World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:15, No:05, 2021

Formation of ZnS/ZnO Heterojunction for Photocatalytic Hydrogen Evolution Using Partial Oxidation and Chemical Precipitation Synthesis Methods

Authors : Saba Didaratae, Abbas Ali Khodadadi, Yadollah Mortazavi, Fatemeh Mousavi

Abstract : Photocatalytic water splitting is one of the most attractive alternative methods for hydrogen evolution. A variety of nanoparticle engineering techniques were introduced to improve the activity of semiconductor photocatalysts. Among these methods, heterojunction formation is an appealing method due to its ability to effectively preventing electron-hole recombination and improving photocatalytic activity. Reaching an optimal ratio of the two target semiconductors for the formation of heterojunctions is still an open question. Considering environmental issues as well as the cost and availability, ZnS and ZnO are frequently studied as potential choices. In this study, first, the ZnS nanoparticle was synthesized in a hydrothermal process; the formation of ZnS nanorods with a diameter of 14-30 nm was confirmed by field emission scanning electron microscope (FESEM). Then two different methods, partial oxidation and chemical precipitation were employed to construct ZnS/ZnO core-shell heterojunction. X-ray diffraction (XRD), BET, and diffuse reflectance spectroscopy (DRS) analysis were carried out to determine crystallite phase, surface area, and bandgap of photocatalysts. Furthermore, the temperature of oxidation was specified by a temperature programmed oxidation (TPO) and was fixed at 510℃, at which mild oxidation occurred. The bandgap was calculated by the Kubelka-Munk method and decreased by increasing oxide content from 3.53 (pure ZnS) to 3.18 (pure ZnO). The optimal samples were determined by testing the photocatalytic activity of hydrogen evolution in a quartz photoreactor with side irradiation of UVC lamps with a wavelength of 254 nm. In both procedures, it was observed that the photocatalytic activity of the ZnS/ZnO composite was sensibly higher than the pure ZnS and ZnO, which is attributed to forming a type-II heterostructure. The best ratio of oxide to sulfide was 0.24 and 0.37 in partial oxidation and chemical precipitation, respectively. The highest hydrogen evolution was 1081 µmol/gr.h, gained from partial oxidizing of ZnS nanoparticles at 510℃ for 30 minutes.

Keywords : heterostructure, hydrogen, partial oxidation, photocatalyst, water splitting, ZnS
Conference Title : ICHPN 2021 : International Conference on Heterogeneous Photocatalytic Nanomaterials
Conference Location : Sydney, Australia
Conference Dates : May 17-18, 2021