

Controlled synthesis of ZnGa₂O₄ nanorod arrays from hexagonal ZnO microdishes and their photocatalytic activities on degradation of RhB

Zesheng Li,^{*a} Bolin Li,^a Zhenghui Liu,^a Dehao Li,^a Chunyu Ge,^b Yueping Fang^{*b}

^a Development Center of Technology for Petrochemical Pollution Control and Cleaner Production of Guangdong Universities,

College of Chemical Engineering, Guangdong university of Petrochemical Technology, Maoming, Guangdong, 525000, China;

^b Institute of Biomaterial, College of Science, South China Agricultural University, Guangzhou, 510642, China.

Correspondence author: Zesheng Li E-mail: lzs212@163.com; Yueping Fang E-mail: ypfang@scau.edu.cn.

Experimental

Synthesis of materials

The Ga-doped giant ZnO nanorod arrays were prepared by the hydrothermal method. In a typical synthesis, 0.5 g Ga was ultrasonically dispersed in 12.5 ml of ethanol for 1.5 hours. Subsequently, 1.25 g Stearic acid, 0.5 g Zinc stearate (ZnSt₂) and 7.5 mL of distilled water were added with stirring to form a uniform solution. Then the mixture was transferred into a Teflon-lined autoclave (30 ml), heated to 175 °C and maintained at this temperature for 12 hours. After the hydrothermal treatment, the white precipitates were collected and washed via filtration and redispersion cycles with each successive supernatant being decanted and replaced with heated ethanol, then dried in air for further characterizations. The hexagonal ZnO flowerpots were prepared by similar procedure without the use of Ga. The giant ZnGa₂O₄ nanorod arrays were further synthesized by heat-treating topological morphology conversion process from Ga-doped giant ZnO nanorod arrays. The heat-treating process was conducted at 2°C/min up to 800 °C for 6 h under air atmosphere.

Characterizaiton

The as-prepared products were directly subjected to thermal field emission scanning electron microscopy characterizations (FE-SEM, FEI, Quanta 400) attaching energy dispersive X-ray (EDX) spectroscopy, powder-X-ray diffraction (XRD, Philips PW-1830 X-ray diffractometer). For the transmission electron microscopic (TEM, JEOL 2010 microscopes operated at an accelerating voltage of 200 kV) observations, the as-prepared products were sonicated in ethanol for 20 min and the suspension was dropped onto a carbon-coated Cu grid, followed by evaporation of the solvent in the ambient environment. The Brunauer-Emmett-Teller (BET) specific surface areas were measured by N₂ adsorption at liquid N₂ temperature in an ASAP 2010 analyser.

Catalysis Experiments

The photocatalytic activity of the as-prepared products was evaluated by the photocatalytic decomposition of RhB aqueous solution at room temperature using a XPA-II photochemistry reactor equipped with a 300 W mercury lamp (with a predominant wavelength at 365nm). The experimental details were as follows: 0.100 g of the as-prepared products was dispersed in 250 mL of 1.04×10^{-5} mol/L RhB aqueous solution in a beaker. Before irradiation, the suspensions were magnetically stirred in the dark for about 6 h to ensure the establishment of adsorption-desorption equilibrium of the dye on the catalyst surface. At given time intervals, 8 mL of reaction mixture was sampled and centrifuged to remove the as-prepared products. The concentration of RhB was determined by UV-vis spectrophotometer (Shimadzu UV-2550).