Supporting Information

Charging Dynamics Engineering: Quantum Dots-Induced Full-Space Electric Field Cooperative Ag_2S QDs/$CoWO_4$ S-Scheme Heterojunction boosting photocatalytic hydrogen evolution

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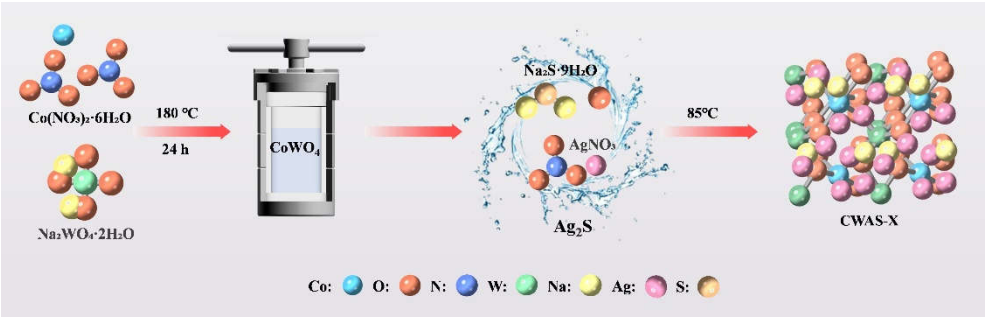

Fig. S1 The preparation process of CWAS–10.

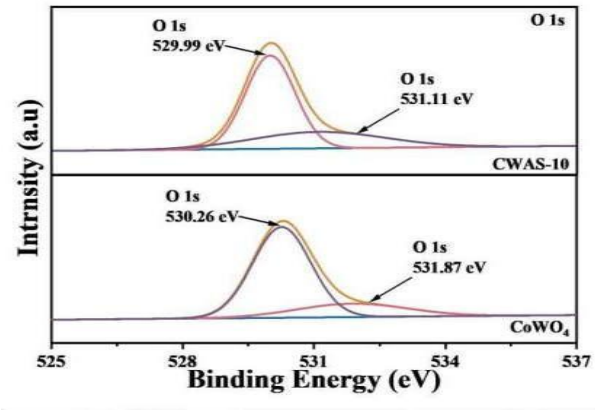

Fig. S2 High–resolution XPS spectrum of O 1*s*.

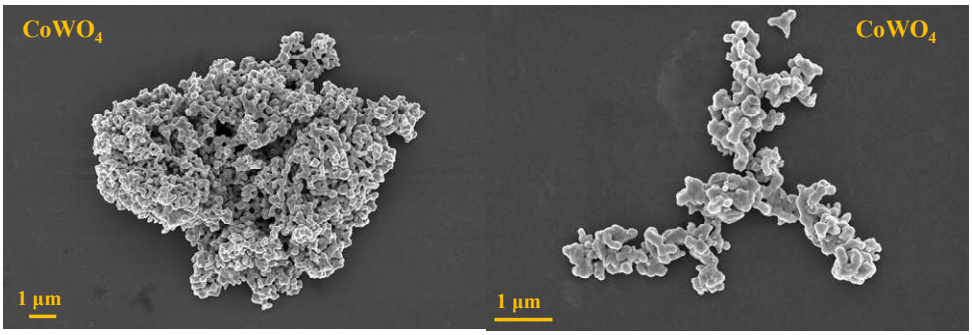

Fig. S3 SEM of $CoWO_4$.

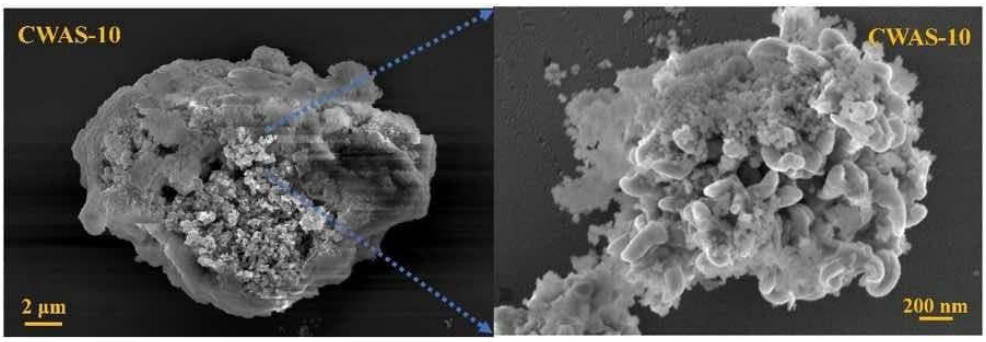

Fig. S4 SEM of CWAS–10.

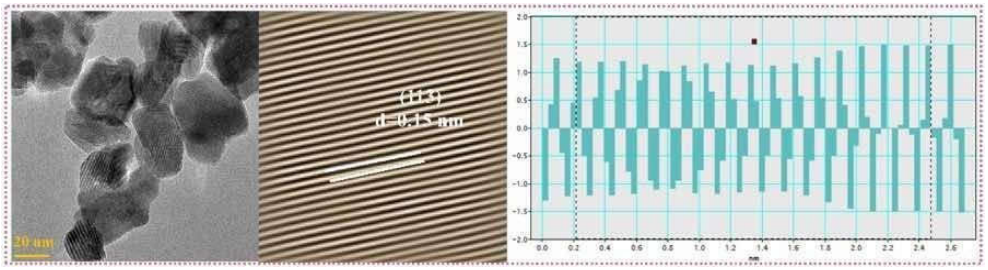

Fig. S5 HRTEM of $CoWO_4$.

