Two – Dimensional GaSe and GeSe Nanoflakes for Photoelectrochemical Water Splitting and (PEC)-Type Photodetectors

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Aqueous-based photoelectrochemical (PEC) devices, such as self-powered photodetectors and water splitting cells, represent powerful tools to convert the electromagnetic radiation into chemical fuels and electricity.[1] In this context, two-dimensional (2D) materials are continually attracting utmost interest as potential advanced photo(electro)catalysts,[2] and recently, group-III and group-IV transition metal monochalcogenides. These layered materials can be exfoliated in 2D form due to their low cleavage energy (typically < 0.5 J m^{-2}), being theoretically predicted to act as photocatalysts for water splitting.[3] Among them, layered gallium selenide (GaSe) and germanium selenide (GeSe), are promising material candidates for optoelectronic devices due to their tuneable electronic structure, strong visible-light absorbance, photoresponse and environmental stability.[4] However, the evaluation of their photo(electro)catalytic properties was still incomplete until last years, pointing out the need of experimental trials and validation. Here, we report the first experimental evidence of the PEC water splitting activity of single-/few-layer flakes of GaSe and GeSe produced in inks form by scalable liquid-phase exfoliation approach in non-toxic solvent (*i.e.*, 2-propanol).[5] The PEC behaviour of monochalcogenides(MCs)-based photoelectrodes, obtained by spray coating approach,[6] were evaluated in different aqueous media, ranging from acidic to alkaline solutions and under different illumination wavelengths, *i.e.*, 455, 505 and 625 nm. The obtained performances (responsivity and external quantum efficiency up to 0.32 A/W and 86.3%) are superior to those of several self-powered and low-voltage solution-processed photodetectors, approaching the ones of their commercial UV–Vis counterparts. Finally, we demonstrate the use of MCs-based photoelectrodes as photoanodes or photocathodes for water splitting reactions under simulated sunlight.

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FIGURES

a) b)

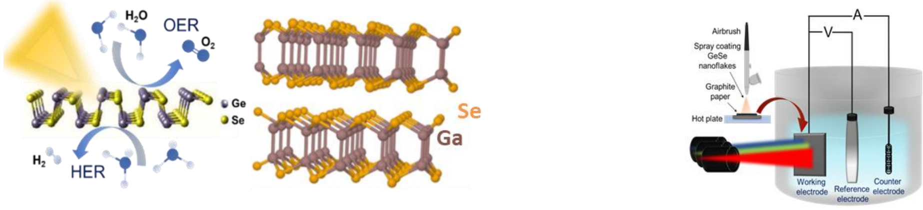

Figure 1: a) Crystal structure of monchalcogenides and schematic processes of photoelectrochemical water splitting; b) experimental setup for photoelectrochemical characterization.

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