Supplementary Materials

Achieving photocatalytic water reduction and oxidation over narrow bandgap $FeVO_4$

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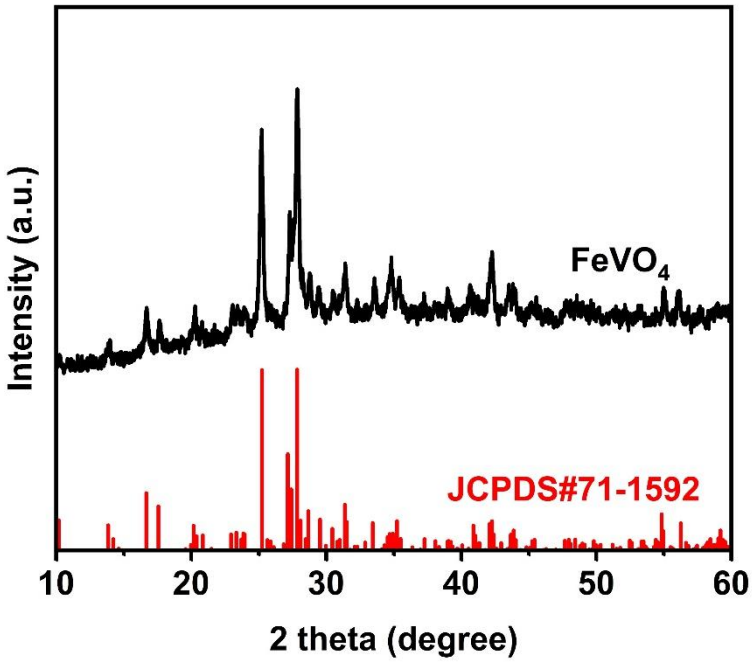
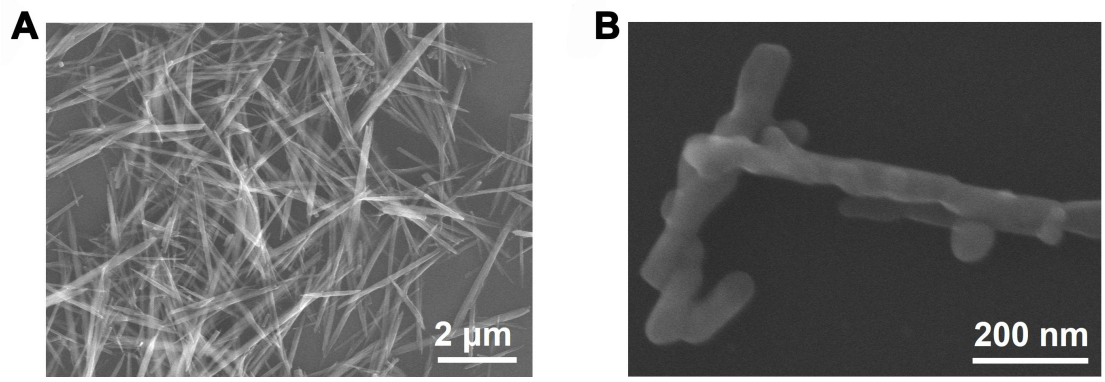
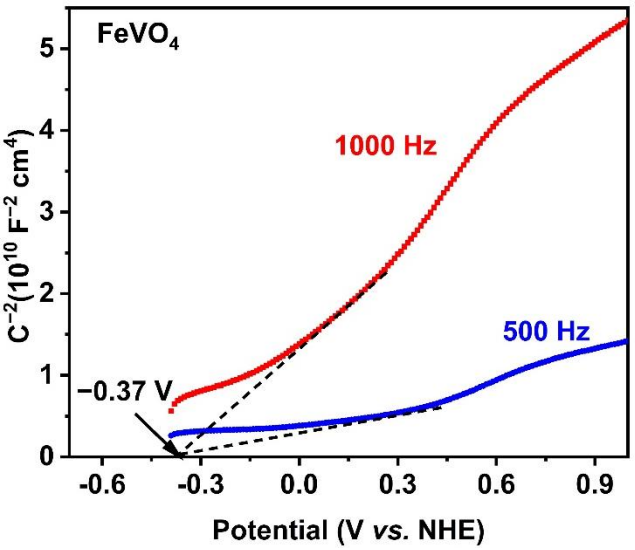