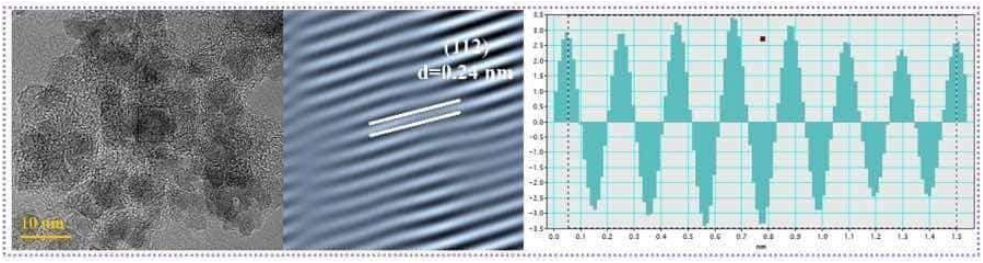

Fig. S6 HRTEM of Ag_2S.

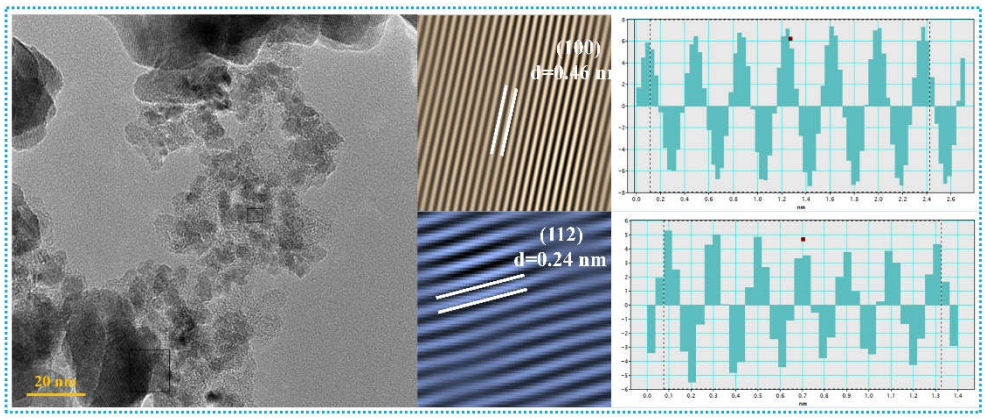

Fig. S7 HREM of CWAS–10.

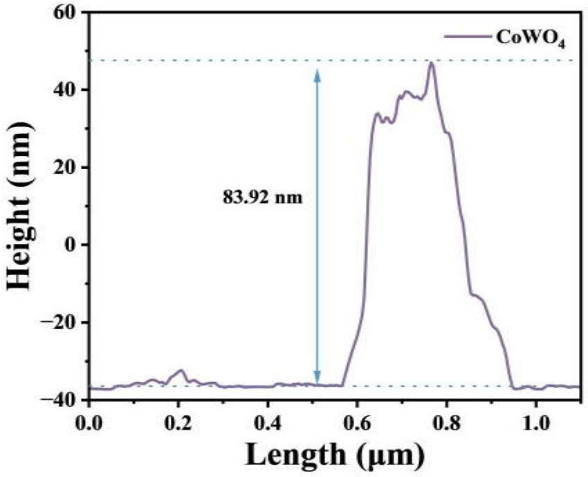

Fig. S8 AFM of $CoWO_4$.

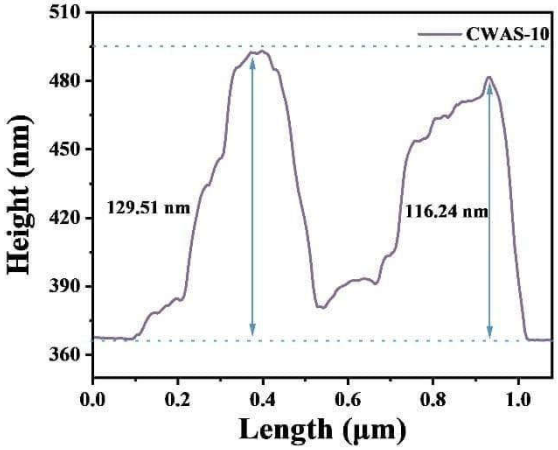

Fig. S9 AFM of CWAS–10.

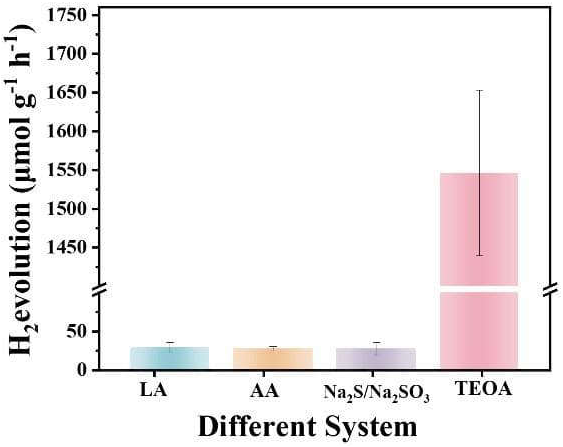

Fig. S10 the H_2 production amounts of different sacrificial reagents.

