

Supporting information

Synthesis and Photocatalytic Activity of Cation-Doped Titanium Oxynitrides ($\text{Ti}_{2.85-x}\text{M}_x\text{O}_4\text{N}$, $M = \text{Zn, Co, Cu}$)

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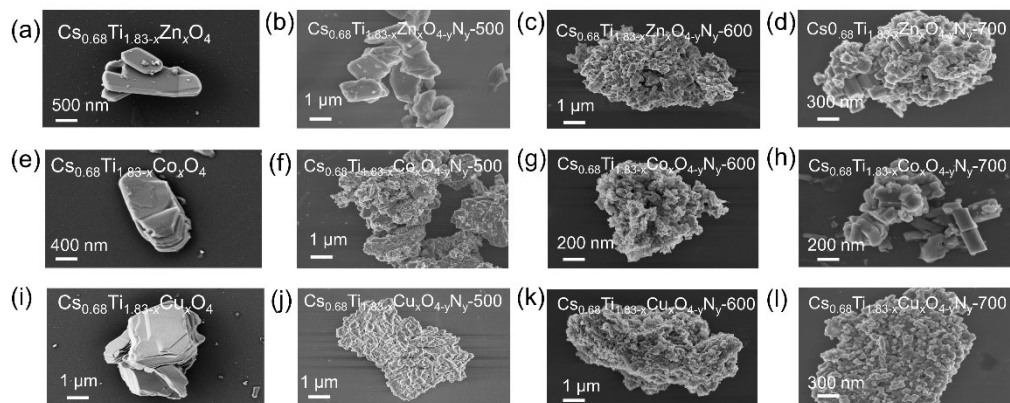


Figure S1. SEM images of oxides and oxynitrides doped with different cations: (a-d) Zn; (e-h) Co; (i-l) Cu.

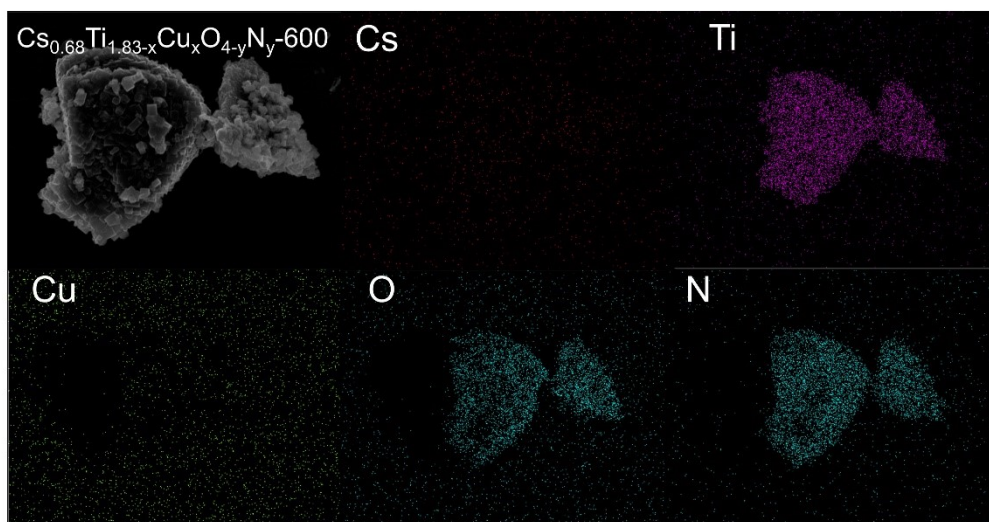


Figure S2. EDS mapping spectrum of $\text{Cs}_{0.68}\text{Ti}_{1.83-x}\text{Cu}_x\text{O}_{4-y}\text{N}_y-600$.