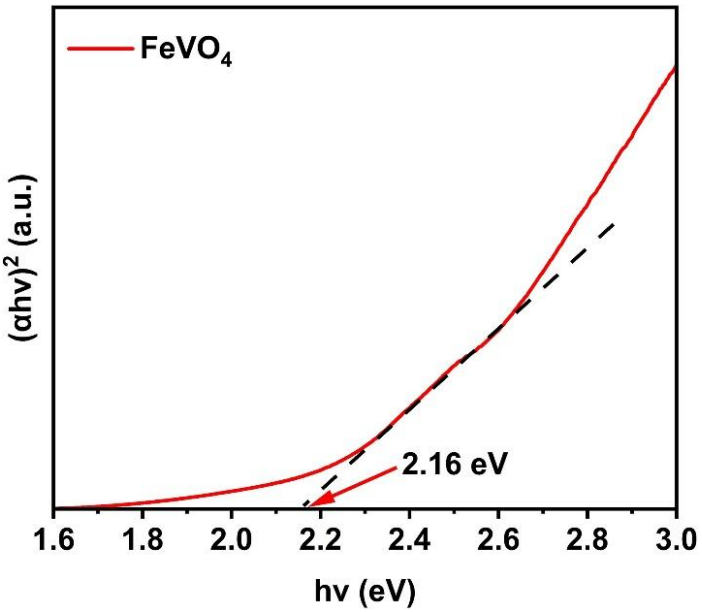
Supplementary Figure 1. X-Ray diffraction (XRD) pattern of $FeVO_4$.



Supplementary Figure 2. Scanning electron microscope (SEM) images of (A) $FeVO_4 \cdot 1.1H_2O$ and (B) $FeVO_4$.



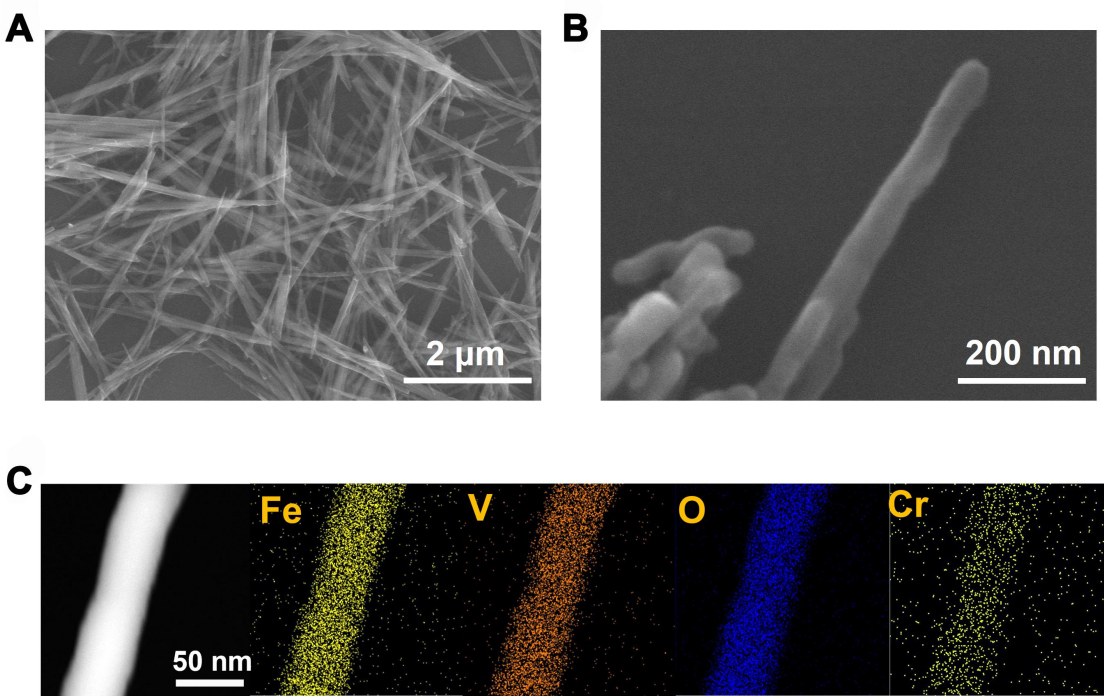
Supplementary Figure 3. Mott-Schottky plots of $FeVO_4$.



