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Effect of Morphology and Plasmonic on Au/ZnO Films for Efficient Photo electrochemical Water

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To improve photo electrochemical (PEC) water splitting, various ZnO nanostructures (Nano rods (NRs), Nano discs (NDs), NRs/NDs and ZnO NRs decorated with gold nanoparticles) have been manufactured. The pure ZnO nanostructures have been synthesized using the successive ionic layer adsorption and reaction (SILAR) combined with the chemical bath deposition (CBD) process at various deposition times. The structural, chemical composition, Nano morphological and optical characteristics have been examined by various techniques. The SEM analysis shows that by varying the deposition time of CBD from 2 to 12 h, the morphology of ZnO nanostructures changed from NRs to NDs. All samples exhibit hexagonal phase quartzite ZnO with polycrystalline nature and preferred orientation alongside (002). The crystallite size along (002) decreased from approximately 79 to 77 nm as deposition time increased from 2 to 12 h. The bandgap of ZnO NRs was tuned from 3.19 to 2.07 eV after optimizing the DC sputtering time of gold to 4 min. Via regulated time-dependent ZnO growth and Au sputtering time, the PEC performance of the nanostructures was optimized. Among the studied ZnO nanostructures, the highest photocurrent density (Jph) was obtained for the 2 h ZnO NRs. As compared with ZnO NRs, the Jph (7.7 mA/cm2) of 4 min Au/ZnO NRs is around 50 times greater. The maximum values of both IPCE and ABPE are 14.2% and 2.05% at 490 nm, which is closed to surface Plasmon absorption for Au NPs. There are several essential approaches to improve PEC efficiency by including Au NPs into ZnO NRs, including increasing visible light absorption and minority carrier absorption, boosting photochemical stability and accelerating electron transport from ZnO NRs to electrolyte carriersas.

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