Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Figure S1. *S, D*, R* of TiO_2 NRAs/SiO_2/Si and H:TiO_2 NRAs/SiO_2/Si under 950 nm light at -7 V

	R (A/W)	*S* ($\times10^4 cm^2W^{-1}$)	*D**($\times10^{11} cmHz^{1/2}W^{-1}$)
Fabricated	6.92	3.42	8.5
350°C	11.4	87	55.6
500°C	7.52	2.75	4.4

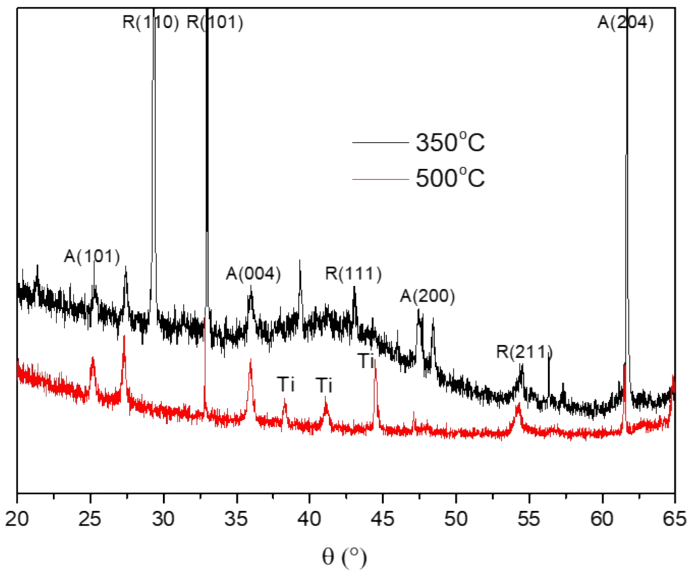

Figure S2. XRD spectra of H:TiO_2 nanorods annealed in hydrogen at various temperatures (350 and 500 °C).

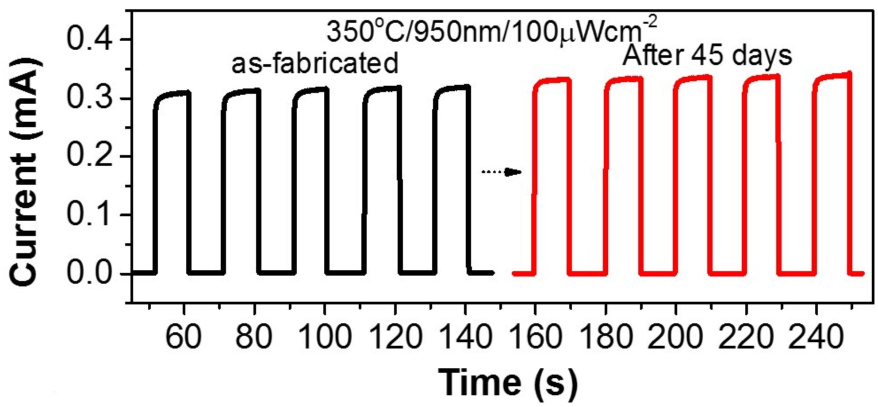

Figure S3. Stability and reproducibility of fabricated H:TiO_2 NRAs/SiO_2/Si after storing in ambient condition for 45 days.

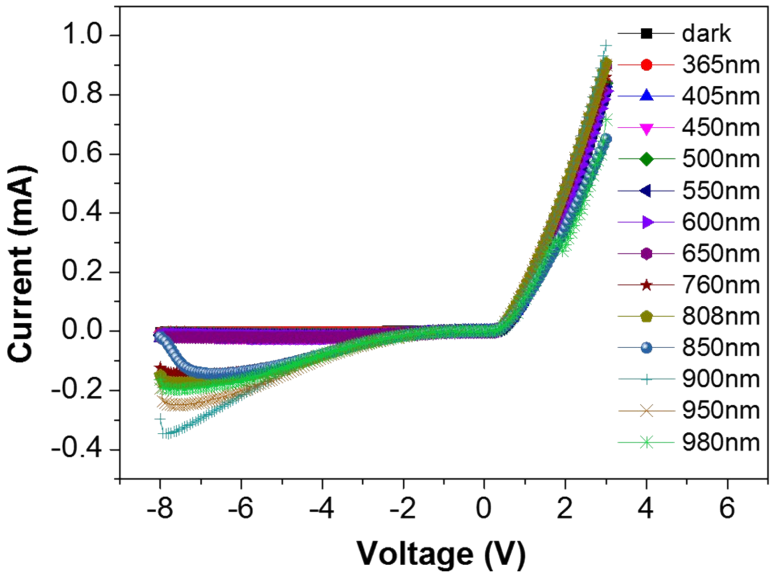

Figure S4. *I-V* curves of the $H:TiO_2$ NRAs/SiO_2/Si heterojunction photodetector ranging from the UV to NIR light at 100 μWcm^{-2}.

