INFLUENCE OF THE NANOWIRE DIAMETER ON THE PHOTOELECTROCATALYTIC PROPERTIES OF ZnO NANOWIRE ARRAYS

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World demand for energy continues to increase with the passage of time. For this reason, a better exploitation of renewable energy sources is one of the major challenges in our society. Among the renewable power sources, photocatalytic water splitting offers a promising way for hydrogen production by solar energy. The development of photoelectrochemical (PEC) cells with high stability and efficiency is mandatory to induce a breakthrough in the daily usage of this technology. Metal oxide semiconductors such as TiO_2 and ZnO are the best candidates to be used as anodes for PEC cells. TiO_2 nanoparticulate films prepared by various methods have been widely explored as anode materials for PEC cells for more than three decades, while the PEC features of ZnO nanostructured films are still not thoroughly understood. The role of the ZnO nanowire (NW) morphology on hydrogen production is an open issue to be resolved and is the subject of the current work.

ZnO NWs were prepared by chemical bath deposition method on FTO (SnO_2:F) conductive glass substrates. Samples with different diameters ranging from 20 nm to 200 nm (with narrow to moderate size distribution), were prepared by properly tuning the NW's growth parameters, and employed as anodes of a PEC cell. SEM images of ZnO NWs reveal that as the diameter of the NWs increases, their orientation relative to the substrate improves. In addition, the occupied space of the NWs increases, while their shape changes from cylindrical to hexagonal-like. A hydrogen reference electrode (RHE) and a platinum wire (Pt) as cathode were used. The electrolyte was an aqueous solution of NaOH. The ZnO NWs were illuminated with a UV- LED. Cyclic voltammetry was used for evaluating the stability and the efficiency of the anode electrode for hydrogen production. The I-V curves of NW arrays exhibit a non-monotonic behavior in relation to the NW diameter, but in all cases the photocurrent increased with increasing diameter until an optimum value (for ZnO NW diameter of 150 nm). On the other hand, the open circuit voltage, V_{oc}, decreases when the diameter increases. Cyclic voltammetry experiments of the ZnO NW anodes confirmed their good stability.

The high photocurrent, low open circuit potential and good stability prove that ZnO NWs is a promising material for PEC solar hydrogen production.

Bibliography

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