Synthesis and characterize TiO2 and SnO2 nanocomposite for dye waste water treatment by photocatalysis process

Natthida Wonginta, Korawith Pimpa, Saitharn Limsakul and Yothin Chimupala

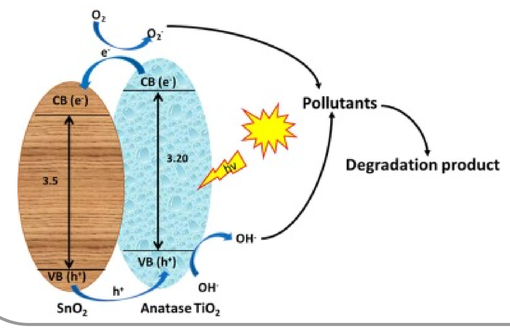
Research Laboratory of Pollution Treatment and Environmental MaterialsDepaetment of Industrial chemmistry, Facculty of Science, Chian Mai University

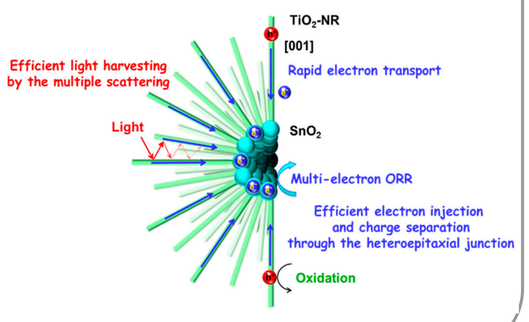
Abstract

Dye-containing wastewater from the textile industry poses a serious environmental problem because most dyes are chemically stable and difficult to degrade using conventional treatment methods. This study aims to synthesize and characterize a titanium dioxide TiO_2 and SnO_2 nanocomposite for photocatalytic wastewater treatment. TiO_2 particles were prepared via a hydrothermal method and calcined at 500, 700, and 900 °C for 2 h to obtain different crystalline structures. SnO_2 was subsequently deposited onto TiO_2 using a reflux process to enhance charge separation, as electrons can transfer from TiO_2 to SnO_2 due to the lower conduction band of SnO_2. The effects of TiO_2 calcination temperature and influence SnO2 doping on dye degradation were investigated. The crystalline structure and surface morphology were characterized using X-ray diffraction (XRD) and scanning electron microscopy (SEM). The photocatalytic activity of the synthesized materials was evaluated through the degradation of methyl orange (MO) dye.

Introduction

- **TiO_2** is a promising photocatalyst but suffers from rapid electron–hole recombination.
- Coupling TiO_2 with SnO_2 can form a heterojunction that improves charge separation.