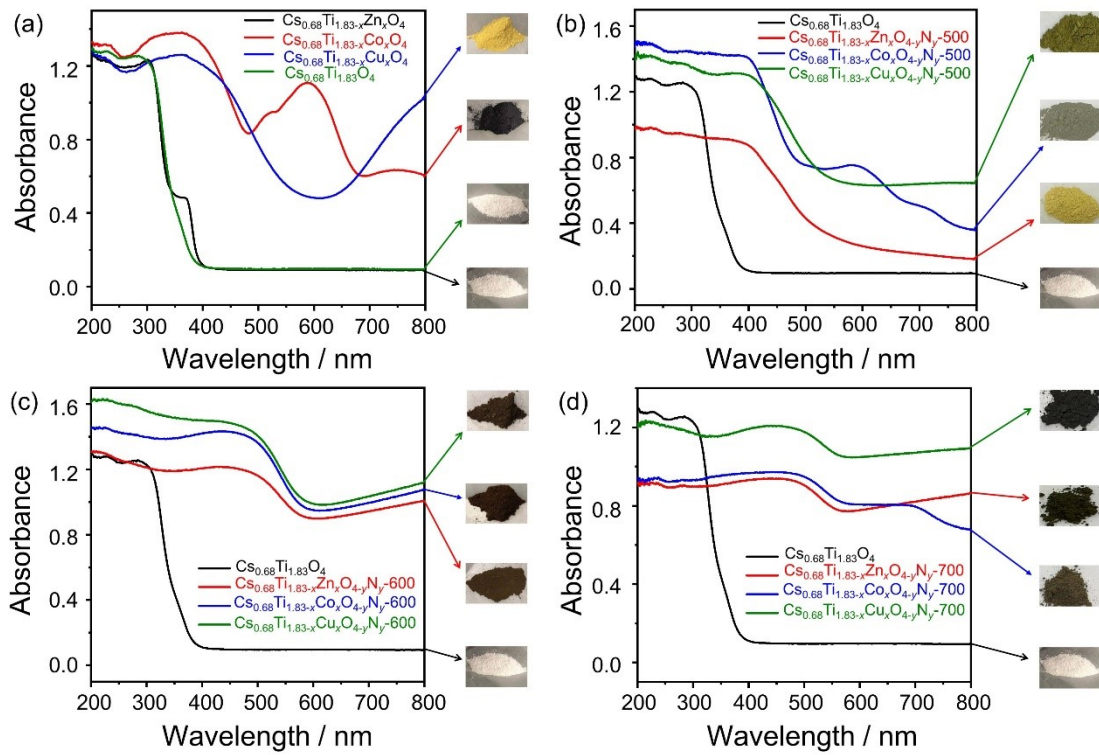


Figure S3. UV-visible diffuse reflection spectroscopy of (a) the oxides doped with different cations and synthesized oxynitrides at different temperatures (b) 500 °C; (c) 600 °C; (d) 700 °C.

