Synthesis, surface modification and characterisation of biocompatible magnetic iron oxide nanoparticles for biomedical applications

ABSTRACT

Superparamagnetic iron oxide nanoparticles (MNPs) with appropriate surface chemistry exhibit many interesting properties that can be exploited in a variety of biomedical applications such as magnetic resonance imaging contrast enhancement, tissue repair, hyperthermia, drug delivery and in cell separation. These applications required that the MNPs such as iron oxide Fe 3O4 magnetic nanoparticles (Fe3O4 MNPs) having high magnetization values and particle size smaller than 100 nm. This paper reports the experimental detail for preparation of monodisperse oleic acid (OA)-coated Fe3O4 MNPs by chemical co-precipitation method to determine the optimum pH, initial temperature and stirring speed in order to obtain the MNPs with small particle size and size distribution that is needed for biomedical applications. The obtained nanoparticles were characterized by Fourier transform infrared spectroscopy (FTIR), transmission electron microscopy (TEM), scanning electron microscopy (SEM), energy dispersive X-ray fluorescence spectrometry (EDXRF), thermogravimetric analysis (TGA), X-ray powder diffraction (XRD), and vibrating sample magnetometer (VSM). The results show that the particle size as well as the magnetization of the MNPs was very much dependent on pH, initial temperature of Fe2+ and Fe 3+ solutions and steering speed. The monodisperse Fe 3O4 MNPs coated with oleic acid with size of 7.8 ± 1.9 nm were successfully prepared at optimum pH 11, initial temperature of 45 °C and at stirring rate of 800 rpm. FTIR and XRD data reveal that the oleic acid molecules were adsorbed on the magnetic nanoparticles by chemisorption. Analyses of TEM show the oleic acid provided the Fe3O4 particles with better dispersibility. The synthesized Fe3O 4 nanoparticles exhibited superparamagnetic behavior and the saturation magnetization of the Fe3O4 nanoparticles increased with the particle size.

Keyword: Iron oxide; Magnetic nanoparticles; Surface modification.