Supporting Information

Efficient charge transfer on tunable morphology of TiO_2/MoS_2 photocatalyst for enhanced hydrogen production

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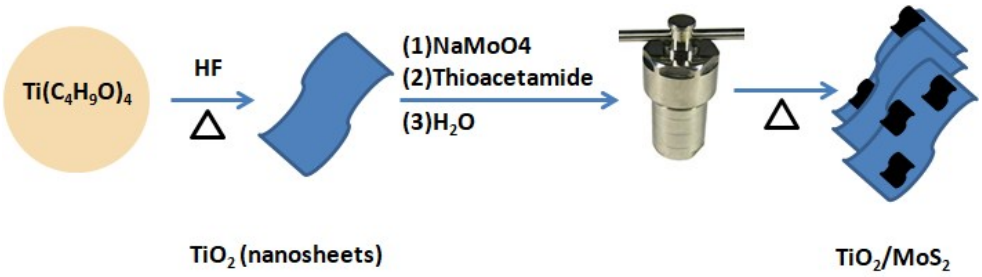
CHARACTERIZATION

The crystallographic phase of the prepared samples were determined by X-ray diffraction (XRD). The crystallite size was calculated by using the Scherrer formula ($d = 0.9\lambda/B \cos\theta$, where d, λ, B and θ are the crystallite size, Cu Kα wavelength, full width at half maximum (FWHM) intensity in radians and Bragg's diffraction angle, respectively. The light harvesting capability of the samples were assessed by using UV-vis diffuse reflectance spectroscopy (DRS) Perkin Elmer Lambda 750 accompanied by an integrating sphere accessory and utilizing $BaSO_4$ as a diffuse reflectance standard in the wavelength spanning from 300 to 2000 nm. The valance states and surface chemical composition of sample was studied by XPS analysis on a KRATOS AXIS 165 with Mg Kα irradiation. About 10^{-9} Torr pressure was maintained in the spectrometer. The Field emission scanning electron microscopy (FESEM) images of sample were taken by using JEOL JSM 7610F. The high-resolution transmission electron microscopy (HR-TEM) images of $TiO_2@MoS_2$ were obtained using FEI Tecnai FE12 transmission electron microscope with a changeable accelerating voltage range of 40- 120V. All TEM samples were prepared by depositing a drop of diluted suspensions in acetone on a carbon coated copper grid and allowed to dry naturally. Photoelectrochemical studies were executed on CHI 6005E electrochemical analyzer (CH Instruments Inc., USA).



Scheme S1. Schematic presentation for preparation of TiO_2/MoS_2 composite.