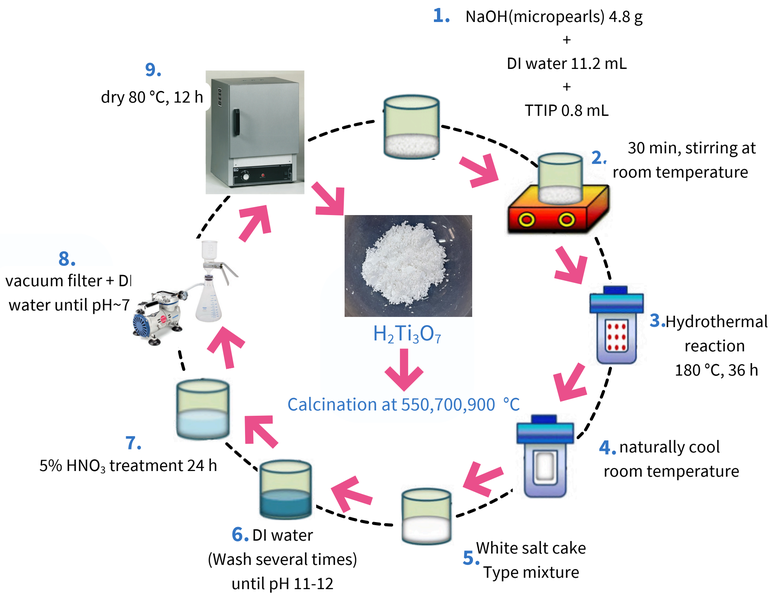


Objectives

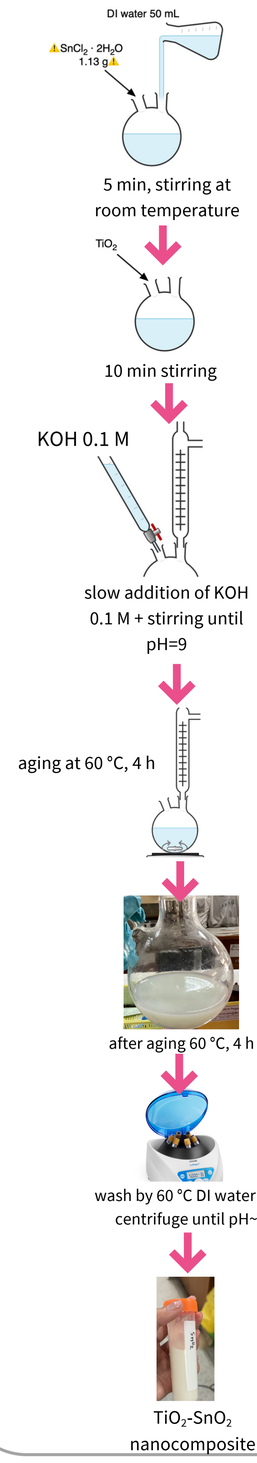
1. To synthesize and characterize TiO_2–SnO_2 nanocomposites as photocatalysts for dye wastewater treatment.
2. To develop photocatalytic materials for efficient wastewater treatment.

Experiment

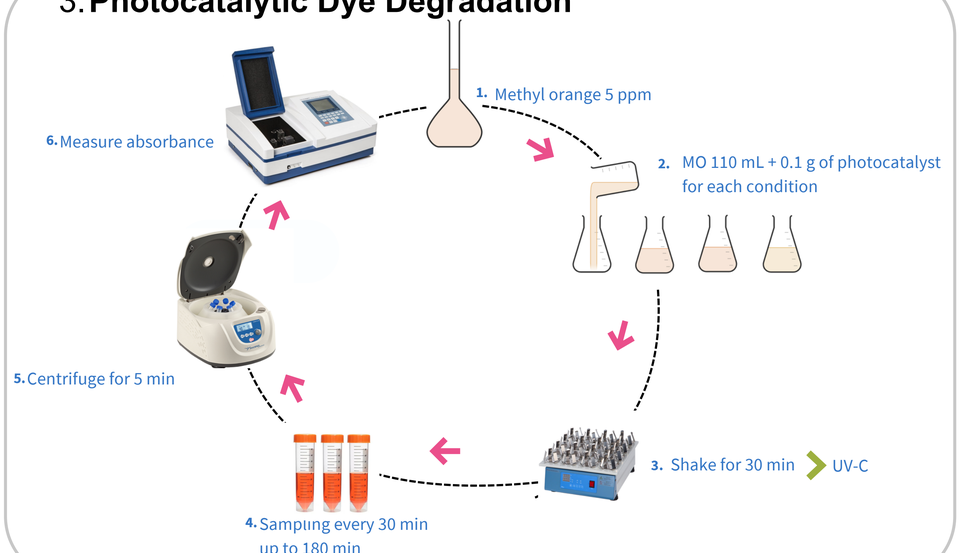
1. Synthesis of TiO_2 nanorods (mixed phase) by hydrothermal process



