Nuclear magnetic resonance relaxation efficiency of $Mn_{0.3}Fe_{2.7}O_4$ magnetic nanoparticles

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From a series of magnetic nanoparticles of Mn-substituted magnetite $Mn_xFe_{3-x}O_4$ (x = 0.1 – 1.8) that previously were described in [1] the powder of composition $Mn_{0.3}Fe_{2.7}O_4$ showed the highest value of saturation magnetization of relatively unsubstituted magnetite. MNPs $Mn_{0.3}Fe_{2.7}O_4$ were stabilized in the form of colloidal solutions using a number of polyelectrolytes, such as poly(diallyldimethylammonium chloride) (PDDA), chitosan 60 kDa (CH60), copolymer of chitosan 60 kDa and polyethylene glycol 5 kDa (χ = 0.15) (CH60-PEG), copolymer of chitosan 60 kDa and dextran 6 kDa (χ = 0.15) (CH60-DEX) and silica (SiO_2). Nuclear magnetic resonance relaxation of protons in aqueous solutions of $Mn_{0.3}Fe_{2.7}O_4$ stabilized nanoparticles has been investigated (Table).

Table. Physicochemical characteristics of $Mn_{0.3}Fe_{2.7}O_4$ magnetic nanoparticles stabilized by different reagents

MNP composition	Z_{av}, nm	PdI	d_{HD}, nm	Relaxation efficiency, $l \cdot mmol^{-1} \cdot s^{-1}$		r_2/r_1
				r_1	r_2	
$Mn_{0.3}Fe_{2.7}O_4$/PDDA	86,4 ± 0,8	0,153 ± 0,021	68,1	11,7	89,9	7,68
$Mn_{0.3}Fe_{2.7}O_4$/CH60	195,5 ± 1,3	0,294 ± 0,032	78,8	—	61,5	—
$Mn_{0.3}Fe_{2.7}O_4$/CH60-PEG	220,6 ± 3,4	0,241 ± 0,021	68,1 141,8 w	12,3	129,0	10,5
$Mn_{0.3}Fe_{2.7}O_4$/CH60-DEX	214,3 ± 1,3	0,178 ± 0,033	190,1	12,5	135,5	10,8
$Mn_{0.3}Fe_{2.7}O_4$/SiO_2	48.13 1000 (0,1%)	0,247 ± 0,024	—	13,8	105,2	7,62

w – weak intensity

Measurements of spin-relaxation properties have shown that nature of the dispersion stabilizer in most cases has little effect on the relaxation parameters (r_1 and r_2). Typical contrast agents with a r_2/r_1 ratio of 2 to 40 are treated as T_2-contrast agents, while for T_1-contrast agents this ratio is less. The resulting dispersion has a sufficiently high contrasting ability for magnetic resonance studies.

References

[1] A.S. Korsakova et al. Journal of the Belarusian State University. Physics. (2021) 1:12