Integrating Planar p-Si Photocathode with Anti-corrosive Protector and Anti-reflective Cocatalyst for Durable Hydrogen Generation in Alkaline Media

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Photoelectrochemical (PEC) water splitting is promising to solve global environmental and energy issues through converting solar energy into renewable clean fuels, involving hydrogen evolution (HER) and oxygen evolution (OER). Developing durable Si-based photoelectrochemical hydrogen evolution reaction in alkaline media is attracting attention in device-level water splitting, because OER requires a higher overpotential to cope with slower kinetics in acid than HER. Since alkaline solutions can cause severe Si etching, there is a great need to develop an appropriate Si-based photocathode that can balance the trade-off between alkalic corrosion resistance and light transmittance.

Herein, a synergetic strategy is proposed to deposit an anti-reflective Co-P cocatalyst on a WS_x-stabilized planar p-Si photocathode for efficient and durable PEC-HER performance in an alkaline solution (1.0 M KOH). The introduction of the WS_x thin film plays a vital role in supporting the alkali-corrosion resistance of Si semiconductor and providing a nucleation base for Co-P cocatalysts, which forms a robust structure and promotes the electron transfer from photocathode to electrolyte. Meanwhile, the morphology of Co-P cocatalyst could be modulated by the controllable WS_x to possess an anti-reflective effect while maintaining excellent catalytic activity. The optimal Co-P/20WS_x/Si photocathode exhibits superior catalytic properties, in terms of the onset potential of +0.47 V_{RHE}, the photocurrent density of −25.1 mA cm^{-2} at 0 V_{RHE} (Figure 1a), and the superior durability of up to 300 h at 0 V_{RHE} without noticeable degradation (Figure 1b). These findings offer a facile and effective approach for the further development of durable Si-based photoelectrochemical devices.

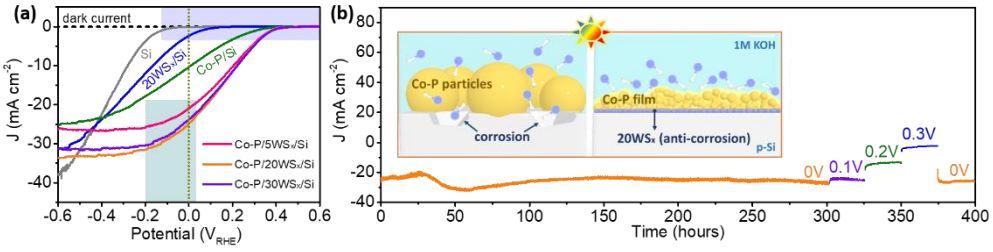

Figure1. (a) Linear sweep voltammograms of as-prepared samples, (b) The chronoamperometric current–time profiles of Co-P/20WS_x/Si sample and its schematic diagram of the anti-corrosive mechanism.

References: Sijie Li, Jinhua Ye*, et al., *Applied Catalysis B: Environmental*, 2022, 304, 120954.