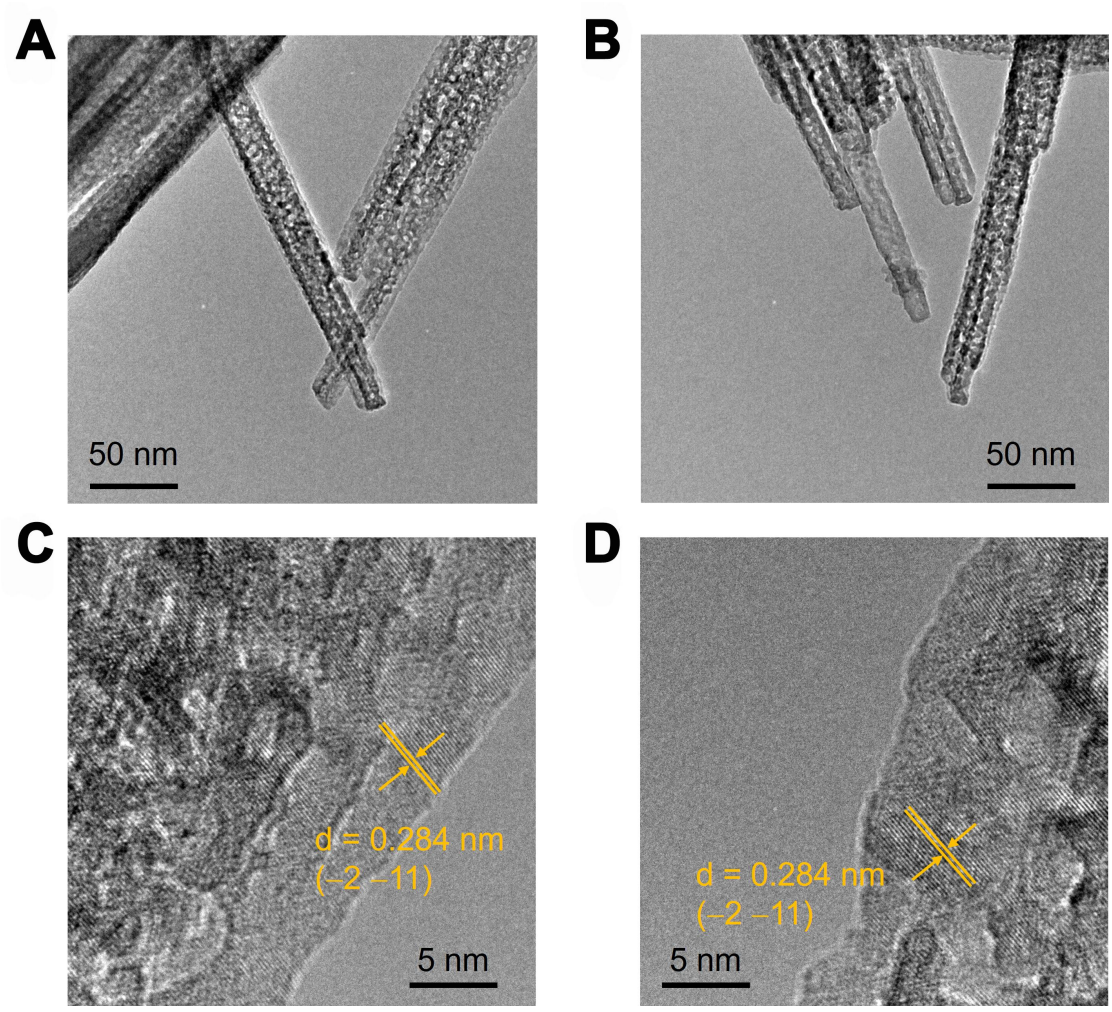
Supplementary Figure 4. Tauc plot of $FeVO_4$ (obtained from Figure 1A).

Supplementary Table 1. The molar ratio of Cr/(Cr+Fe) measured by ICP-OES

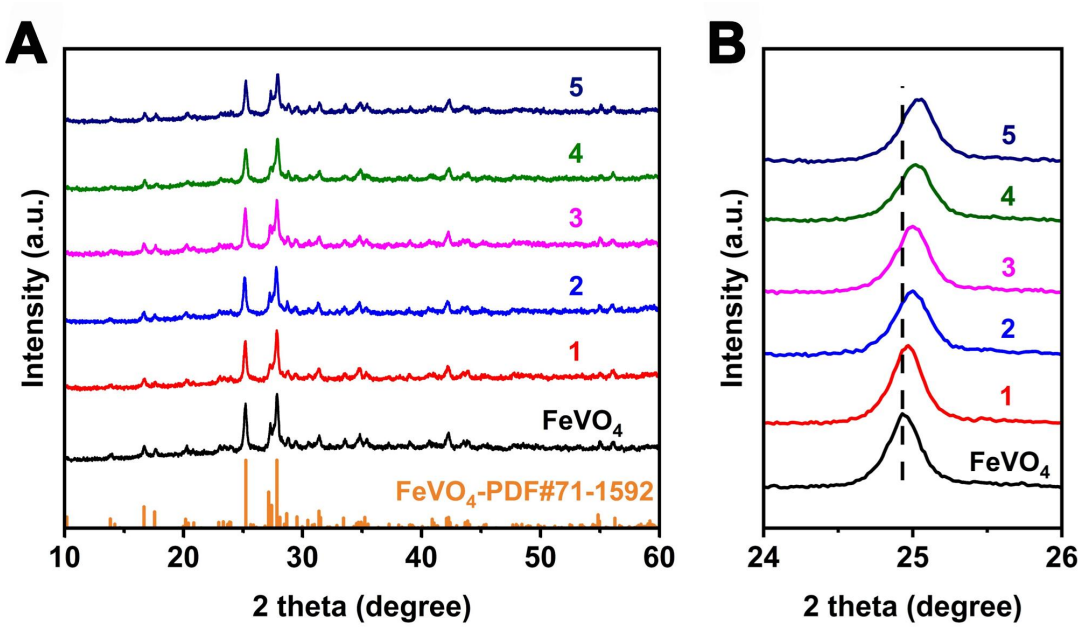
Sample	The molar ratio of Cr/(Cr+Fe) (%)	
	Theoretical value	Measured value
$FeVO_4$:Cr(2.5%)	2.5	1.4
$FeVO_4$:Cr(3.0%)	3.0	1.8