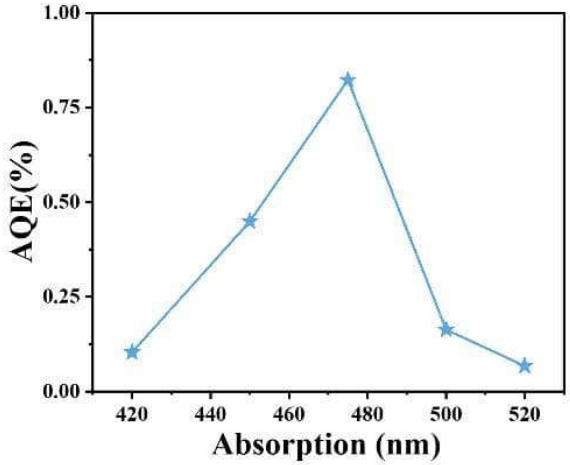

Fig. S11 AQE of CWAS-10.

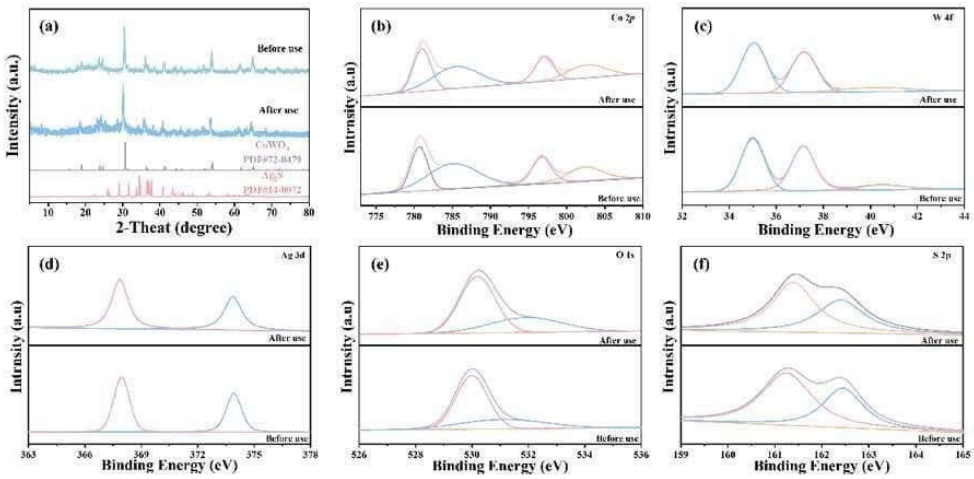

Fig. S12 a) XRD after hydrogen production experiment of CWAS–10; XPS detailed spectra after the CWAS–10 hydrogen generation experiment: b) Co 2*p*; c) W 4*f*; d) Ag 3*d*; e) O 1*s*; f) S 2*p*.

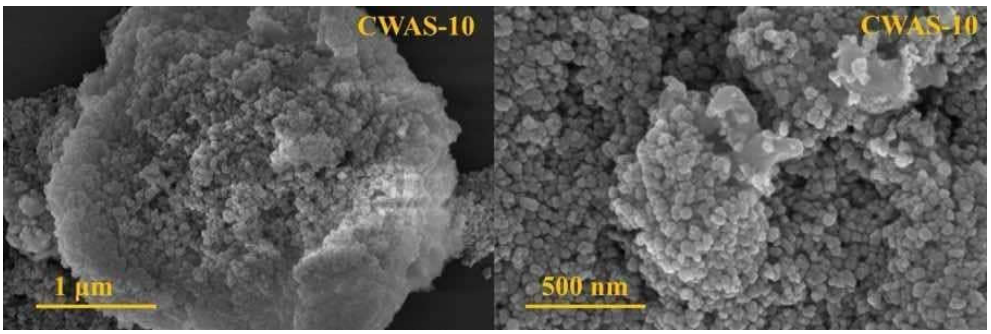

Fig. S13 SEM after hydrogen production experiment of CWAS–10.