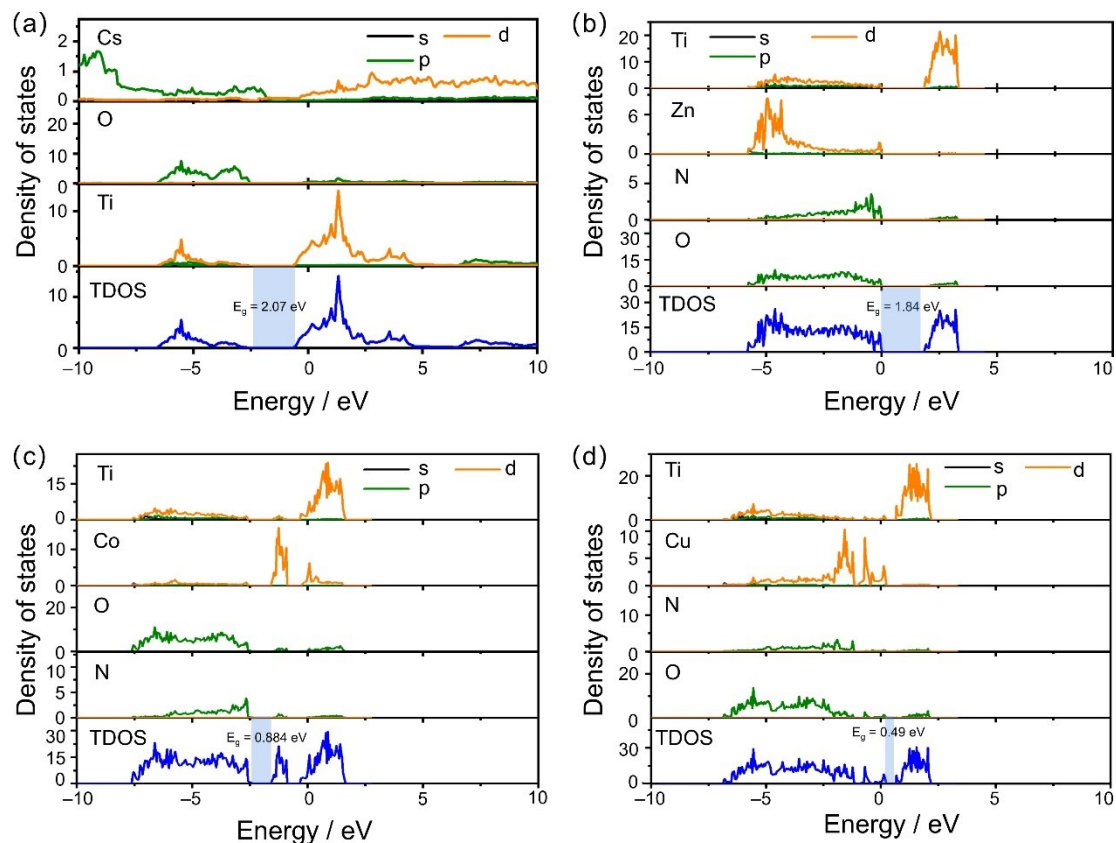


Figure S4. Total density states (TDOS) and partial density states (PDOS) of (a) $\text{Cs}_{0.68}\text{Ti}_{1.83}\text{O}_4$ and (b) $\text{Cs}_{0.68}\text{Ti}_{1.83-x}\text{Zn}_x\text{O}_{4-y}\text{N}_y$ -600, (c) $\text{Cs}_{0.68}\text{Ti}_{1.83-x}\text{Co}_x\text{O}_{4-y}\text{N}_y$ -600, and (d) $\text{Cs}_{0.68}\text{Ti}_{1.83-x}\text{Cu}_x\text{O}_{4-y}\text{N}_y$ -600.

