

## Supporting Information

*for New Journal of Chemistry*

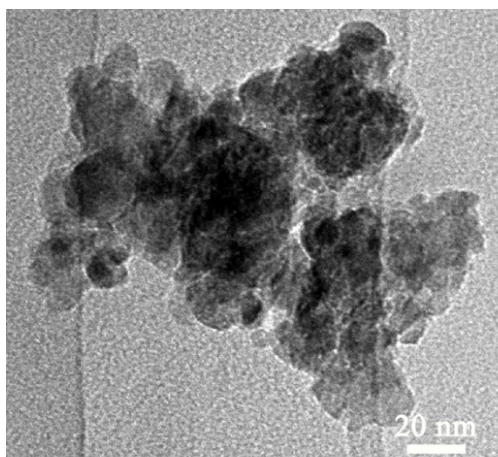
### Improved light absorption and photocatalytic activity of Zn,N-TiO<sub>2-x</sub> via nitridation and hydrogenation co-treatment

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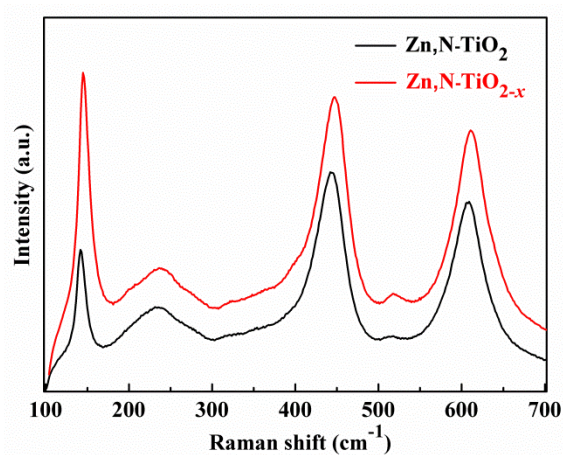
#### Experimental Section

**Characterization.** The as-prepared samples were characterized by transmission electron microscopy (HR-TEM, FEI, Tecnai G2 S-Twin), powder X-ray diffraction (XRD, Rigaku D/max-2000, Cu/K $\alpha$ 1), ultraviolet-visible diffuse reflection spectra (UV-vis DRS, PG, TU-1900/1901), X-ray photoelectron spectroscopy (XPS, PHI5700ESCA, Al K $\alpha$ ), Raman spectra (Renishaw via micro-Raman spectroscopy system, 458 nm argonion laser excitation source), and photoluminescence (PL) emission spectra (Perkin-Elmer LS-55).

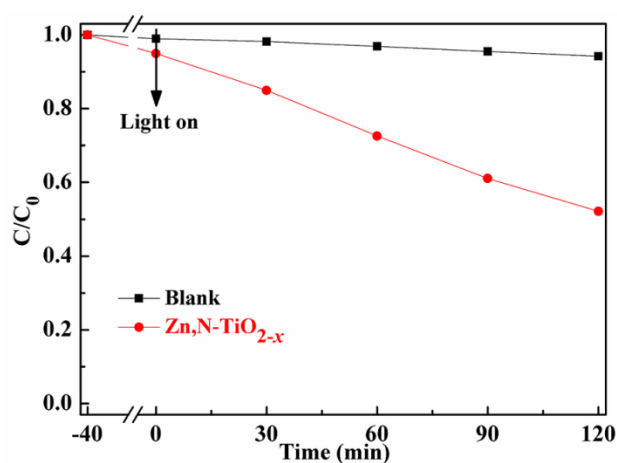
**Photocatalytic Activity Test.** Photocatalytic activities of the samples were measured by photodegradation of RhB. The light source was used as a 300 W Xe lamp (Trusttech PLS-SXE 300, Beijing) with a cutoff filter or band pass filter to provide visible-light ( $\lambda > 400$  nm, 240 mW cm<sup>-2</sup>) or monochromatic central wavelength visible-light with 550 nm, respectively. The distance between the light source and the liquid level was 10 cm. In a typical test: 0.1 g photocatalyst was added to 100 mL RhB solution (10 mg/L) in a quartz reactor. Suspensions was ultrasonicated for 5 min and magnetically stirred in dark for 40 min to establish an adsorption and desorption equilibrium. During the photodegradation, aliquots was withdrawn from the reactor every 30 min, followed by centrifuged at 10000 rpm for 3 min, and then analyzed by UV-vis spectrophotometer (PG, TU-1900,  $\lambda = 554$  nm).



