

## *Supporting Information*

# Synthesis of TiO<sub>2</sub> Nanosheet Photocatalysts from Exfoliation of TiS<sub>2</sub> and Hydrothermal Treatment

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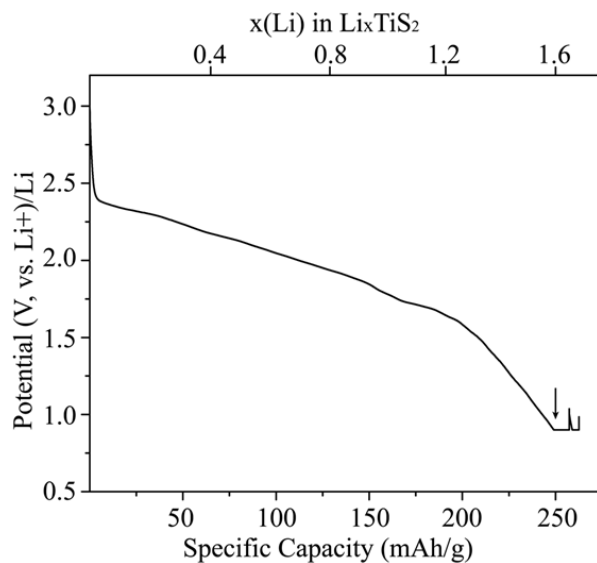
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## Supporting Table

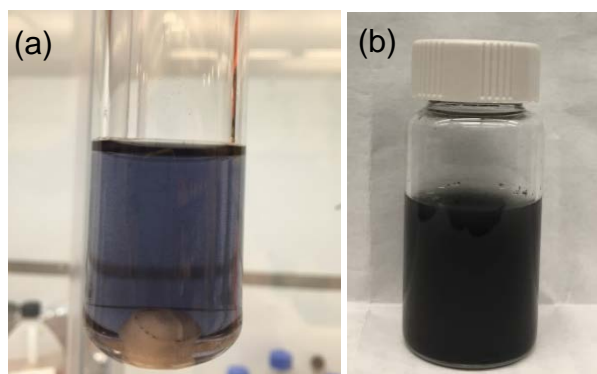
**Table SI.** Kinetic fitting results for MB degradation by TiO<sub>2</sub>-based photocatalysts. The data were fit to a first-order model, which can be described as:  $\ln(C_{\text{initial}}/C) = kt$ , where  $C_{\text{initial}}$  is the initial concentration of MB (5 ppm),  $C$  is the concentration of MB at irradiation time  $t$ , and  $k$  is the rate constant.

Photocatalyst	$k$ (min <sup>-1</sup> )	$r^2$
P25	0.185	0.991
TiO <sub>2</sub> nanosheets	0.103	0.992
P25 + CB	0.071	0.957
P25 + CB + PVDF	0.071	0.978

