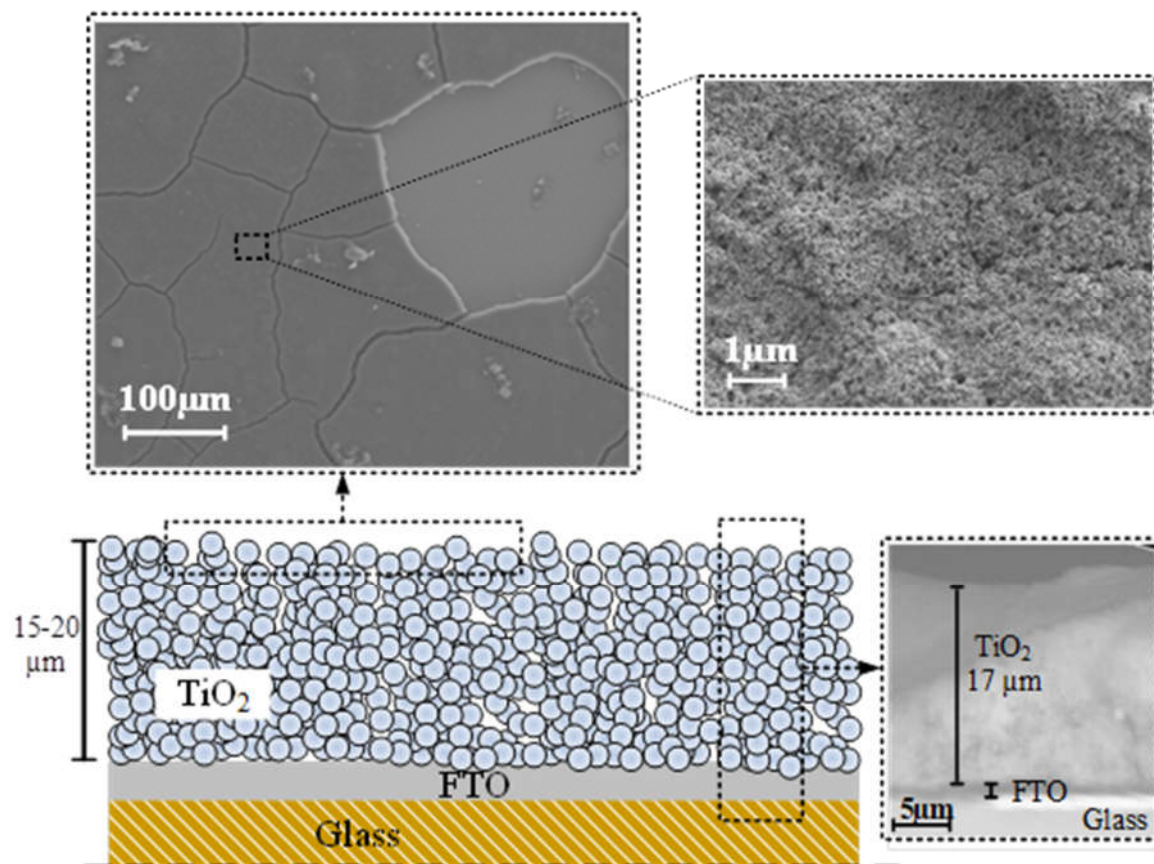


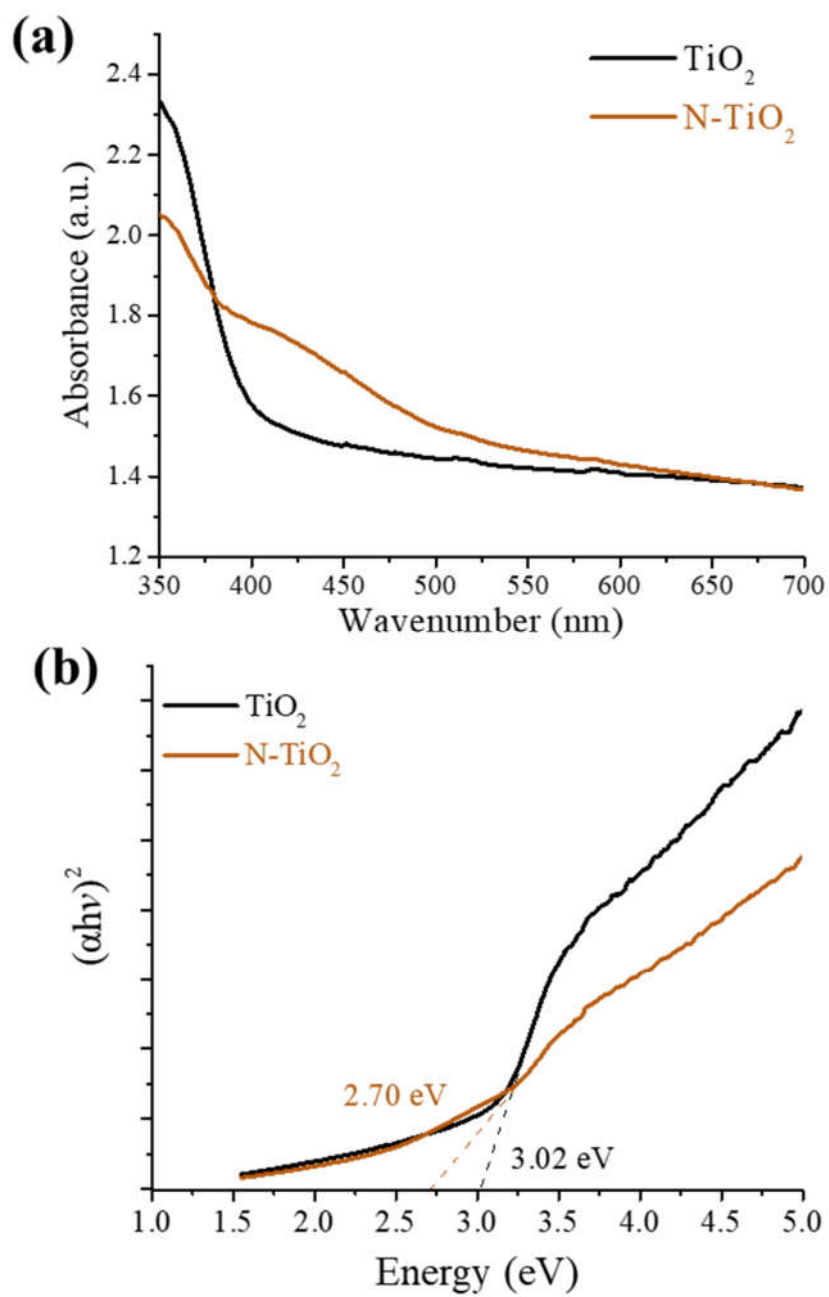
## SUPPORTING INFORMATION

**Table S1** Comparison of literature results of DSSCs with different nitrogen doping methods on TiO<sub>2</sub>.

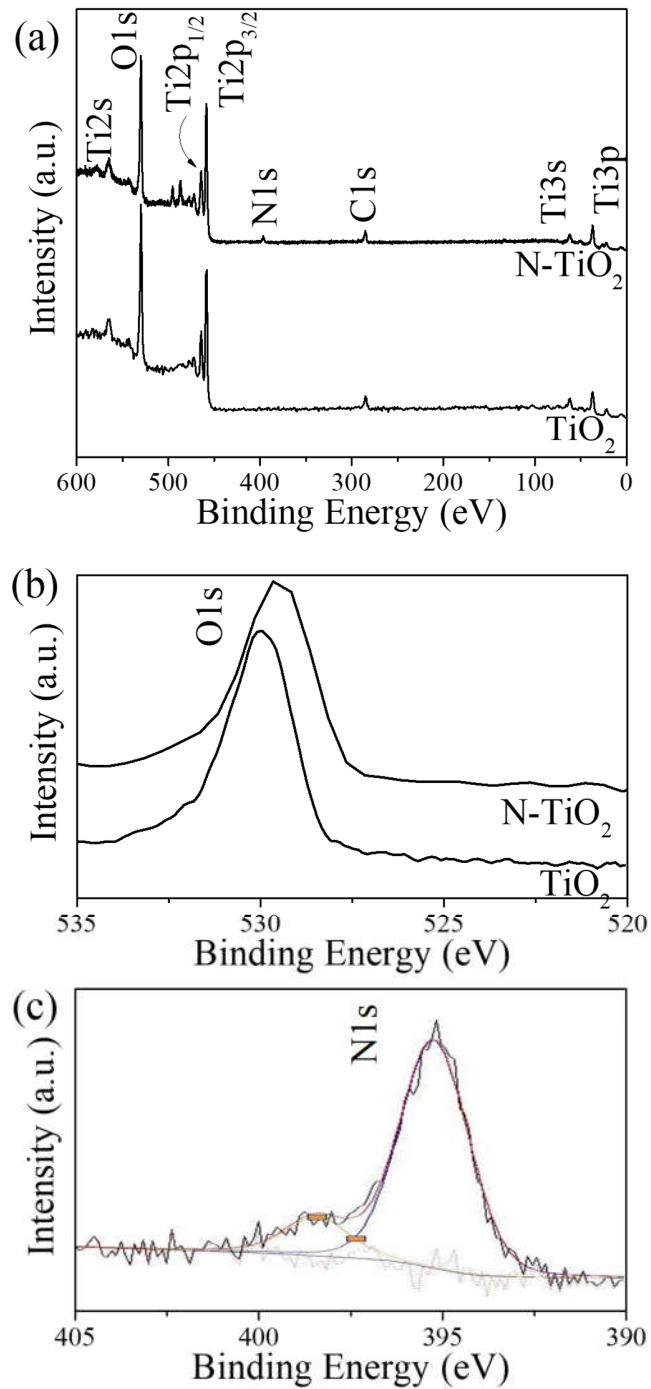
N-doping method	WE area (cm <sup>2</sup> )	Eff undoped DSSC (%)	Eff N-doped DSSC (%)	Jsc N-doped DSSC (mA/cm <sup>2</sup> )	Voc N-doped DSSC (V)	FF N-doped DSSC	N atom. (%)	TiO <sub>2</sub> particle size (nm)	WE thickness (μm)	Dye
sol-gel <sup>1</sup>	0.36	4.04	6.01	12.82	0.607	0.77	-	550	12	N719
solvothermal <sub>2</sub>	0.25	1.56	4.70	11.16	0.750	0.56	-	Ø 241 nm nanofiber	12-15	N719
gas trt <sup>3</sup>	0.16	8.90	10.10	19.05	0.778	0.68	2.49	25	15	N719
sol-gel <sup>3</sup>	0.16	7.20	8.30	15.58	0.784	0.68	2.49	25	15	N719
sputter <sup>4</sup>	2.25	lower	higher	2.32	0.670	-	-	-	2	N3
sol-gel <sup>5</sup>	-	5.34	5.10	11.00	0.745	0.62	-	-	18	N719
solvothermal <sub>6</sub>	0.1	1.52	2.53	8.82	0.670	0.43	1.43	10 nm N-TiO <sub>2</sub>	1.8	N719
gas trt (in-house)	0.25	5.51	6.60	15.52	0.727	0.59	1.63	20	15	N719



