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Difference in the Behavior of Relaxation Times of T_1 and T_2 of Hydrogen Protons as a Function of Concentration of Nanoparticles in the Aqueous Solution of Iron Ferrite Magnetic Nanoparticles

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The stable iron ferrite nanoparticles were formulated by the direct coprecipitation of the aqueous solution of iron salt and tetramethylammonium hydroxide (TMAOH) solution. The size of nanoparticles was observed to be uniformly distributed around the diameter of 7 nm. The superparamagnetic behavior of these nanoparticles was checked by a vibrating sample magnetometer [1]. The relaxation times of T_1 and T_2 of hydrogen protons in the colloidal aqueous solution of magnetic nanoparticles were measured using a nuclear magnetic resonance spectrometer for the wide range of concentration of nanoparticles from a few tenth of ppm to a few thousand ppm. The inverse of relaxation times of T_1 was observed to be directly dependent on the concentration of nanoparticles for the whole nanoparticle concentration ranges observed. However, the inverse of relaxation times of T_2 was found to deviate from this linear behavior in the higher range of nanoparicle concentration than about a thousand ppm. The relaxation time T_1 of hydrogen protons depends on the rate of energy transfer to the surrounding atoms, while T_2 is mainly influenced by the inhomogeneity of surrounding magnetic field. Consequently the decrease rate in T_2 rapidly increases as the concentration increases because the magnetic fluctuations increase as the number of surrounding magnetic nanoparticles increases.

References

[1] C. Kim and I. Rhee, Journal of Magnetism and Magnetic Materials, 261, 410 (2003).