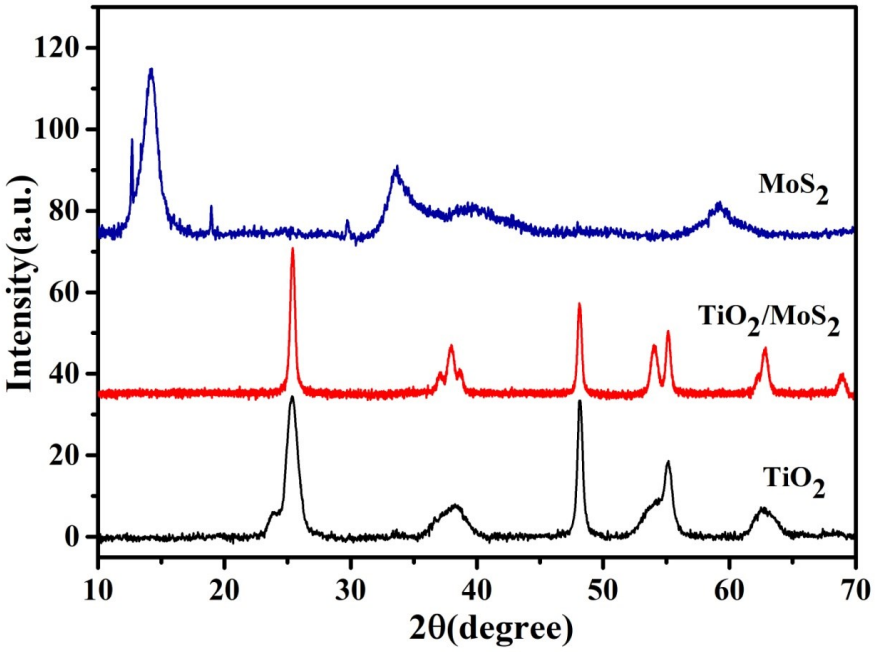


Figure S1. XRD pattern of TiO_2, MoS_2 And TiO_2/MoS_2 composite.

