Supplementary Information

TiO_2 Shell Layer on Highly Conducting Indium Tin Oxide Nanowire for Photovoltaic Devices

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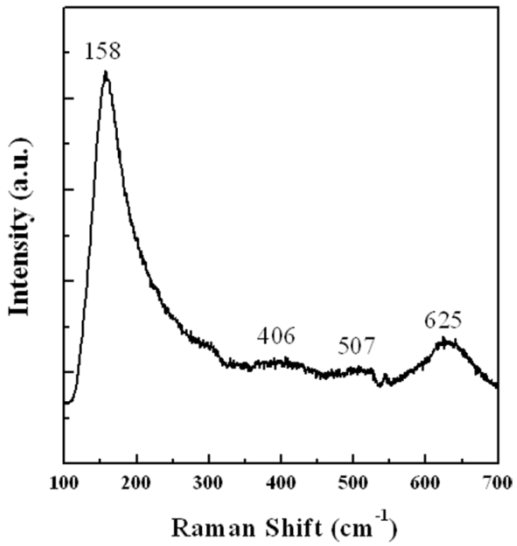

Fig. S1 Raman spectrum of the as-prepared TiO_2 shell layer.

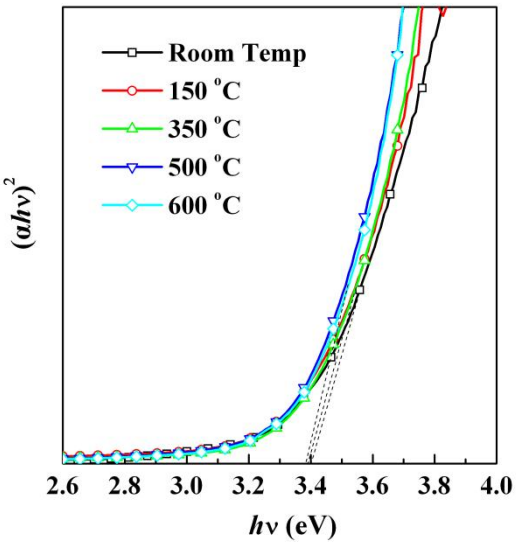

Fig. S2 Tauc plot of the TiO_2 shell layer for optical band gap.

The sizes of TiO_2 NCs with various annealing temperatures are obtained by following Scherrer equation,

$$t = \frac{0.9\lambda}{B\cos\theta_B} \qquad \text{(eq. S1)}$$

where t is the size of crystallite, λ is the wavelength of incident X-rays, B is the line broadening at half the maximum intensity (FWHM) in radians and θ_B is the center angle of the peak.

	λ(nm)	B (rad)	θ_B	Size (nm)
150 °C	0.1540	0.028	12.65	5.0
350 °C	0.1540	0.019	12.65	7.3
500 °C	0.1540	0.012	12.65	11.4
600 °C	0.1540	0.009	12.65	15.9

Table. S1 Parameters for Scherrer equation and calculated particle size of TiO_2 shell layers with different annealing temperatures

An electrochemical workstation (Zennium, Zahner) with an attached frequency response analyzer and a light-emitting diode (667 nm) was utilized for the intensity-modulated photovoltage spectroscopy (IMVS) study.

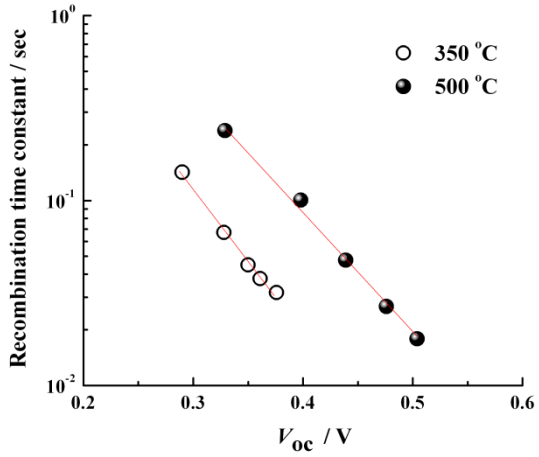

Fig. S3 The electron recombination (IMVS) time constant as a function of the open-circuit voltage for ITO-TiO_2 core-shell nanowire array DSSCs with annealing temperatures of 350 °C and 500 °C

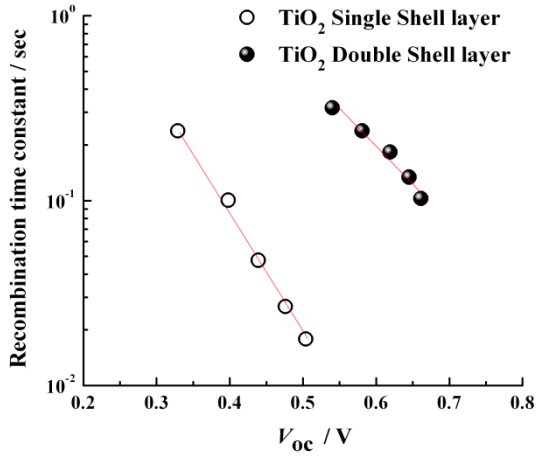

Fig. S4 The electron recombination (IMVS) time constant as a function of the open-circuit voltage for ITO-TiO_2 core-shell nanowire array DSSCs TiO_2 single shell layer and double shell layer.