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Magnetic Chloromethylated Polymer Nanocomposite for Selective Pollutant Removal

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Abstract : Nanocomposites designed by embedding magnetic nanoparticles into a polymeric matrix stand out as ideal magnetic-hybrid and magneto-responsive materials as sorbents for removal of pollutants in environmental applications. Covalent coupling is often desired for the immobilization of species on these nanocomposites, in order to keep them permanently bounded, not desorbing or leaching over time. Moreover, unwanted adsorbates can be separated by successive washes/magnetic separations, and it is also possible to recover the adsorbate covalently bound to the nanocomposite surface through detaching/cleavage protocols. Thus, in this work, we describe the preparation and characterization of highly-magnetizable chloromethylated polystyrene-based nanocomposite beads for selective covalent coupling in environmental applications. For synthesis optimization, acid resistant core-shelled maghemite (γ-Fe_2O_3) nanoparticles were coated with oleate molecules and directly incorporated into the organic medium during a suspension polymerization process. Moreover, the cross-linking agent ethylene glycol dimethacrylate (EGDMA) was utilized for co-polymerization with the 4-vinyl benzyl chloride (VBC) to increase the resistance of microbeads against leaching. After characterizing samples with XRD, ICP-OES, TGA, optical, SEM and TEM microscopes, a magnetic composite consisting of ~500 nm-sized cross-linked polymeric microspheres embedding ~8 nm γ-Fe_2O_3 nanoparticles was verified. This nanocomposite showed large room temperature magnetization (~24 emu/g) due to the high content in maghemite (~45 wt%) and resistance against leaching even in acidic media. Moreover, the presence of superficial chloromethyl groups, probed by FTIR and XPS spectroscopies and confirmed by an amination test can selectively adsorb molecules through the covalent coupling and be used in molecular separations as shown for the selective removal of 4-aminobenzoic acid from a mixture with benzoic acid.

Keywords : nanocomposite, magnetic nanoparticle, covalent separation, pollutant removal
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