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A multifunctional SBA-15 / P(N-iPAAm) / Fe_3O_4 hybrid system for biomedical application

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Abstract – In this work we study the synthesis of a multifunctional hybrid system based on magnetic nanoparticles embedded into mesoporous silica and Poly(*N*-isopropylacrylamide) as organic phase. The samples were characterized by thermal analysis, X-ray diffraction, N_2 adsorption desorption isotherms, X-ray photoelectron spectroscopy and ^{57}Fe Mössbauer spectroscopy. The structural characteristics of the magnetic hybrid nanocomposite, including the effect of the swelling behavior on heating by the application of an alternating magnetic field are presented and discussed.

In recent years stimuli-responsive polymers such as pH, temperature and electric field have attracted a great deal of interest due to their potential applications that comprise a broad range of topics. Poly(N-isopropylacrylamide) P(*N*-iPAAm) is one of the most well-known member of the class of responsive polymers Such a thermosensitive polymer with reversible phase transition characteristics is attractive as a polymeric material for the temperature responsive drug release systems. On the other hand, magnetic nanoparticles with appropriate chemical surface have been used for numerous applications in vivo, like in the hyperthermic treatment for anticancer therapy due their unique magnetic properties. However non-surface-modified magnetic nanoparticles with a large surface-area-to-volume ratio tend to agglomerate and form large clusters, with the consequent loss of interesting characteristics. Therefore, a suitable coating is essential to prevent such limitations, what can be obtained by using mesoporous silica like SBA-15. For SBA-15/Fe_3O_4, it is possible to obtain magnetite nanoparticles embedded into mesoporous silica, preventing the agglomeration. Moreover, the application of an alternating high-frequency magnetic field to the hybrid system containing magnetic nanoparticle should lead to heat generation, which could drive the swelling transition of the polymer. In this case, we could thing on synergistic effects of hyperthermia and controlled drug delivery for a hybrid system composed by the combination of SBA-15, Fe_3O_4 nanoparticles and P(*N*-iPAAm).

In this work the synthesis strategy of a multifunctional system of [SBA-15/P(*N*-iPAAm)/Fe_3O_4] hybrids of interest for bioapplications was explored. Magnetite nanoparticles coated by mesoporous silica were prepared by an alternative chemical route using neutral surfactant and without the application of any functionalization method [1]. Monomer adsorption followed by in situ polymerization initiated by a radical was the adopted procedure to incorporate the hydrogel into the pore channels of silica nanocomposite. Characterization of the materials was carried out by using thermal analysis, X-ray diffraction, N_2 adsorption desorption isotherms, X-Ray Photoelectron Spectroscopy and ^{57}Fe Mossbauer spectroscopy. The structural characteristics of the magnetic hybrid nanocomposite, including the effect of the swelling behavior on heating by the application of an alternating magnetic field are presented and discussed.

Reference

[1] K. C. Souza; J. D. Adirson; W. A. A. Macedo; E. M. B. Sousa. Nanotechnology (Bristol), v. 19, p. 185603-185609, 2008.