Materials Research Express

PAPER

RECEIVED
25 July 2017

REVISED
21 August 2017

ACCEPTED FOR PUBLICATION
30 August 2017

PUBLISHED
12 September 2017

Greener synthesis of magnetite nanoparticles using green tea extract and their magnetic properties

V C Karade [1], P P Waifalkar [2], T D Dongle [1], Subasa C Sahoo [3], P Kollu [4,5], P S Patil [1,6] and P B Patil [1]

[1] School of Nanoscience and Technology, Shivaji University, Kolhapur 416004, India
[2] Department of Physics, Shivaji University, Kolhapur 416004, India
[3] Department of Physics, Central University of Kerala, Kasaragod 671314, India
[4] CASEST, School of Physics, University of Hyderabad, Gachibowli, Hyderabad 500046, India
[5] Thin Film Magnetism group, Cavendish Laboratory, Department of Physics, University of Cambridge, Cambridge CB3 0HE, United Kingdom
[6] Department of Physics, The New College, Kolhapur 416012, India

E-mail: prashantphy@gmail.com

Keywords: green synthesis, green tea, Fe_3O_4, magnetic nanoparticles, solvothermal

Abstract

The facile green synthesis method has been employed for the synthesis of biocompatible Fe_3O_4 magnetic nanoparticles (MNPs) using green tea extract. The effective reduction of ferric ions (Fe^{3+}) were done using an aqueous green tea extract where it acts as reducing as well as capping agent. The effect of iron precursor to green tea extract ratio and reaction temperature was studied. The MNPs were characterized by x-ray diffraction, Fourier transform infrared spectroscopy, field-emission scanning electron microscopy, dynamic light scattering and vibrating sample magnetometer. It was observed that the reaction temperature strongly affects the magnetic and structural properties of MNPs. The magnetic measurements study showed that Fe_3O_4 MNPs are superparamagnetic at 300 K, while at 60 K have ferromagnetic as well as superparamagnetic contributions.

1. Introduction

The magnetic nanoparticles (MNPs) have numerous applications in the field of biomedical sciences such as targeted drug delivery [1], cell tracking [2], magnetic resonance imaging (MRI) [3], magnetic fluid hyperthermia [4] and so on. The Fe_3O_4 MNPs offer high saturation magnetization, which makes easy magnetic separation of Fe_3O_4 MNPs under external magnetic field [5]. There are several reports on the synthesis MNPs where different reducing agents such as hydrazine [6], dimethyl formamide (DMF) [7], sodium borohydride ($NaBH_4$) [8], carbon monoxide (CO) [9] etc were used. These reducing agents are highly reactive chemicals have adverse effects on the environment and hinder the biocompatiblity of MNPs, which leads to limited bio-medical applications of chemically reduced MNPs. In order to use MNPs in bio-medical applications, they should be strictly biocompatible. Therefore, the novel and environmentally friendly biogenic reduction/greener synthesis methods are highly soughted. Biogenic reduction methods which includes use of bacteria, fungi, algae and higher plants extracts for reduction can be one of the best options for synthesizing the metal and metal oxide nanoparticles (NPs). Such greener methods are environment-friendly, cost-effective, provide good yield, and have decent reproducibility [10]. The availability of biogenic reductive materials in nature makes them a promising candidate for the synthesis of NPs. Such greenly synthesized biocompatible MNPs are particularly useful for magnetic separation of enzymatic catalysis for reuse [11].

There are several reports on the biogenic synthesis of NPs using bacteria, fungi, algae and higher plants extracts. Different plants extracts have been used to obtain nano zero valent iron (NZVI) (Fe^0) and iron oxide NPs [12, 13]. Ahmmad *et al* have first reported preparation of highly crystallized and mesoporous α-Fe_2O_3 NPs by a combination of hydrothermal and biosynthesis method [14]. Phumying *et al* have synthesized Fe_3O_4 NPs with particle sizes of ~6–30 nm by a hydrothermal method using ferric acetylacetonate and Aloe Vera plant extract solution [15].

The viscosity of the solvent strongly affects the size of the primary nanocrystals, because the increasing viscosities of polyols causes increase in the hydrocarbon chain length [16]. Ethylene glycol (EG) is one of the polyol used