SUPPORTING INFORMATION

A Supersensitive, Ultrafast, and Broadband Light-Harvesting Scheme Employing Carbon Nanotube/TiO₂ Core-Shell Nanowire Geometry

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The MWNT-TiO₂ core-shell structures are grown using an ALD method. The as-grown MWNT array is preheated in the ALD reactor chamber at 150 °C. A TiCl₄/H₂O flow is then introduced into the chamber and the flow rate is controlled at 0.25 Å/cycles. After performing the ALD treatment for 200 cycles, uniformly coated TiO₂ layer can be formed on MWNTs, as shown in Figure SI-c and SI-d.

Figure SI. SEM images of the MWNTs and the core-shell nanostructures: (a) Cross-sectional and (b) top-view images of the pristine MWNT; (c) cross-sectional and (d) top-view images of the core-shell nanostructures.

The fabrication process of the CNT-TiO₂ core-shell NW PD is as following. The CNT-TiO₂ NWs were dispersed in isopropyl alcohol by sonication and then transferred onto a substrate with prepatterned

electrodes, as shown in Figure SII-a. Contacting both sides of a single NW with Ti/Au (30 nm/70 nm) electrodes, the core-shell PD devices were made, as shown in Figure SII-b. However, from the SEM image, it is difficult to distinguish whether the electrodes connect to the TiO_2 or CNT due to the SEM limitation. Alternatively, the contacts can be confirmed by the IV characteristics. Generally, when both electrodes contact to the shell TiO_2 , the devices exhibit a low current level, as shown in Figure 2b in the main article. Control experiments show that if both electrodes contact to the metallic MWNT without TiO_2 , the device should exhibit a relatively high current level in quasi linear IV curves, shown in Figure 2a in the main article. In addition, the photoresponse also provides the evidence to confirm the structures and the contacts. The detail discussion can be found in the main article.

Figure SII. The process of NW PD fabrication. (a) Recording the position of the NW. (b) After the electron-beam-lithography process and the deposition of the electrodes.

Based on $G = (\Delta I_{\text{ph}}/q)/(P/h\nu)$, the photoconductive gain can be calculated, where ΔI_{ph} is the difference between measured photocurrent and dark current, q is the electron charge, P is the power of incident light absorbed by the device, and $h\nu$ is the photon energy. The light absorption area of the device is estimated according to the SEM and TEM image of the device (Figure 1a and 1c), where the length and width of the nanostructure is 3.2 μm and 65 nm, respectively. Since the incident power is dependent of the incident wavelength (Figure SIII), the power should be normalized as computing the photoconductive gain. Our measurement system employs the Keithley 4200-SCS semiconductor characterization system to measure photocurrent and the EQE-R3011 (Enli Technology Co., Ltd.) spectral response system to modulate wavelengths using the halogen lamp. Before the measurement, the power of the light source as a function of wavelengths was calibrated (Figure SIII) and used to calculate the responsivity and the gain. As a result, the photogain can be quantitatively deduced.

Figure SIII. The power density of the halogen lamp as a function of wavelength.