Electronic Supplementary Material (ESI) for RSC Advances.

Supporting information

Nanostructured $ZnO/ZnFe_2O_4$ Heterojunction for Visible Light Photoelectrochemical Oxidation of Water

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Experimental

ZnO nanorods were prepared as follows: Precursor solution was prepared by dissolving 3.78 g zinc nitrate ($Zn(NO_3)_2$) and 2.8 g hexamethylenetetramine ($C_6H_{12}N_4$) in 100 mL DI water. The substrates deposited with zinc oxide seed layer were put in a 100 mL bottle containing 80 mL precursor solutions. The reaction was conducted at 95 ºC for 3 h. After growth, the substrates were washed with deionized water several times and allowed to dry in air. The ZnO nanorods arrays were obtained after annealing the sample at 350 ºC for 1 h to remove the organic residue.

ZnO seed layer on FTO were grown as following method: 0.5g zinc acetate and 0.25g poly(vinyl alcohol) powders were dissolved into 3 mL deionized water, followed by a vigorous magnetic stirring for 1 h at 60 ºC to get zinc oxide colloid. The as-prepared zinc oxide colloid solution was then spin-coated on the pretreated FTO glass substrates and the samples were then annealed at 500 ºC for 1 h.

Synthesis of $ZnFe_2O_4$ nanoparticles and surface modification were conducted according to the method reported earlier. [1,2] Deposition solution was prepared by dissolving 2 mg $ZnFe_2O_4$ particles in 5 mL DI water.

The morphology and size of ZnO nanorods and ZnO/$ZnFe_2O_4$ film were characterized by using a field-emission scanning electron microscope (Zeiss ULTRA Plus) operated at an accelerating voltage of 5 kV. X-ray diffraction patterns (XRD) were recorded on a PANalytical X'Pert PRO instrument using Cu Kα radiation (40 kV, λ = 1.5406 Å) between 20° to 70° at a scanning rate of 0.067°/s. UV-visible diffusion reflectance spectra were measured on a UV-2550 (Shimadzu) spectrometer by using $BaSO_4$ as the reference. Photoelectrochemical measurements were made using a three-electrode configuration with the ZnO or ZnO/$ZnFe_2O_4$ film as the working photoelectrode, saturated calomel electrode (SCE) as the reference electrode, and platinum foil as the counter electrode in 0.1 M Na_2SO_4. Sunlight was simulated with a 300 W xenon lamp and an AM1.5G filter (HSX-F300, Beijing NBeT Technology Co., Ltd), coupled with a 420 nm UV filter. The light intensity was set using a calibrated crystalline silicon solar cell. Photocurrent response and electrochemical impedance spectroscopy (EIS) were recorded using a CHI-660D potentiostat. The superimposed alternating current (AC) signal was maintained at 5 mV, while the frequency was scanned between 100 kHz and 0.05 Hz at potentials of 0.8 V versus SCE under illumination by visible light in an electrolyte of 0.1 M Na_2SO_4, with Pt as the counter electrode. STEM-EDX mapping techniques were measured using an FEI Tecnai TF20 microscope operated at 200 kV.

References:

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