www.elsevier.com/locate/jcrysgro

Hydrothermal Growth of Fine Magnetite and Ferrite Crystals

Shayan Byrappa, C.S. Vicas, Neel Dhanraj, K. Namratha, S.D. Keerthana, Ravi Dey, K. Byrappa

PII: S0022-0248(15)00633-8
DOI: http://dx.doi.org/10.1016/j.jcrysgro.2015.10.027
Reference: CRYS23038

To appear in: *Journal of Crystal Growth*

Received date: 6 October 2015
Accepted date: 23 October 2015

Cite this article as: Shayan Byrappa, C.S. Vicas, Neel Dhanraj, K. Namratha S.D. Keerthana, Ravi Dey and K. Byrappa, Hydrothermal Growth of Fin Magnetite and Ferrite Crystals, *Journal of Crystal Growth* http://dx.doi.org/10.1016/j.jcrysgro.2015.10.027

Hydrothermal Growth of Fine Magnetite and Ferrite Crystals

Shayan Byrappa*, C. S. Vicas[1], Neel Dhanraj[†], K. Namratha[1], S. D. Keerthana[1], Ravi Dey* and K. Byrappa[1]
[*]Department of Materials Science and Engineering, Stony Brook University, Stony Brook, New York, 11794, USA
[†]Merrimack High School, Merrimack, New Hampshire, 03054, USA
[1]Centre for Materials Science and Technology, Vijnana Bhavan, Mysore, India – 570006
*Corresponding author: mbshayan@gmail.com

Abstract
In the present work, magnetite (Fe_3O_4, avg. ~ 70 nm) synthesis employing Azadirachta indica (neem) leaf extract is reported originally using hydrothermal conditions and the results obtained were compared with that of D-glucose. Fourier transform infrared spectroscopy confirms the presence of polysaccharides and proteins in the extract which act as both surfactants and reducing agents, aided the formation of magnetite nanostructures. Authors also reported the selective doping of Zn, Cu and Co on nickel ferrite for the enhancement of adsorptive dye removal property, adopting and investigating the use of eloquent one-step green hydrothermal approach (T=180°C, t=4 hr, pH=12) with sodium dodecyl sulphate as surfactant. X-ray diffraction studies reveal that all the materials synthesized are isometric spinel structures and furthermore, morphological evidences using scanning electron microscopy are accounted. Adsorptive dye removal ability of synthesized materials was investigated using trypan blue as a probe. It was evident from the results that magnetite using neem extract showed enhanced adsorption ability (75%) than that of D-glucose (62%). Also, exponential increase in dye removal efficiency from 55% to 81% due to the presence of copper in nickel ferrite was duly noted.

Keywords: A2. Hydrothermal Crystal Growth, B1. Nanomaterials, A1. Crystal Morphology, A1. X-ray Diffraction, A1. Characterization, A1. Crystal Structure

1. Introduction

Magnetic nanoparticles are one of the commonly researched materials of the modern scientific era for their various dye degradation applications and biomedical applications like cell separation, immunoassay and so on [1]. Magnetite (Fe_3O_4) is one of the very important metal oxides in terms of its unique magnetic properties and applications in various fields including biomedicine [2]. Apart from magnetite, nickel ferrite, cobalt ferrite, copper ferrite and zinc ferrite materials are known to possess potential applications in varied fields. Metal ferrites, the source of present study, has inverse spinel structure, with isometric symmetry, and is usually represented by the formula $[Fe^{3+}]tet[A^{2+}, Fe^{3+}]octO_4^{2-}$ (A= Ni, Ni-Zn, Ni-Cu, Ni-Co) [3].

A great variety of metals oxides can be fabricated under ambient to near ambient conditions by employing the nature inspired conditions. Therefore, coupling bio-molecules with hydrothermal processing could facilitate the in situ size, morphology control and surface modification that is advantageous in the production of high performance materials under benign conditions [4]. Leaves of aloe vera [5], carob tree and datura have been successfully employed for magnetite preparation [6]. Fruit of Passiflora tripartita and sargassm (algae) have also been used to synthesize magnetite nanoparticles. There is also a report on in vivo synthesis of magnetite by soya bean sprouts [7].

In this paper, a simple, bio-inspired, soft hydrothermal processing for the synthesis of magnetite particles by reducing the iron precursor solution using neem (Azadirachta indica) extract under hydrothermal conditions is presented for the first time and the results were compared with the synthesis done using D-glucose. Furthermore, syntheses of metal ferrites such as nickel ferrite, nickel zinc ferrite, nickel copper ferrite and nickel cobalt ferrite using sodium dodecyl sulphate (SDS) as surfactant have been studied by altering the hydrothermal parameters for obtaining nanoparticles. Phase purity, functional