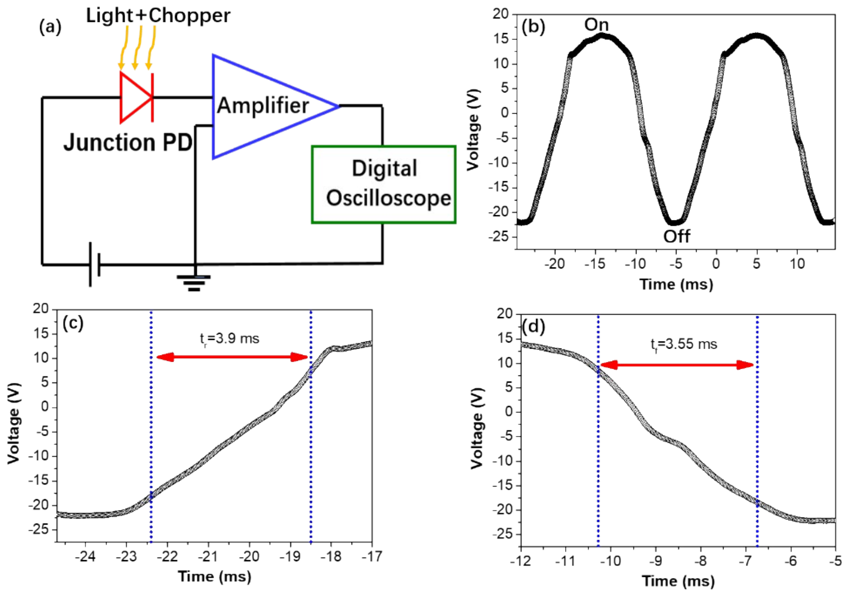

Figure S5. (a) Schematic diagram of measurement circuit of transient response of $H:TiO_2$ NRAs/SiO_2/Si photodetector. (b) Transient response of the $H:TiO_2$ NRAs/SiO_2/Si photodetector measured under the frequency of 50 Hz under 900 nm light. (c and d) Characteristic response times at (c) rise edge and (d) fall edge.

As shown in Fig. S5, in order to investigate the response and recovery times of $H:TiO_2$ NRAs/SiO_2/Si heterojunctions accurately, the schematic diagram of measurement circuit of transient response of $H:TiO_2$ NRAs/SiO_2/Si photodetector is show in Fig. S5a. The amplifier is used to converted the current signal into a voltage signal. The digital oscilloscope is used to collect the voltage signal of the amplifier and output the voltage dependent time curves. As shown in Fig. 5b, the voltage value is related to the operating voltage of the amplifier. Finally, under closer examination, the response and recovery times of the present detector are 3.9 ms and about 3.55 ms respectively, as shown in Fig. 5 c and d.

The effect of an insulating SiO_2 layer on the photoresponse of heterojunction

An insulating SiO_2 layer between the SnO_2 and Si plays an important role in the photoresponse.[1,2] At present, it has been reported that adding the SiO_2 passivation layers can reduce the leakage current and make ZnO/*p*-Si heterojunction exhibit the enhanced on-off ratio.[3] It has been also demonstrated that the carrier multiplication process in the insulating oxide layer can improve the response of PDs. Moreover, it has been mentioned that in this work the thickness of natural SiO_2 layer on Si surface is only about 1.2 nm[4], which is accord with the optimized SiO_2 thickness (several nanometers) according to reported results.[5] The electric field in the SiO_2 layer is estimated to be 8.3×10^6 V/cm at 1 V bias using $E=V/d$, where E is the electric field, V is the bias voltage, and d is the thickness of the SiO_2 layers. Under the high intensity of the electric field the photo-generated carriers can tunnel through the SiO_2 layer. Meanwhile, it also is demonstrated that the thicker the SiO_2 layer is, the bigger the bias voltage is.[3] Therefore, the SiO_2 layer plays an important role in the photo-response and the operating bias voltage of SnO_2 nanoparticles thin film/SiO_2/*p*-Si heterojunction. The optimized SiO_2 thickness is several nanometers according to reported results.[5] If the SiO_2 layer is too thick, it can decrease the effectiveness of the carrier tunneling due to the scattering and trapping of the carriers in the SiO_2 layer, at the same time offers a high potential barrier preventing the carriers from the diffusion and shift tunneling the junction interface.[6] Thus, the photo-response of SnO_2/SiO_2/*p*-Si heterojunction would be degraded. At this moment, only a higher light power intensity and a greater bias voltage can remedy the negative impact produced by thicker SiO_2 layer. For example, in ZnO nanorods arrays/SiO_2/*p*-Si (lateral structure) the SiO_2 layer with about 50 nm make the operating bias voltage of detector be ~15 V.[3]

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