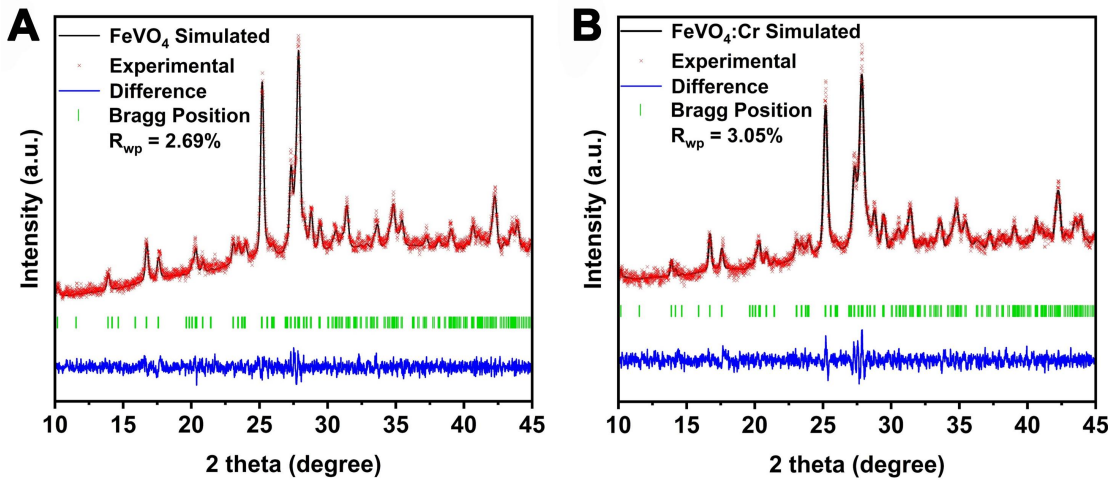
Supplementary Figure 5. SEM images of (A) $FeVO_4$:Cr·1.1H_2O and (B) $FeVO_4$:Cr samples. (C) Energy dispersive X-ray spectroscopy (EDS) mapping images of $FeVO_4$:Cr sample.



Supplementary Figure 6. Transmission electron microscopy (TEM) images of (A) $FeVO_4$ and (B) $FeVO_4$:Cr samples. (C) High-resolution TEM (HRTEM) images of (C) $FeVO_4$ and (D) $FeVO_4$:Cr samples.



