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Fabrication of α-Fe_2O_3 Nanostructures: Synthesis, Characterization and Their Promising Application in the Treatment of Carcinoma A549 Lung Cancer Cells.

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Article

Fabrication of α-Fe_2O_3 Nanostructures: Synthesis, Characterization, and Their Promising Application in the Treatment of Carcinoma A549 Lung Cancer Cells

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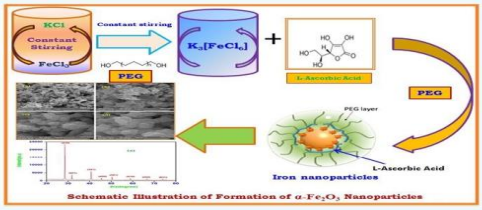
ABSTRACT: In the present work, iron nanoparticles were synthesized in the α-Fe_2O_3 phase with the reduction of potassium hexachloroferrate(III) by using L-ascorbic acid as a reducing agent in the presence of an amphiphilic non-ionic polyethylene glycol surfactant in an aqueous solution. The synthesized α-Fe_2O_3 NPs were characterized by powder X-ray diffraction, field emission scanning electron microscopy, transmission electron microscopy, atomic force microscopy, dynamic light scattering, energy dispersive X-ray spectroscopy, Fourier transform infrared spectroscopy, and ultraviolet−visible spectrophotometry. The powder X-ray diffraction analysis result confirmed the formation of α-Fe_2O_3 NPs, and the average crystallite size was found to be 45 nm. The other morphological studies suggested that α-Fe_2O_3 NPs were predominantly spherical in shape with a diameter ranges from 40 to 60 nm. The dynamic light scattering analysis revealed the zeta potential of α-Fe_2O_3 NPs as -28 ± 18 mV at maximum stability. The ultraviolet−visible spectrophotometry analysis shows an absorption peak at 394 nm, which is attributed to their surface plasmon vibration. The cytotoxicity test of synthesized α-Fe_2O_3 NPs was investigated against human carcinoma A549 lung cancer cells, and the biological adaptability exhibited by α-Fe_2O_3 NPs has opened a pathway to biomedical applications in the drug delivery system. Our investigation confirmed that L-ascorbic acid-coated α-Fe_2O_3 NPs with calculated $IC_{50} \leq 30$ μg/mL are the best suited as an anticancer agent, showing the promising application in the treatment of carcinoma A549 lung cancer cells.



Schematic Illustration of Formation of α-Fe_2O_3 Nanoparticles

1. INTRODUCTION

In the recent past, lung cancer has been the second-most commonly diagnosed cancer in human beings worldwide. In 2019 in the United States, one-fourth of all deaths were due to lung cancer. Recent statistics show that about 228,150 new cases and 142,670 deaths could occur due to lung and bronchus cancer in the USA.[1] To improve the efficacy of lung cancer therapy and minimize its hazardous impacts on healthy tissues and organs, new treatment methods are urgently needed.[2] Recently, interdisciplinary research in nanotechnology has been an emerging area to diagnose a large number of diseases incurable to humans and disastrous to the environment.[3] Nanoparticles (NPs), therefore, in interdisciplinary nanosized fabricated nanostructures have shown potential applications in the fields of medicine, biosensors, and carcinoma treatment due to their microporous and mesoporous discipline.[4] Mesoporous materials have been synthesized using two key approaches: one is the soft-templating method and the other is the hard-templating method with desired morphology.[5] It is mostly synthesized by using the soft-templating method because of the easy approach with a low molecular weight polymer like polyethylene glycol (PEG) as a surfactant.[6,7] Many researchers have employed iron oxide nanoparticles thoroughly because of their unique properties such as low Curie temperature, high magnetic susceptibility, high surface area-to-volume ratio, high surface energy, tunable pore size, and uniform distribution, which provide a high demand for *in vivo* and *in vitro* application in the field of biomedical science to targeted drug delivery,[8] magnetic resonance imaging (MRI),[9] cancer hyperthermia,[10] catalysis,[11] biosensing,[12] environmental remediations,[13] and other industrial applications.[14] The use of iron nanoparticles in the

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