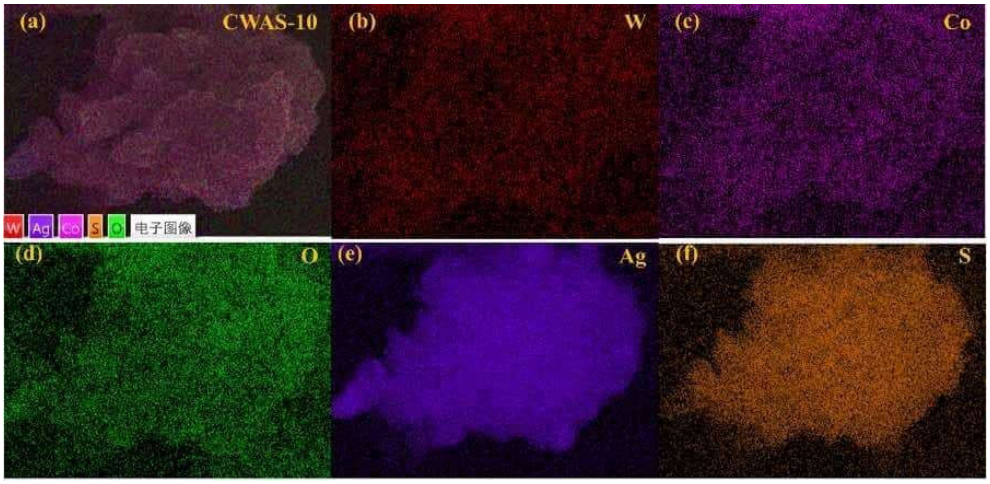

Fig. S14 EDS analysis after the hydrogen production experiment of CWAS–10

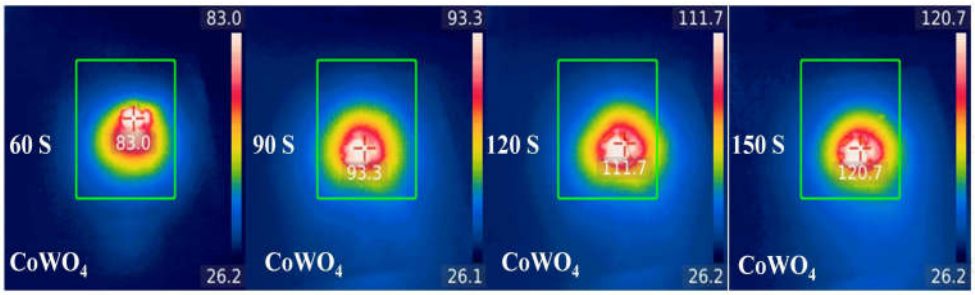

Fig. S15 The surface temperatures of $CoWO_4$.

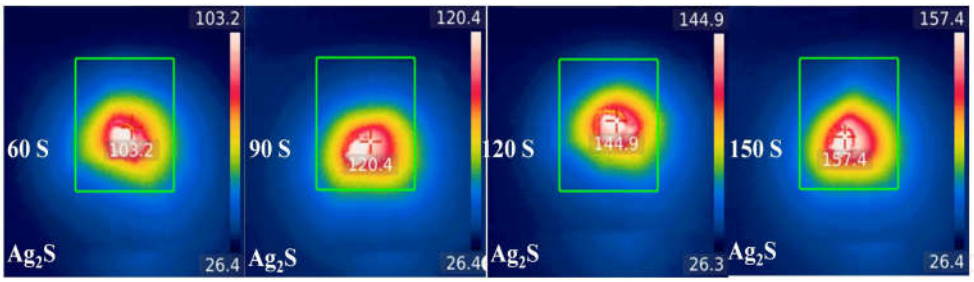

Fig. S16 The surface temperatures of Ag_2S.

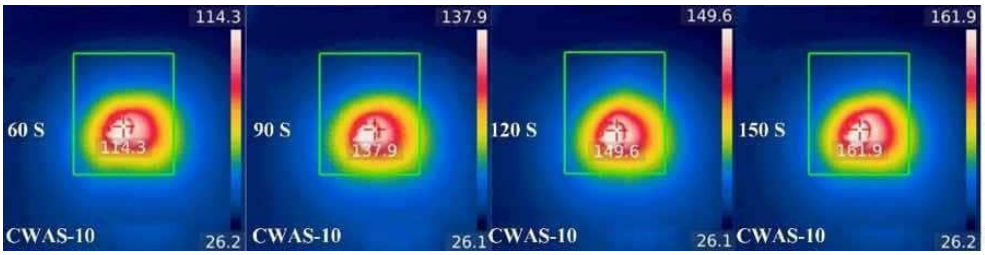

Fig. S17 The surface temperatures of CWAS-10.

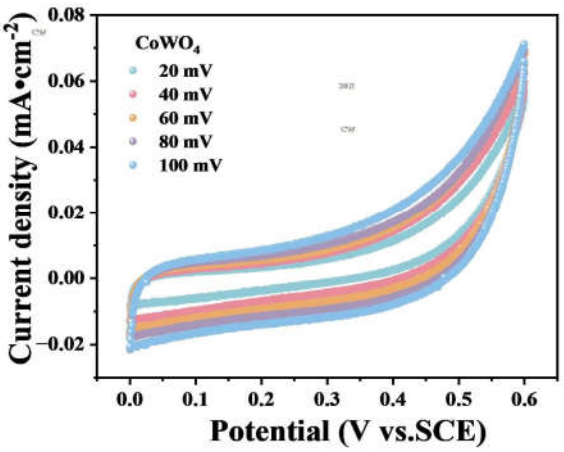

Fig. S18 Cycling voltammograms of $CoWO_4$.

