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Supporting Information

Tunable UV Response and High Performance of Zinc Stannate Nanoparticle Film Photodetectors

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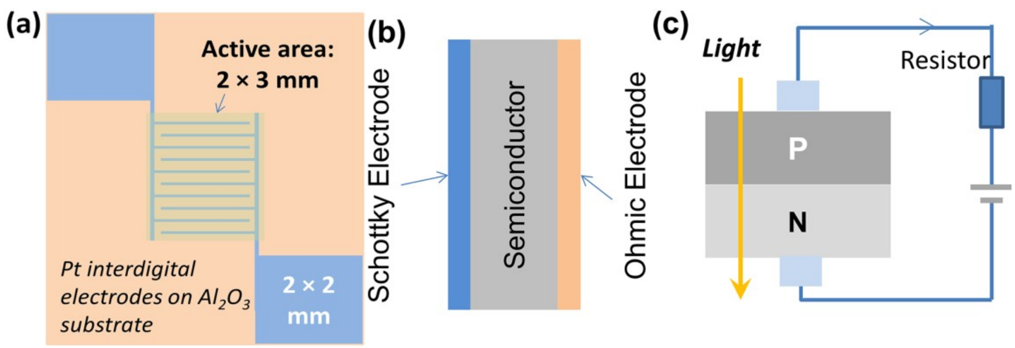

Figure S1. Schematics of various photodetector/photodiode structures. (a) our MSM zinc stannate nanoparticle film photodetector fabricated readily by drop-casting suspension on alumina substrates printed with Pt interdigitated electrodes; (b) a typical semiconductor-metal Schottky photodiode; (c) a *p-n* junction photodiode. Dimensions of our zinc stannate photodetectors illustrated in (a): 5 pairs of interdigital metal electrodes formed with 1.9 mm length, 0.05 mm width, 0.2 mm gap by Pt layer (150±50 nm in thickness), with an active area of 2 × 3 mm^2.

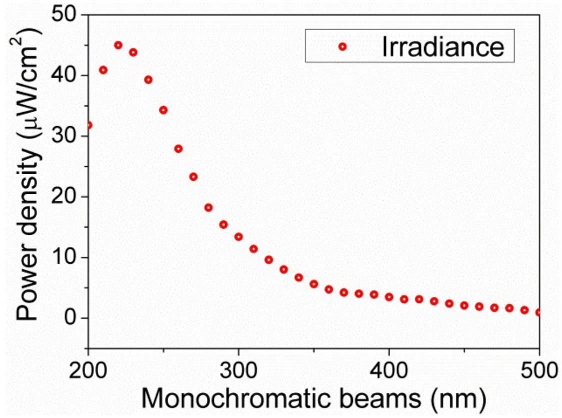

Figure S2. Irradiance of each monochromatic light for the spectroscopic response test. The monochromatic lights was generated by a complex setup consisting of a 30-W Apex Deuterium lamp (Newport Optics, Model: 70635), a mechanic chopper, a Newport optics monochromator (Model: MS257) with order sorting filters and apertures. It shows the power density measured via standard Si detectors.