2. Synthesis of TiO_2 and SnO_2 nanocomposite by reflux process

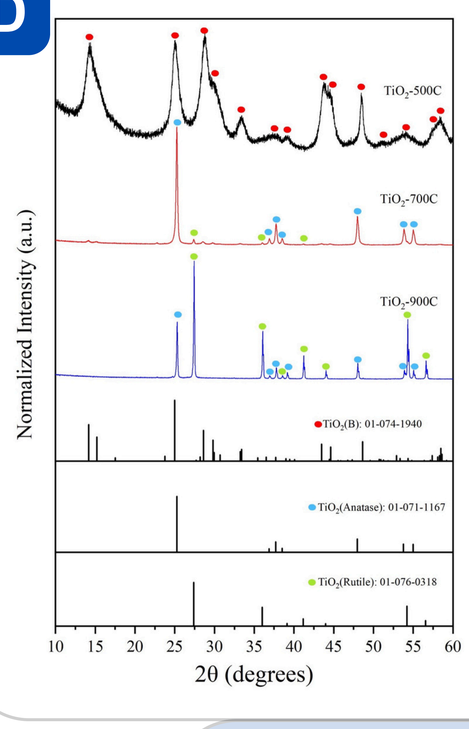


3. Photocatalytic Dye Degradation

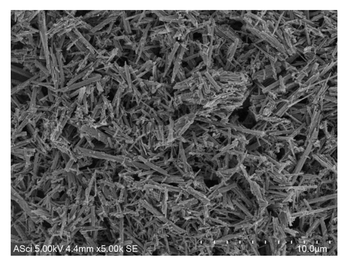


Results & Discussion

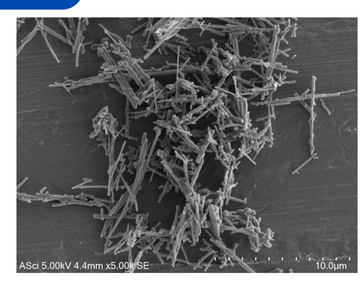
XRD



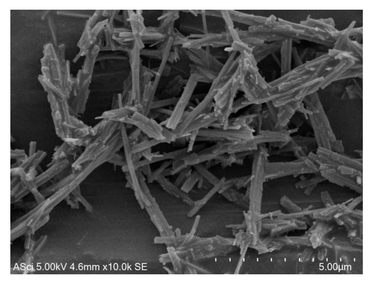
SEM



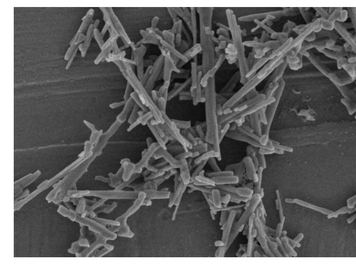
TiO_2-700-SnO_2 75:25 °C



TiO_2-900-SnO_2 75:25 °C



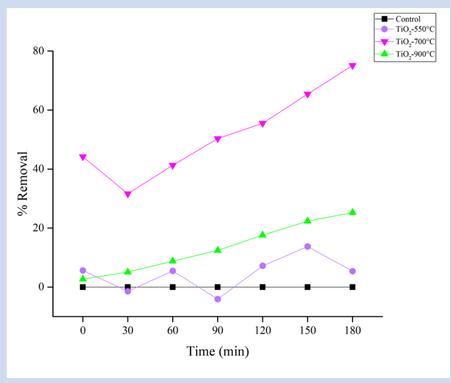
TiO_2-550°C



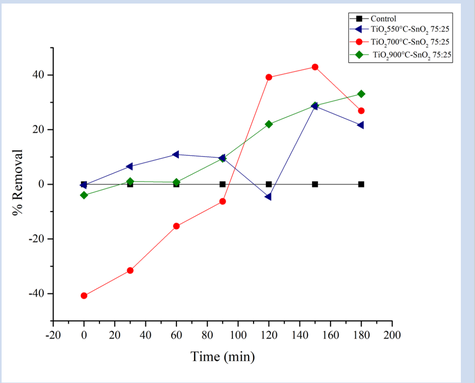
TiO_2-900°C

The calcination temperature is the primary driver of morphological changes. While 550°C preserves a fine nanorod structure, increasing the temperature to 900°C leads to severe sintering and loss of the high-surface-area rod morphology. The 700°C composite represents an intermediate state where the rod structure is preserved despite the addition of SnO_2 and increased thermal energy.

Photocatalytic efficiency



Calcination temperature TiO_2 effect



SnO_2 doping effect

The 700°C calcination is the optimal condition for TiO_2-SnO_2 synthesis. It provides a strategic mixed phase for improved charge separation while maintaining a high-surface-area nanorod structure, resulting in superior dye treatment efficiency.

Conclusion

The calcination temperature is the critical factor determining the material's phase and morphology. Increasing the temperature from 550°C to 900°C induces a phase transformation from TiO_2(B) to a mixed Anatase/Rutile phase, accompanied by sintering, which leads to particle coalescence and reduced surface area. The 700°C condition is the optimal synthesis parameter; it achieves a strategic heterojunction between TiO_2-SnO_2 and a balanced mixed phase, while maintaining a high-surface-area nanorod structure. This synergy effectively suppresses charge recombination, resulting in superior photocatalytic dye degradation efficiency.