Electronic Supplementary Information for

## Terbium doped ZnCr-layered double hydroxides with largely enhanced visible light photocatalytic performance

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**Fig. S1** (a) FT-IR spectra of the Tb-ZnCr-LDH with different doping content of Tb; (b) the FT-IR comparison between LDH-0% (pristine ZnCr-LDH) and LDH-0.5%.

Sample	Molar ratio			Tb (%)
	Zn	Cr	Tb	
LDH-0%	2	0.9905	0	0%
LDH-0.1%	2	0.9913	0.00060	0.06%
LDH-0.5%	2	0.9843	0.00407	0.41%
LDH-1%	2	0.9804	0.00871	0.88%
LDH-5%	2	0.9671	0.05115	5.02%

Table S1. ICP-AES of the prepared Tb-ZnCr-LDH



**Fig. S2** SEM images of the ZnCr-LDH doped with various amount of Tb: (a) LDH-0%; (b) LDH-0.1%; (c) LDH-1%; (d) LDH-5%.



Fig. S3 (a)  $N_2$ -sorption isotherms and (b) pore-size distribution of the Tb-ZnCr-LDH with various amount of Tb doping.

Sample	BET surface area (m <sup>2</sup> g <sup>-1</sup> )
LDH-0%	166.6
LDH-0.1%	174.8
LDH-0.5%	187.6
LDH-1%	158.3
LDH-5%	165.9

Table S2. BET surface area of Tb-ZnCr-LDH with various content of Tb



**Fig. S4** (a) TEM image of the catalyst after photocatalysis; (b) high resolution image for the used photocatalyst. (c) EDX for elemental composition analysis.

## Calculation of apparent quantum yield and turnover number:

Apparent quantum yields (AQY) were estimated under the same condition of photocatalytical reaction condition except the monochromatic filter was added to the xenon arc lamp for the monochromatic light source to trigger the water splitting. And the power of light was determined by an irradiatometer (Beijing AuLight Co., Ltd.). The apparent quantum yields at various wavelengths were obtained by following equation<sup>1,2</sup>:

 $AQY(\%) = \frac{Number of reacted eletrons}{Number of incident photons} \times 100\%$  $= \frac{Number of evolved oxygen molecules \times 4}{Number of incident photons} \times 100\%$ 

The turnover number (in 24 h) was calculated by the following equation<sup>1,3</sup> and shown in Fig. S5:

 $TON = \frac{Number of reacted molecules}{Number of active sites}$ 

 $=\frac{moles \ of \ evolved \ oxygen}{moles \ of \ the \ catalyst}$ 



Fig. S5 Turnover number of the prepared Tb-ZnCr-LDH photocatalysts.



**Fig. S6** (a) Electrochemical impedance spectra (EIS) measured at 0.3 V, (b) currentvoltage behavior upon chopped light illumination in 0.5 M Na<sub>2</sub>SO<sub>4</sub>, (c) amperometric *I*-*t* curves at a potential of 0.6 V, (d) current-voltage behavior under visible light illumination ( $\lambda$ > 420 nm) and dark condition in 0.5 M Na<sub>2</sub>SO<sub>4</sub> with 0.5 M H<sub>2</sub>O<sub>2</sub> for the Tb-ZnCr-LDH with various amount of Tb doping. (e) Current-voltage behavior under visible light illumination ( $\lambda$ > 420 nm) in 0.5 M Na<sub>2</sub>SO<sub>4</sub> with or without 0.5 M H<sub>2</sub>O<sub>2</sub> for the synthesized Tb-ZnCr-LDH.

## References

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