**Fig. S1.** TEM image of Zn,N-TiO<sub>2</sub> sample.



**Fig. S2.** Raman spectra of the Zn,N-TiO<sub>2</sub> and Zn,N-TiO<sub>2-x</sub> samples.



**Fig. S3.** Dynamic curves of MO photodegradation over Zn,N-TiO<sub>2-x</sub> under visible light irradiation.

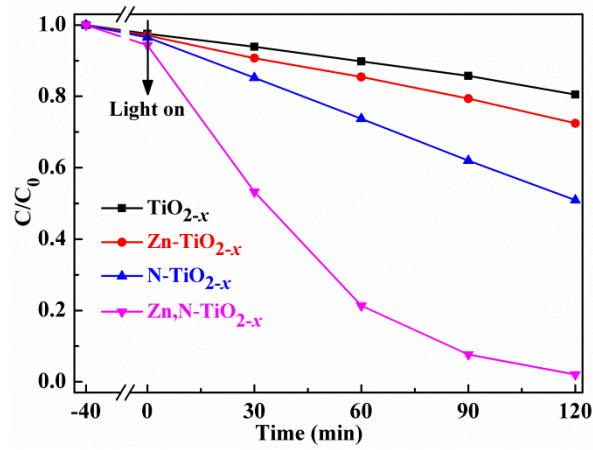


Fig. S4. Dynamic curves of RhB photodegradation over  $\text{TiO}_{2-x}$ ,  $\text{Zn-TiO}_{2-x}$ ,  $\text{N-TiO}_{2-x}$  and  $\text{Zn,N-TiO}_{2-x}$  under visible light irradiation.

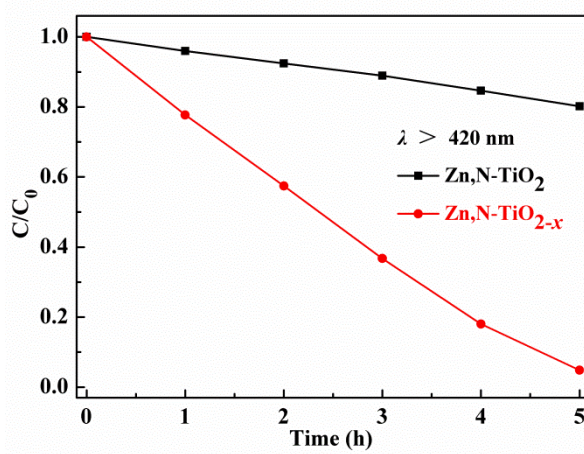


Fig. S5. Dynamic curves of RhB photodegradation over  $\text{Zn,N-TiO}_2$  and  $\text{Zn,N-TiO}_{2-x}$  samples ( $\lambda > 420 \text{ nm}$ ).

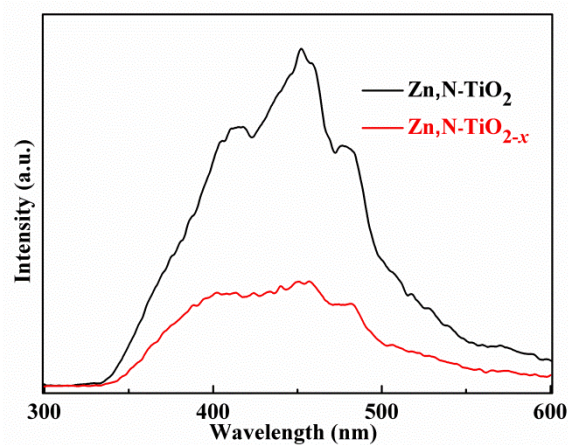
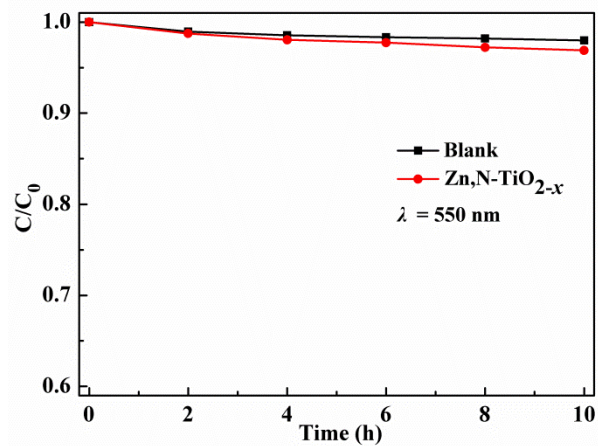


Fig. S6. PL spectra of  $\text{Zn,N-TiO}_2$  and  $\text{Zn,N-TiO}_{2-x}$  samples.



**Fig. S7.** Dynamic curves of RhB photodegradation over  $Zn,N-TiO_{2-x}$  under the monochromatic central wavelengths at 550 nm ( $\Delta\lambda = \pm 15$  nm).