

Volume 27
Magnetic Properties of Non-Metallic Inorganic Compounds Based on Transition Elements

Subvolume E
Garnets

	Introductory material	
4	Magnetic properties of garnets	1
4.1	Iron garnets (P. NOVAK)	1
4.1.1	Introduction	1
4.1.1.1	General remarks	1
4.1.1.2	List of frequently used symbols and abbreviations	1
4.1.2	Magnetic properties	4
4.1.2.1	Magnetic moments and molecular field data	4
4.1.2.1.1	Saturation magnetization and Curie temperature	4
4.1.2.1.2	Molecular-field- and exchange constants	18
4.1.2.1.3	Magnetic moments of the rare earth ions	20
4.1.2.2	Magnetic phase transitions	21
4.1.2.2.1	Spontaneous spin-reorientational transitions	22
4.1.2.2.2	Field induced transitions	23
4.1.2.3	Magnetocrystalline anisotropy	25
4.1.2.3.1	Cubic anisotropy	25
4.1.2.3.2	Non-cubic anisotropy	31
4.1.2.4	Ferromagnetic resonance (FMR)	39
4.1.2.4.1	Resonance field	39
4.1.2.4.2	FMR line width	40
4.1.2.4.3	g-factor	43
4.1.2.5	Spin waves, magnetostatic modes and relaxation	45
4.1.2.5.1	Spin waves and magnetostatic modes	45
4.1.2.5.2	Non-linear effects and relaxation	46
4.1.2.6	Nuclear magnetic resonance (NMR)	49
4.1.2.7	Mössbauer spectroscopy	51
4.1.2.8	Magnetic domains (stripe and bubble domains)	53
4.1.2.8.1	Static properties	53
4.1.2.8.2	Dynamic properties	58
4.1.3	Magnetoelastic properties	60
4.1.3.1	Magnetostriction	60
4.1.3.2	Magnetoelastic waves	63
4.1.4	Elastic properties	63
4.1.5	Optical and magneto-optical properties	64
4.1.5.1	Optical properties	65
4.1.5.1.1	Absorption of light	65
4.1.5.1.2	Reflection of light	73
4.1.5.1.3	Refractive index	75
4.1.5.2	Magneto-optical properties	77
4.1.5.2.1	Faraday rotation	77
4.1.5.2.2	Magnetic circular dichroism (MCD)	93

4.1.5.2.3	Kerr effects	100
4.1.5.2.4	Magnetic linear birefringence (MLB) and nonmagnetic linear birefringence	102
4.1.5.2.5	Magnetic linear dichroism (MLD)	103
4.1.5.3	Photoinduced effects	104
4.1.6	Thermal properties	106
4.1.7	Electrical properties	107
4.1.7.1	Electrical conductivity	107
4.1.7.2	Magnetoresistance and magnetoelectric effect	110
4.1.8	Crystal structure	111
4.1.9	References for 4.1	113
4.1.10	List of iron garnets in Vols. 4A, 4B, 12A and 27E	123
4.2	Non-iron garnets (Z.A. KAZEI, N.P. KOLMAKOVA, V.I. SOKOLOV)	136
4.2.1	Introduction	136
4.2.1.1	General remarks	136
4.2.1.2	List of frequently used symbols and abbreviation	136
4.2.2	Magnetic susceptibility	140
4.2.2.1	Rare earth garnets	140
4.2.2.2	3d-ion garnets	143
4.2.3	Magnetization and magnetic structure	148
4.2.3.1	Magnetic moments and magnetic anisotropies of terbium, dysprosium and holmium aluminum garnets	149
4.2.3.2	Magnetic moments of rare earth gallium garnets	151
4.2.3.3	Magnetic neutron scattering in dysprosium aluminum garnets	153
4.2.3.4	Magnetic neutron scattering in terbium, holmium and dysprosium gallium garnets	156
4.2.3.5	Magnetization and magnetic phase transitions in manganese germanium garnets	157
4.2.3.6	Garnets with several 3d-ions	160
4.2.4	Results of magnetic resonance experiments	162
4.2.4.1	Electron paramagnetic resonance of paramagnetic metal ions in diamagnetic garnets	162
4.2.4.2	Electron paramagnetic resonance of rare earth ions in diamagnetic garnets	164
4.2.4.3	Electron paramagnetic resonance of impurities in paramagnetic garnets	166
4.2.4.4	Nuclear magnetic resonance	167
4.2.4.5	Antiferromagnetic resonance	167
4.2.5	Optical and magnetooptical properties	169
4.2.5.1	Crystal-field parameters	169
4.2.5.2	Optical spectra and index of refraction	171
4.2.5.3	Information on colour centres	186
4.2.5.4	Further references for results from optical measurements	190
4.2.5.5	Magnetooptical properties	197
4.2.6	Mössbauer spectroscopy	202
4.2.7	Electron spin-lattice relaxation of paramagnetic ions in garnets	205
4.2.8	Thermal properties	207
4.2.8.1	Heat capacity	207
4.2.8.2	Derived thermodynamic functions	215
4.2.8.3	Debye temperature	218
4.2.8.4	Thermal expansion	219
4.2.8.5	Kapitza conductance	222
4.2.8.6	Thermal conductivity	223
4.2.8.7	Ultrasound attenuation	227
4.2.9	Elastic and photoelastic properties	230

4.2.9.1	Elastic and photoelastic constants at room temperature	230
4.2.9.2	Temperature dependences	231
4.2.10	Magnetostriction	232
4.2.10.1	Magnetostriction of rare earth garnets	232
4.2.10.2	Magnetostriction of antiferromagnetic garnets with 3d-ions	235
4.2.11	Electrical properties	237
4.2.11.1	Electrical conductivity and thermoelectric power	238
4.2.11.2	Photoconductivity	242
4.2.12	References for 4.2	243
4.2.13	List of non-iron garnets in Vols. 4B, 12A and 27E	253