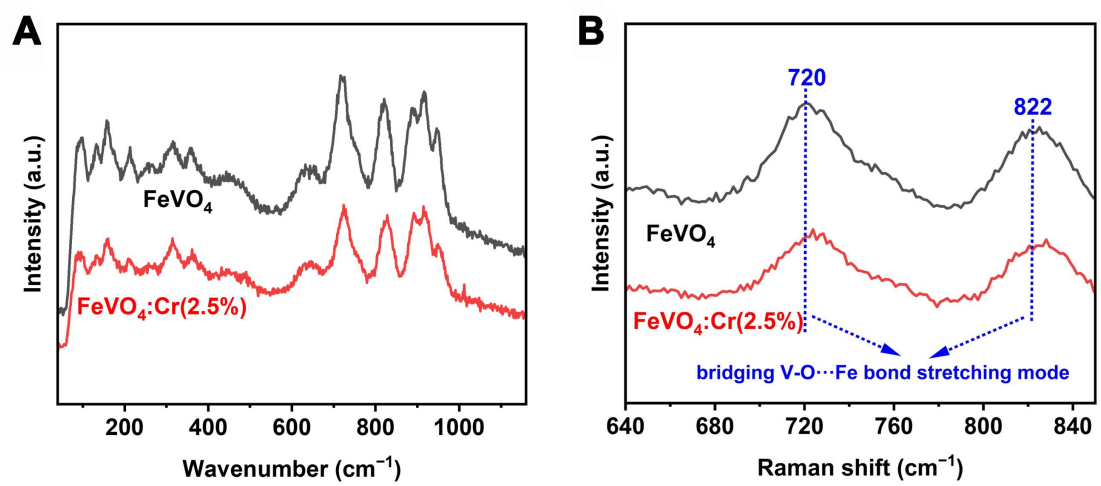
Supplementary Figure 7. (A) XRD patterns and (B) enlarged XRD patterns of $FeVO_4$:Cr samples with different doping proportions. Herein, 1: $FeVO_4$:Cr(1.5%), 2: $FeVO_4$:Cr(2.0%), 3: $FeVO_4$:Cr(2.5%), 4: $FeVO_4$:Cr(3.0%), 5: $FeVO_4$:Cr(3.5%).



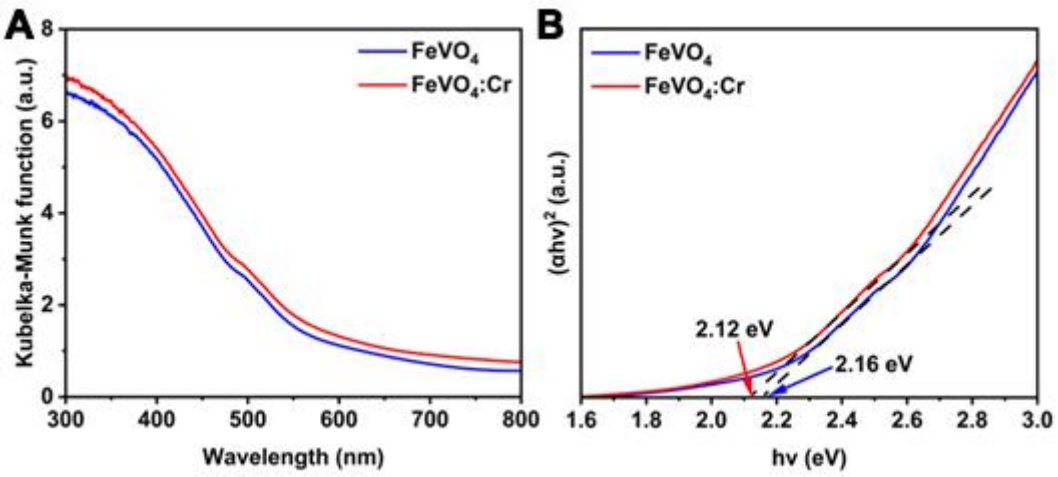
Supplementary Figure 8. Rietveld refined XRD patterns of (A) $FeVO_4$ and (B) $FeVO_4$:Cr samples.

Supplementary Table 2. Lattice parameters of $FeVO_4$ and $FeVO_4$:Cr samples obtained by XRD Rietveld refinement

