

Electronic Supplementary Material

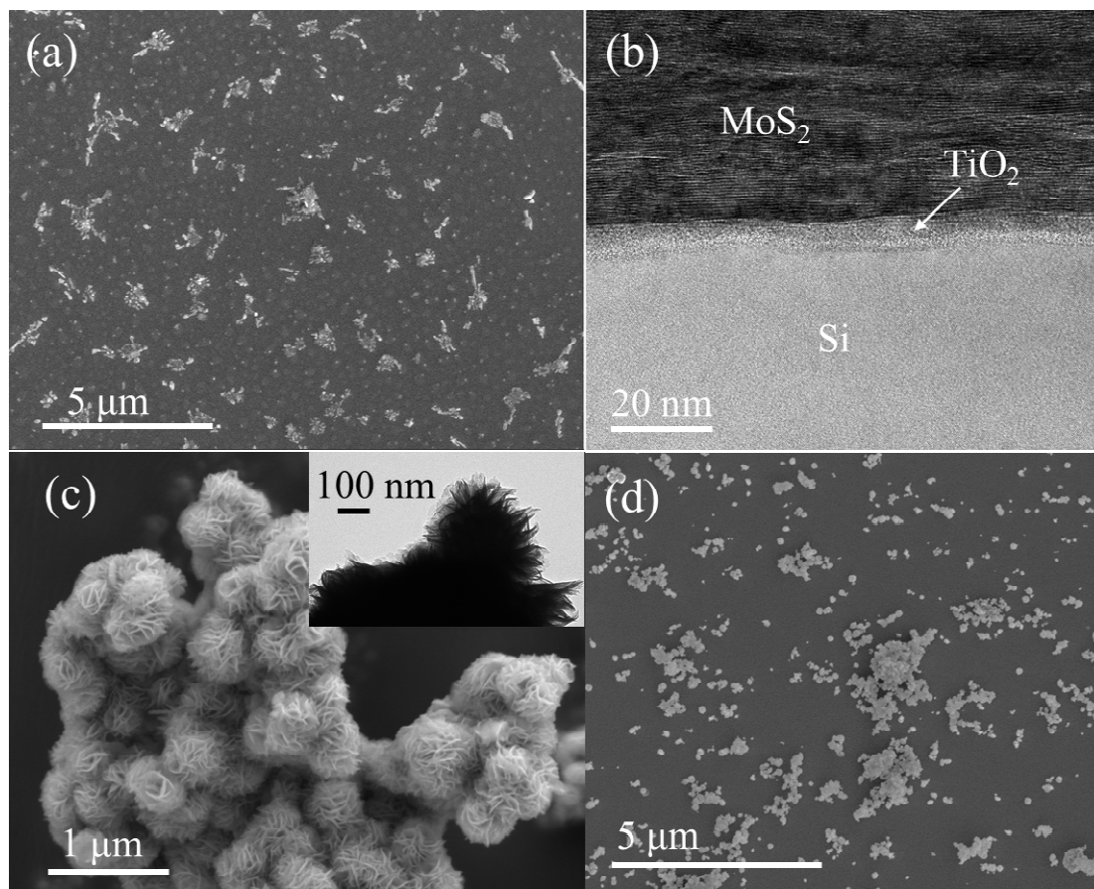


Fig. S1 Morphology characterization of the controlled samples.

(a) SEM image of nano-MoS₂/TiO₂/p-Si; (b) HRTEM image of nano-MoS₂/TiO₂/p-Si; (c) SEM and TEM images (inset) of nano-MoS₂; (d) SEM image of meso-Pt/TiO₂/p-Si.

