

Supporting Information

Design of multi-layered TiO₂ nanotube/nanoparticle hybrid structure for enhanced efficiency in dye-sensitized solar cells

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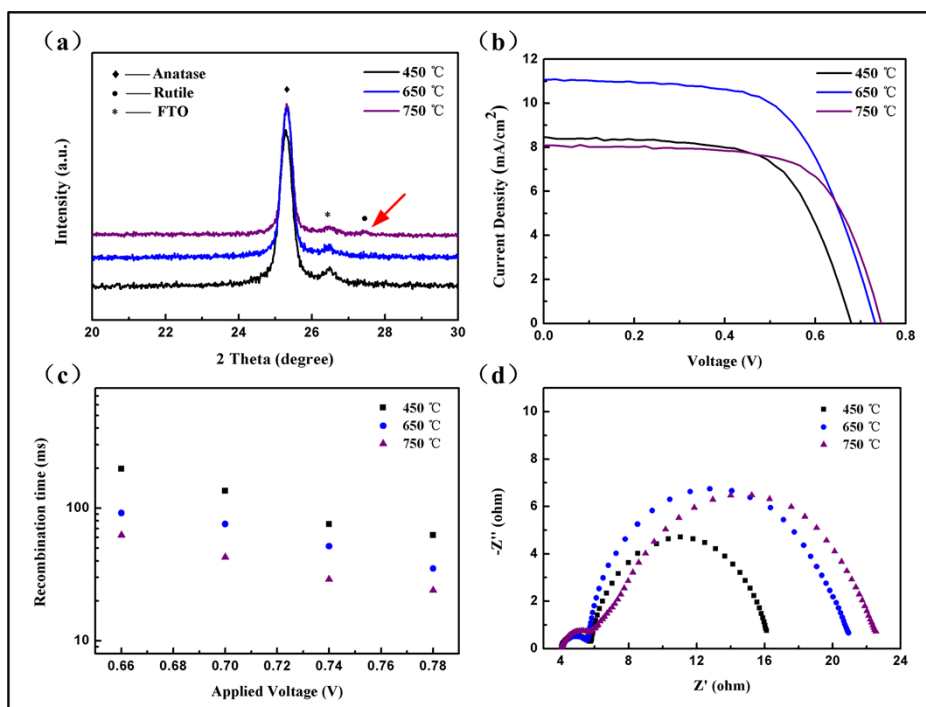


Fig. S1 (a) XRD patterns of the top of the SNT membranes annealed at different temperatures; (b) Photocurrent-voltage curves of DSSCs based on the SNT membranes pre-treated at different temperatures; (c) Electron lifetimes of DSSCs as a function of bias voltage; (d) Nyquist phase plots.

Table S1. Photovoltaic properties of the DSSCs based on SNT photoanode under different annealing temperatures.

Samples	Annealing temperature	J_{sc} (mA·cm ⁻²)	V_{oc} (V)	FF	Relative Dye loading	η (%)
NP5+SNT15	450 °C	8.45	0.679	0.640	0.470	3.68
NP5+SNT15	650 °C	11.07	0.732	0.623	0.419	5.05
NP5+SNT15	750 °C	8.09	0.746	0.673	0.378	4.06

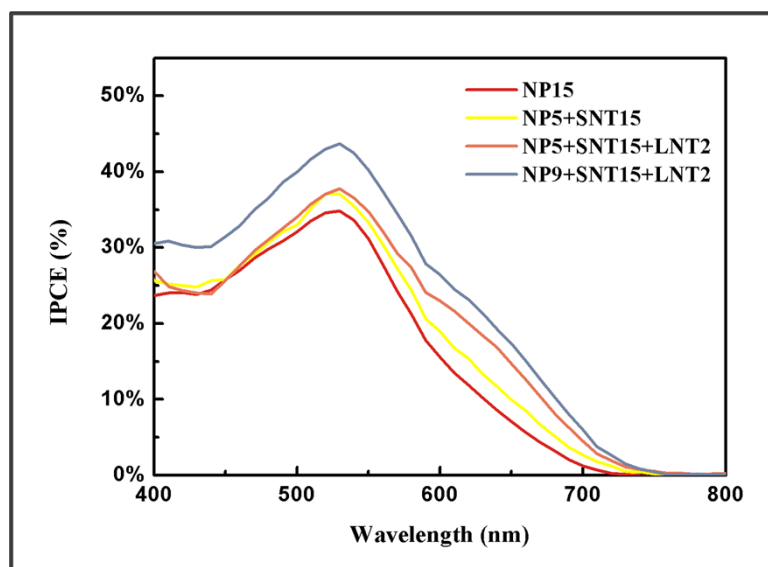


Fig. S2 IPCE of different types of photoanodes with and without light-scattering layers.

Table S2. Photovoltaic properties of the DSSCs based on multi-layered photoanodes with different SNT and NP layer thicknesses.

Samples	thickness of each layer (μm)	J_{sc} ($\text{mA}\cdot\text{cm}^{-2}$)	V_{oc} (V)	FF	Relative Dye loading	η (%)
NP5+SNT15+LNT2	5/15/2	11.39	0.758	0.627	0.474	5.42
NP9+SNT10+LNT2	9/10/2	11.71	0.753	0.642	0.546	5.66
NP9+SNT15+LNT2	9/15/2	13.17	0.760	0.651	0.582	6.52
NP15+SNT10+LNT2	15/10/2	11.44	0.700	0.628	0.790	5.03