

# Contents

<b>1 Interest of Nanomaterials in Medicine</b> . . . . .	1
References. . . . .	2
<b>2 Magnetic Properties</b> . . . . .	5
2.1 Diamagnetic Substances . . . . .	5
2.2 Paramagnetic Substances . . . . .	6
2.3 Ferromagnetic Substances. . . . .	6
2.4 Ferrimagnetic Substances . . . . .	7
2.5 Antiferromagnetic Substances. . . . .	7
2.6 Superparamagnetic Substances . . . . .	7
References. . . . .	10
<b>3 Imaging Probes</b> . . . . .	13
3.1 Magnetic Resonance Imaging (MRI) . . . . .	13
3.1.1 Classical Description of NMR—Description on the Macroscopic Scale . . . . .	15
3.1.2 NMR Signal Acquisition. . . . .	17
3.1.3 Principle of MRI. . . . .	18
3.2 MRI Contrast Agents . . . . .	20
References. . . . .	21
<b>4 Paramagnetic Gadolinium Complexes</b> . . . . .	23
4.1 Relaxation Mechanims of Gadolinium Complexes . . . . .	25
4.1.1 Innersphere Mechanism. . . . .	26
4.1.2 Outer-Sphere Mechanism . . . . .	27
4.1.3 Second-Sphere Mechanism . . . . .	28
4.1.4 Influence of the Different Parameters on the Innersphere and Outersphere Contributions . . . . .	29

4.2	Different Classes of Gadolinium Based MRI Contrast Agents . . . .	30
4.2.1	Vascular Contrast Agents . . . . .	30
4.2.2	Smart Contrast Agents . . . . .	31
4.2.3	Specific Contrast Agents for Molecular Imaging. . . . .	36
4.2.4	How to Obtain High Relaxivity with Paramagnetic Gd-Derivatives by Increasing $\tau_R$ . . . . .	37
4.2.5	PARACEST Agents . . . . .	43
	References. . . . .	45
<b>5</b>	<b>Superparamagnetic Iron Oxide Nanoparticles . . . . .</b>	<b>55</b>
5.1	Superparamagnetic Properties of Iron Oxide Nanoparticles . . . . .	58
5.1.1	Relaxometric Properties. . . . .	58
5.2	Synthesis of Magnetic Nanoparticles . . . . .	66
5.2.1	Coprecipitation Method. . . . .	66
5.2.2	Hydrothermal Method . . . . .	68
5.2.3	Thermal Decomposition Method . . . . .	69
5.2.4	Sol-Gel Methods. . . . .	70
5.2.5	Microemulsions. . . . .	71
5.2.6	Polyol Methods. . . . .	72
5.2.7	Electrochemical Methods . . . . .	72
5.2.8	Aerosol/Vapor Method . . . . .	72
5.2.9	Sonolysis/Thermolysis. . . . .	73
5.3	Stabilization of Nanoparticle Suspensions. . . . .	73
5.3.1	Stability of Charged Nanoparticles . . . . .	75
5.3.2	Steric Stabilization . . . . .	80
5.3.3	The Surface of Iron Oxide Nanoparticles . . . . .	80
5.3.4	Stabilization Strategies . . . . .	84
5.3.5	Recent Advances on the Stabilization of Hydrophobic Iron Oxide Nanoparticles . . . . .	88
	References. . . . .	99
<b>6</b>	<b>MRI Applications: Classification According to Their Biodistribution. . . . .</b>	<b>111</b>
6.1	Non-specific Agents (Interstitial Diffusion of Gadolinium Complexes). . . . .	112
6.1.1	Toxicity of Free Gadolinium and Gd-Complexes . . . . .	112
6.1.2	NSF Disease . . . . .	114
6.2	Hepatic Agents. . . . .	115
6.2.1	Gadolinium Complexes with Biliary Excretion: Gd-EOB-DTPA and Gd-BOPTA . . . . .	115
6.2.2	Superparamagnetic Iron Oxide Nanoparticles as Specific Agents of Kupffer Cells . . . . .	116
6.2.3	Contrast Agents for Lymphatic System. . . . .	118

6.3	Vascular Contrast Agents . . . . .	119
6.3.1	Superparamagnetic Nanoparticles . . . . .	120
6.3.2	Macromolecular Contrast Agents (Albumin-Dextran, Polylysine-Gd-DTPA) . . . . .	120
6.3.3	Applications . . . . .	120
6.4	Conclusions . . . . .	121
	References. . . . .	122

MRI Contrast Agents

From Molecules to Particles

Laurent, S.; Henoumont, C.; Stanicki, D.; Boutry, S.;

Lipani, E.; Belaid, S.; Muller, R.N.; Vander Elst, L.

2017, VII, 125 p. 63 illus., 44 illus. in color., Softcover

ISBN: 978-981-10-2527-3