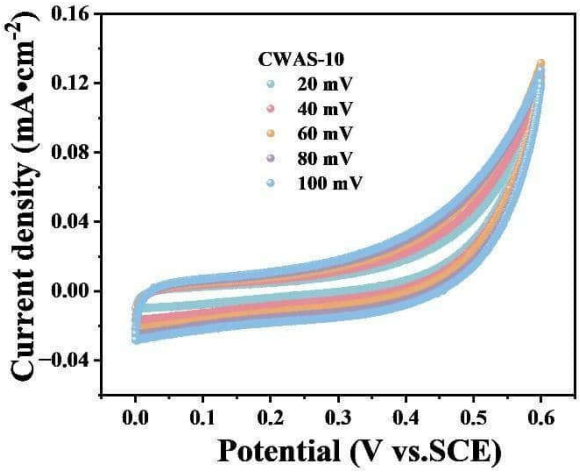

Fig. S19 Cycling voltammograms of CWAS-10

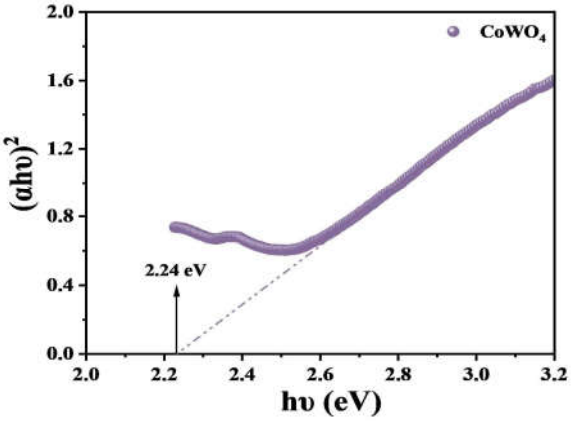

Fig. S20 Kubelka–Munk diagram of $CoWO_4$.

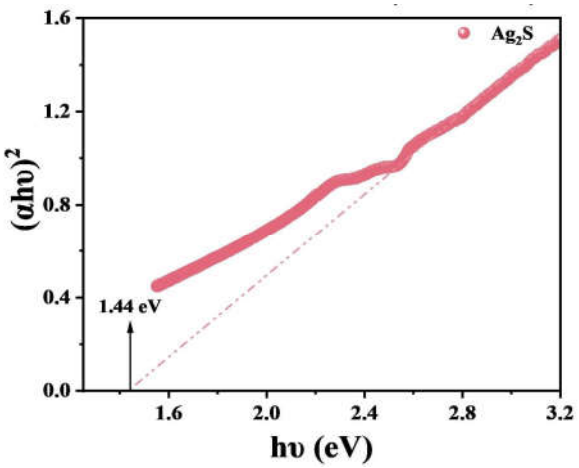

Fig. S21 Kubelka–Munk diagram of Ag_2S.

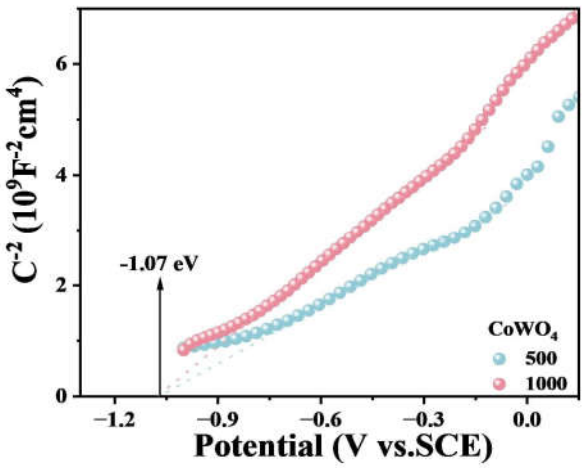

Fig. S22 Mott–Schottky diagrams of $CoWO_4$.

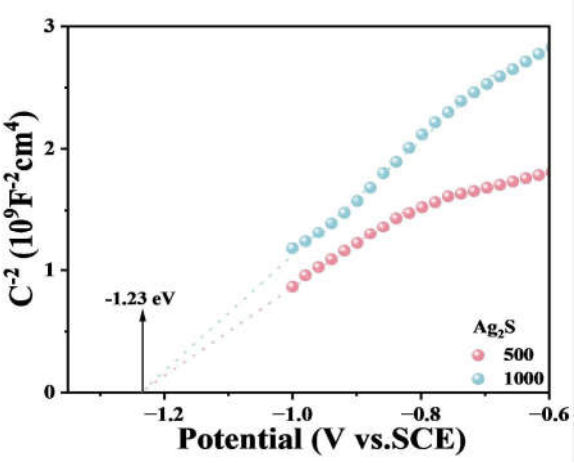

Fig. S23 Mott–Schottky diagrams of Ag_2S.

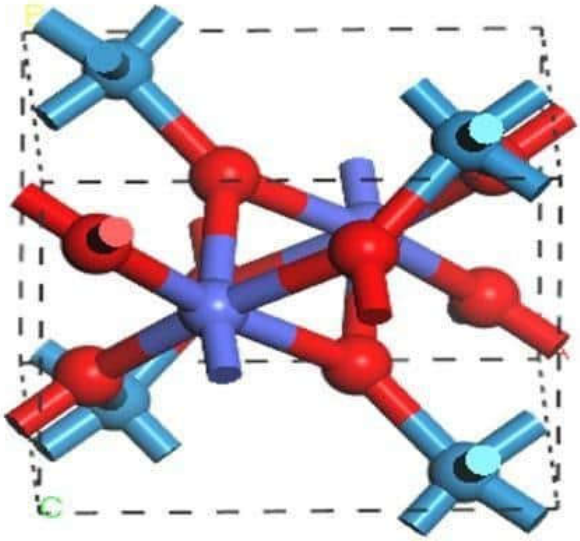

Fig. 24 The model of $CoWO_4$.