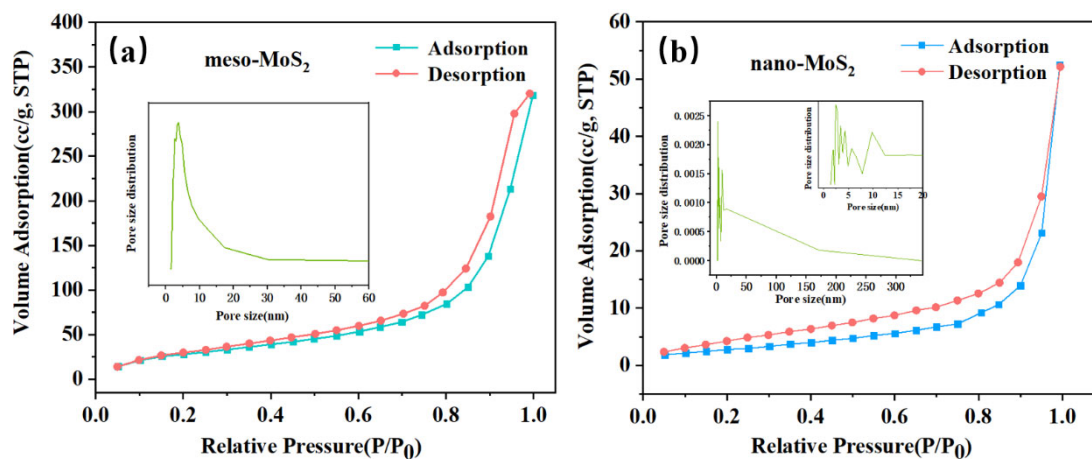


Fig. S2 Specific surface area and porous structure characterization of the cocatalysts. (a) N₂ adsorption-desorption isotherms at 77 K and pore size distribution curves (insets) of meso-MoS₂; (b) N₂ adsorption-desorption isotherms at 77 K and pore size distribution curves (insets) of nano-MoS₂.

