NMR Transversal Relaxivity of Aqueous Suspensions of Particles of Ln$^{3+}$-Based Zeolite Type Materials

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A series of zeolite-type silicates containing stoichiometric amounts of Ln$^{3+}$ ions in the framework (Ln-AV-9 materials), with composition (Na₄K₂(Ln₂Si₁₆O₄₈).₁₀H₂O (Ln = Nd, Sm, Eu, Tb, Gd, Dy) has recently been synthesized and characterized (Fig.1). They form paramagnetic microparticles, which as aqueous suspensions have negligible water $^1$H longitudinal relaxivities ($r_1$) for all Ln$^{3+}$ ions studied and quite large transverse relaxivities ($r_2$) [1]. In this work we further analysed the size distribution of the Ln-AV-9 particles and their $r_2^*$ and $r_2$ relaxivities [2]. The $r_2^*$ relaxivity effects are explained by the Static Dephasing Regime (SDR) theory. The $r_2$ relaxivities appear to be strongly dependent on the interval between two consecutive refocusing pulses ($τ_{CP}$) in the train of 180° pulses applied. For long $τ_{CP}$ values, the $r_2$ of the systems saturates at a value, which is always an order of magnitude smaller than $r_2^*$. These features are explained by a crude model, which takes into account the residual diffusion effect in the static dephasing regime. The large microparticles, although not efficient in $T_1$ relaxation, are quite effective in enhancing $T_2$ relaxation, particularly at high magnetic fields. The $r_2^*$ values and the saturation values for $r_2$ were found to increase linearly with $B_0$ and $μ_0^2$ (Fig. 2). The largest transversal relaxation rate enhancements were observed for Dy-AV-9 with a saturation value of $r_2$ of 60 s$^{-1}$ mM$^{-1}$ and a $r_2^*$ value of 566 s$^{-1}$ mM$^{-1}$ at 9.4 T and 298 K.

Fig.1


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