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Synthesis of Mesoporous Sulfur-Doped Ta₂O₅ Nanocomposites and Their Photocatalytic Activities

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Abstract

Mesoporous sulfur (S)-doped Ta₂O₅ nanocomposites have been synthesized for the first time through the sol-gel reaction of tantalum chloride and thiourea in the presence of a F127 triblock copolymer as structure directing agent. The as-formed mesophase S-doped Ta₂O₅ hybrid gels were calcined at 700 °C for 4 hours to obtain mesoporous S-Ta₂O₅ nanocomposites. The experimental results indicated that the surface area of the S-doped Ta₂O₅ was up to 50 m²g⁻¹ and the pore diameter was controllable in the range of 3-7.7 nm. The S-doped Ta₂O₅ nanocomposites behave as superior visible light-sensitive photocatalysts and the 1.5 at% S-doped Ta₂O₅ (S1.5) photocatalyst exhibited excellent photocatalytic activity of ~92% for the photodegradation of methylene blue, identical to 80% TOC removal after three hours illumination under visible light. The photodegradation rate of S1.5 photocatalyst showed 3.4 times higher than the undoped Ta₂O₅ due to their narrow bandgap, large surface area, mesostructure and well crystalline state. The S1.5 photocatalyst could be recycled at least five times without an apparent decrease in its photocatalytic efficiency, indicating its high stability for practical applications. To the best of our knowledge, this is the first report that demonstrates one-step synthesis of mesoporous S-doped Ta₂O₅ nanocomposites as an efficient photocatalyst under visible light illumination.

Keywords: Mesoporous; S-doped Ta₂O₅; Nanocomposites; Photocatalyst; Visible light.

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