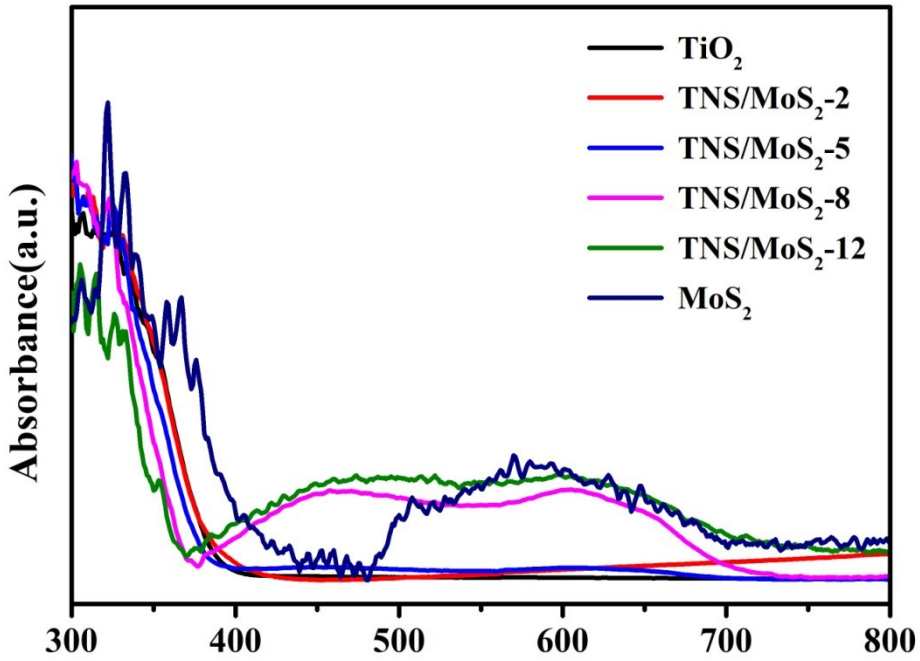


Figure S2. UV-Vis DRS spectra of TNS/MoS_2

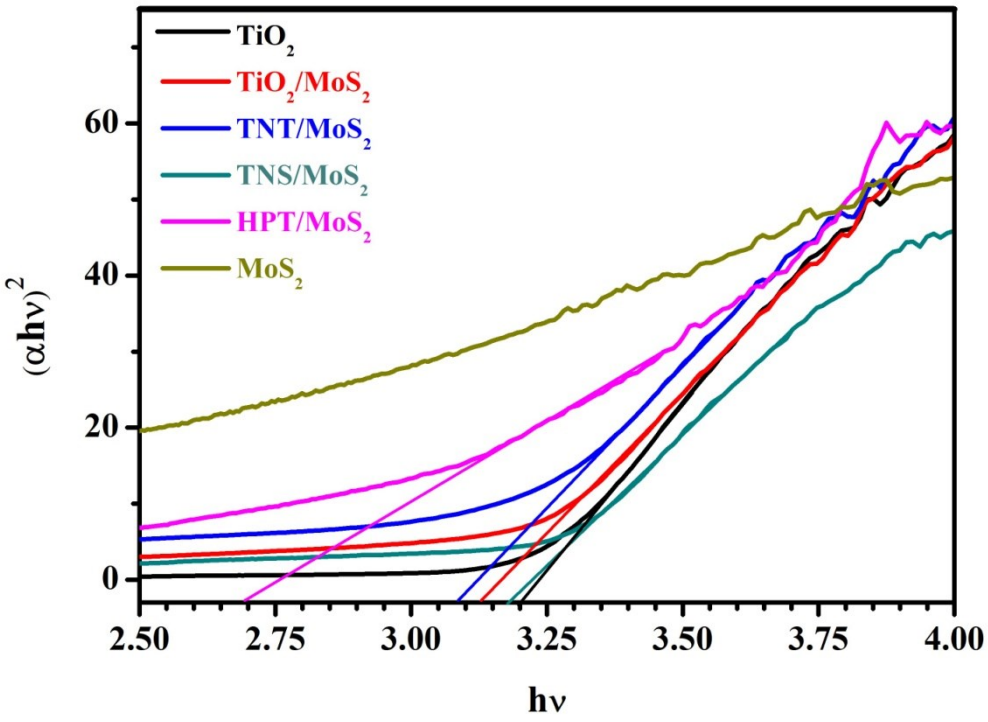


Figure S3. Tauc plot of TiO_2 and TiO_2/MoS_2 composite.