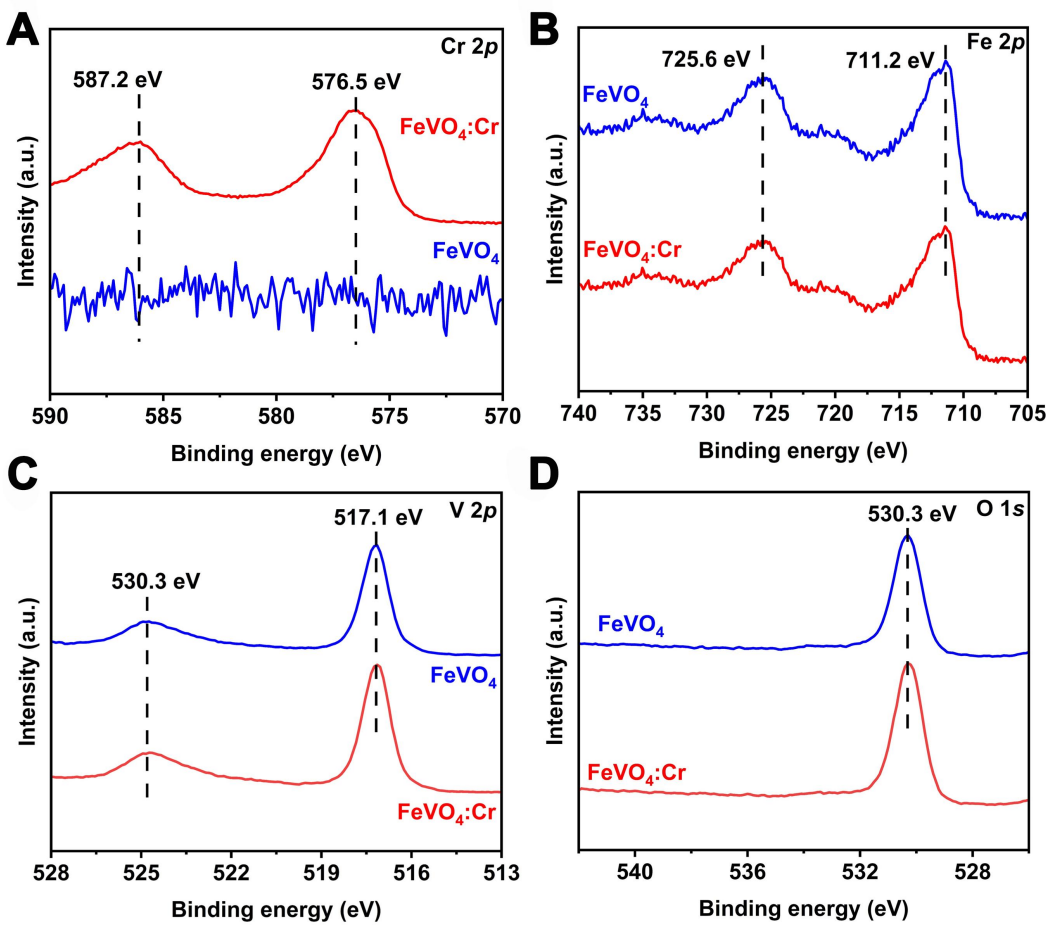
Samples	Lattice parameters					
	a(Å)	b(Å)	c(Å)	α(°)	β(°)	γ(°)
$FeVO_4$	6.7824	8.0682	9.3358	96.678	106.226	101.842
$FeVO_4$:Cr	6.7728	8.0601	9.3191	96.696	106.176	101.854



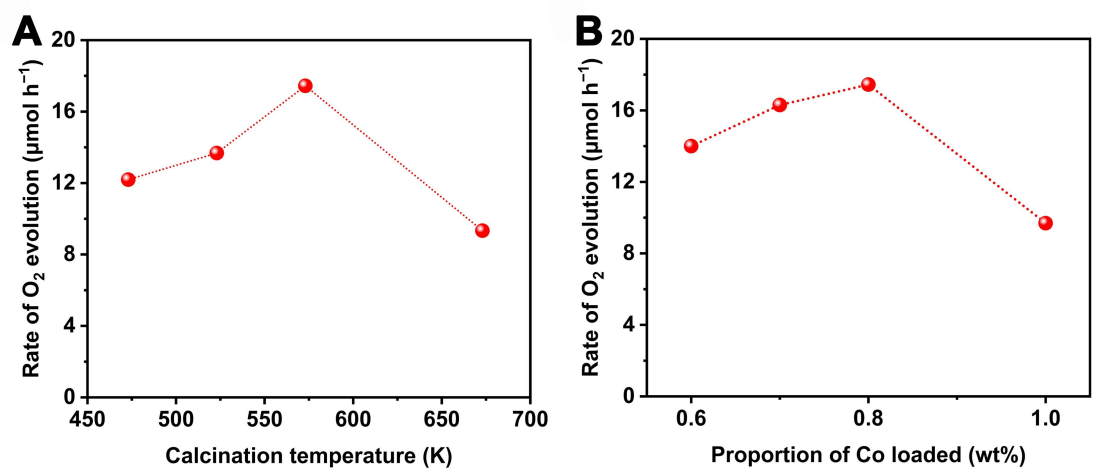
Supplementary Figure 9. (A) Raman spectra and (B) enlarged Raman spectra of $FeVO_4$ and $FeVO_4$:Cr samples.



