Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supporting Information:

Hollow MoS_2-Supported $MAPbI_3$ Composites for effective photocatalytic hydrogen evolution

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Chemicals:

All reagents were used without any purification. PbI_2 (Lead(Ⅱ) Iodide, 99%, Aldrich), hydroiodic acid (HI, 57 wt.% in water, Aladdin), methylamine (CH_3NH_2, 30 wt.% in absolute ethanol, Aladdin), hypophoaphoeous acid (H_3PO_2, 50wt% in water, Aladdin), Manganese Carbonate ($MnCO_3$, Aladdin), L-cysteine ($C_3H_7NO_2S$, Aladdin), Sodium molybdate ($Na_2MoO_4 \cdot 2H_2O$), Ethyl acetate ($C_4H_8O_2$, 99.8%, Sinopharm)

Synthesis of MAI:

Under ice water bath, 20 mL of HI solution and 45 mL of CH_3NH_2 ethanolic solution were added to the round-bottomed flask, and stirring was continued for 2 hours; the solution was then transferred to a rotary evaporator and evaporated to dryness at 60 °C. The obtained solid powder was dissolved in anhydrous ethanol and recrystallized from anhydrous ether. This process was repeated 3 times to obtain a white powder. Dry in a vacuum oven at 60 °C for ten hours to obtain a white MAI powder.

Characterizations

The phase structure of the material can be obtained by analyzing the X-ray diffraction pattern (Cu Kα (λ = 0.15406 nm)). The Zeta potential of H-MoS_2 and $MAPbI_3$ was measured using a multi-angle particle size potential analyzer (Nanobrook Omni). Sample preparation method: the sample is dispersed in HI solution through ultrasonic treatment, and then the suspension is put in the sample pool for detection. FEI Inspect F50 scanning electron microscope was used to characterize the morphology and element distribution of the samples; TEM and HRTEM images of the material were obtained by FEI G2 20 transmission electron microscope with an accelerating voltage of 200 eV. The absorption spectra of the materials were obtained with an ultraviolet-visible (UV-vis) spectrophotometer (UV2700), and the photoluminescence (PL) was obtained on a Fluoromax-4 fluorescence spectrometer (Horiba), and fit the mean life using a second-order function. X-ray photoelectron spectroscopy (XPS) was used to characterize the chemical state information of the element surface, and the carbon signal at 284.8 eV was used for nuclear correction. Gaussian fitting was performed on the obtained energy spectral images using the corresponding software.

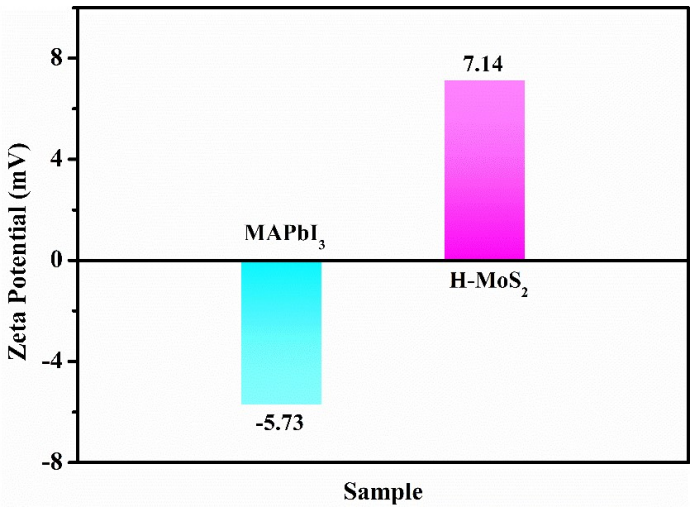

Figure S1. Zeta potentials of $MAPbI_3$ and H-MoS_2.