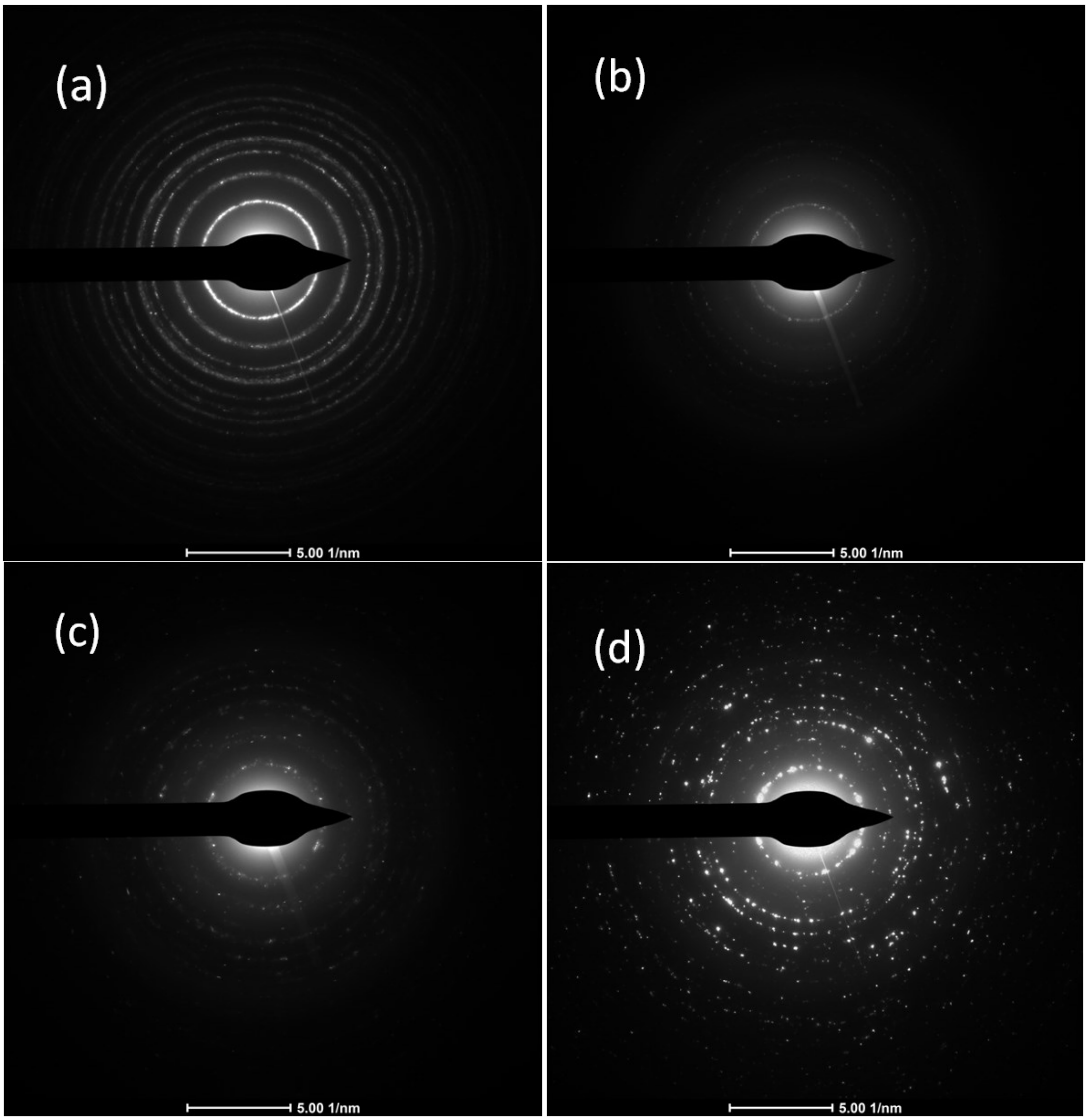
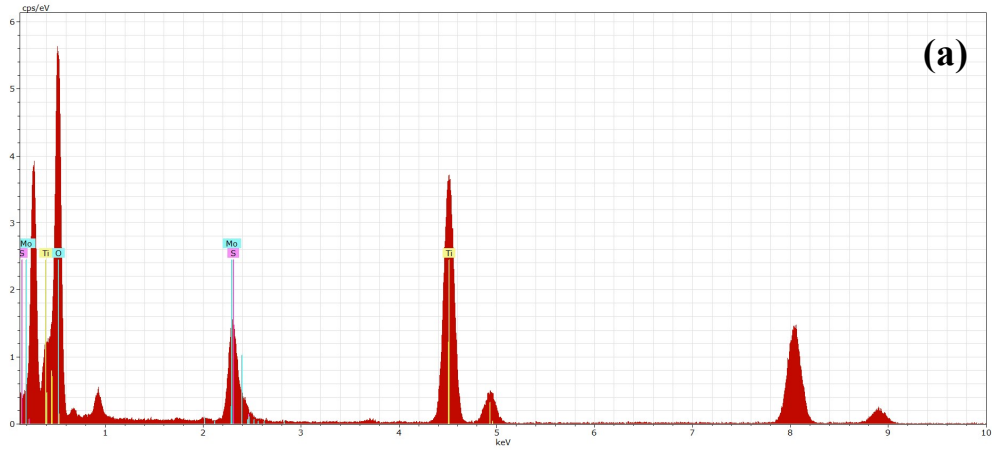