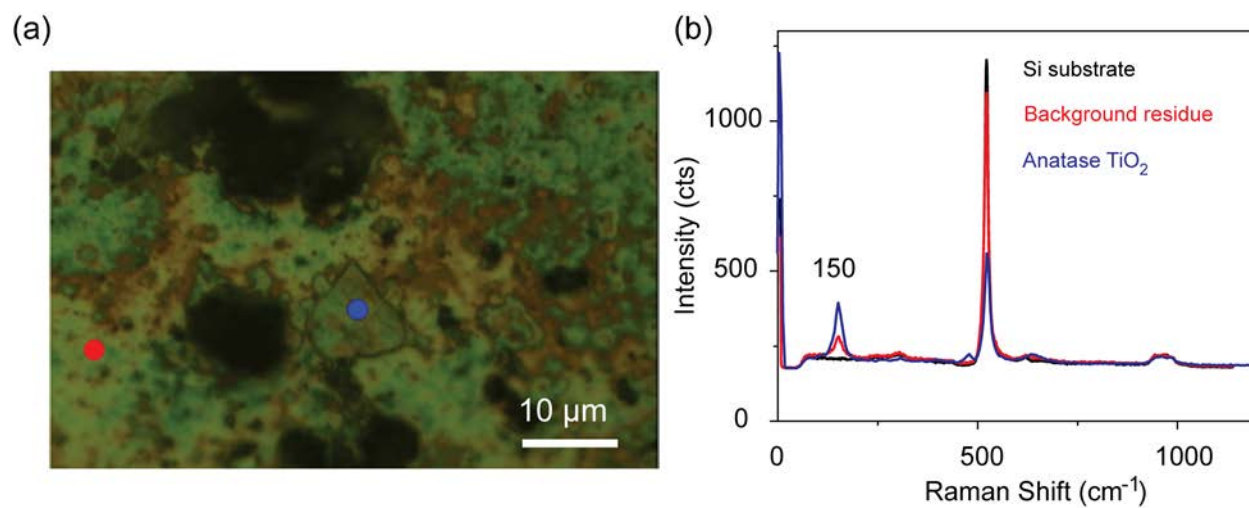
## Supporting Figures



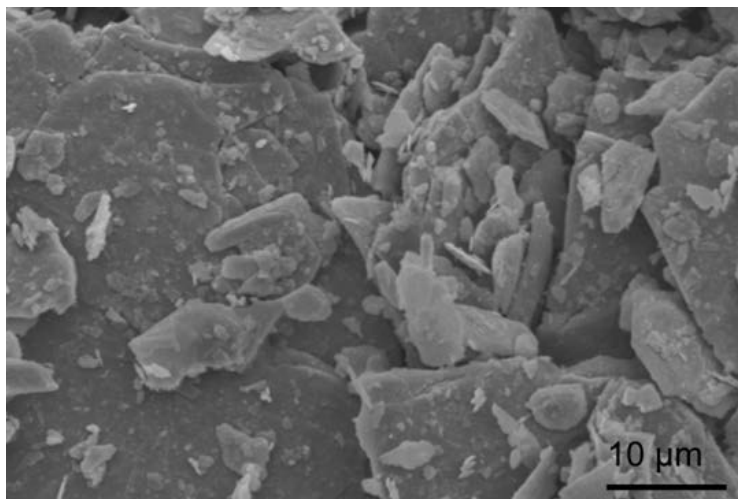
**FIG. S1.** Lithiation voltage profile of bulk TiS<sub>2</sub>. The electrode was charged galvanostatically using a 0.05 C rate until the potential reached 0.9 V vs. Li/Li<sup>+</sup>, as indicated by the arrow. Then, the electrode was held at 0.9 V for 2 h, followed by a 1.5 h rest at open circuit. If the voltage was higher than 1 V vs. Li/Li<sup>+</sup> after this relaxation period, the electrode was charged galvanostatically again using a 0.05 C rate until the potential reached 0.9 V vs. Li/Li<sup>+</sup>, followed by another 2 h potentiostatic hold at 0.9 V. These steps were repeated until the open circuit voltage was less than 1 V vs. Li/Li<sup>+</sup> to ensure sufficient lithiation to weaken the van der Waals interactions between the TiS<sub>2</sub> interlayers and enable exfoliation of the nanosheets after applying ultrasonic frequencies.



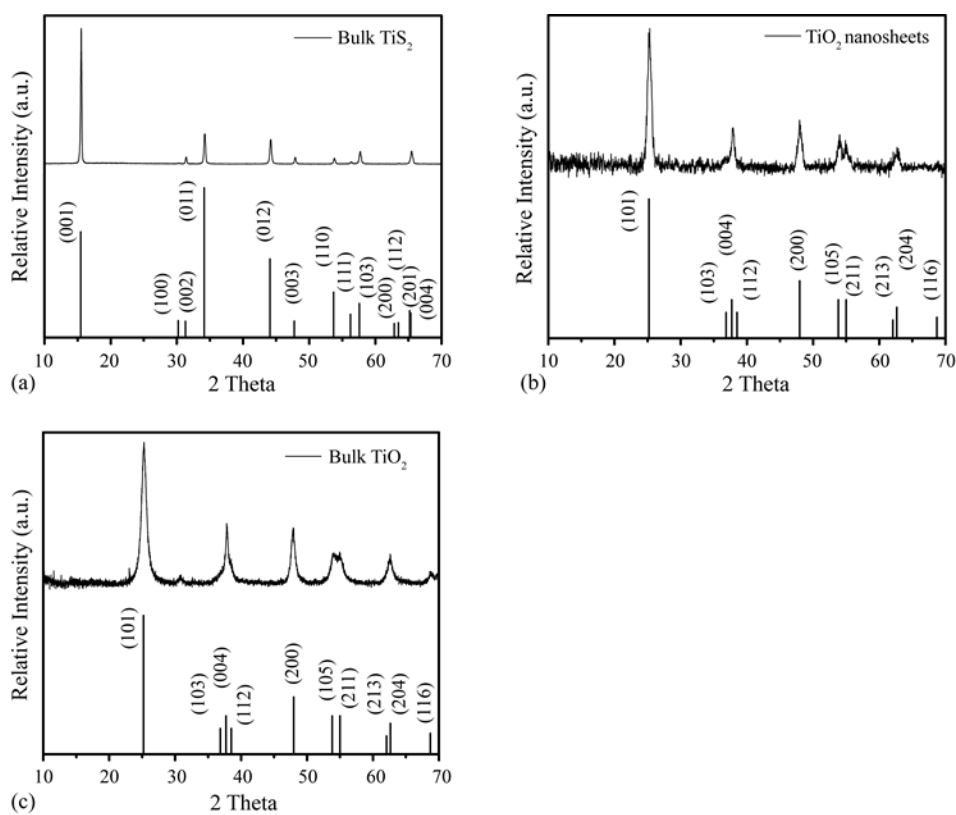
**FIG. S2.** Photographs of (a) dispersed  $\text{Li}_x\text{TiS}_2$  nanosheets obtained after electrochemical lithiation of bulk  $\text{TiS}_2$ , and (b)  $\text{TiO}_2$  nanosheets obtained after hydrothermal treatment.