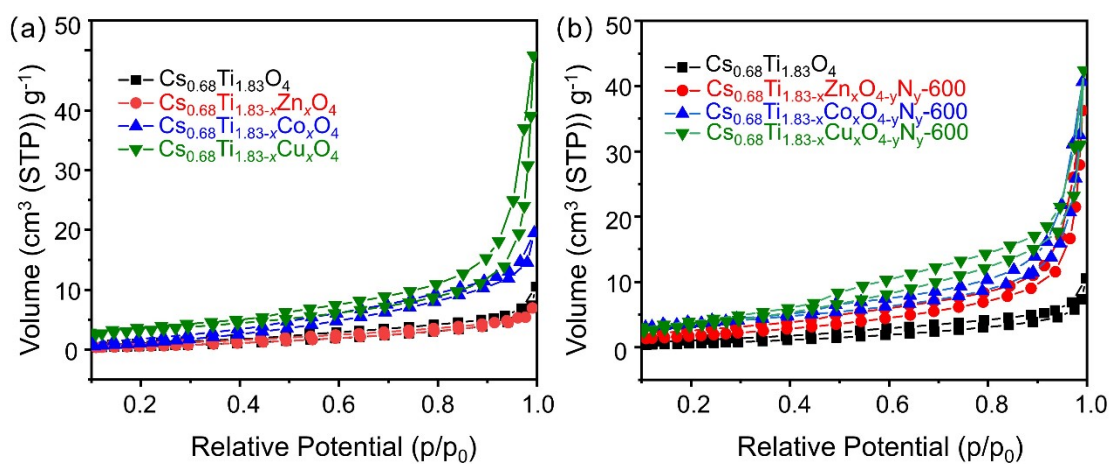


Figure S5. Nitrogen adsorption-desorption curves of (a) the oxides doped with different cations and (b) synthesized oxynitrides at 600 °C.

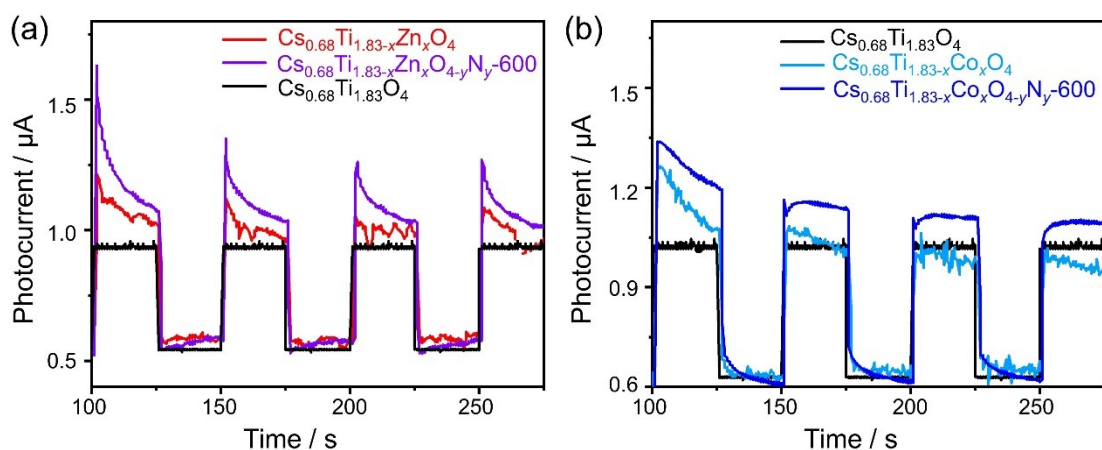


Figure S6. Transient photocurrent spectra of (a) $\text{Cs}_{0.68}\text{Ti}_{1.83-x}\text{Zn}_x\text{O}_{4-y}\text{N}_y-600$ and (b) $\text{Cs}_{0.68}\text{Ti}_{1.83-x}\text{Co}_x\text{O}_{4-y}\text{N}_y-600$