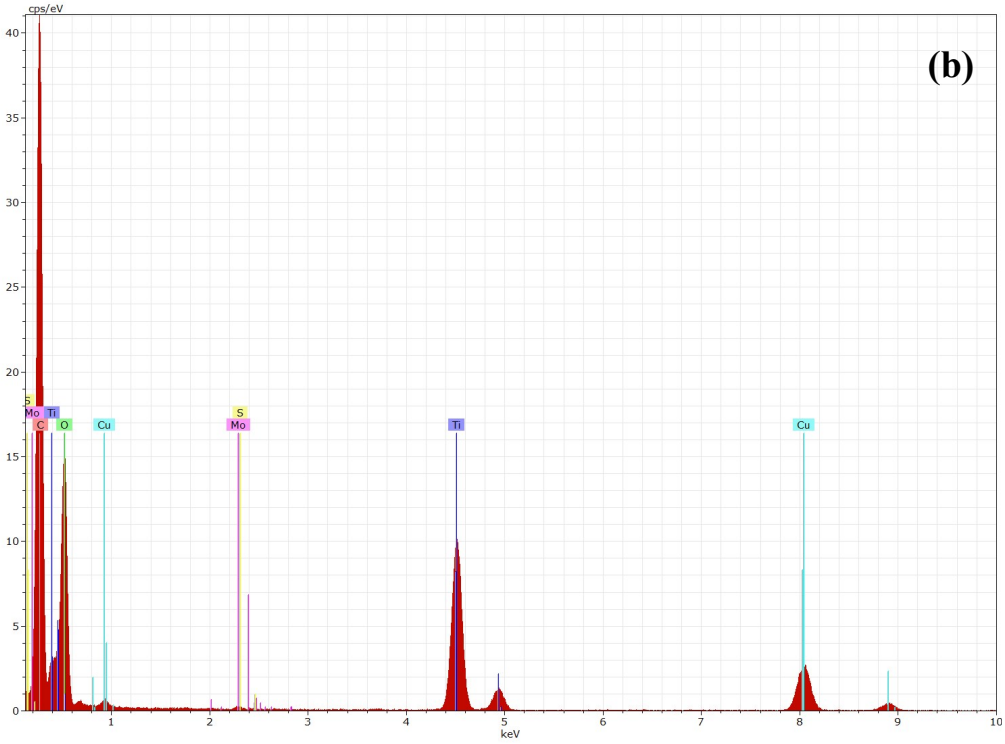
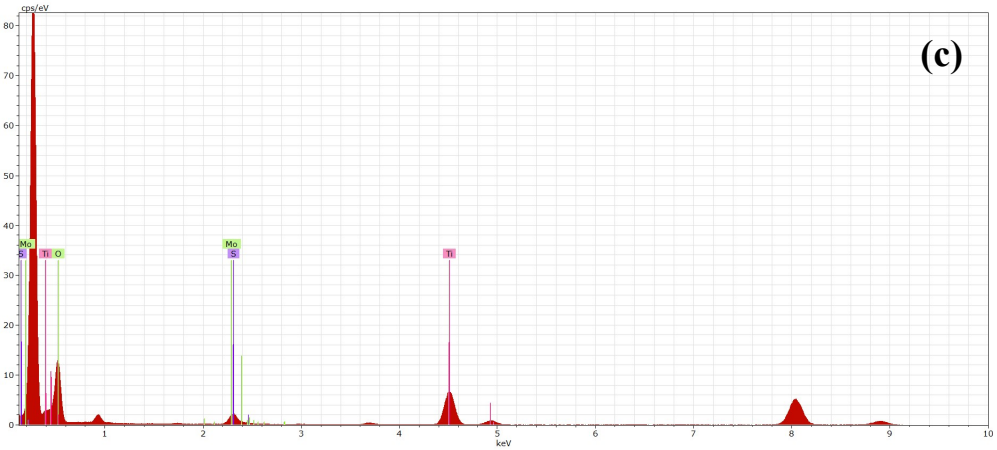