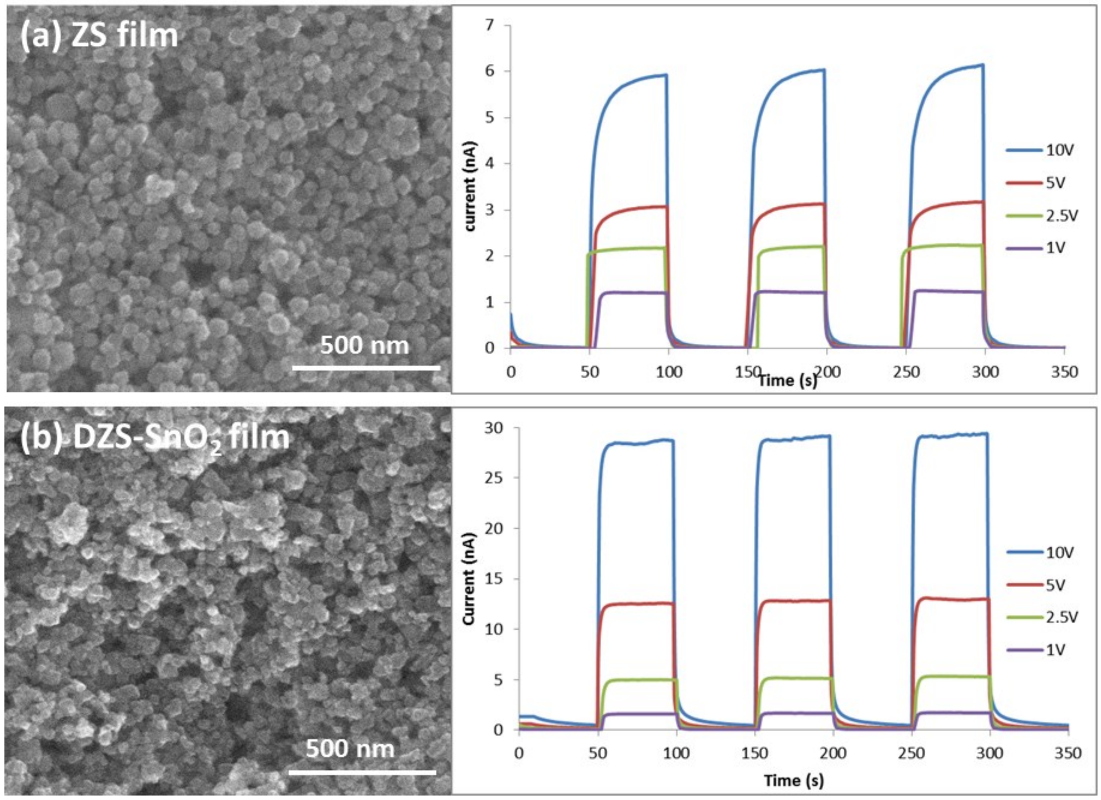

Figure S3. After a 2-year shelf ambient exposure, both a) ZS and b) DZS-SnO_2 based devices maintained both structure integrity and good sensitivity, with slightly longer rise time for the ZS device, while DZS – SnO_2 device maintaining very short rise time. The photo-response were measured with 254 nm UV irradiation with intensity of ~ 1.1 mW/cm^2.

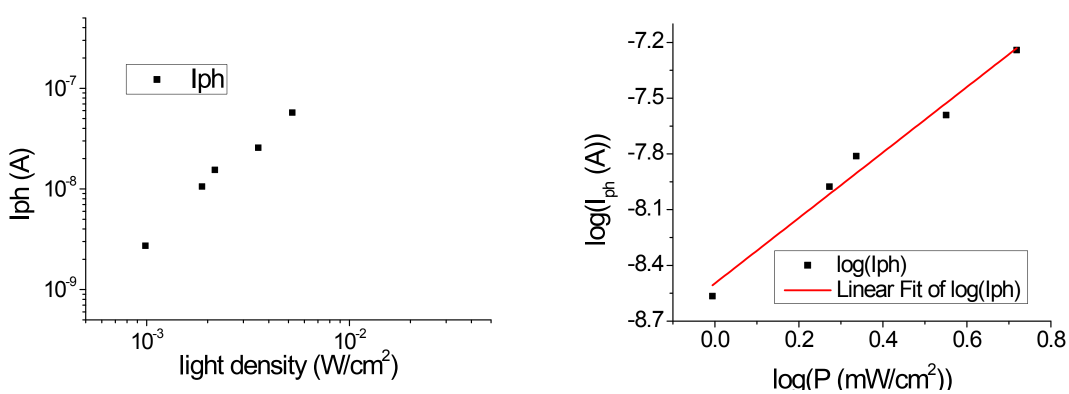

Figure S4. Plots of output photocurrent vs input optical power density.

