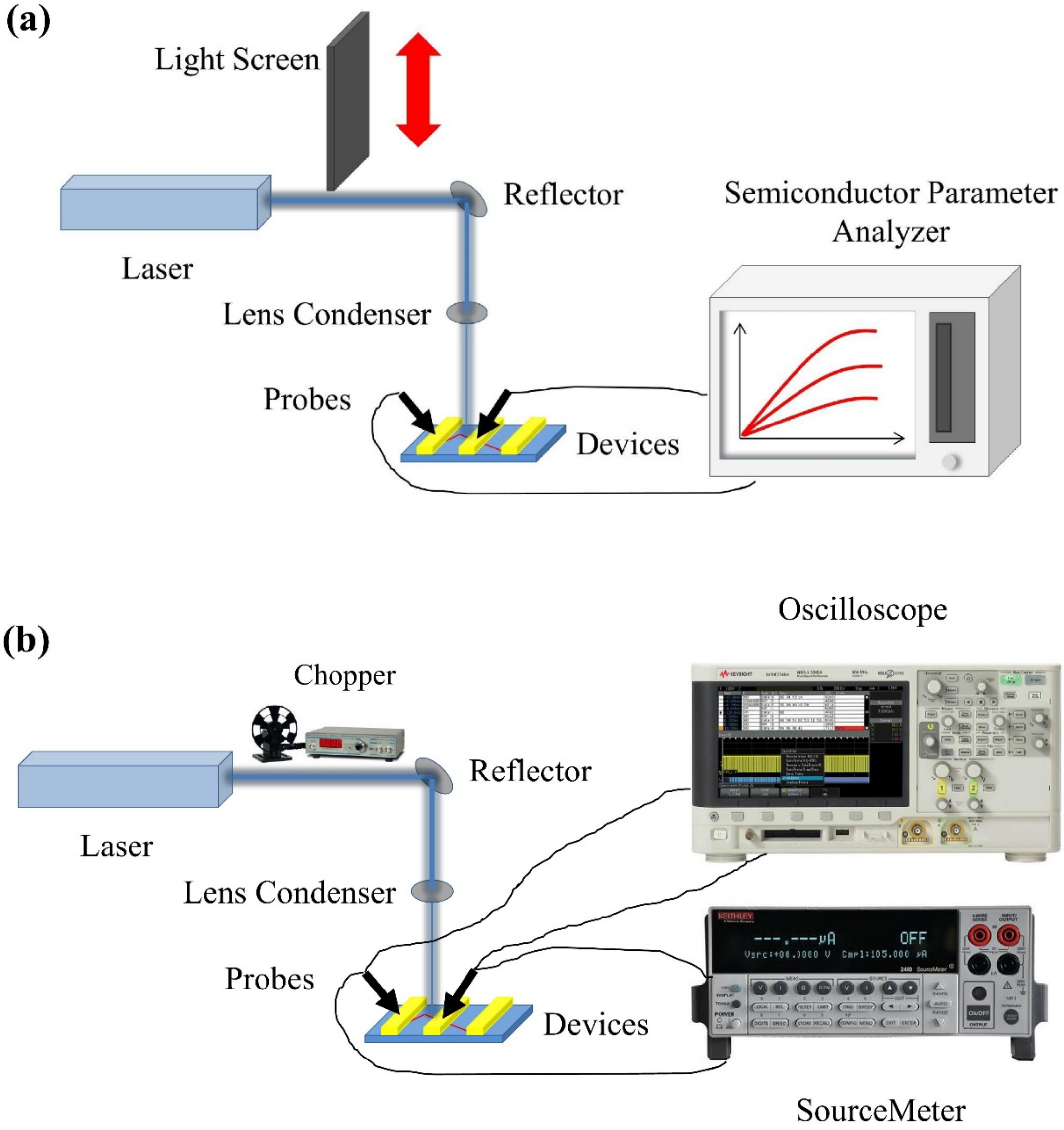

Figure S6. The diagram for demonstration of photoresponse measurement. a) A light screen was utilized to block the laser manually and the final data was processed in a semiconductor parameter analyzer. b) To achieve faster photoresponse measurement, an oscilloscope was adopted.

Calculation of photoresponsivity and EQE

The photoresponsivity of kinked SnO_2 nanowire was calculated with below formula:

$$R\left[\frac{A}{W}\right] = \frac{\Delta I}{PS}$$

The EQE of kinked SnO_2 nanowire was calculated with below formula:

$$EQE = \frac{hc\Delta I}{e\lambda PS}$$

Where, ΔI is the current difference between kinked nanowire under illumination and dark, P is the light power density illuminated on nanowire and S is the illuminated area of nanowire, which has S= $L \times d$, L and d are the length and diameter of nanowire, respectively. λ is the exciting wavelength, h is Planck's constant, c is the velocity of the light, and e is the electronic charge.

In here, the diameter and length of nanowire under illumination are about 50 nm and 2.5 µm, respectively. The wavelength of light is 250 nm and the power density of light illuminated on nanowire is about 0.983×10^{-4}A/W.

Therefore, the photoresponsivity is:

$$R\left[\frac{A}{W}\right] = \frac{\Delta I}{PS} = \frac{1.455 \times 10^{-6} A}{0.983 \times 10^{-4} \frac{W}{cm^2} \times 50 \times 10^{-7} cm \times 2.5 \times 10^{-4} cm} = 1.2 \times$$

A/W

And the EQE is:

$$EQE = \frac{hc\Delta I}{e\lambda PS} = \frac{6.63 \times 10^{-34} js \times 3 \times 10^{8} m}{1.602 \times 10^{-19} C \times 250 \times 10^{-9} m} \times 1.2 \times \frac{10^{7} A}{W} = 6.0 \times 10^{9}$$

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