Figure S4. SAED pattern of (a)TiO_2/MoS_2, (b)TNT/MoS_2, (c)HPT/MoS_2 and (d) TNS/MoS_2.


(a)
cps/eV
keV
Mo
Si
Ti
O


(b)
cps/eV
keV
S
Mo
Ti
C
O
Cu


(c)
cps/eV
keV
Mo
Si
Ti
O

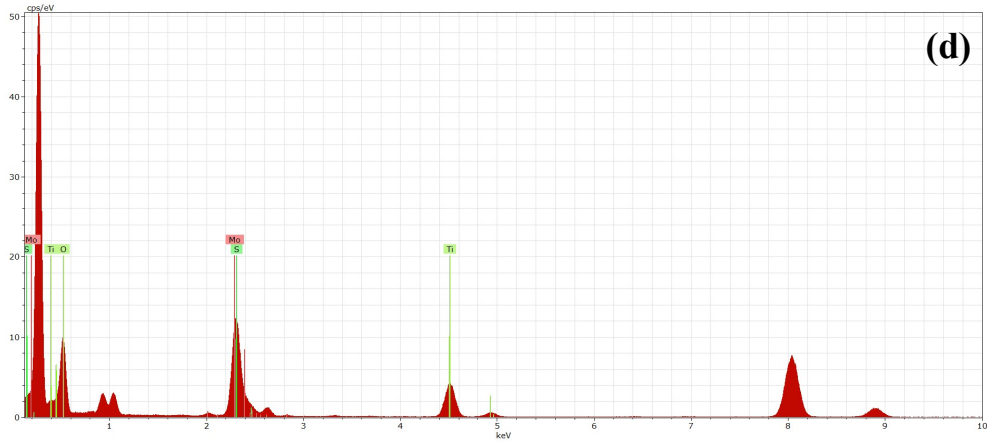


Figure S5. EDAX pattern of (a) TiO_2/MoS_2 (b) TNS/MoS_2 (c) TNT/MoS_2 and (d) HPT/MoS_2.

