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Development of Superparamagnetic Particles Dispersions Basic Materials of Markers for Molecular Imaging

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Superparamagnetic systems are likely to play a major role in the context of molecular imaging. Their quality control is however difficult.

Nuclear Magnetic Relaxation Dispersion (NMRD) profiles of suspensions of superparamagnetic particles 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 a reaction carried out in 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.

We have also evaluated the effects of the binding of molecular vectors (peptides, proteins or small molecules like biotine or folate), on the magnetic and relaxometric properties of the grafted superparamagnetic moeities.

Proton relaxometry has proved to be a rapid and comprehensive method allowing for the control of the quality of magnetic colloids.