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Controllable electrochemical anodization method for the synthesis of Fe@ γ -Fe₂O₃ core-shell nanoparticles

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Abstract

The Fe@ γ -Fe₂O₃ core-shell nanoparticles were synthesized by an electrochemical anodization method in a potentiostatic way. The core-shell structure was clearly shown by the HRTEM observation; With increasing the anodization potential and time, the thickness of γ -Fe₂O₃ shell increased, which was proved by the measurements of XRD and magnetization. Compared with the naked Fe nanoparticles, the anodized Fe@ γ -Fe₂O₃ core-shell nanoparticles show the better magnetization stability and can be more easily functionalized by TiO₂.

Key words: Fe nanoparticle; Electrochemical anodization; Fe/ γ -Fe₂O₃ core-shell structure

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1. Introduction

The core-shell structured two-component system generally exhibits the novel properties or expands the applicable fields as compared with the single component [1-7]. For examples, in the Fe@Fe₃O₄ or Co-Fe@CoFe₂O₄ magnetic nanoparticles, the Fe₃O₄ or CoFe₂O₄ ferrite shell can prevent the Fe or Co-Fe from the oxidation and corrosion, stabilizing the high moment of Fe or Co-Fe; Furthermore the ferrite shell is biocompatible [8]. Therefore these core-shell nanoparticles are expected to be promising materials for biological, photocatalytic and bio-sensing applications [9,10].

The aforesaid core-shell structures were synthesized by the oxidation of metal or alloy in air at high temperature [5,9,10], inevitably leading to the agglomeration of nanoparticles. To solve this problem, before the oxidation, the metallic nanoparticles were dispersed into the MgO or SiO₂ matrix [11-14]; Then the MgO or SiO₂ matrix was removed in the acidic or alkaline solution after the oxidization in order to recover the dispersity of metallic nanoparticles. These processes are complex and non environment-friendly; Moreover MgO or SiO₂ cannot be removed completely,

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