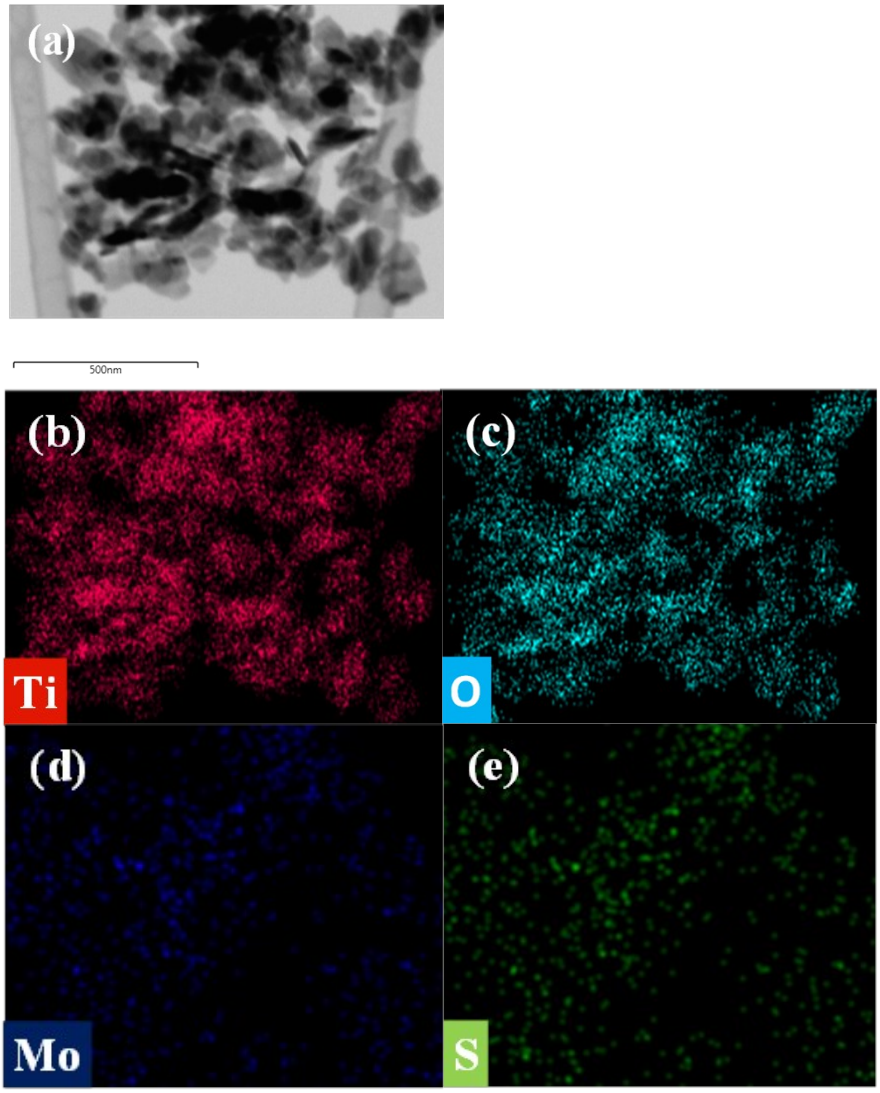


Figure S6. Elemental mapping of TNS/MoS_2

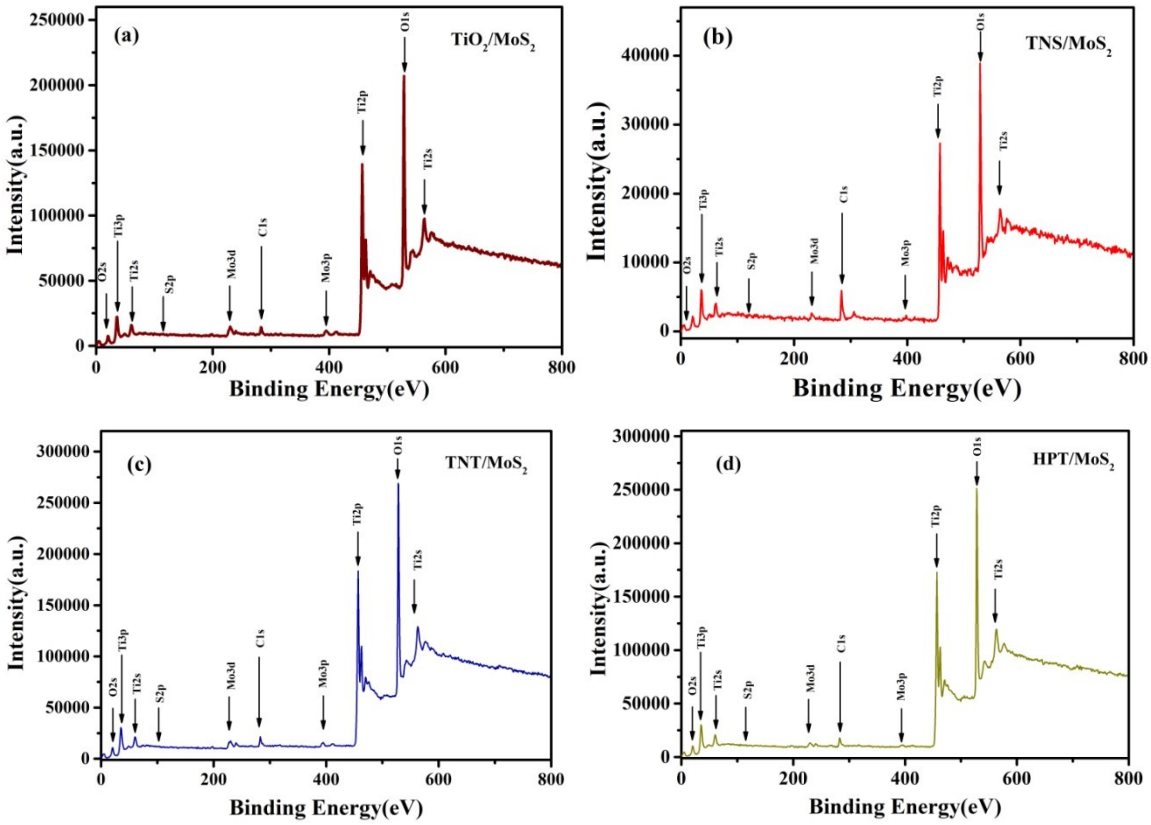


Figure S7. Survey XPS spectrum of (a)TiO_2 /MoS_2 (b)TNS/MoS_2 (c) TNT/MoS_2 and (d) HPT/MoS_2.

