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PHOTOELECTROCHEMICAL GREEN HYDROGEN PRODUCTION UTILIZING ZNO NANOSTRUCTURED PHOTOELECTRODES

Abstract

One of the emerging and environmentally friendly technologies is the photoelectrochemical generation of green hydrogen; however, the cheap cost of production and the need for customizing photoelectrode properties are thought to be the main obstacles to the widespread adoption of this technology. The primary players in hydrogen production by photoelectrochemical (PEC) water splitting, which is becoming more common on a worldwide basis, are solar renewable energy and widely available metal oxide based PEC electrodes. This study attempts to prepare nanoparticulate and nanorod-arrayed films to better understand how nanomorphology can impact structural, optical, and PEC hydrogen production efficiency, as well as electrode stability. Chemical bath deposition (CBD) spray pyrolysis are used to create ZnO nanostructured photoelectrodes. Various characterization methods are used to investigate morphologies, structures, elemental analysis, and optical characteristics. The crystallite size of the wurtzite hexagonal nanorod arrayed film was 100.8 nm for the (002) orientation, while the crystallite size of nanoparticulate ZnO was 42.1 nm for the favored (101) orientation. The lowest dislocation values for (101) nanoparticulate orientation and (002) nanorod orientation are 5.6 x 10-4 and 1.0 x 10-4 dislocation/nm2, respectively. By changing the surface morphology from nanoparticulate to hexagonal nanorod arrangement, the band gap is decreased to 2.99 eV. Under white and monochromatic light irradiation, the PEC generation of H2 is investigated using the proposed photoelectrodes. The solar-to-hydrogen conversion rate of ZnO nanorod-arrayed electrodes was 3.72is higher than previously reported values for other ZnO nanostructures. The output H2 generation rates for white light and 390 nm monochromatic illuminations were 28.43 and 26.11 mmol.h1-cm2-, respectively. The nanorod-arrayed photoelectrode retains 96.610 reusability cycles, compared to 87.4of conversion efficiencies, H2 output rates, Tafel slope, and corrosion current, as well as the application of low-cost design methods for the photoelectrodes, show how the nanorod-arrayed morphology offers low-cost, high-quality PEC performance and durability.