



Magnetic Iron Oxide Nanocomposite: Synthesis, Stabilization, Characterizations and Applications

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Abstract – Superparamagnetic nanoparticles have been widely studied for their many technological applications: including magnetic storage media, biosensing and medical applications such as target drug delivery, contrast agents in magnetic resonance imaging, cell separation and enzyme and protein immobilization. In this paper we propose a new synthetic route to prepare FeFe₂O₄ magnetic nanostructures in aqueous media, by using poly(diallyldimethylammonium chloride) (PDAC) as cationic polymeric stabilizer. We apply a new strategy to assemble multilayered FeFe₂O₄ nanostructured films onto indium tin oxide (ITO)-covered substrates for use as electroactive magnetic interfaces. The next step will be the functionalization of nanoparticles with the biology molecule for the biomedical applications.

We report the synthesis, characterization and magnetic properties of magnetic nanoparticles. There are several methods that can be used to prepare magnetic nanoparticles as coprecipitation, microemulsions, sol-gel syntheses, sonochemical reactions, among others. Our approach reveals a simple alternative method for the synthesis of oxide iron magnetic nanoparticles (FeFe₂O₄ NPs) in the aqueous media using poly(diallyldimethylammonium chloride) (PDAC) as cationic polymeric stabilizer. The synthesis consists in the coprecipitation of Fe²⁺ and Fe³⁺ ions by a base, usually NaOH, NH₃·H₂O or 1,6-hexanediamine. We propose a method for alkalization of the iron ions solution in the presence of the PDAC that serves as a protective agent to stabilize colloidal dispersions of magnetite and prevent the coagulation of particles. Transmission Electron Microscopy (TEM) images showed a mean particle size of about 5,0 nm.

Nanostructured films were built-up upon alternate layer-by-layer (LbL) deposition of poly(vinylsulfonic acid) (PVS) and FeFe₂O₄-PDAC polyelectrolytes¹. The kinetics of adsorption and film growth were investigated by UV-VIS spectroscopy and it was possible to observe that 10 minutes of immersion are sufficient for adsorption of nanoparticles, resulting in a linear increase of absorbance as a function of numbers of bilayers. Film morphology was examined by Atomic Force Microscopy (AFM). Temperature dependent magnetic properties of the powder PDAC-FeFe₂O₄ nanoparticles were studied using the magnetization measurements. A monotonic increase in the magnetization was observed with decreasing temperature with the nanoparticles showing a representative magnetic susceptibility. Cyclic voltammetry of ITO-PVS/PDAC-FeFe₂O₄ electrodes in sulfuric acid presented a redox couple attributed to Fe²⁺/Fe³⁺. We considered electron hopping as the charge transport mechanism between the PVS/PDAC-FeFe₂O₄ layers within the LbL films. Furthermore, the cyclic voltammograms revealed that faradaic current response is directly correlated to the number of deposited bilayers. The latter may allow the use of the magnetic NPs in nanoelectronics and bioelectrochemical devices, where reversible and magnetic redox materials are required. The next step will be the functionalization of nanoparticles with biologic molecules for the biomedical applications.

References

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