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Mohammad E Khosroshahi[1-3]* and Maral Asemani[1]

[1]Amirkabir University of Technology, Faculty of Biomedical Engineering, Biomaterial Group, Laser and Nanobiophotonics Laboratory, Tehran, Iran
[2]University of Toronto, Department of Mechanical and Industrial Engineering, Toronto, ON M5S 3G8, Canada
[3]MIS-Electronics, Nanobiophotonics and Biomedical R&D Center, Richmond Hill, ON L4B 1B4, Canada

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***Corresponding author:** Mohammad E Khosroshahi, MIS-Electronics, Nanobiophotonics and Biomedical R&D Center, Richmond Hill, ON L4B 1B4, Canada, E-mail: khosrom@mie.utoronto.ca

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Research Article

Synthesis, Characterization and Imaging of Fluorescine Isothiocyanate Conjugated Magnetite Nanoparticles in MCF 7 Breast Cancer Cell Lines

Abstract

In this work we describe fabrication, characterization and possible application of FITC (fluorescine isothiocyanate) conjugated magnetite nanoparticles (MNPs) for biomedical applications such as imaging of cancer cells. The MNPs possessed octahedral-like geometry with almost completely dispersed distribution with high saturation magnetization. The final FMNPs (fluorescine isothiocyanate magnetite nanoparticles) absorption band showed 30 nm red shift towards longer wavelength compared to bare MNP and the laser-induced fluorescence was observed at 518 nm. The MTT (3-(4,5-Dimethylthiazol-2-yl)-2,5-Diphenyltetrazolium Bromide) results showed that FITC conjugation diminishes the toxicity MNPs mainly due to the reduction of surface charge. Fluorescence microscopy confirmed the uptake and distribution of FMNPs in MCF 7 (Michigan Cancer Foundation-7) breast cancer cells, which suggests that it can be utilized for applications such as a magnetic fluorescent probe for bioassay.

Introduction

It is well known that biomarkers (or biological markers) are measurable sign of an organism evaluated as an indicator of normal biological processes, pathogenic processes or pharmacological responses to a therapeutic intervention. Some of potential applications of biomarkers include oncology, screening, differential diagnosis, prediction of response to treatment, and monitoring of progression of disease [1]. Equally important is the critical and effective role that nanotechnology, particularly the nanobiomaterials that can play in achieving the above goals. Indeed, the design and development of a reliable and green chemistry process for synthesis of nanomaterials is an important aspect of ongoing nanotechnology research namely biomedical engineering. Cancer nanotechnology has already shown its capability in revolutionizing the current techniques in cancer early diagnosis, imaging, treatment and prevention [2].

Magnetite, Fe_3O_4, is a common magnetic iron oxide that has a cubic inverse spinel structure with oxygen forming an fcc closed packing and Fe cations occupying interstitial tetrahedral sites and octahedral sites. The electrons can hop between Fe^{2+} and Fe^{3+} ions in the octahedral sites at room temperature, rendering magnetite an important class of half-metallic materials. With proper surface coating, these magnetic nanoparticles can be chemically stable, well dispersed with uniform size distribution. When the size of these nanoparticles becomes so small that their dimension can be considered as a single domain, they lack a hysteresis loop and a possess high field irreversibility, high saturation field and extra anisotropy contributions called superparamagnetic iron oxide nanoparticle (SPION) [3,4]. Over the past decades SPIONs with size and morphology dependent physical and chemical properties including biocompatibility, biodegradability, long blood retention time, chemical composition, magnetic behaviour, surface structure, adsorption properties, solubility, low toxicity, and good magnetic response have attracted world-wide research attention [5-7]. These unique materials have been utilized successfully for number of applications including contrast-enhanced imaging [8,9] and drug delivery due to their magnetic nature which can be manipulated by an external magnetic field [10,11]. In magnetically guided nanoparticles (NPs), a constant external magnetic field is used to transport magnetic NPs loaded with drugs to a specific site within the body or to increase the transfection capacity.

There are number of frequently used imaging modalities which can be utilized to visualize targeted cells or molecules including positron emission tomography (PET), single photon emission computed tomography (SPECT), X-ray computed tomography (CT), magnetic resonance imaging (MRI), optical

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