Fabrication of MoS_2/TiO_2 heterostructure with enhanced photocatalytic activity

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Table S1 The average grain size of TiO_2 and MoS_2/TiO_2.

Sample	Average grain size / nm
TiO_2 (T)	8.7
MoS_2/TiO_2 (5MT)	52.0
MoS_2/TiO_2 (10MT)	55.6
MoS_2/TiO_2 (30MT)	54.2
MoS_2/TiO_2 (50MT)	63.6

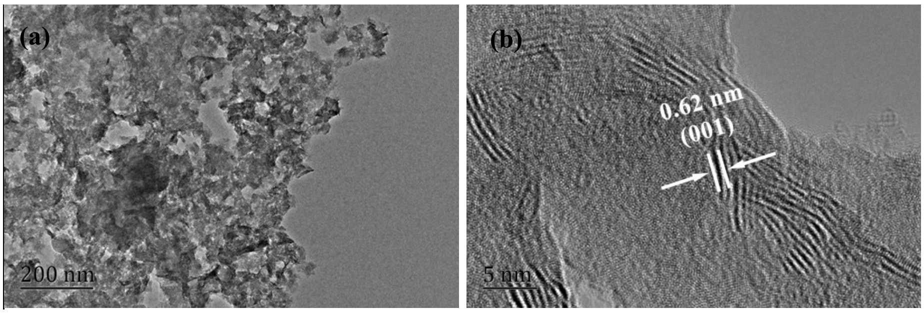

Fig. S1. TEM (a) and HRTEM (b) image of pure MoS_2

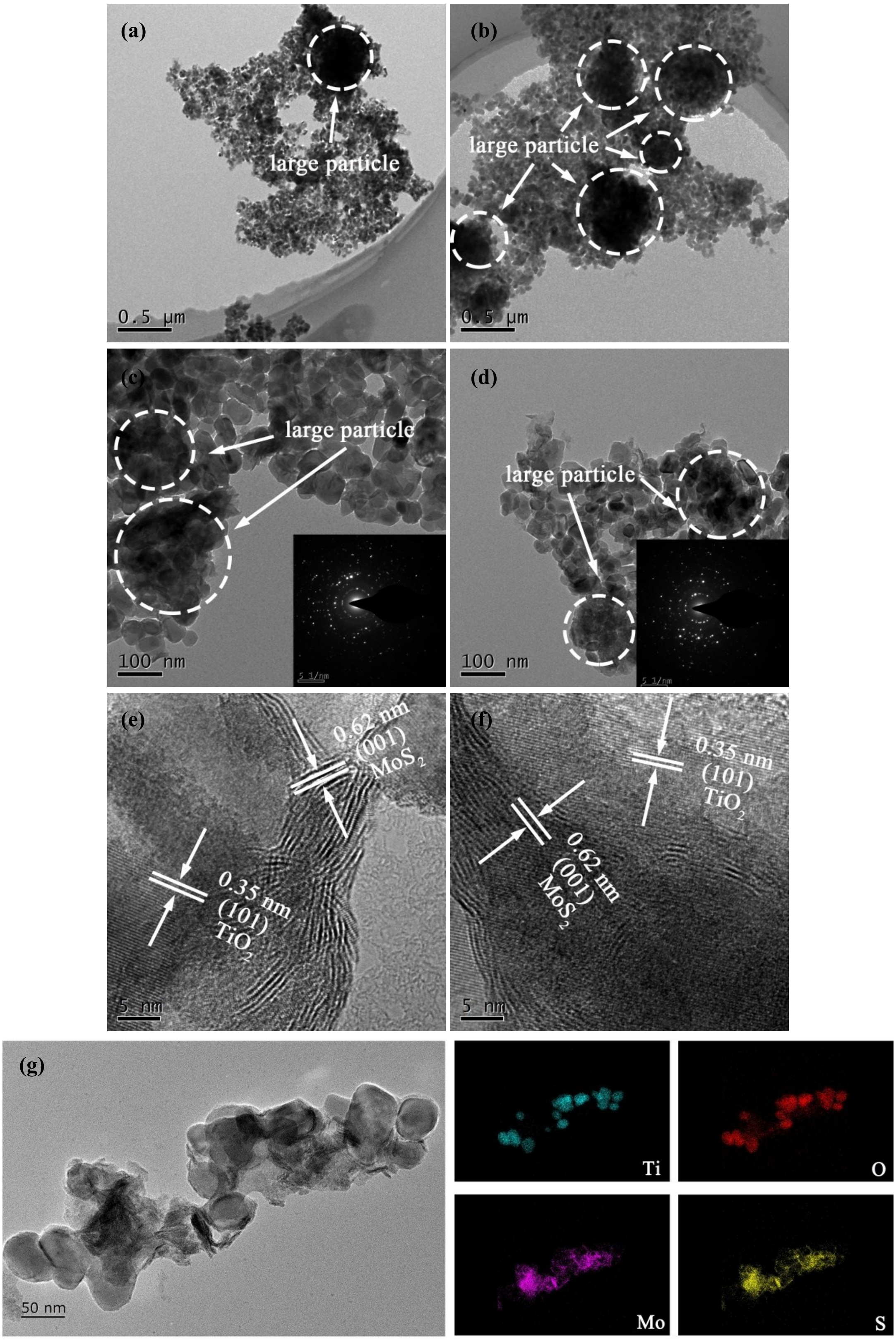

Fig. S2. TEM (a, b, c and d) and HRTEM (e and f) images of MoS_2/TiO_2 (50MT), and the EDS mapping (g).

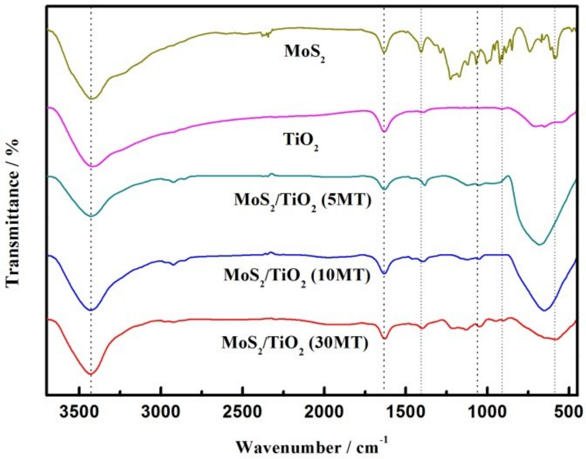

Fig. S3. FT-IR spectra of the MoS_2, TiO_2 and MoS_2/TiO_2.

To ascertain the contributions of reactive species in the photocatalytic degradation of RhB, the trapping experiments were carried out, and the ethylene diamine tetraacetic acid (EDTA), isopropanol (IPA) and benzoquinone (BQ) were used as scavengers to quench photogenerated hole h^+, hydroxyl free radical •OH and superoxide radical anion $\bullet O^{2-}$, respectively. The degradation efficiency of RhB over MoS_2/TiO_2 (10MT) samples with different scavengers is shown in Fig. S2. The degradation rate of RhB without any scavengers after illuminated for 2 h was 93%. After EDTA was added to the solution, the degradation rate decreased to 53 %, and the degradation efficiency was also quenched to 31 % when adding the BQ as a scavenger, illustrating that h^+ and $\bullet O^{2-}$ are crucial active species in the photocatalytic degradation process. However, a tiny decrease in the degradation rate of RhB is observed after the addition of IPA, indicating that •OH has a minor effect on the photocatalytic reaction, which may due to the valence band edge potential of MoS_2 is not sufficiently high to oxidize the H_2O or hydroxide ions to produce •OH.

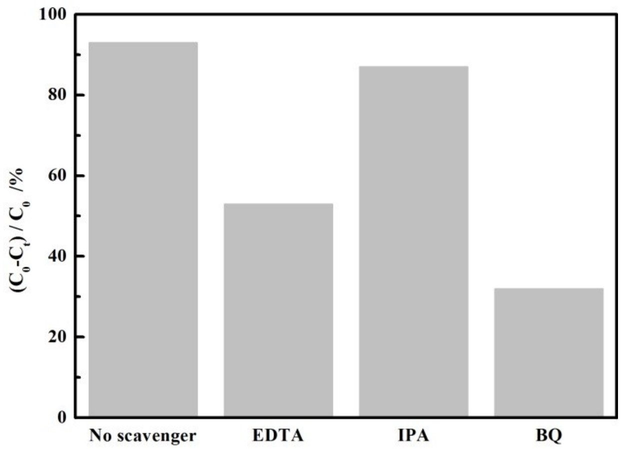

Fig. S4. Trapping experiments of photocatalytic degradation of RhB over MoS_2/TiO_2 (10MT).