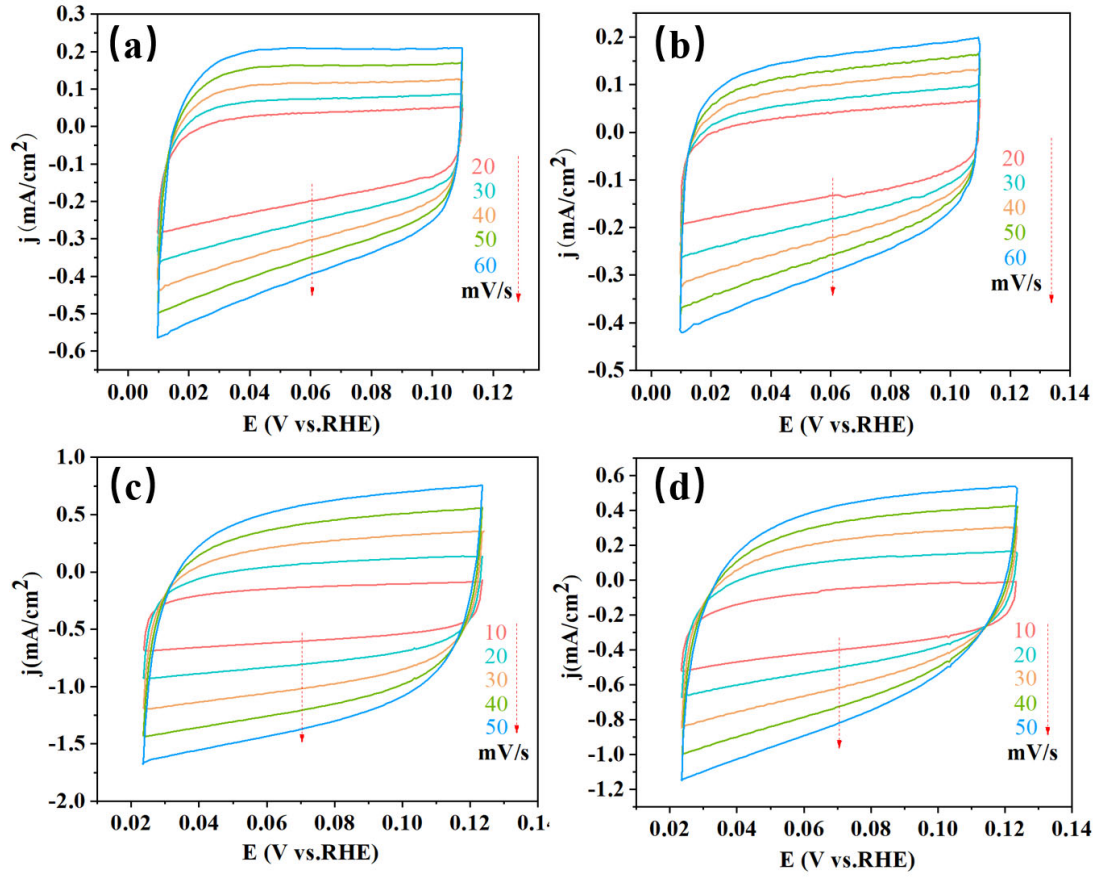


Fig. S3 CV curves at different scan rates for measuring C_{dl} in 0.5 mol/L H_2SO_4 . (a) Meso- MoS_2 ; (b) nano- MoS_2 and in 1 mol/L KOH; (c) meso- MoS_2 ; (d) nano- MoS_2 .

Calculation of electrochemical active surface area (ECSA):

$$ECSA = \frac{C_{dl} \times 1 \text{ cm}^2}{C_s} \quad (S1)$$

The ECSA was determined assuming a C_s capacitance of $40 \mu F \cdot cm^{-2}$ ¹
In 0.5 mol/L H_2SO_4 :

$$ECSA_{\text{meso-MoS}_2} = \frac{C_{dl} \times 1 \text{ cm}^2}{C_s} = \frac{22.9 \text{ mF} \cdot \text{cm}^{-2}}{40 \mu F \cdot \text{cm}^{-2}} = 572.5 \text{ cm}^2, \quad (S2)$$

$$ECSA_{\text{nano-MoS}_2} = \frac{C_{dl} \times 1 \text{ cm}^2}{C_s} = \frac{17.5 \text{ mF} \cdot \text{cm}^{-2}}{40 \mu F \cdot \text{cm}^{-2}} = 437.5 \text{ cm}^2. \quad (S3)$$

In 1 mol/L KOH:

$$ECSA_{\text{meso-MoS}_2} = \frac{C_{dl} \times 1 \text{ cm}^2}{C_s} = \frac{9.2 \text{ mF} \cdot \text{cm}^{-2}}{40 \mu F \cdot \text{cm}^{-2}} = 230.0 \text{ cm}^2, \quad (S4)$$

¹ Chen W, Gu J, Du Y, et al. Achieving rich and active alkaline hydrogen evolution heterostructures via interface engineering on 2D 1T- MoS_2 quantum sheets. *Advanced Functional Materials*, 2020, 30(25): 2000551

$$\text{ECSA}_{\text{nano-MoS}_2} = \frac{C_{\text{dl}} \times 1 \text{ cm}^2}{C_s} = \frac{5.5 \text{ mF} \cdot \text{cm}^{-2}}{40 \mu\text{F} \cdot \text{cm}^{-2}} = 137.5 \text{ cm}^2. \quad (\text{S5})$$

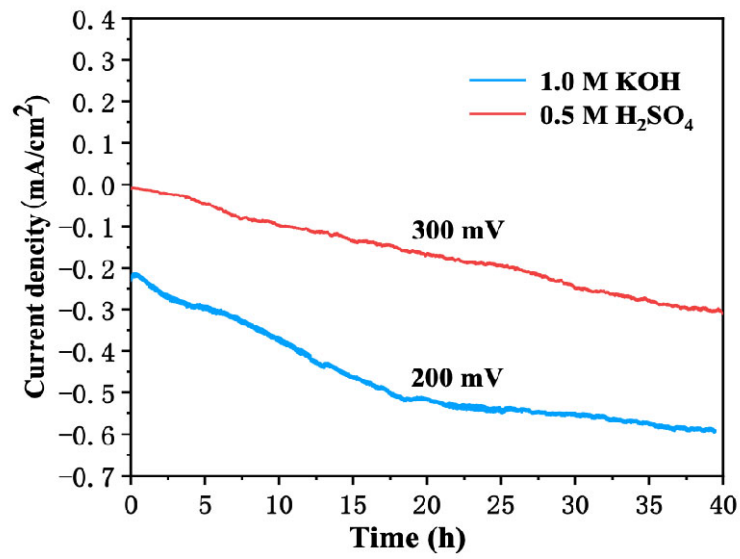


Fig. S4 Durability measurements of nano-MoS₂/TiO₂/p-Si photocathodes in 0.5 mol/L H₂SO₄ and 1.0 mol/L KOH solutions.