Solution-processed GaSe nanoflake-based films for photoelectrochemical water splitting and photoelectrochemical-type photodetectors

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Layered semiconductors of IIIA−VIA group have attracted considerable attention due to their potential in energy storage[1] and conversion applications.[2] In particular, 2D gallium selenide (GaSe) has been theoretically proposed as photocatalyst for water splitting reactions.[2] In fact, its 2D nature intrinsically guarantees that the charge carriers are directly photogenerated at the interface with the electrolyte, where redox reactions take place before they recombine.[2] Moreover, its electronic structure can be tuned by controlling the number of the layers to fulfil the fundamental requirements for a water splitting photocatalysts[2]. In our work,[3] we investigate for the first time the photoelectrochemical (PEC) properties of GaSe nanoflakes, produced by scalable liquid-phase exfoliation[4] in eco-friendly solvents[5]. We reveal that the GaSe nanoflakes can act as solution-processable materials for PEC water splitting reactions, *i.e.*, hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) with a ratiometric power-saved metric for HER and OER of 0.09% and 0.25%, respectively. Furthermore, the PEC properties of the GaSe nanoflakes can be exploited to conceive PEC-type photodetectors for visible wavelengths (*e.g.*, 455, 505 and 625 nm), reaching a stable responsivity up to 0.16 A W^{-1}. The obtained performances outperform the one of self-powered or low-voltage operating solution-processed photodetectors, approaching those of self-powered commercial UV–Vis photodetectors (e.g., Si- or GaP-based photodiodes).

References

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Figure

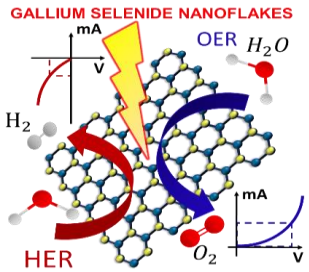

Figure 1: a) Schematic diagram of HER and OER processes.