Abstract

In this work, superparamagnetic Zn and Gd substituted magnetite nanoparticles with a narrow size distribution were synthesized by the effective and environmental friendly "citric acid-assisted hydrothermal reduction method". The prepared nanoparticles were characterized by different methods and instruments, including X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), transmission and scanning electron microscopies (TEM and SEM respectively), dynamic light scattering (DLS), TG and DTA thermal analyses and vibrating sample magnetometer (VSM). Magnetic measurements showed that the prepared nanoparticles had high saturation magnetizations with a maximum of ٨٢ emu/g and were hydrophilic. Magnetic ferrofluids (MFFs) containing these nanoparticles had good stabilities at neutral pH. Intrinsic loss power (ILP) calculations on different MFFs showed that the MFFs containing $Zn_{٠,٣}Fe_{٢,٧}O_{٤}$ nanoparticles had the highest ILP (٤,٨ $nHm^{٢}/kg$) which is higher than the maximum ILP of the commercial MFFs (٣,١٢ $nHm^{٢}/kg$). In order to coat the magnetic nanoparticles, Pluronic F١٢٧-Chitosan co-polymer was synthesized successfully. Formation of the desired co-polymer was proved by H-NMR and FTIR experiments. The magnetic nanoparticles were coated by this co-polymer due to the strong electrostatic interactions between the negative charge of the nanoparticles surfaces and the positive charge of the Chitosan. The coated nanoparticles were characterized by FTIR, TG and TEM experiments. The TEM results showed the formation of nanocapsules with the mean size of about ٨٤ nm. Investigating the cytotoxic effects of the MFFs containing coated and uncoated $Zn_{٠,٣}Fe_{٢,٧}O_{٤}$ nanoparticles by MTT assay method on Hella cells showed that cytotoxic effects of the nanoparticles decreased because of the coating, and the MFFs containing nanocapsules with concentrations not larger than ٣,٥ mg ferrite/ml had less toxic effects. The magnetic hyperthermia experiments using the MFFs with concentration of ٣,٥ mg/ml and without the anticancer drug (Doxorubicin) could kill more than ٨٠٪ of Hella cells, while in the presence of Doxorubicin, magnetic hyperthermia could kill all the cancer cells.

Key words: Magnetite nanoparticles, Zinc substituted magnetite nanoparticles, Zinc and Gadolinium substituted magnetite nanoparticles, Hydrothermal-reduction method, Citric acid, Magnetic hyperthermia, Ferrofluids.