**Fig. S1** SEM images of the cross section and surface of a fabricated TiO<sub>2</sub> working electrode

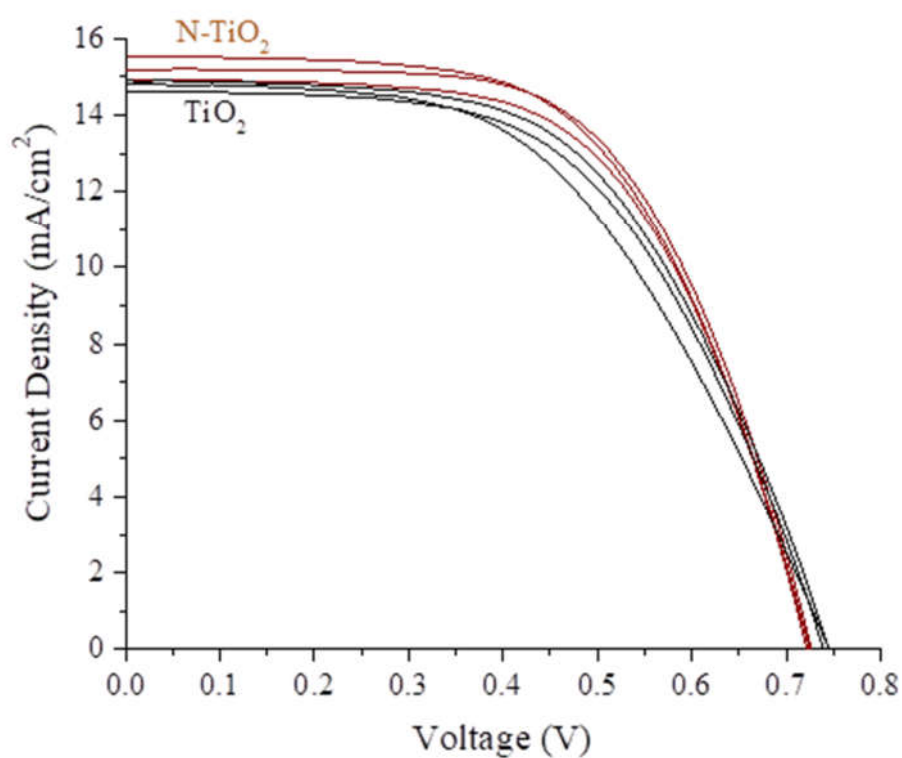


**Fig. S2** (a) UV-Vis spectra and (b) Tauc plot of  $\text{TiO}_2$  and  $\text{N-TiO}_2$  working electrodes.

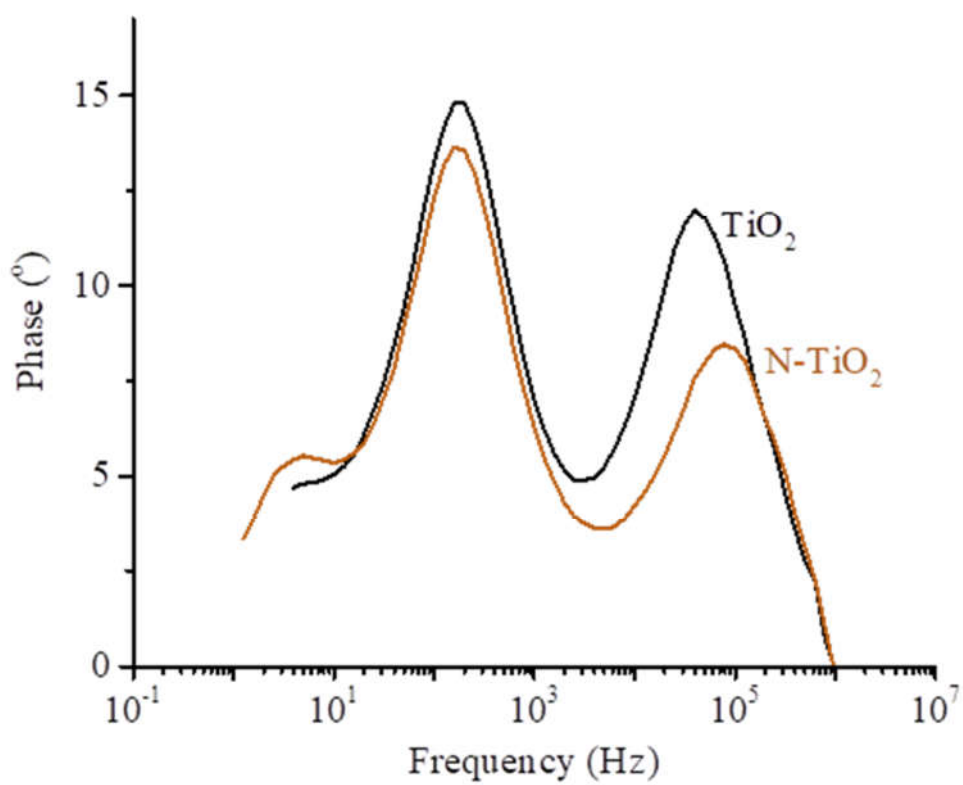


**Fig. S3** (a) XPS spectra of TiO<sub>2</sub> and N-TiO<sub>2</sub> working electrodes, (b) XPS spectra at O1s core level of TiO<sub>2</sub> and N-TiO<sub>2</sub> working electrodes, and (c) XPS spectrum at N1s core level of N-TiO<sub>2</sub> working electrode.