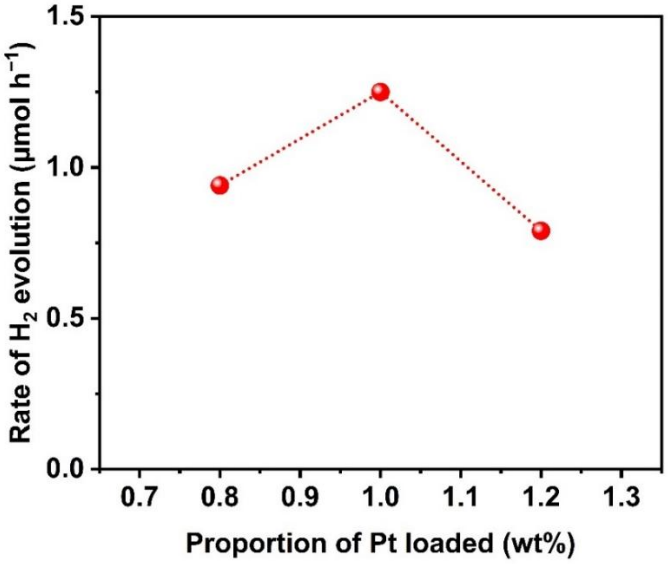
Supplementary Figure 10. (A) The ultraviolet-visible diffuse reflectance spectra obtained using Kubelka-Munk function and (B) Tauc plots of $FeVO_4$ and $FeVO_4$:Cr samples.



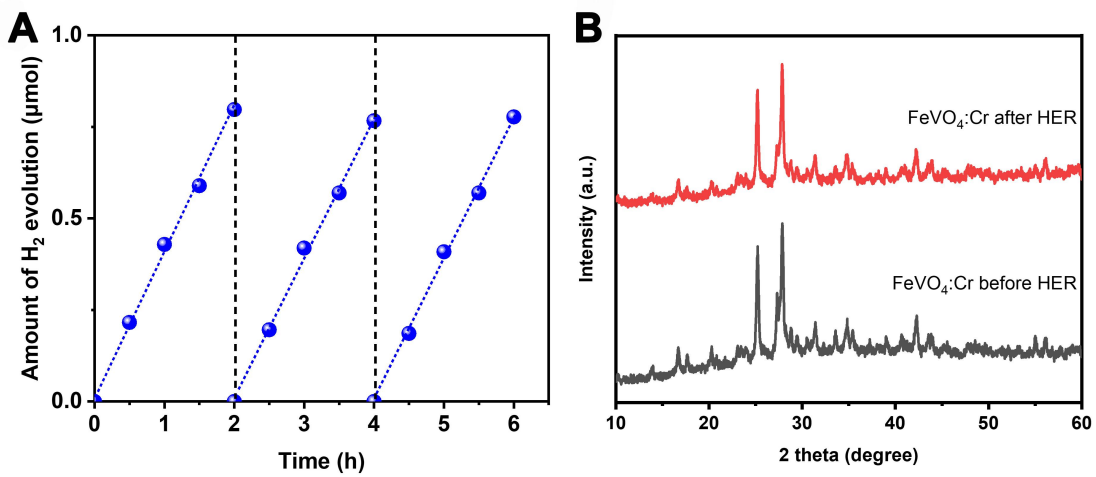
Supplementary Figure 11. X-ray photoelectron spectroscopy (XPS) (A) Cr 2*p*, (B) Fe 2*p*, (C) V 2*p* and (D) O 1*s* of $FeVO_4$ and $FeVO_4$:Cr samples.



Supplementary Figure 12. Effect of (A) the calcination temperature and (B) the loaded proportion of CoO_x on the initial O_2 evolution rate over $CoO_x/FeVO_4$:Cr sample (the molar ratio of Cr/(Cr+Fe) is 2.5%). Reaction conditions: 0.1 g of photocatalyst; 100 mL of $AgNO_3$ aqueous solution (50 mM); 0.1 g of La_2O_3; 300 W Xe lamp with a cutoff filter ($\lambda \geq 420$ nm).

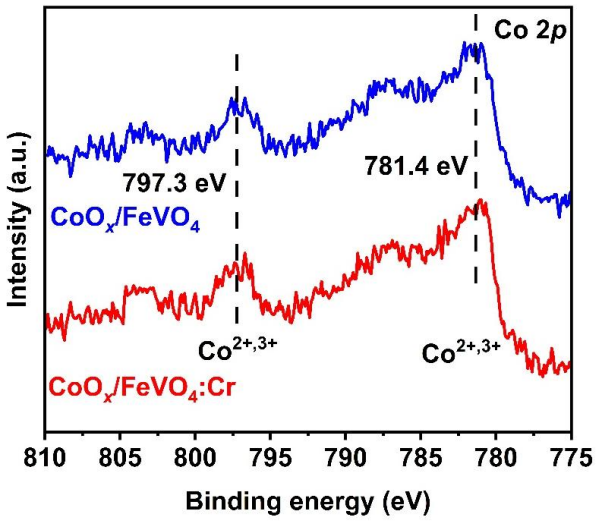


Supplementary Figure 13. Effect of the loaded proportion of Pt on the initial H_2 evolution rate over $Pt/FeVO_4$:Cr sample (the molar ratio of Cr/(Cr+Fe) is 3%). Reaction conditions: 0.1 g of photocatalyst; 100 mL of ascorbic acid aqueous solution (10 mM); 300 W Xe lamp with a cutoff filter ($\lambda \geq 420$ nm).

