

Carboxymethyldextran-coated Fe₃O₄ biocompatible nanoparticles for biomedical applications by a new microemulsion route

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Abstract – A new cation-substituted iron(III) dodecylsulphate surfactant synthesis and its use as cation/surfactant source in an also new synthetic route based on the one-step microemulsion system to obtain magnetite nanoparticles were reported. This strategy leads to avoiding the coalescence step typically observed in microemulsion systems and provide an outstanding size and composition control. Monodisperse magnetite with 2.8 ± 0.2 nm was obtained. Carboxymethyldextran coating changes the nanoparticle surfaces to biocompatible nanoparticles adequate for biomedical and biotechnological applications.

In the last years, different methods employed for nanoparticles (NP) synthesis have been intensified mainly due to great nanotechnology development. In this context, microemulsion systems (μ e) provide a unique environment for nucleation, growth and morphological particles control [1]. Typically reaction occurs by mixing two individual μ e systems (M_1 e M_2) containing in M_1 , the cation of interesting and in M_2 , the reagent that promotes the reaction [2]. This methodology involves a coalescence step between two nanoreactors during the mixture in order to promote the solid precipitation. However, in the coalescence step the nanoreactor size can be drastically changed avoiding NP properties control. In this work, a best size and composition NP control was achieved avoiding the nanoreactors coalescence step by using a new cation-substituted surfactant, iron(III) dodecylsulphate (IDS) as iron source. In this new synthetic route, only one μ e system was needed and successfully used to synthesize magnetite NP. In addition, these NP were properly coated with carboxymethyldextran (CMD) in order to obtain a biocompatible-functionalized magnetic NP. A properly amount of IDS was dissolved in octanol with 12% excess related to the critical micelle concentration (cmc) [3] previously determined by electrical conductivity measurements. NaBH₄ aqueous solution was added into the system under N₂ blank and vigorous stirring. After purifying, an aqueous NP dispersion has the pH adjusted to 11 by NaOH solution addition and then the temperature was raised up to 45 °C. CMD aqueous solution was then added and the system sonicated for 1 h in order to promote the CMD coating. Mixture of the alcoholic surfactant and aqueous reducing agent solutions leads to μ e formation and then the reduction reaction between Fe³⁺ and BH₄⁻ ions in the presence of water into the nanoreactors takes place. The fresh NP formed has great affinity by water phase, probably due to surface characteristics, remaining in the aqueous phase. The observed cmc value of the IDS in octanol medium was 1.31×10^{-3} mol/L in a good agreement with the reported values for similar surfactants. TEM results (Fig. 1a) show a monodisperse 2.8 ± 0.2 nm spherical NP. According to XRD and Mössbauer spectroscopy (Fig 1b) results, the magnetite was the only phase present in the sample. The CMD coating was evaluated by infrared spectroscopy (FTIR) and electrophoretic mobility (Fig. 1c) measurements. The infrared result shows the presence of the CMD molecules in the NP system and the electrophoretic measurement confirm the presence of CMD on NP surface according to isoelectric point (i.e.p.) changes from 6.5 to 2.7, respectively for naked and coated NP (Fig. 1c). Avoidance of the coalescence due to only one-step μ e used was unpublished and yielding a strong size and composition NP control. The NP properties allied with the biocompatible surface provides for CMD coating infer potential materials for biomedical and biotechnological applications.

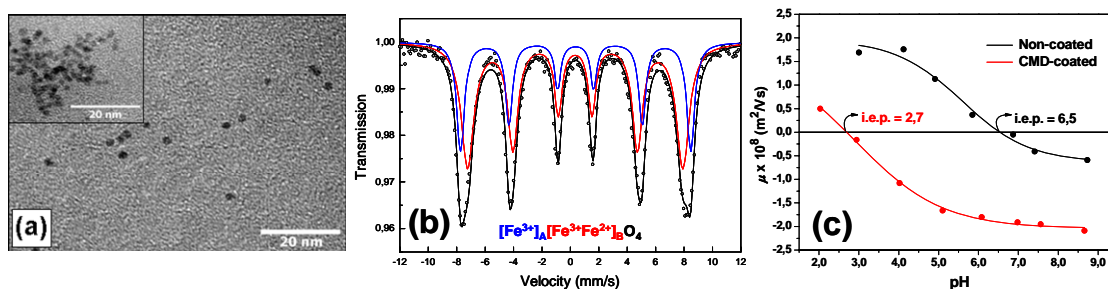


Figure 1: (a) TEM images of the magnetite NP, (b) Mössbauer spectra and (c) electrophoretic mobility showing the magnetite phase formation and the CMD coating by i.e.p. changes, respectively.

References

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