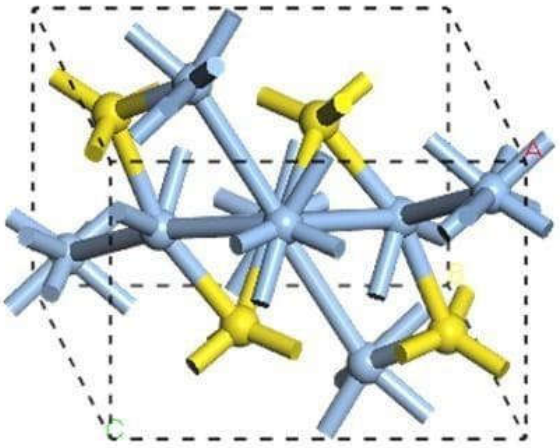

Fig. S25 The model of Ag_2S.

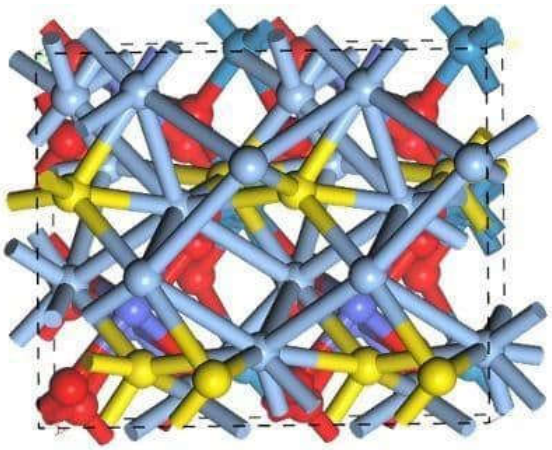

Fig. S26 The model of CWAS-10.

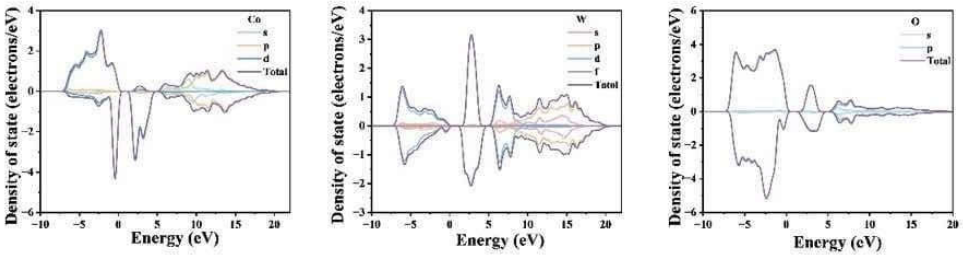

Fig. S27 DOS of Co, W and O.

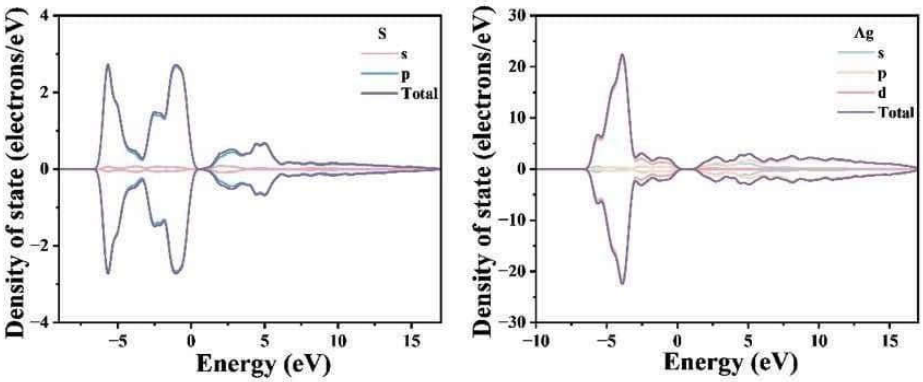

Fig. S28 DOS of S and Ag.

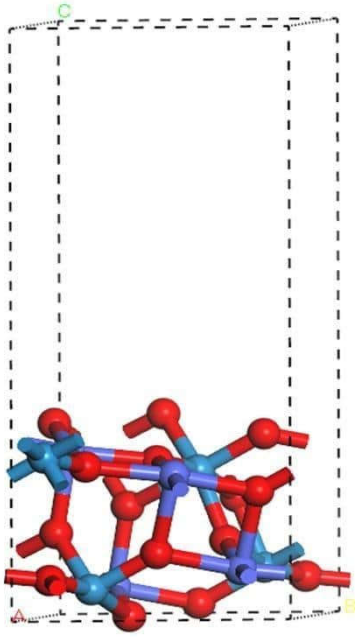

Fig. S29 The 1 0 1 crystal plane model of $CoWO_4$.

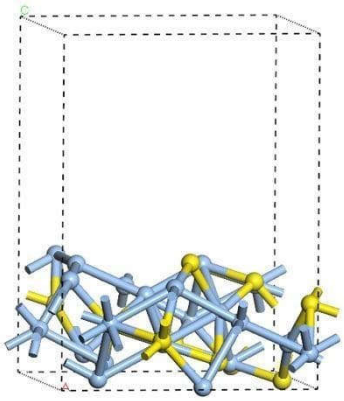

Fig. S30 The 1 2 1 crystal plane model of Ag_2S.

