Photoelectrochemical hydrogen evolution on macroscopic SnSe–based electrodes

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Solar-driven photoelectrochemical (PEC) water splitting is a very promising approach to convert sunlight into hydrogen energy[1]. Tin selenide (SnSe) is a good candidate for PEC hydrogen evolution reaction (HER) due to its high absorption coefficient to absorb solar light energy and suitable conduction band edge position to drive water reduction process[2-3]. Moreover, the PEC HER performance of SnSe has not been widely investigated[4]. Liquid phase exfoliation (LPE) is one of the most applied methods to produce suspension of nanoflakes from its bulk counterpart with low-cost and high yield[5]. In this study[6], LPE process was used to prepare SnSe nanoflakes in the mixture of isopropanol (IPA)/H_2O with different IPA contents. The PEC HER activity of SnSe electrodes was increased with the rising IPA content in the solvent mixture of IPA/H_2O. Moreover, the SnSe nanoflakes produced from pure IPA showed 10 times higher PEC activity than from the mixture of IPA/H_2O (Fig. 1A). Additionally, a sieving system was used to separate as-received SnSe crystals to large, medium, and small sized crystals prior to LPE process, which further improved the PEC performance of SnSe electrodes. The electrodes prepared by the large sized SnSe crystal exfoliated in IPA showed the highest photocurrent of 2.44 ± 0.65 mA cm^{-2} at –0.74 V versus RHE. Pt co-catalyst photodeposited on SnSe surface further improved the PEC activity to 4.39 ± 0.15 mA cm^{-2} (Fig. 1B). Intensity modulated photocurrent spectroscopy results demonstrated that, the Pt co-catalyst enhanced the charge transfer process and suppressed charge carrier recombination (Fig. 1C). Overall, the solvent for exfoliation, the edge density of SnSe nanoflakes, immobilization method, and Pt co-catalyst affected the PEC HER performance of SnSe. These results indicate the applicability of SnSe electrodes in PEC HER and inspire us to explore other photoelectrocatalytic reactions on the exfoliated SnSe electrodes.

References

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Figures

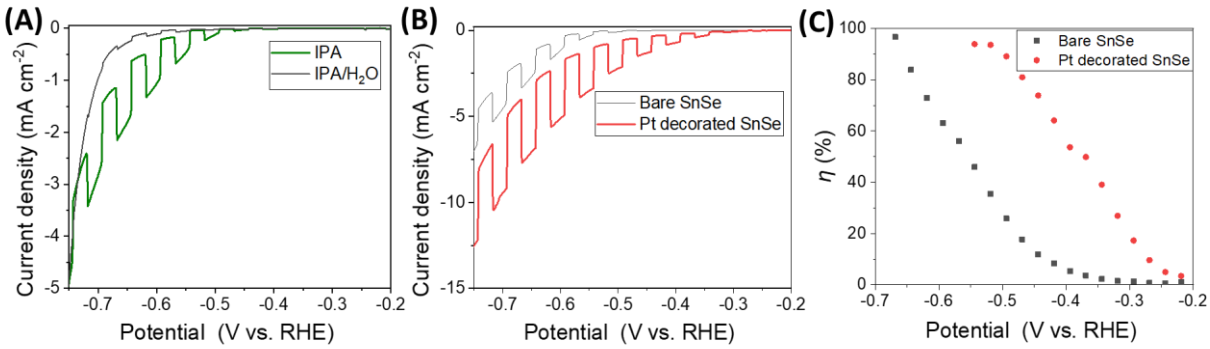

Figure 1: PEC HER activity of (A) SnSe flakes exfoliated from IPA and mixture of IPA/H_2O, and (B) bare and Pt decorated SnSe electrodes, and (C)charge transfer efficiency of bare and Pt decorated SnSe.