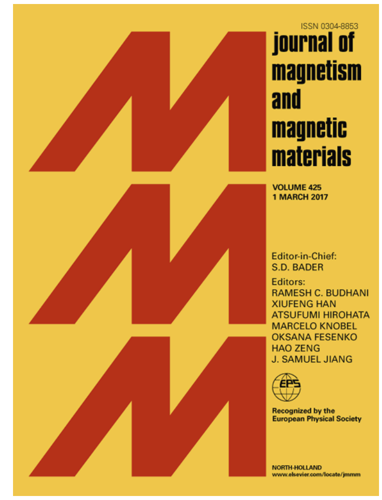

Research articles

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PII: S0304-8853(17)33926-4
DOI: https://doi.org/10.1016/j.jmmm.2018.04.005
Reference: MAGMA 63851

To appear in: *Journal of Magnetism and Magnetic Materials*

Received Date: 21 December 2017
Revised Date: 22 March 2018
Accepted Date: 2 April 2018

Magnetite Nanoparticles with Controlled Sizes via Thermal Degradation of Optimized PVA/Fe(III) Complexes

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Abstract

In this manuscript, magnetite nanoparticles have been synthesized via an optimized method that consists in the thermal degradation of a polymer-metal complex prepared from an appropriated mix of polyvinyl alcohol and iron nitrate. Negatively charged (Zeta potential) nanoparticles, with a cubic spinel structure ($Fd\bar{3}m$ space group) and a narrow size distribution (mean particle size close to 5 nm) were successfully processed. Magnetic characterizations reveal a single-domain superparamagnetic-like behavior with a decreased saturation magnetization (11 emu/g) due to surface effects. Nanoparticle dispersions were investigated by SAXS (hard spheres, Beaucage model) and the average gyration radius (2.1 nm) and Porod's length (2.4 nm) are found to be close to the nanoparticle's physical and magnetic sizes. The results revealed that this easy, reproducible and cheap method is suitable to synthesize high-quality single-domain magnetite nanoparticles that can be functionalized for future biological applications.

Keywords: Magnetite, superparamagnetic nanoparticles, magnetic nanoparticles, complexes, polyvinyl(alcohol) (PVA), thermal degradation

Introduction

Magnetic nanoparticles (MNP) have attracted great attention because of their potential applications in many advanced technological areas [1, 2], including data storage, catalysis [3], magnetic ferrofluids [4], magnetic resonance imaging (MRI) [5, 6], magnetically guided drug delivery [7] and magnetic hyperthermia treatment [8].

The most common magnetic material in nature is magnetite (Fe_3O_4). It has a cubic inverse spinel structure, i.e., the oxygen ions are in a cubic close packed arrangement while Fe(III) ions occupy tetrahedral sites and Fe(III) and Fe(II) ions are randomly distributed in octahedral sites. Due to transference of electrons between Fe(II) and Fe(III) in the octahedral sites, magnetite exhibits outstanding electrical and magnetic properties [9, 10], and is commonly used in biomedical applications due to its low toxicity and biocompatibility with the human body [2, 11, 12].