Iron oxide-coated bimetallic magnetic nanoparticles: improved magnetic properties and functionalization for biomedical applications

W. Beck Jr.[1] and L. C. Varanda[1]
[1]*IQSC, Universidade de S. Paulo, S. Carlos, SP, Brazil*

In recent years, the uses of magnetic nanoparticles in many biomedical and biotechnological areas have received great attention due to their application possibilities such as: tissue repair, diagnostics, magnetic resonance imaging, cancer treatment, cell separation, and controlled drug delivery, among others **[1,2]**. This biomedical applications of magnetic nanoparticles are mainly based on magnetic iron oxides, which exhibit superparamagnetic behavior at room temperature and low saturation magnetization (M_S) around 60 emu g^{-1}. The utilization of magnetic oxides has two main reasons: easily and versatility of surface functionalization due to hydroxyl groups present on the nanoparticles surface, and low toxicity compared with the metallic nanoparticles. Biocompatibility and targetable functionalizations are generally obtained by paramagnetic and/or diamagnetic materials incorporations onto the nanoparticle surface contributing to decreases the already low M_S of the oxides. In this context, the development of new magnetic nuclei with M_S value closed to the metallic iron values (~200 emu g^{-1}) is required. However, this value is only observed in highly toxic metallic nanoparticles. Therefore, in this study, bimetallic magnetic nanoparticles of FePt, CoPt and NiPt coated with iron oxide and Ni- or Co-ferrites in a core-shell structure was synthesized by using the modified polyol process combined with the seed-mediated growth method **[3,4]**. Obtained nanoparticles presented size, shape and size distribution compatible for biomedical applications and the M_S of the different synthesized systems were enhanced compared with the pure magnetic oxide nanoparticles. Oleic acid and oleylamine present on the as-synthesized magnetic nanoparticles surface were properly changed by (3-aminopropyl)trimethoxysilane (APTMS) molecules leading to water-dispersible magnetic nanoparticles system. In addition, carboxymethyl-dextran molecules were conjugated with the APTMS molecules changing the nanoparticles surfaces and resulting in biocompatible water-soluble magnetic nanoparticles systems with improved magnetic response. These synthesized biocompatible magnetic systems present a great potential for many biomedical applications.
Keywords: Biocompatible magnetic nanoparticles, core-shell structure, improved magnetic properties, surface functionalization, biomedicine.

Work supported by CNPq and FAPESP.

[1] A. K. Gupta, M. Gupta, Biomaterials **26**, 3995 (2005).
[2] Q. A. Pankhurst, N. K. T. Thanh, S. K. Jones, J. Dobson, J. Phys. D-Appl. Phys **42**, 224001 (2009).
[3] L. C. Varanda, M. Jafelicci Jr., J. Am. Chem. Soc. **128**, 11062 (2006).
[4] L. C. Varanda, M. Imaizumi, F. J. Santos, M. Jafelicci Jr., IEEE Trans. Magn. **44**, 4448 (2008).
wbeckj@yahoo.com.br