Pt nanoclusters on GaN nanowires for solar-assisted seawater hydrogen evolution

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Seawater electrolysis provides a viable method to produce clean hydrogen fuel. To date, however, the realization of high-performance photocathodes for seawater hydrogen evolution reaction has remained challenging. Here, we introduce n^+-p Si photocathodes with dramatically improved activity and stability for hydrogen evolution reaction in seawater, modified by Pt nanoclusters anchored on GaN nanowires (Fig 1). We find that Pt-Ga sites at the Pt/ GaN interface promote the dissociation of water molecules and spilling H* over to neighboring Pt atoms for efficient H_2 production. Pt/GaN/Si photocathodes achieve a current density of −10 mA/cm^2 at 0.15 and 0.39 V vs. RHE and high applied bias photon-to-current efficiency of 1.7% and 7.9% in seawater (pH = 8.2) and phosphate-buffered seawater (pH = 7.4), respectively. We further demonstrate a record-high photocurrent density of ~169 mA/cm^2 under concentrated solar light (9 suns). Moreover, Pt/GaN/Si can continuously produce H_2 even under dark conditions by simply switching the electrical contact. This work provides valuable guidelines to design an efficient, stable, and energy- saving electrode for H_2 generation by seawater splitting.

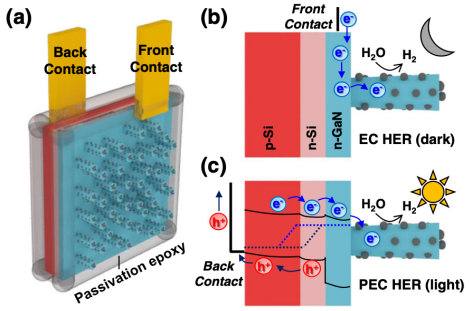

Figure 1: PEC/EC switchable electrode. (a) Schematic of switchable dual contact electrode. The front contact is placed on the front side of GaN nanowires (NWs) and the back contact is placed on the back side of n^+-p Si wafer. GaIn eutectic was sandwiched between the Cu contacts and the substrate for Ohmic connection. Illustrations of working principles of (b) front contact for electrochemical HER under dark and (c) back contact for photoelectrochemical HER under light. *Nature Comm.* (2023) **14**:179.