From the mass spectra, these identified intermediates with m/z value of 443, 415, 387, 359 were those of initial RhB, N–de–ethylated intermediates such as N, N–diethyl–N'–ethylrhodamine, N, N–diethylrhodamine, N–ethyl–N'–ethylrhodamine, N–ethylrhodamine respectively, which were further degraded into possible intermediate corresponding to the m/z values of 331. This intermediate could be further degraded into m/z values of 149 (N, N–diethylaniline) and 125 (N–ethylmaleimide). These intermediate compounds are similar to previous studies on the degradation of RhB [1, 2]. According to the observation, it can confirm that RhB were photocatalytic degraded under the MoS_2/TiO_2 system.

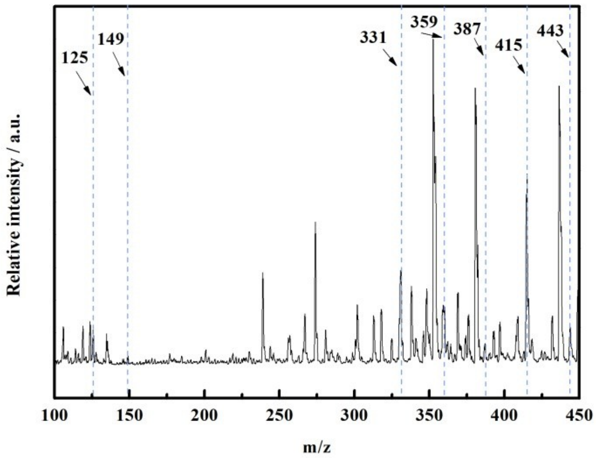

Fig. S5. LC–MS spectra of the photodegradation products of RhB.

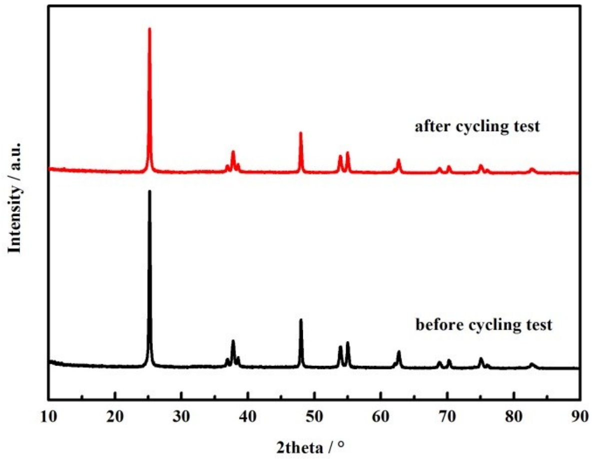

Fig. S6. XRD patterns of MoS_2/TiO_2 (10MT) before and after cycling test.

Table S2 Photocatalytic hydrogen generation performance of previous reports.

Sample	Light source	Average hydrogen production rate	Reference
TiO_2@MoS_2	300 W Xe lamp	1.68 mmol h^{-1} g^{-1}	[3]
2D–2D MoS_2/TiO_2	300 W Xe lamp	2.15 mmol h^{-1} g^{-1}	[4]
TiO_2/MoS_2/graphene	350 W Xe lamp	1.65 mmol h^{-1} g^{-1}	[5]
TiO_2@MoS_2	300 W Xe lamp	1.60 mmol h^{-1} g^{-1}	[6]
$TiO_2/MoS_2/TiO_2$	300 W Xe lamp	0.56 mmol h^{-1} g^{-1}	[7]
N–TiO_{2-x}@MoS_2	/	1.882 mmol h^{-1} g^{-1}	[8]
MoS_2 Quantum Dots@TiO_2	300 W Xe lamp	0.135 mmol h^{-1} g^{-1}	[9]
MoS_2/TiO_2 (10MT, this work)	300 W Xe lamp	1.93 mmol h^{-1} g^{-1}	

Table S3 The impedance parameters derived by fitting the EIS responses on TiO_2 and MoS_2/TiO_2 in 0.1 M Na_2SO_4.

Sample	Rs (Ω)	Rct (Ω)	CPE (mF/cm^2)
TiO_2 (T)	113.96	1.61×10^7	0.95
MoS_2/TiO_2 (5MT)	114.47	2.54×10^6	0.92
MoS_2/TiO_2 (10MT)	117.13	2.04×10^6	0.82
MoS_2/TiO_2 (30MT)	118.56	3.26×10^6	0.88
MoS_2/TiO_2 (50MT)	116.12	4.99×10^6	0.92

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