2D Indium selenide (InSe)/indium tin oxide (ITO) hybrid films for photoelectrochemical (PEC)-type photodetectors

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Two-dimensional (2D) metal monochalcogenides have recently attracted interest for their applications in photoelectrochemical (PEC) applications in aqueous electrolytes [1][2]. Their optical bandgaps in the visible and near-infrared spectral region are adequate for energy conversion and photodetection/sensing applications. Their large surface-to-volume ratio guarantees that the charge carriers are photogenerated at the material/electrolyte interface in which redox reactions take place, thus minimizing recombination processes. In particular, 2D indium selenide (InSe) has emerged as a promising candidate for these applications.[3] In this work, we report a PEC characterization of single-/few-layer flakes of InSe, produced in inks form through scalable liquid-phase exfoliation (LPE) [4,5,6], as photoactive material for PEC-type photodetectors. The PEC behaviour of 2D InSe-based photoelectrodes was evaluated in both acidic (0.5 M H₂SO₄) and alkaline (1 M KOH) media under different illumination wavelengths, i.e., 455, 505, and 625 nm. The highest photoresponse of the InSe photoelectrodes was observed in acidic media, reaching promising responsivities up to 31.1 mA W⁻¹ at 0.8 V vs. RHE under 0.5 mW cm⁻² 455 nm illumination. In addition, to improve the performances of our devices by increasing the electrode thickness without lacking efficient charge carrier collection toward the current collectors, we also hybridized InSe flakes with conductive indium tin oxide (ITO) nanocrystals, achieving a responsivity up to 60.0 mA W⁻¹ at +0.4 V vs. RHE in the 0.5 M H₂SO₄ under blue.

References

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Figures



Figure 1: Energy level diagram of the PEC-type hybrid ITO/InSe

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