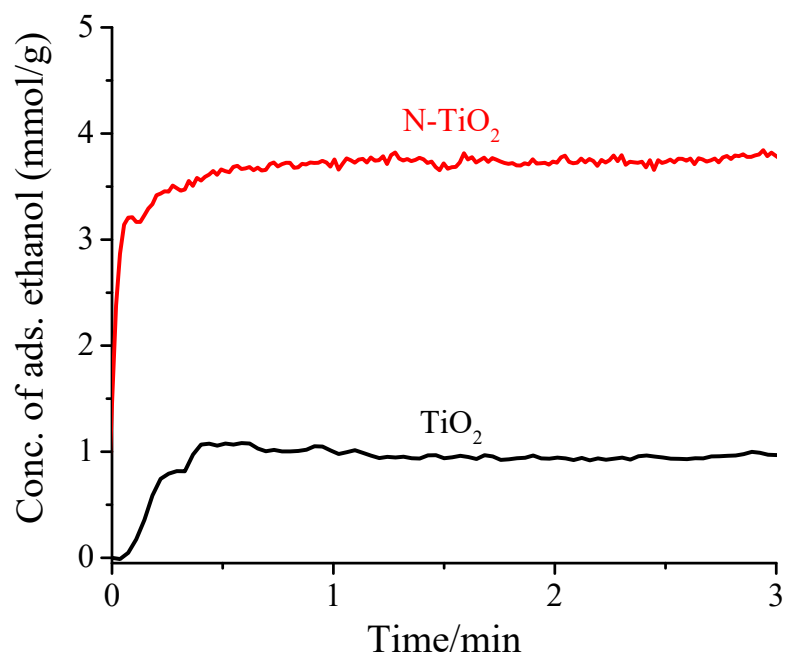
Figure S3 shows N1s spectrum of N-doped TiO<sub>2</sub>. The N1s peak was deconvoluted into two peaks attributed to O-Ti-N at 398.8 eV and N-Ti-N at 395.9 eV. The higher binding energy peak was assigned to O-Ti-N due to the reduced electron density of nitrogen compared with oxygen in O-Ti-O.<sup>7-9</sup> The N content of the N-TiO<sub>2</sub> catalyst was determined to be  $A_{N/Ti} = 5.4/100$  atomic ratio.



**Fig S4** Repeat results of current density-voltage curves of DSSCs based on TiO<sub>2</sub> and N-TiO<sub>2</sub> working electrodes.



**Fig. S5** Bode plot of TiO<sub>2</sub>/N719 and N-TiO<sub>2</sub>/N719 DSSCs



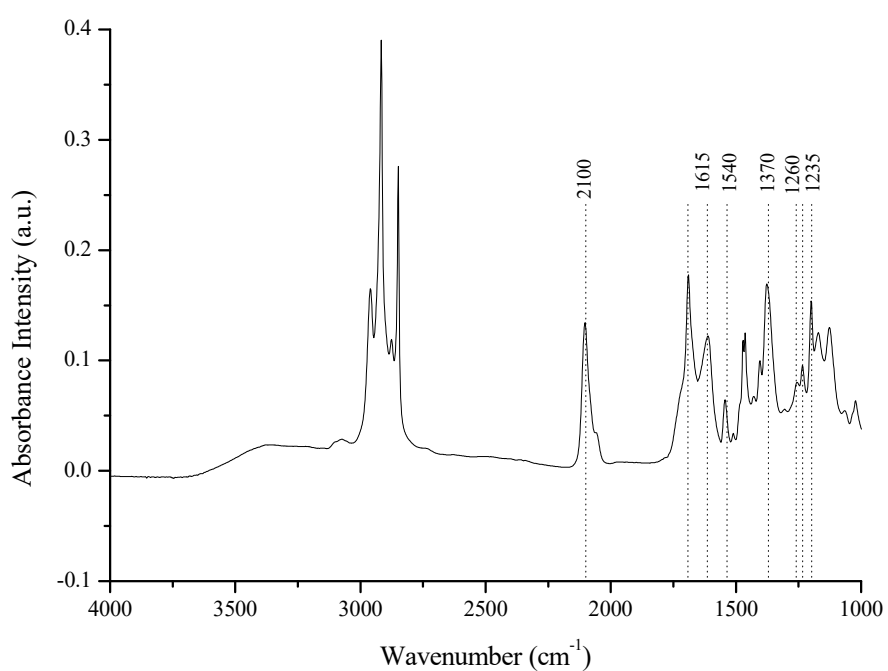
**Fig. S6** Adsorption rate and amount of ethanol on TiO<sub>2</sub> and N-TiO<sub>2</sub>

**Table S2.** Literature results of bandgap and Fermi level on TiO<sub>2</sub> and N-TiO<sub>2</sub><sup>10</sup>

Catalyst	N %	E <sub>bg</sub> (eV)	E <sub>f</sub> (V, NHE)
TiO <sub>2</sub>	0.00	3.18	-0.63
TiO <sub>2</sub> -N1	1.01	2.46	-0.56
TiO <sub>2</sub> -N1	11.70	2.20	-0.47

**Table S3.** Comparison of materials' property with literature/label value

Property	Experiment results	Literature/label value
Particle size of TiO <sub>2</sub>	25 ± 5 nm by SEM	25 nm (Aldrich)
N719 dye	FTIR spectrum in Fig. S7	<i>RSC Adv.</i> , 2015,5, 102803-102810



**Fig. S7** FTIR spectrum of N719 dye used in this study



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