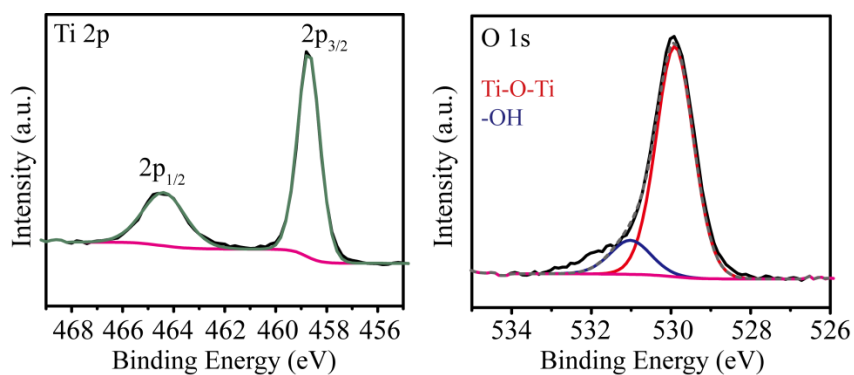
**FIG. S3.** Raman spectroscopy analysis of prepared  $\text{TiO}_2$  nanosheets. (a) Optical microscopy image with blue spot localized on a  $\text{TiO}_2$  nanosheet and red spot on carbon residue on the background. (b) Corresponding Raman spectrum from the red and blue spots in (a). The peak at  $150\text{ cm}^{-1}$  is from the  $E_g$  mode of anatase while the large peak at  $520\text{ cm}^{-1}$  is from the crystalline Si substrate.



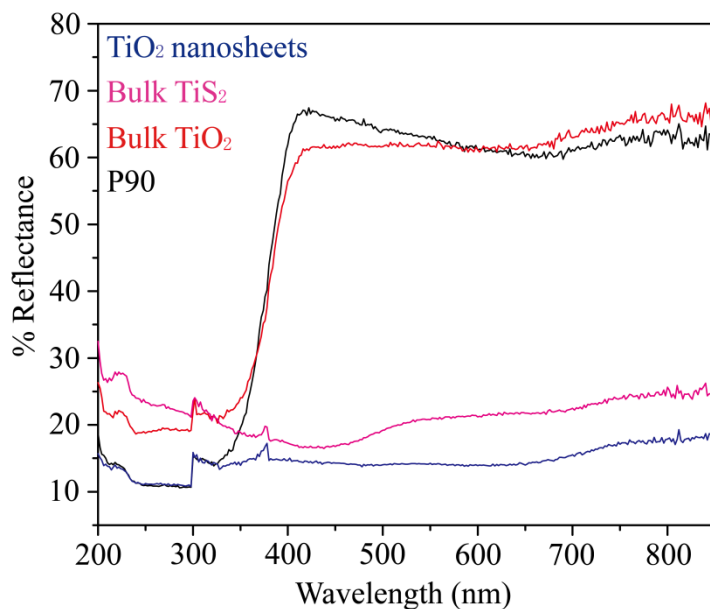
**FIG. S4.** SEM images of as-received, bulk  $\text{TiS}_2$ .



