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Synthesis of highly hydrophilic magnetic nanoparticles of Fe_3O_4 for potential use in biologic systems

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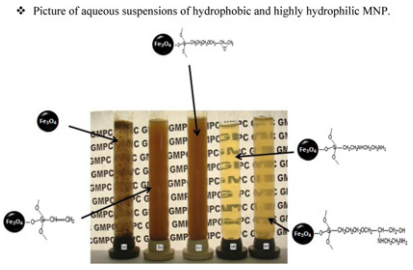
HIGHLIGHTS

- Nanoparticles of Fe_3O_4 with enhanced hydrophilic properties were synthesized.
- A strategy was developed to coat silanized nanoparticles with ethylenediamine.
- Aqueous suspensions of nanoparticles without ethylenediamine showed segregation.
- Aqueous suspensions of ethylenediamine-coated nanoparticles are stables.
- The forces that maintain the particles suspended in water are hydrogen bonds.

GRAPHICAL ABSTRACT



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ABSTRACT

Nanoparticles of Fe_3O_4 with enhanced hydrophilic properties were synthesized using a co-precipitation approach of Fe^{2+} and Fe^{3+} ions in a basified aqueous solution followed by a surface treatment. Two surfacing strategies, using a two-step approach, were used to coat synthesized nanoparticles with silanes of different functional groups for further treatment with ethylenediamine: (i) Michael addition and (ii) nucleophilic addition. Wide-angle X-ray diffraction (WAXD) revealed the pristine nanoparticles with 6.3 nm of diameter. Before the surface treatment with ethylenediamine, stirred suspensions of silanized nanoparticles in water showed segregation after a few minutes in repose. On the other hand, the suspensions of nanoparticles silanized and functionalized with ethylenediamine became homogenous and translucent in water. The advantage of the developed nanoparticles is that (because of their high hydrophilicity) they could interact with biological species such as enzymes, proteins, aminoacids and DNA.

1. Introduction

Nanometer-sized structures are of high importance to modern (bio)technology because, from a molecular point of view, they show enhanced chemical, physical and biological properties. These characteristics are evident in the nanocomposites, which exhibit unique physical and/or chemical property [1]. Oxides such as magnetite (Fe_3O_4) are the most explored materials in nanomanufacturing technologies. The properties of being sensitive to a remote magnetic field allow the magnetite particles to be widely applied in biomedical sector, owing to an improvement in both biodistribution and bioelimination processes because of their size [2–6].

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