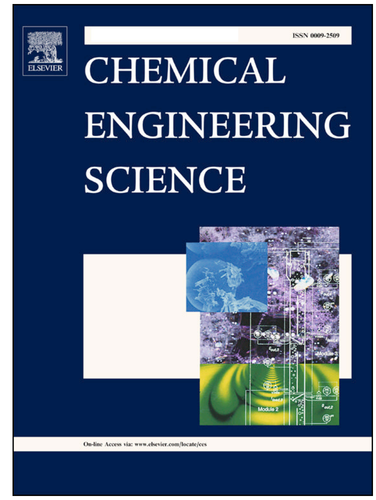

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Synthesis of Yttrium Oxide Nanoparticles via a Facile Microplasma-assisted Process

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Abstract

Plasma electrochemistry is an emerging technique for nanomaterial synthesis. The present study reports the preparation of yttrium oxide nanoparticles via a simple, environmentally benign, microplasma-assisted process operated in pin-to-liquid configuration under ambient atmospheric conditions using yttrium nitrate aqueous solution as the precursor. The plasma-liquid interaction was monitored *in-situ* by optical emission spectroscopy. The morphology, structure and chemical composition of the obtained products were examined by complementary analytical methods. It was demonstrated that high purity crystalline Y_2O_3 nanoparticles with adjustable sizes can be fabricated via a two-step method: plasma electrodeposition of yttrium hydroxide followed by heat-treatment at various temperatures. A microplasma array design was proposed for the process upscaling towards industrial level production. Moreover, possible mechanisms for plasma-assisted yttrium hydroxide precipitation were discussed by correlating optical emission spectroscopic studies, plasma kinetic analysis and the precipitation equilibrium. As a proof-of-concept, this process offers a facile, environmental friendly and scalable route for rare-earth oxide nanomaterial synthesis.

Keywords: microplasma; micro reactor; electrochemistry; plasma-liquid interaction; Y_2O_3 nanoparticles

Introduction

The synthesis of yttrium oxide (Y_2O_3) nanostructures has been of long standing interest, motivated primarily by their fascinating properties such as high refractory performance (melting point ~2450℃), good thermal conductivity (33 $W·m^{-1}K^{-1}$), superior chemical stability as well as excellent mechanical properties (Aghazadeh et al., 2010; Lakshminarasappa et al., 2014). Nanoscale Y_2O_3 powders have been widely used in many areas especially where high performance or high temperature are required, such as nuclear ceramics (Verhiest et al., 2009),