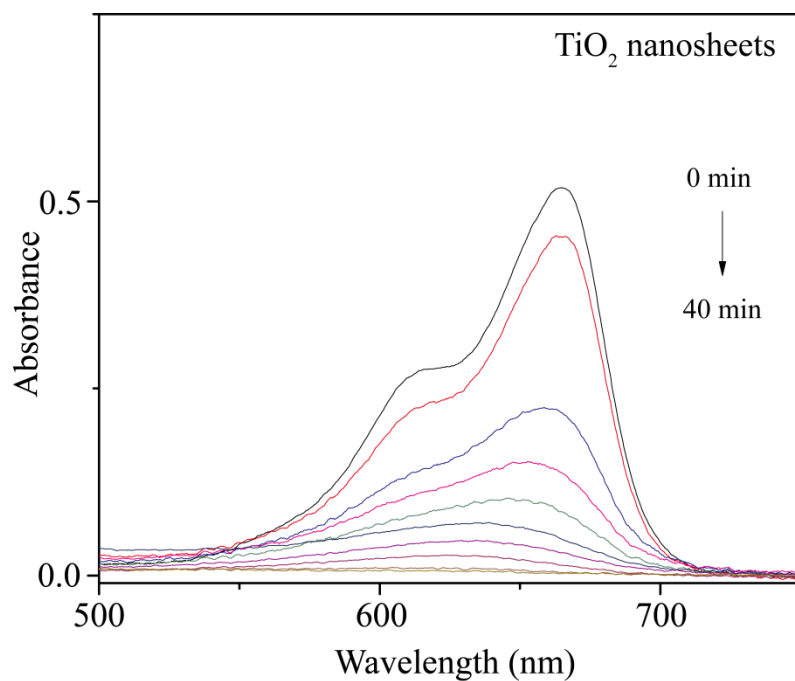
**FIG. S5.** XRD pattern of (a) as-received, bulk  $\text{TiS}_2$ , (b) as-prepared  $\text{TiO}_2$  nanosheets obtained after hydrothermal treatment of  $\text{TiS}_2$  nanosheets, and (c) as-prepared bulk  $\text{TiO}_2$  obtained after hydrothermal treatment of bulk  $\text{TiS}_2$ . The reference patterns for  $\text{TiS}_2$  and  $\text{TiO}_2$  were obtained from JCPDS No.15-0853 and JCPDS No. 21-1272, respectively.



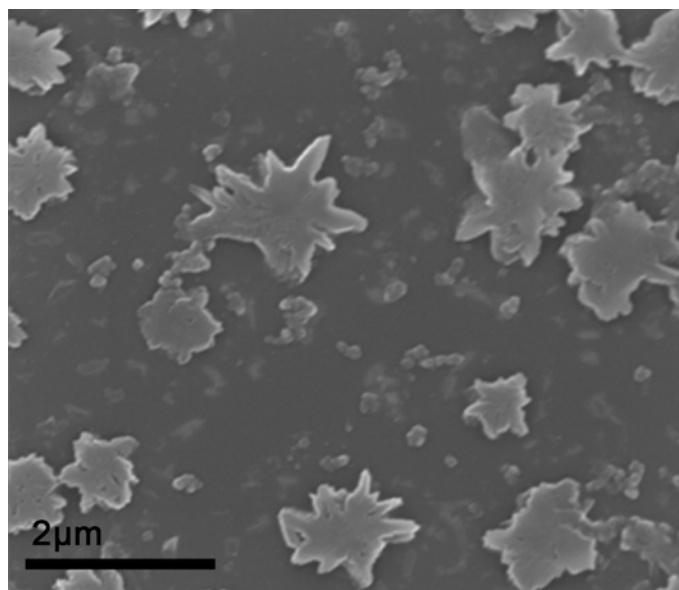
**FIG. S6.** XPS analysis of P25  $\text{TiO}_2$  (aligning to the C 1s peak at 284.7 eV). The Ti  $2p^{3/2}$  and Ti  $2p^{1/2}$  peaks are found at 587.3 eV and 464.4 eV. In the O 1s spectrum, the peak at 529.2 is assigned to oxygen in the  $\text{TiO}_2$  lattice (e.g., Ti-O-Ti) while the peak at 531.01 eV is attributed to surface hydroxide.



**FIG. S7.** Diffuse reflectance spectra obtained for  $\text{TiO}_2$  nanosheets, bulk  $\text{TiS}_2$ , bulk  $\text{TiO}_2$  and P90  $\text{TiO}_2$ . Bulk  $\text{TiS}_2$  refers to the as-obtained  $\text{TiS}_2$  powder. Bulk  $\text{TiO}_2$  refers to the  $\text{TiO}_2$  obtained after hydrothermal treatment of the bulk  $\text{TiS}_2$  powder (without electrochemical lithiation and exfoliation).



**FIG. S8.** Change in UV-vis absorbance of MB (5 ppm initial concentration) in aqueous suspension of TiO<sub>2</sub> nanosheets under UV irradiation (0 – 40 min).



**FIG. S9.** SEM image of product obtained after electrochemical reduction of carbon-black free TiS<sub>2</sub> electrode followed by sonication. In this case, the binder used was carboxymethyl cellulose.