# Supporting Information

# $[10\bar{1}0]$ oriented multichannel ZnO nanowire arrays with enhanced optoelectronic device performance

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**Experimental Section**

FTO-coated glasses (TEC-8) were cleaned by using acetone, 2-propanol and methanol. After being dried in air, a ZnO seed layer was deposited by dip-coating (0.1 M zinc acetate in ethanol) followed by 30 min heat treatment at 450 ºC in air. The substrates were then loaded into a reactor containing aqueous solution of zinc nitrate (0.03 M), hexamethylenetetramine (0.03 M), tetrabutylammonium fluoride (0.015 M). The reactor was then heated to 80 ºC and maintained at this temperature from 15 min to 3 h to grow Zn(OH)F NW arrays. Longer NW was obtained by refreshing the growth solution every 3 hours. The Zn(OH)F NW arrays covered FTO substrate was then washed with water and ethanol, dried in air and heated up to 500 ºC in oxygen environment inside a tube furnace. *Care must be taken here*, the furnace was first heated from 25 to 300 ºC within 1 hour and then maintained at this temperature for 30 min with an oxygen flow rate of 1.8 ml/s. After that, oxygen flowing was stopped, and the temperature was increased to 500 ºC within 100 min and maintained at this temperature for another 30 min. ZnO NW arrays covered FTO coated substrates were taken out after the furnace was cooled down naturally to room temperature.

X-ray diffraction (XRD) patterns were recorded on X'Pert PRO (PANalytical, Almelo, The Netherlands). Field-emission scanning electron microscopy (FE-SEM) images were captured on S-4800 Hitachi (Tokyo, Japan). The transmission electron microscopy (TEM) were performed using a Tecnai F20 (FEI, Hillsboro, OR, USA) microscope at an accelerating voltage of 200 kV. Nitrogen adsorption-desorption measurements were made at 77.35 K on an ASAP 2020 analyzer.

ZnO NW array was immersed in 0.5 mM N719 dye in ethanol for 1 h and assembled into DSCs. The electrolyte was composed of 0.8 M 1-hexyl-2, 3-dimethylimidazolium iodide and 50 mM iodine in methoxypropionitrile. The thickness of the electrolyte layer between the NW array and platinized counter-electrode was fixed by the use of a 25 μm thick SX-1170 spacer (Solaronix). The photocurrent density and photovoltage of the DSCs were measured with active sample areas of 0.5 $cm^2$. The photocurrent was measured at NREL using AM-1.5 simulated sunlight (Oriel Sol3A Class AAA Solar Simulator). The light spectrum and intensity were checked before measurement. Electron transport and recombination properties of DSCs were measured by intensity modulated photocurrent and photovoltage spectroscopies as described previously.[1]

(1) Schlichthörl, G.; Park, N. G.; Frank, A. J. *J. Phys. Chem. B* **1999**, *103*, 782.