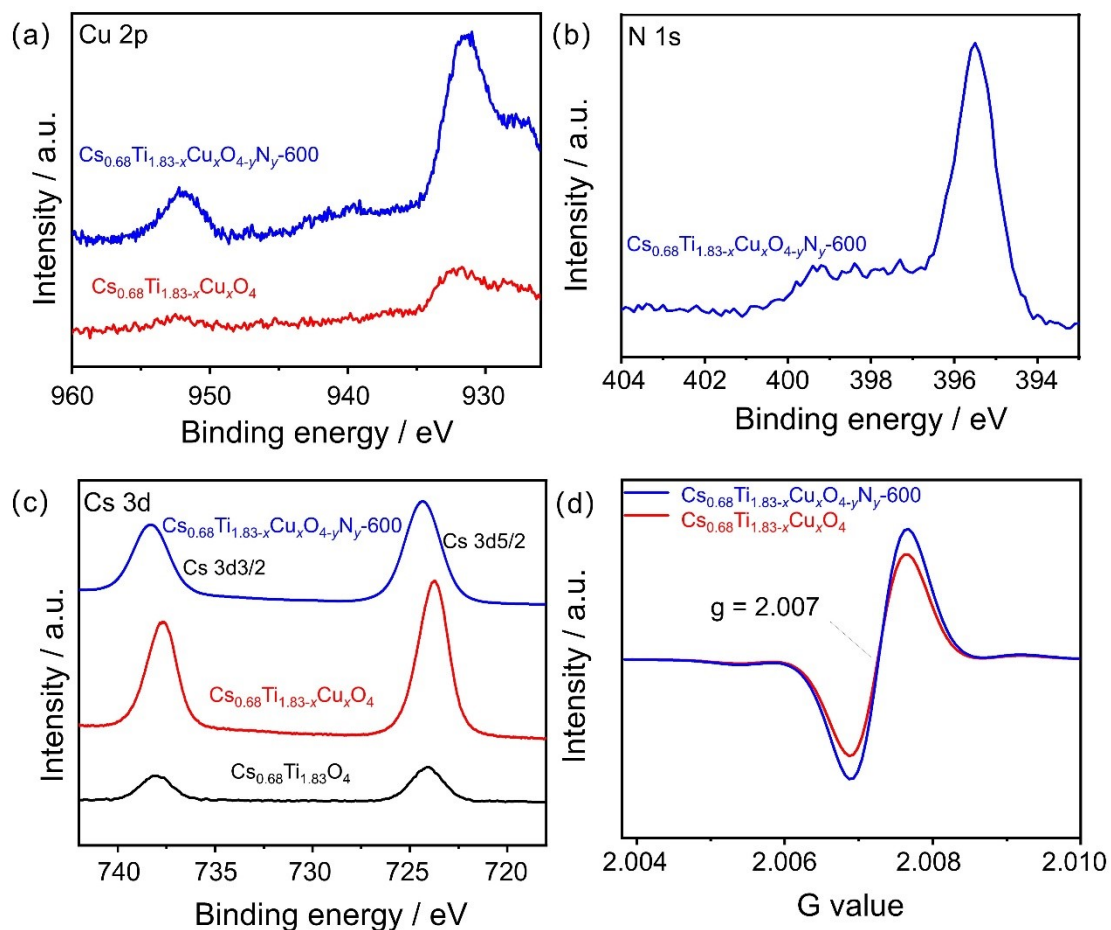


Figure S7. XPS spectrum of (a) Cu 2p (b) N 1s and (c) Cs 3d for $\text{Cs}_{0.68}\text{Ti}_{1.83}\text{O}_4$, $\text{Cs}_{0.68}\text{Ti}_{1.83-x}\text{Cu}_x\text{O}_4$, and $\text{Cs}_{0.68}\text{Ti}_{1.83-x}\text{Cu}_x\text{O}_{4-y}\text{N}_y-600$ were etched with Ar ion clusters at 30 nm, and (d) ESR spectra for $\text{Cs}_{0.68}\text{Ti}_{1.83-x}\text{Cu}_x\text{O}_4$ and $\text{Cs}_{0.68}\text{Ti}_{1.83-x}\text{Cu}_x\text{O}_{4-y}\text{N}_y-600$