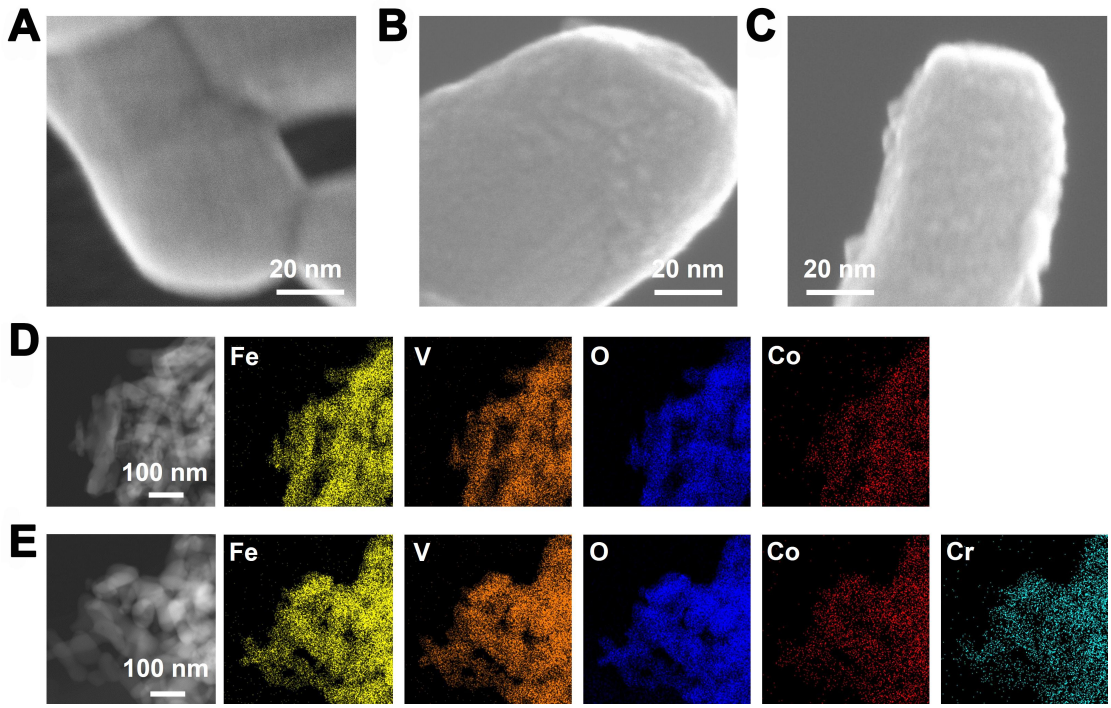


Supplementary Figure 14. (A) The recycling test of H_2 generation over $FeVO_4$:Cr photocatalyst loaded with Pt cocatalyst. Reaction conditions: 0.1 g of photocatalyst (1.0 wt% Pt is loaded); 100 mL of ascorbic acid aqueous solution (10 mM); 300 W Xe lamp with a cutoff filter ($\lambda \geq 420$ nm). (B) XRD patterns of $FeVO_4$:Cr samples before and after the HER (hydrogen evolution reaction). The molar ratio of Cr/(Cr+Fe) in $FeVO_4$:Cr is 3%.

The recycling test with three cycles was conducted to evaluate the stability of the $FeVO_4$:Cr photocatalyst, and no obvious decrease was observed in the long-term test (Supplementary Figure 14A). XRD results also show that there is no obvious difference between the photocatalysts before and after the reaction (Supplementary Figure 14B).



Supplementary Figure 15. XPS Co 2*p* of $CoO_x/FeVO_4$ and $CoO_x/FeVO_4$:Cr samples.



Supplementary Figure 16. SEM images of (A) $FeVO_4$, (B) $CoO_x/FeVO_4$ and (C) $CoO_x/FeVO_4$:Cr samples. EDS mapping images of (D) $CoO_x/FeVO_4$ and (E) $CoO_x/FeVO_4$:Cr samples.

As shown in Supplementary Figures 16A-C, compared with $FeVO_4$, the surface of $CoO_x/FeVO_4$ and $CoO_x/FeVO_4$:Cr is deposited with numerous CoO_x nanoparticles in similar particle size. EDS mapping images (Supplementary Figure 16D and E) further confirm that the CoO_x species evenly distributes on the surface of $CoO_x/FeVO_4$ and $CoO_x/FeVO_4$:Cr samples.