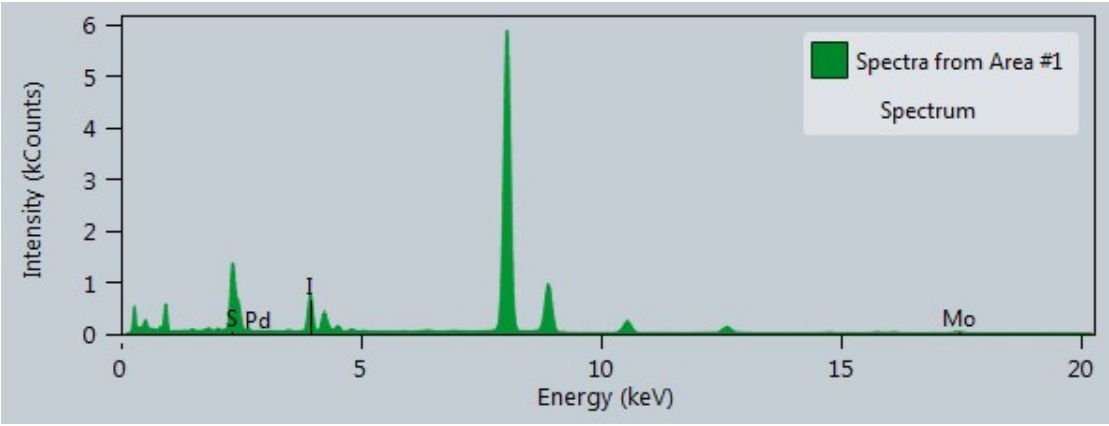

Figure S2. EDS analysis spectra

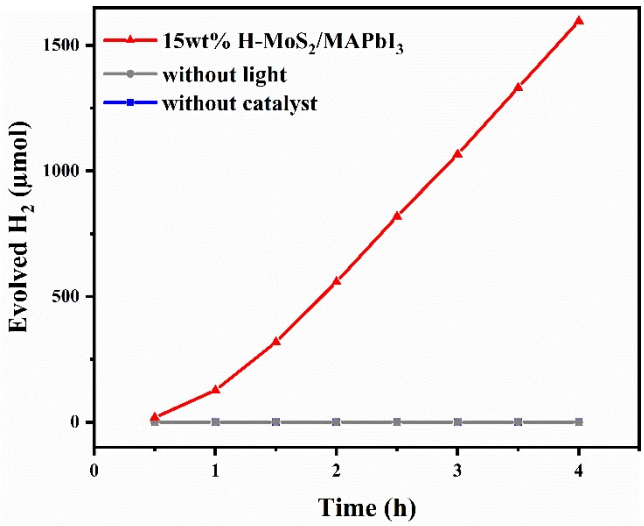

Figure S3. Comparison of H_2 evolution activities of 15wt%H-MoS_2/$MAPbI_3$, without light irradiation and without photocatalyst.

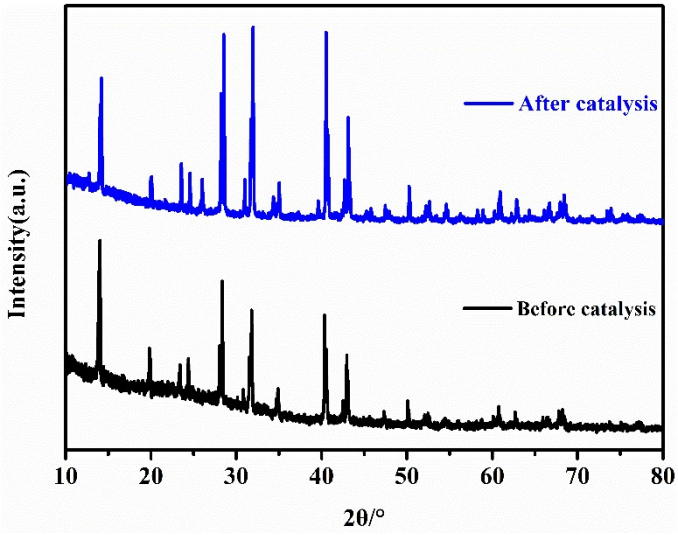

Figure S4. (a) XRD patterns 15% H-MoS_2/$MAPbI_3$ before and after catalysis.

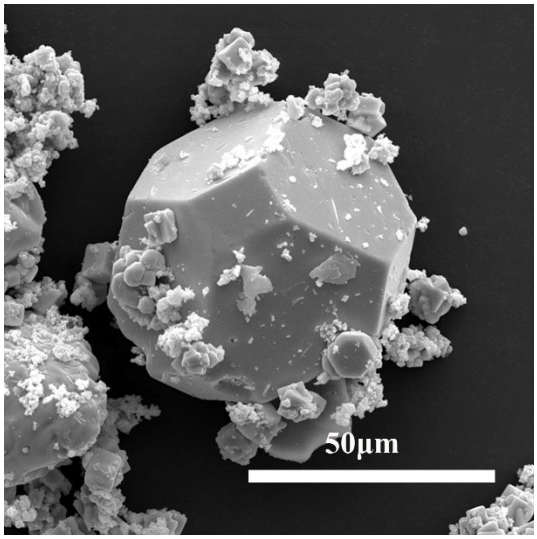

Figure S5. SEM images of 15% H-MoS_2/$MAPbI_3$ after catalysis.

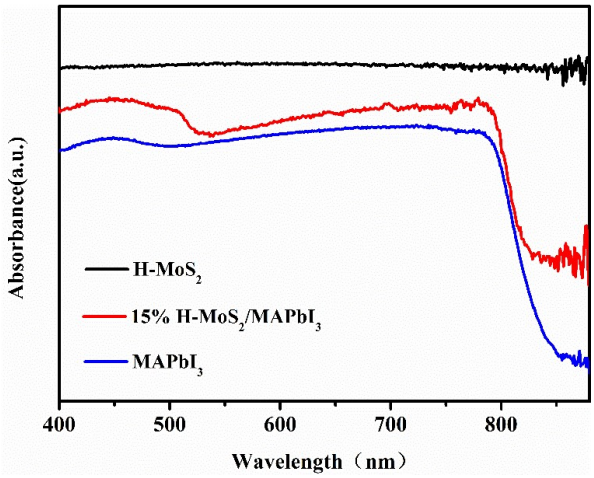

Figure S6. UV-vis absorption spectra of MoS_2, $MAPbI_3$ and 15% MoS_2/$MAPbI_3$.