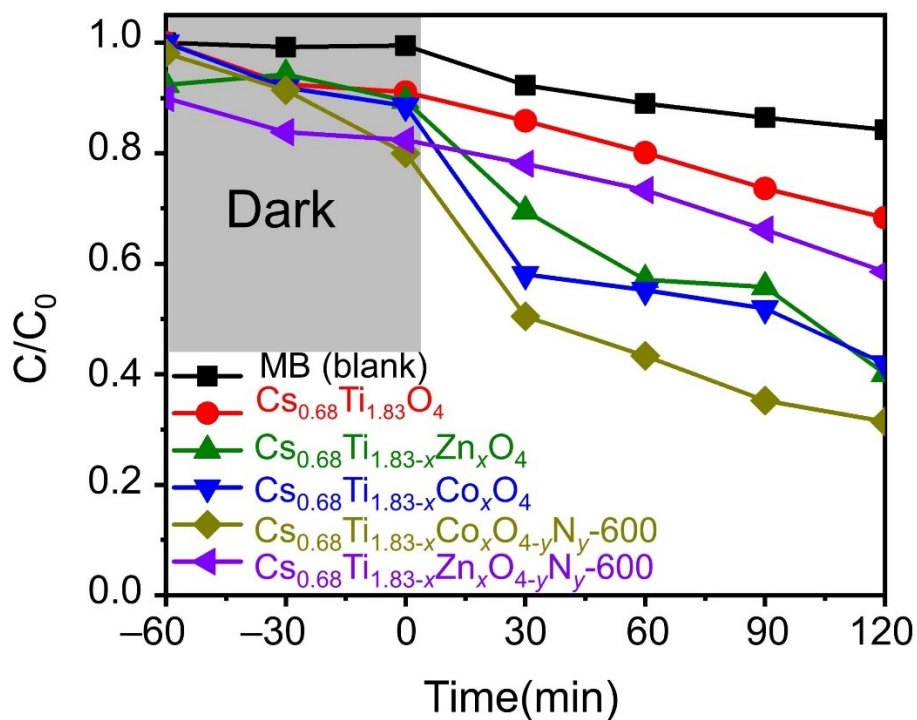


Figure S8. Photocatalytic degradation efficiency plots of Zn- and Co-doped titanium oxides and titanium nitrogen oxides for the photocatalytic degradation of methylene blue.

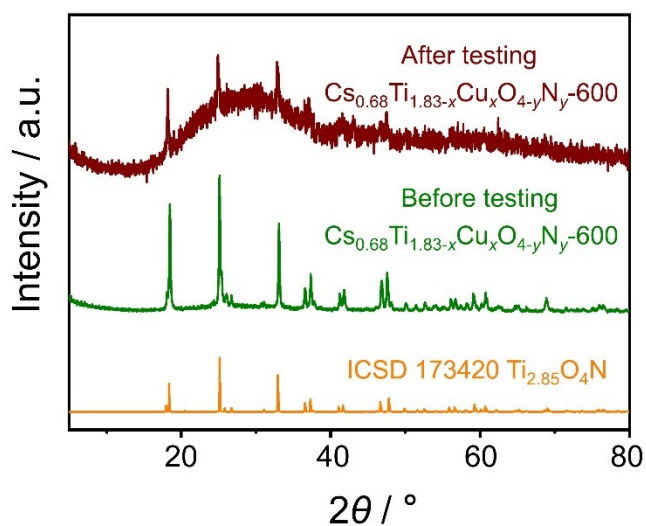


Figure S9. XRD patterns of $Cs_{0.68}Ti_{1.83-x}Cu_xO_{4-y}N_y-600$ before and after photocatalytic reaction.

Table S1. The specific surface area and pore size of the oxides doped with different cations and synthesized oxynitrides at 600 °C.

	Surface area (m ² g ⁻¹)	Pore volume (cm ⁻³ g ⁻¹)	Pore size (nm)
Cs _{0.68} Ti _{1.83} O ₄	2.9837	0.0119	15.9533
Cs _{0.68} Ti _{1.83-x} Zn _x O ₄	2.9236	0.0106	14.5027
Cs _{0.68} Ti _{1.83-x} Co _x O ₄	11.2711	0.0277	9.8305
Cs _{0.68} Ti _{1.83-x} Cu _x O ₄	12.1303	0.0671	22.1264
Cs _{0.68} Ti _{1.83-x} Zn _x O _{4-y} N _y -600	7.2967	0.0544	29.8217
Cs _{0.68} Ti _{1.83-x} Co _x O _{4-y} N _y -600	12.9577	0.0614	18.9540
Cs _{0.68} Ti _{1.83-x} Cu _x O _{4-y} N _y -600	14.3266	0.0572	15.9703