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Article

Controlling dispersion and morphology of MoS_2 nanospheres by hydrothermal method using SiO_2 as template[#]

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Abstract Monodispersed MoS_2 nanospheres were successfully synthesized by using SiO_2 as hard template. The size and morphology of the MoS_2 nanospheres could be finely controlled by the content of SiO_2 and sulfur precusors. Furthermore, higher surface area of monodispersed MoS_2 nanospheres exhibited high reaction rate for hydrodesulfurization (HDS) of Dibenzenethiophene(DBT).

Keywords: Molybdenum disulfide; Hard template; Monodisperse; hydrodesulfurization

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1 Introduction

Molybdenum disulfide (MoS_2) is a transition metal chalcogenide material widely used in photocatalysis [1], synthesis catalyst [2], hydrodesulfurization [3], hydrodeoxygenation [4]. Two-dimensional MoS_2 is widely used in electronic [5], optical [6], mechanical [7], even in hydrogen elvolution reaction (HER) [8]. Morphology and particle size of MoS_2 can obviously influence their chemical and physical properties, but possessing controllable morphology and dispersion of MoS_2 nanocrystal still remain big challenges. A variety of methods to controllably synthesize MoS_2 nanomaterials with different shape have been reported using different precursors and reaction conditions. Early method was sulfidation of molybdenum oxides MoO_3 by sulfur compounds (KSCN [9], Na_2S [10], sulfur powder [11]) in a stainless steel autoclave under a suitable temperature to obtain MoS_2 with high crystalinity but their surface area was only < 100 $m^2 \cdot g^{-1}$. Other precursors such as Mo(CO) [12], $MoCl_5$ [13] in the reaction decomposed quickly and uncontrollable. $(NH_4)_2MoS_4$ is a new precursor, which can decompose easily in reducing gas or solvent, and form MoS_2 with high crystallinity, but morphology of MoS_2 cannot be also controlled well. Recently, template method is probably the most effective and general route to prepare nanostructures and can be used to controllably adjust morphology of MoS_2. MoS_2 nanospheres were synthesized by using Pluronic P-123 and other surfactants, unfortunately, surface area was lower than 140 $m^2 \cdot g^{-1}$ and these organic compounds interact with MoS_2 removing difficultly. MoS_2 nanotubes, nanorods, nanosheres were successfully prepared by using hard templates such as: mesoporous Al_2O_3 [14], MoO_3 nanorods [15] and carbon nanospheres [16]. However, size of these MoS_2 nanomaterials was difficult to control and the rigid templates were hard to remove completely. Skrabalak *et al*. [17] reported that mesoporous MoS_2 with a narrow pore size distribution and high surface area of 200 $m^2 \cdot g^{-1}$ used SiO_2 nanoparticles as hard templates was synthesized successfully and the SiO_2 template can be

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