

CHAPTER 4

CONCLUSIONS



4.1 Synthesis of tungsten oxide by a hydrothermal method using ammonium metatungstate hydrate as a tungsten source

In this work, orthorhombic tungsten oxide (α - WO_3) was synthesized by the 200 °C, 24 h hydrothermal reaction of ammonium metatungstate solutions containing different volumes of 1M HCl and hexadecyltrimethylammonium bromide (CTAB) cationic surfactant. In the HCl-free solution, the product was an amorphous phase. When 2.50 ml 1M HCl was added to the solution, both orthorhombic $\text{WO}_3 \cdot 0.33\text{H}_2\text{O}$ and WO_3 phases were detected. These products became pure orthorhombic WO_3 in the 5.00 ml and 7.50 ml 1M HCl-added precursor solutions. In 7.50 ml 1M HCl-added solution, the product was α - WO_3 microflowers, with microsquare layers growing out of their cores. These analyses showed that their phases and morphologies were controlled by the acidity of the solutions. FTIR and Raman vibrations of $\text{W}=\text{O}$, $\text{O}-\text{W}-\text{O}$, and $\text{W}-\text{O}-\text{W}$ stretching modes were detected, and showed typical crystalline WO_3 . Their optical properties showed a maximum absorption at 275 nm in the UV region and a maximum emission peak at 375 nm.

4.2 Synthesis of tungsten oxide by a hydrothermal method using sodium tungstate dihydrate as a tungsten source

Tungsten oxide (WO_3) nanostructures with different morphologies were synthesized by hydrothermal reactions of sodium tungstate solutions containing different volumes of 3M HCl and ammonium sulphate as a capping reagent. A various factors influencing on the final morphologies of WO_3 such as acidity, reaction temperature and time were studied. The XRD patterns revealed pure phase hexagonal WO_3 (h- WO_3) by comparing with its JSPDS database. Their morphologies were observed by SEM that shows nanoparticles, nanorods and nanowires, controlled by various factors. Hexagonal WO_3 nanowires with a diameter of 20-30 nm and lengths of up to several micrometers were successfully synthesized by a hydrothermal reaction at 200 °C for 48 h in a solution containing 5.00 ml 3M HCl-added precursor solution. FTIR and Raman vibrations of W=O, O-W-O, and W-O-W stretching modes were detected, and showed typical crystalline WO_3 . Their optical properties showed a maximum absorption at 275 nm in the UV region.