Field Cycling Relaxometry, an Efficient Tool for the Quality Control of Superparamagnetic Particles Dispersions

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Nuclear Magnetic Relaxation Dispersion (NMRD) profiles of superparamagnetic particles suspensions provide physical information about the magnetic nanocrystals, namely their average radius r, their specific magnetization M_s, their anisotropy energy Ea and the extent of their clustering. Relaxometric results can be combined with those obtained by magnetometry, which gives crystal radius and specific magnetization, and by PCS which reports on the particle hydrodynamic size.

Colloidal nanomagnets coated with dextran were synthesized by coprecipitation of a solution of ferric and ferrous ions with an alkali in the presence of dextran. The reaction was carried out through a mini mixing chamber. Reaction parameters like temperature and flow rates were carefully controlled.

NMRD profiles confirmed the reproducibility of the syntheses.

The effects of the reaction parameters like iron concentration, $[Fe^{2+}]/[Fe^{3+}]$ ratio, dextran concentration and dextran molecular weight were investigated.

Several features of the reaction were observed:

i) the amount of particles containing more than one crystal per particle increases when the concentration of dextran decreases, and,

ii) the crystal radius increases with the $[Fe^{2+}]/[Fe^{3+}]$ ratio. The evolution of size and magnetization determined by relaxometry agrees with the one observed by magnetometry.

Proton relaxometry has thus proved to be a rapid and comprehensive method allowing for the control of the quality of magnetic colloids, in particular of the agglomeration state of the crystals.