Synthesis and characterization of magnetite nanoparticles embedded in the monodisperse PMMA spheres

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We have used a solution polymerization following inversion suspension process to synthesize Fe_3O_4 nanoparticles embedded in the monodisperse PMMA nanospheres. The Fe_3O_4 nanoparticles with mean crystallite size of 8.8 nm were prepared by a standard co-precipitation method in N_2 atmosphere and coated with lauric acid (LA). To obtain PMMA/Fe_3O_4 hybrid nanospheres, the LA-coated Fe_3O_4 nanoparticles mixed with deionized water were added into a reactor equipped with a stirrer, an inlet of N_2 gas and a condenser. A solution composed of $K_2S_2O_8$, methyl methacrylate (MMA) and methacrylic acid (MAA) monomers was dropped slowly into the reactor which had been heated up to 75 °C. The size PMMA/Fe_3O_4 nanospheres is 120 nm examined by the dynamic light scattering (DLS) as well as from the image taken by TEM. FTIR spectra and TEM were used to characterize the ability of Fe_3O_4 nanoparticles functionalized with PMMA. The nanospheres display superparamagnetic behavior at room temperature, with transition to a blocked state at temperature T_B = 150 K, which obtains from the temperature dependence of magnetization measured under the zero-field-cooled condition. This process provided a route to prepare the monodisperse and spherical of polymer containing magnetic nanoparticles that is desirable for the biotechnological application.

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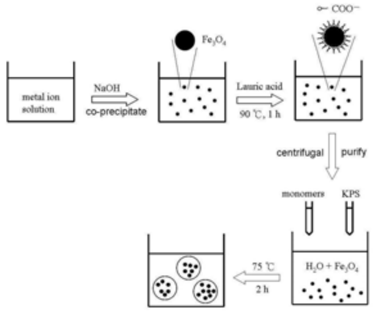

Fig. 1. Schematic representation for the synthesis of magnetite nanoparticles embedded in PMMA spheres using a solution polymerization following inversion suspension process.

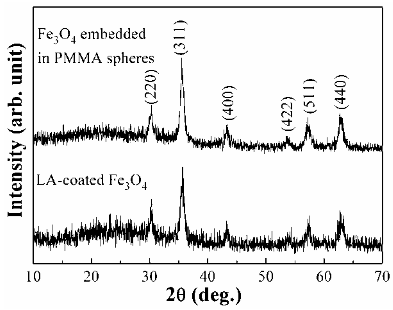

Fig.2. X-ray diffraction (XRD) patterns of LA-coated Fe_3O_4 nanoparticles and Fe_3O_4 nanoparticles embedded in PMMA spheres.

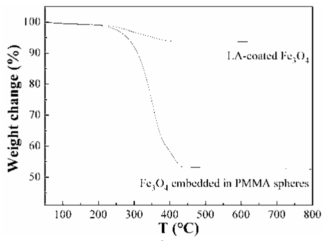

Fig. 3. Thermogravimetric curves of LA-coated Fe_3O_4 nanoparticles and Fe_3O_4 nanoparticles embedded in PMMA spheres.

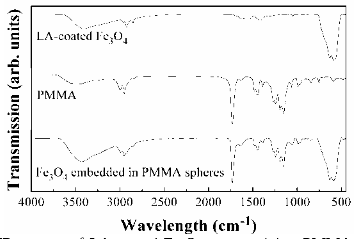

Fig. 4. FTIR spectra of LA-coated Fe_3O_4 nanoparticles, PMMA, and Fe_3O_4 nanoparticles embedded in PMMA spheres.

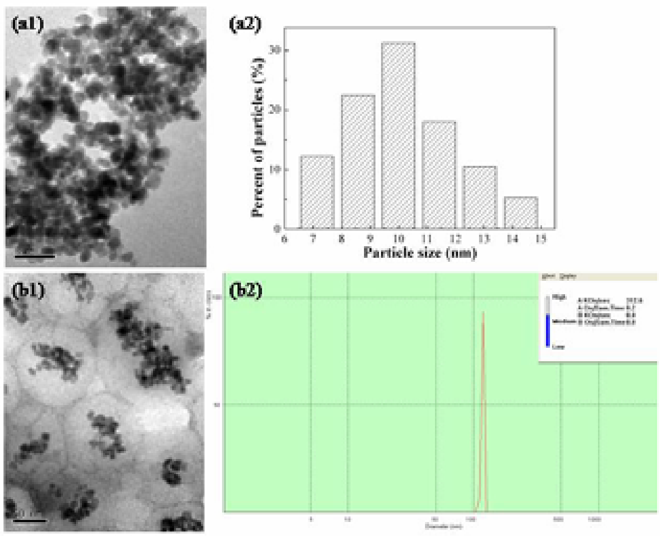

Fig. 5. (a1) TEM micrograph of LA-coated Fe_3O_4 nanoparticles and (a2) particle size distribution. (b1) TEM image of the Fe_3O_4 nanoparticles embedded in PMMA spheres. (b2) Particle size distribution of PMMA spheres which containing Fe_3O_4 nanoparticles measured by the dynamic light scattering (DLS).

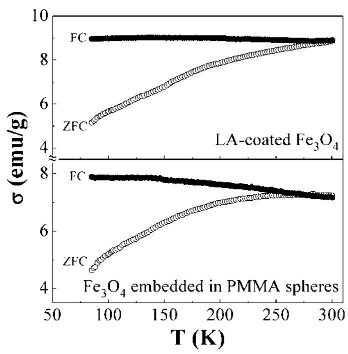

Fig. 6. Temperature dependence of the ZFC and FC magnetization curves for LA-coated Fe_3O_4 nanoparticles and Fe_3O_4 nanoparticles embedded in PMMA spheres.

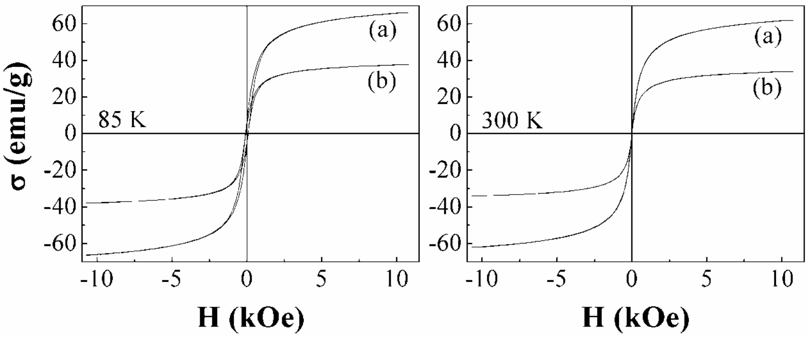

Fig. 7. Hysteresis loops of (a) LA-coated Fe_3O_4 nanoparticles, and (b) Fe_3O_4 nanoparticles embedded in PMMA spheres.

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