Large linearity and dynamic range (LDR) are generally needed so that both the weak and strong light can be detected. And the LDR is limited by noise equivalent power (NEP) at the weak light end and by saturation of photocurrent at the strong light end. To find the LDR, the best is to test the output under a very broad range of light power density (say 10^{-11} – 10^{1} W/cm^2). Unfortunately, in our work the light intensity was adjusted by changing distance between the light source and samples, the test can be only done with the input light intensity in the range of mW/cm^2 due to the limitation of the optical meters and light sources. The lowest input light intensity can be detected by optical meter is around 0.9 mW/cm^2. In Figure S4, if we put x and y axis all in log format with unit in W/cm^2 and A, respectively (as shown in the following figures), it gives a linear line, too. It can be seen that the LDR should be larger than the demonstrated/tested range. However, the full linear and dynamic range is not clear because of the weak input signal.

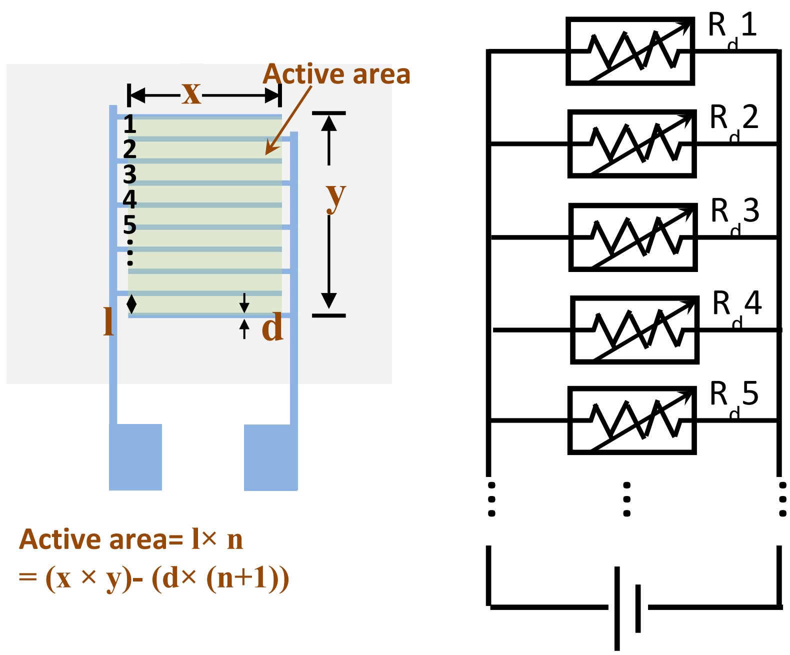

Figure S5. A typical photoconductor with interdigitated electrode geometry design and its equivalent circuit

Spacing and size of the interdigitated electrodes do affect the responsivity. Theoretically, the thin film based photodetectors interdigital electrodes is equivalent to a circuit shown in the following diagram. The photoactive films between each two interdigitated electrode can be seen as a photoresistor/photodiode. And they are connected in parallel (as shown in Figure S5). Though in ZS and DSZ-SnO_2 nanoparticles, the heterojunction or p-n junction exist, the overall device or materials in bulk function as a photoresistor/photoconductor instead of photodiode. In a given area, lower spacing means more unit photoconductor with smaller resistance and capacitance for each connected in parallel. Hence, it will give both larger dark current and photocurrent. So, the responsivity will increase though the Iph /Id (or ΔI/Id) may or may not. Regarding to the size of the interdigitated electrodes, the effective area would decrease if the electrodes bar/line are too wide due to blocking light (electrode-top mode) or invalid space (electrode- bottom configuration). But if too thin (say < 50 nm), then the electrode conductivity could decrease and the electrode edge may not be smooth and uniform. In our work, the spacing and width of the interdigitated electrodes are large. By decrease these parameters to certain extent, the photodetector performance, such as responsivity can be improved.