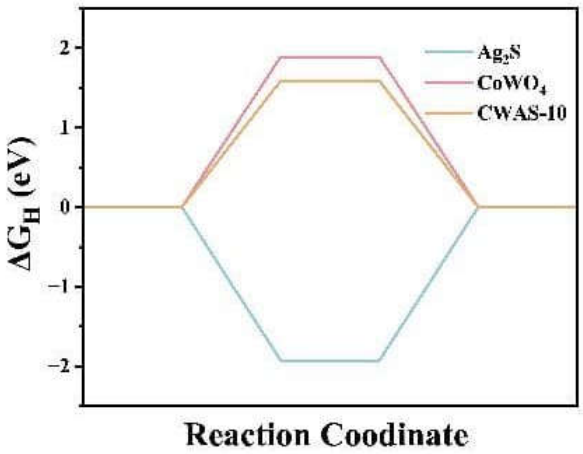

Fig. S31 ΔG_H of different materials.

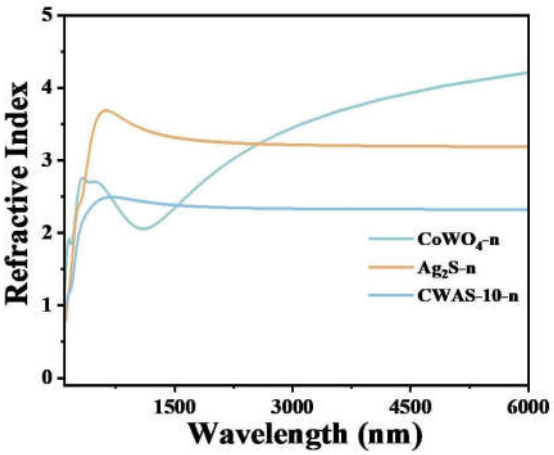

Fig. 32 Refractive index (n) of $CoWO_4$, Ag_2S and CWAS–10.

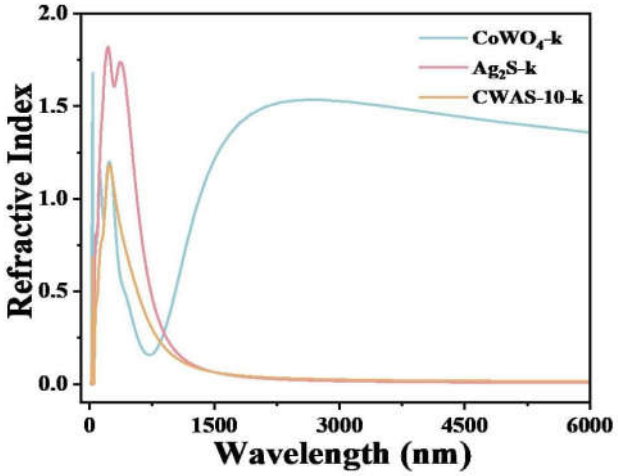

Fig. S33 Attenuation coefficient (k) of $CoWO_4$, Ag_2S and CWAS–10.

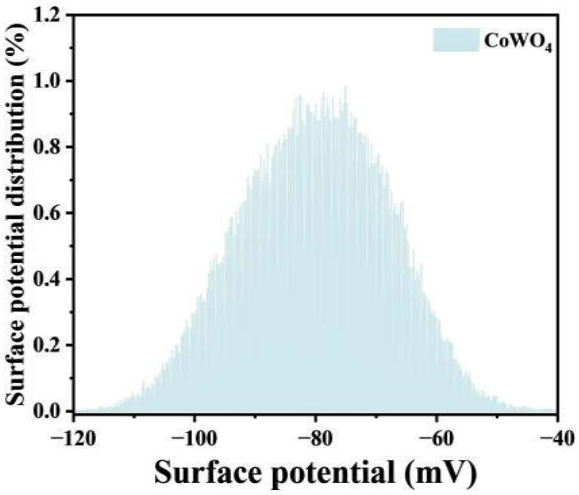

Fig. S34 The surface potential distribution of $CoWO_4$.

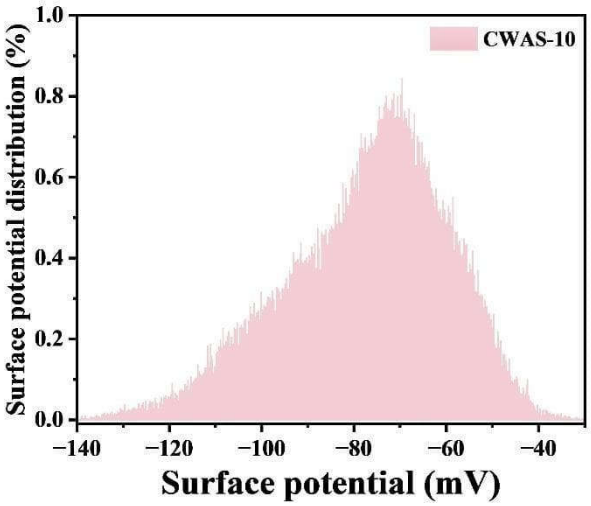

Fig. S35 The surface potential distribution of CWAS–10.

