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WATER SPLITTING

Si photocathode

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Si is a promising photocathode material for photoelectrochemical (PEC) water splitting, while developing highly active non-precious catalysts and stable semiconductor/catalyst interface is critical to bring solar water splitting into reality. Recently, significant progress has been made in two-dimensional (2D) materials, e.g. transition metal dichalcogenides (TMDs), due to that their edge sites show highly catalytic activity for H_2 evolution reaction (HER). To date, however, most of such studies have only been exploited as electrocatalysts for HER. Few works have achieved both efficient catalysis and stability when integrating TMD catalysts onto Si photocathodes for cheap PEC-HER.

The Co-W-S/Ti/n+p-Si photocathode presented by Fan *et al.* reveals good PEC-HER performance and impressive operation durability for solar hydrogen production. An ultrathin and homogeneous Co–W–S catalyst layer was produced on Ti/n+ p-Si surface using a cheap wet chemical method, leading to more active sites for PEC reaction than pure WS_2. Simultaneously, the inserted 5 nm Ti buffer layer played an essential role in protecting Si surface and reducing resistances of charge transfer on the electrode/electrolyte interface. An energy conversion efficiency of 4.0% were obtained under simulated AM1.5G illumination, along with a long-term stability for 6 days of continuous PEC reaction. Our findings emphasize the importance of effective loading of the catalyst and protective layer on the photoelectrode, which subsequently enables the PEC process both efficient and stable.

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PHOTOELECTROCHEMISTRY

Porous Ni–O/Ni/Si photoanode

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Photoelectrochemical (PEC) water splitting is an attractive strategy to convert solar energy into chemical fuels with zero-carbon. However, the photoanode, related to the oxygen evolution reaction (OER), is still regarded as a bottleneck due to the relatively complex 4-electron reaction mechanism. Si has been studied as a good photoanode material, and Ni oxides (Ni–O) is effective catalyst for OER in basic solution. However, the reported methods to integrate the Ni–O on Si, such as evaporation and sputtering, can hardly produce porous surface which can be very important to improve their catalytic effect. Through converting the electrodeposited porous Ni–S by activation in basic solution, the research reported by Huang *et al.* exhibits an unusual but simple way to obtain porous Ni–O catalyst on Ni-protected Si photoanode, leading to the superior PEC activity. An energy conversion efficiency of 3.2% under 1 sun illumination, and a high stability of 100 h continuous PEC testing were achieved. Furthermore, through clarifying the contribution of non-faradaic process, etc, the oxidation of Ni^{2+} to Ni^{3+}, on the PEC current–potential *(J–V)* curves, this study provides a criterion for separating the oxidation effect from the *J–V* curve, ensuring the true PEC activity.

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2D LAYERED MATERIALS

Detecting forbidden Raman modes

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In the commonly used back-scattering Raman configuration, some theoretically active Raman modes of layered materials are undetectable in experiments. Now, a team of researchers from the Hong Kong Polytechnic University and Beijing Institute of Technology can selectively detect these forbidden Raman modes at the edge region of various layered materials (including MoS_2, WS_2, WSe_2 and black phosphorus). Yang Chai and his co-workers choose the edge type of layered materials, the polarization direction of the incident light, and the polarization direction of the scattered Raman signal. They distinctly detect the forbidden Raman modes at the edge region in the case that the polarization direction of the incident/scattered light is perpendicular to the edge of layered materials. Their comprehensively experimental and theoretical studies reveal that the anisotropic refractive index of layered materials can drastically change the polarization and propagation directions of incident and scattered light at the edge region of layered materials. The directions of the light are thoroughly different in the edge and body region of layered materials, which enables to detect forbidden Raman modes at edge region and can be validated through the calculations from Raman scattering formula. This work facilitates future exploration of unique optical properties at the edge region.

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