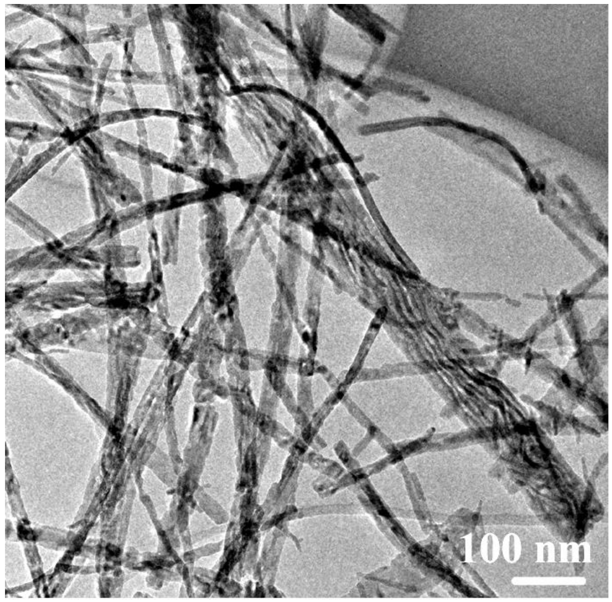


**Figure S1.** TEM image of ZnO nanowires at low magnification.

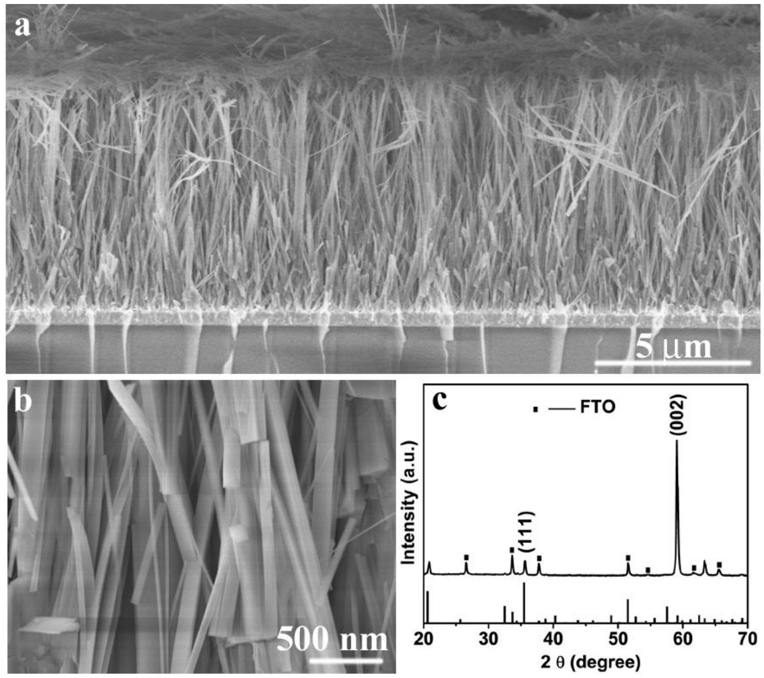


**Figure S2.** FE-SEM images and XRD pattern of Zn(OH)F nanowire arrays with a growth time of 30 min. a) and b) Cross-sectional SEM images of NW arrays on FTO-coated glass substrate at low and high magnifications, respectively. The nanowires have an average length of about 8 m and diameter varies from ~20 nm at the tip part to ~300 nm at the bottom. c) XRD pattern of Zn(OH)F nanowire arrays. All the peaks can be indexed to orthorhombic phase of Zn(OH)F (JCPDS file No. 74-1816). The XRD pattern is dominated by an enhanced (002) peak, indicating that the growth direction of Zn(OH)F nanowire is along the [001] direction. Details on the growth mechanism, characterization will be published elsewhere.

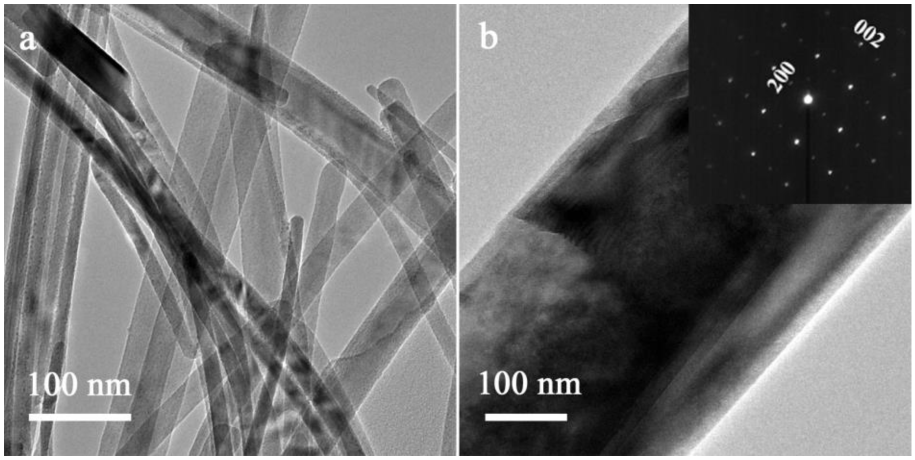


**Figure S3.** TEM images of Zn(OH)F nanowires at (a) low and (b) high magnifications. The inset in (b) is selected area electron diffraction (SAED) patterns, which further confirms that the Zn(OH)F nanowire is single crystal and grows along the [001] direction.

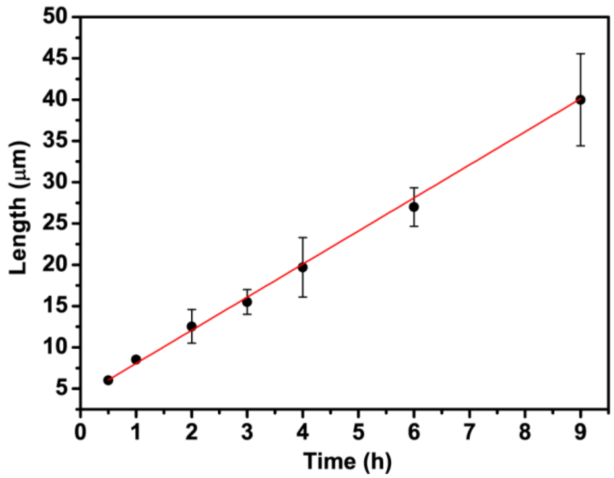


**Figure S4.** Dependence of the average length of Zn(OH)F nanowires on the growth time. The substrates were repeatedly introduced into a new solution bath every 3 h.

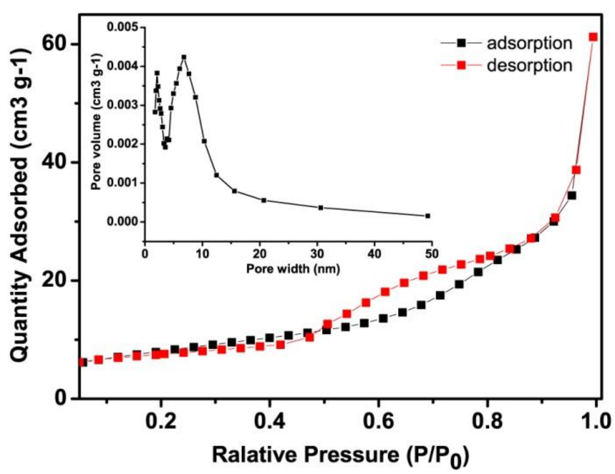


**Figure S5.** Nitrogen adsorption-desorption isotherms and the corresponding pore size distribution within multi-channel ZnO nanowires. The pore-size distribution diagram shows that the nanowires possess small mesostructure with a peak pore size of about 6.6 nm.

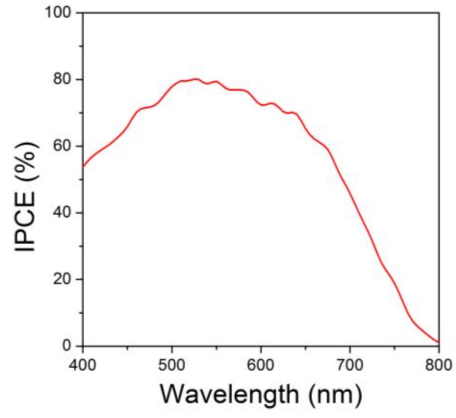


**Figure S6.** The incident photon-to-current efficiency (IPCE) of DSSC based on multichannel ZnO NW arrays with an average thickness of 25 μm.