Abstract

Photocatalytic method is one of the advanced oxidation process to eliminate harmful organic compounds in polluted water which cannot be effectively removed by conventional treatment process. Since the performance of photocatalytic activity is mainly influenced by material properties, tungsten trioxide (WO_3) which has a narrow band gap, harmless, good thermalstability, and good photostability is a prospective material for solar-related material application. Therefore, deep understanding regarding the influence of WO_3 properties on photocatalytic performance is desired.

In this dissertation, synthesis of nanostructured WO_3 particles via aerosol process for photocatalytic application is systematically investigated. Aerosol process was used in this study because it can produce particles in the nano- to submicron-sized ranges with a high production rate, continuous operation, and low cost process. The effect of several process parameters on the particles formation and morphology was studied. The prepared particles were used to decompose rhodamine B (RhB) and amaranth as the model of organic waste under visible light. The major contents of this dissertation are listed as follow.

Chapter 1 provides the background and motivation of current research. Basic theoretical explanation and review of previous researches on photocatalyst materials, especially WO_3 particles were also provided.

Chapter 2 describes the synthesis of WO_3 particles with controllable crystallite and particle sizes using spray-pyrolysis method. To prepare fine particles, ammonium tungstate pentahydrate (ATP) was used as a starting precursor. The crystallite and particle sizes were controlled by changing the synthesis temperatures from 120 to 1300°C and precursor concentrations from 2.5 to 15 mmol/L. Submicron particles were obtained when the synthesis temperature of below 900°C. Increases in temperature process above 900°C lead the production of nanoparticles (NPs) due to the evaporation and condensation of WO_3 material during the high synthesis temperature process. It was found that the synthesis temperature has a more significant effect on the change of particles morphology than precursor concentration. Photocatalytic analysis showed that the ability of WO_3 catalyst to decompose RhB was influenced by crystallinity and particle size. The optimum condition to produce WO_3 particles with the highest photocatalytic performance was the synthesis temperature of 1200°C and the precursor concentration of 10 mmol/L. This condition resulted in the production of WO_3 particles with diameter of 105 nm and crystal size of 25 nm.

In **Chapter 3**, the direct synthesis of composite WO_3/TiO_2 NPs using flame-assisted spray-pyrolysis method is conducted. The mass ratio of ammonium metatungstate (AMT) as a WO_3 source and titanium isopropoxide (TTIP) as a TiO_2 source was varied: 0/100; 10/90; 25/75; 55/45; 70/30; and 100/0. Increases in the AMT amount lead to the production of smaller-sized particle down to 20 nm. Photocataytic analysis showed that the performance of the prepared particles was proportional to that of AMT amount. Therefore, UV-Vis spectrophotometer was used to measure the change of light absorbance. It was found that an increase in AMT amount shifted the light wavelength from 371 (blue region) to 416 nm (red region), resulted in the reduction of band gap energy. It can be concluded that the improvement of photocatalytic performance was influenced by the changes of particle size and band gap energy.

A rapid synthesis of nanostructured macroporous WO_3 particles via spray-drying process with colloidal template is introduced in **Chapter 4**. ATP and 230 nm of polystyrene (PS) particles were used to produce spherical macroporous WO_3 particles. This research is one of strategies to develop efficient catalyst because the entire surface area of the particles can be activated by light illumination effectively. The mass ratio of PS/ATP was varied from 0.00 to 0.64 to generate particles with highly ordered-porous structure. Macroporous WO_3 particles prepared with mass ratio of 0.60 shows the highest photocataytic performance. This work presents simple process for designing nanostructured macroporous material with controllable porous structure.

In **Chapter 5**, a facile route to deposit Pt NPs on the surface of nanostructured macroporous WO_3 particles via in-situ process is discussed. High photocatalytic performance of porous WO_3 particles containing Pt NPs as a co-catalyst material is investigated in this chapter. The nanostructured Pt/WO_3 particles were prepared by spray-drying of a precursor solution containing WO_3 NPs (10 nm), Pt salt, and PS particles (250 nm) at 600°C. The results of morphology characterizations showed that Pt

NPs were distributed on the particle surface with the size around 2 nm. The best photocatalytic activity was achieved for catalyst particles prepared at a PS/WO_3 mass ratio of 0.32 and Pt NPs of 0.23 wt%, whereby the photodecomposition rate was more than 5 times higher than that WO_3 NPs.

A general conclusion of all topics and some suggestions for further investigation were listed in **Chapter 6.**