Table S1. Standard deviation of XPS analysis of actual data and fitted data (mentioned in %)

Catalyst	Ti	O	Mo	S
TiO_2/MoS_2	1.42±0.23	0.88±0.085	4.23±0.12	5.13±0.13
TNT/MoS_2	1.63±0.41	0.86±0.075	5.03±0.17	4.9±0.11
TNS/MoS_2	1.57±0.25	0.79±0.065	4.61±0.12	5.09±0.14
HPT/MoS_2	1.61± 0.52	0.85±0.054	4.83±0.15	4.76±0.12

Table S2. Comparative table of photocatalytic hydrogen production.

S.No	Methods	Materials	Light Source	SED	Vessel	H_2 evolution rate (μmol $g^{-1}h^{-1}$)	Ref.
1	Hydrothermal	$CuInS_2/MoS_2/TiO_2$	300W Xenon arc lamp	Na_2S & Na_2SO_3 (0.1M)	Pyrex flask	141	1
2	Ball mill	MoS_2/TiO_2 (P25)	300W Xenon arc lamp	Methanol	Not mentioned	150.7	2
3	Hydrothermal	MoS_2/TiO_2 nanofibre	300W Xenon arc lamp	Na_2S & Na_2SO_3 (0.25M)	Quartz flask	490	3
4	CVD	MoS_2/TiO_2 nanotube	Not mentioned	Not mentioned	Not mentioned	440	4
5	Hydrothermal	MoS_2/B-TiO_2	300W UV xenon arc lamp	Methanol	Pyrex flask	500	5
6	Hydrothermal	MoS_2/TiO_2 nanofibre	300W Xenon arc lamp	Na_2S (0.35M) Na_2SO_3 (0.25M)	Quartz flask	1600	6
7	Hydrothermal	MoS_2 QD/TiO_2	One sun	Methanol	Quartz flask	3100	7
8	Hydrothermal	MOF-derived flower like MoS_2/TiO_2	300W Xenon arc lamp	TEOA	Not Mentioned	10046	8
9	CVD	MoS_2/TiO_2 nanosheet	300W Xenon arc lamp	Ethanol	Quartz flask	4300	9
10	Hydrothermal	MoS_2-TiO_2/Au Hybrid	300W Xenon arc lamp	Methanol	Quartz flask	190	10
11	Hydrothermal	MoS_2/TiO_2 (commercial anatase)	300W Xenon arc lamp	Na_2S (0.3M) Na_2SO_3 (0.3M)	Pyrex flask	41.33	Our work
12	Hydrothermal	MoS_2/TiO_2 (nanotubes)	300W Xenon arc lamp	Na_2S (0.3M) Na_2SO_3 (0.3M)	Pyrex flask	29.71	Our work
13	Hydrothermal	MoS_2/TiO_2 (nanosheets)	300W Xenon arc lamp	Na_2S (0.3M) Na_2SO_3 (0.3M)	Pyrex flask	77.41	Our work
14	Hydrothermal	MoS_2/TiO_2 (hierarchical)	300W Xenon arc lamp	Na_2S (0.3M) Na_2SO_3 (0.3M)	Pyrex flask	65.54	Our work

Table S3. ICP-AES analysis of different composite.

S.No	Sample	Mo(mg/l)	Ti(mg/l)
1	TiO_2/MoS_2	10.37	437.0
2	TNT/MoS_2	12.57	453.5
3	HPT/MoS_2	13.59	445.9
4	TNS/MoS_2	11.31	460.6

1. Y-J. Yuan, G. Fang, D. Chen, Y. Huang, Li-X. Yang, D-P. Cao, J. Wang, Yu Z-T and Zou Z-G, *Dalton Trans.,* 2018, **47**, 5652-5659.
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