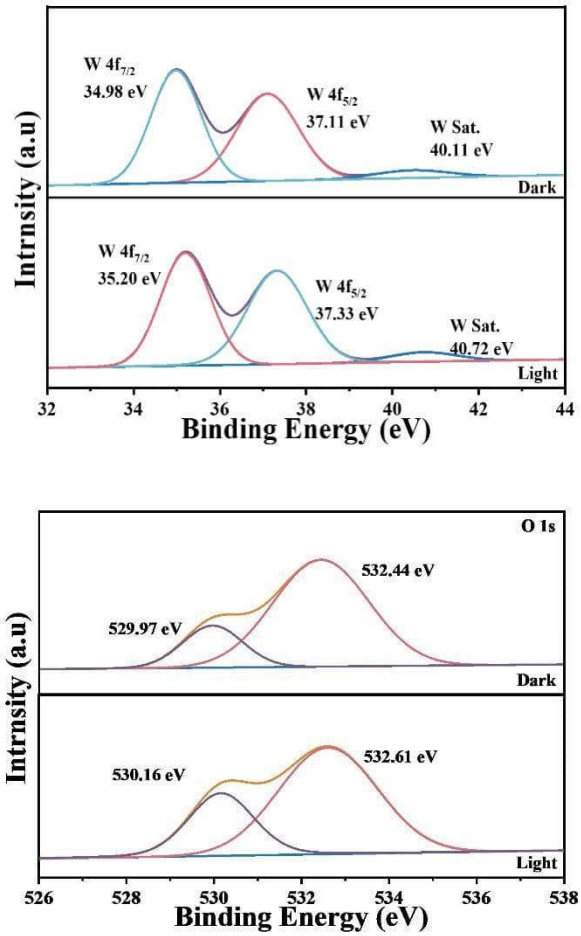

Fig. S36 Fine spectrum of W 4*f* and O 1*s* in in–situ XPS.

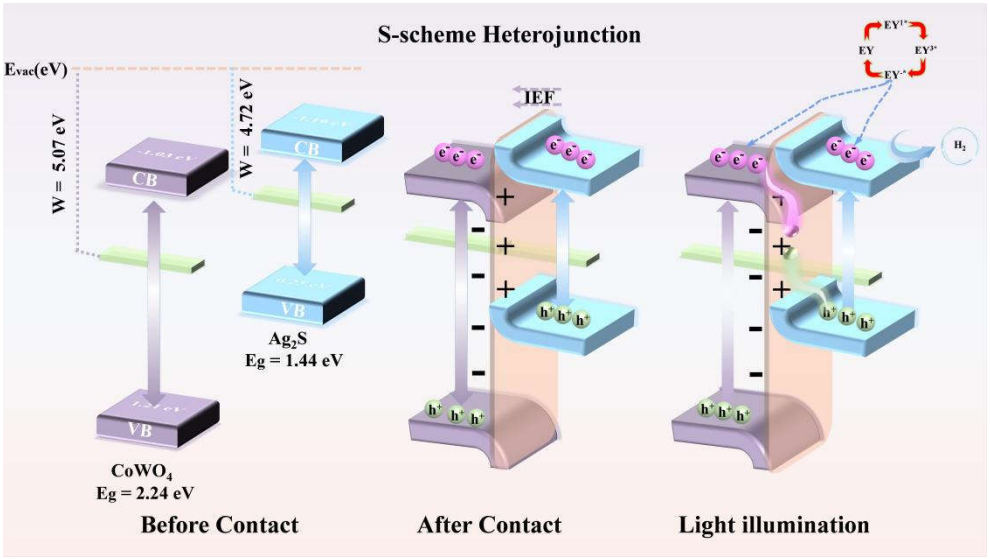

Fig. S37 S–scheme heterojunction of CWAS–10.

Table S1, comparison with other work.

Photocatalysts	Rate of photocatalytic hydrogen production ($\mu mol \cdot h^{-1} \cdot g^{-1}$)	Reference
$CoWO_4/FeWO_4$	36	[1]
$CuO/CdS/CoWO_4$	457.9	[2]
30% CWO/CIS	865.14	[3]
$GDY/CoWO_4$	1803	[4]
Ag_2S QDs / g-C_3N_4 (0.5wt%)	471.1	[5]
Ag_2S/CN	1030.3	[6]
Ag_2S/K-g-C_3N_4	868	[7]
Ag_2S-edged Au-TNPs	796	[8]
CWAS-10	1546.23	This work

Table S2 Fluorescence lifetime of EY, Ag_2S, $CoWO_4$ and CWAS-10.

Materials	Lifetime, τ (ns)	Rel (%)	$<\tau>$ (ns)
EY	τ_1= 1.08	A_1= 89.78	1.16
	τ_2= 2.81	A_2= 10.22	
Ag_2S	τ_1= 1.15	A_1= 92.38	1.21
	τ_2= 3.46	A_2= 7.62	
$CoWO_4$	τ_1=1.08	A_1= 92.11	1.14
	τ_2= 3.02	A_2= 7.89	
CWAS-10	τ_1=1.08	A_1= 90.11	1.13
	τ_2= 2.83	A_2= 9.89	

Table S3 Fitted parameters obtained from the decay curves of the samples

Materials	Lifetime, τ (ps)	Rel (%)	τ_{ave}(ps)
$CoWO_4$	τ_1= 24.72	A_1=50.01	446.82
	τ_2= 469.07	A_2=49.99	
CWAS-10	τ_1= 0.93	A_1= 61.92	201.74
	τ_2= 15.69	A_2= 14.53	
	τ_3= 212.53	A_3= 23.55	

References

[1] M. Sajid, T. Alomayri, H. Zhai, et al., *J. Taibah Univ Sci*, **2023**, 17(1): 2265631.

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