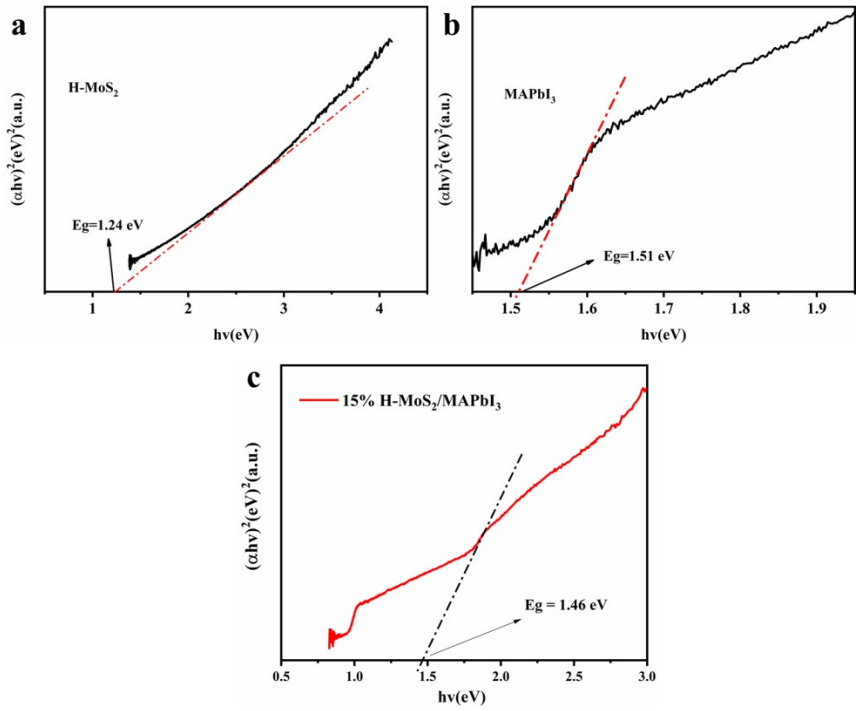

Figure S7. Band gap energy (Eg) of H-MoS_2 , $MAPbI_3$ and H-MoS_2/$MAPbI_3$ calculated by Tauc plot absorption spectroscopy.

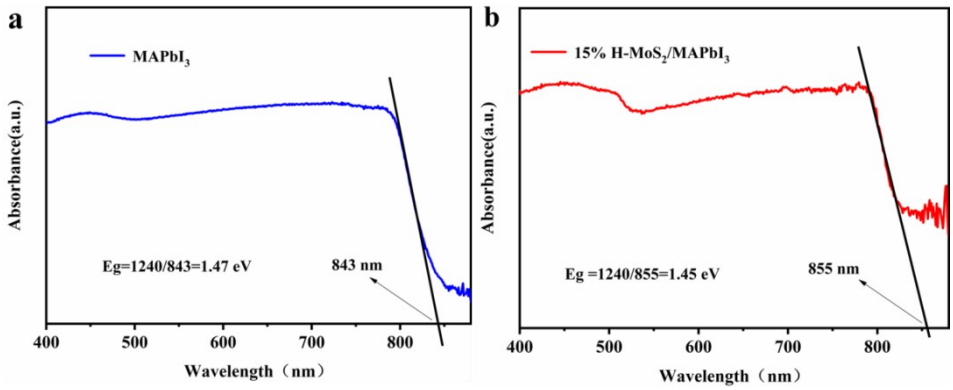

Figure S8. Band gap energy (Eg) of $MAPbI_3$ and H-MoS_2/$MAPbI_3$ calculated by tangent method.

Table S1. Comparison of H_2 evolution over reported $MAPbI_3$ in photocatalytic HI splitting system.

Materials	Light source (λ in nm)	H_2 activity ($\mu mol \cdot h^{-1}$)	Ref
Pure $MAPbI_3$	300 W Xe lamp (λ ≥ 420 nm)	1.53	This work
H-MoS_2/ $MAPbI_3$	300 W Xe lamp (λ ≥ 420 nm)	399	This work

$MAPbI_3$/Pt	300 W Xe lamp (λ ≥ 420 nm)	15.1	This work
$MAPbI_3$/Pt	100W solar simulat (λ > 475nm)	0.57	[1]
$MAPbI_3$/rGO	300 W Xe lamp (λ ≥ 420 nm)	93.9	[2]
$MA_3Bi_2I_9$	300 W Xe lamp (λ ≥ 420 nm)	16.9	[3]
$MAPbI_3/Ni_3C$	300 W Xe lamp (λ ≥ 420 nm)	236	[4]
$MAPb(I_{1-x}Brx)_3$	300 W Xe lamp (λ ≥ 420 nm)	147	[5]
$MAPbI_3$/CoP	150 W Xe lamp (λ≥420 nm)	236.2	[6]
$MAPbI_3/Pt/TiO_2$	300 W Xe lamp (λ ≥ 420 nm)	529.3	[7]
$MAPbI_3$/BP	300 W Xe lamp (λ ≥ 420 nm)	374	[8]

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