

Surface Effects in Magnetic Nanoparticles

Edited by

Dino Fiorani

*ISM-CNR
Area della Ricerca di Roma
Rome, Italy*

 Springer

Contents

CHAPTER 1.	Modern Electronic Structure Theory for Complex Properties of Magnetic Materials	1
	<i>A.J. Freeman, K. Nakamura and R. Wu</i>	
1.1	Introduction	1
1.2	Density functional theory and the FLAPW method	2
1.3	Results and discussion	7
1.4	Non collinear magnetism phenomena at surface and interfaces	21
CHAPTER 2.	Monte Carlo Studies of Surface and Interface Effects in Magnetic Nanoparticles	45
	<i>K.N. Trohidou</i>	
2.1	Introduction	45
2.2	The model	46
2.3	Ferromagnetic particles	48
2.4	Oxidised particles	52
2.5	Antiferromagnetic nanoparticles	57
2.6	Final remarks	70
CHAPTER 3.	Magnetic Nanoparticles as Many-Spin Systems	75
	<i>H. Kachkachi and D.A. Garanin</i>	
3.1	Introduction	75
3.2	Basic relations	78
3.3	Nanoparticle as a multi-spin system: finite size vs boundary effects	80
3.4	A nanoparticle as a multi-spin system: effect of surface anisotropy	91
3.5	Conclusions	102

CHAPTER 4.	From Finite-Size and Surface Effects to Glassy Behaviour in Ferrimagnetic Particles	105
	<i>A. Labarta, X. Battle and O. Iglesias</i>	
4.1	Frustration in ferrimagnetic oxides	105
4.2	Glassy behaviour in ferrimagnetic nanoparticles	107
4.3	Monte Carlo simulations	121
4.4	Open questions and perspectives	136
CHAPTER 5.	Effect of Surface Anisotropy on the Magnetic Resonance Properties of Nanosize Ferroparticles	141
	<i>R. Perzynski and Yu.L. Raikher</i>	
5.1	Introduction	141
5.2	Spin perturbations in fine particles. Interplay of the exchange and surface energies	147
5.3	Spin-wave resonance in the presence of a uniaxial surface anisotropy	153
5.4	Experimental	165
5.5	FMR in a spherical particle with the Aharoni surface anisotropy	172
5.6	FMR in a spherical particle with rotatable exchange anisotropy	177
5.7	Concluding remarks	182
CHAPTER 6.	Surface-Driven Effects on The Magnetic Behaviour of Oxide Nanoparticles	189
	<i>R.H. Kodama and A.E. Berkowitz</i>	
6.1	Introduction	189
6.2	Atomic-scale magnetic modeling	192
6.3	Ferrimagnetic nanoparticles	198
6.4	Antiferromagnetic nanoparticles	206
6.5	Remarks	213
CHAPTER 7.	Exchange Coupling in Iron and Iron /Oxide Nanogranular Systems	217
	<i>L. Del Bianco, A. Hernando and D. Fiorani</i>	
7.1	Introduction	217
7.2	Nanocrystalline Fe	219
7.3	Fe/Fe oxide nanogranular system	228
7.4	Conclusions	236

CHAPTER 8.	Surface and Interparticle Effects in Amorphous Magnetic Nanoparticles	239
	<i>R.D. Zysler, E. De Biasi, C.A. Ramous, D. Fiorani and H. Romero</i>	
8.1	Introduction	239
8.2	The core-shell model	241
8.3	Sample characteristics	242
8.4	Non-interacting particles	243
8.5	Interacting nanoparticles	258
8.6	Conclusions	260
CHAPTER 9.	Magnetic Anisotropy and Magnetization Reversal Studied in Individual Particles	263
	<i>W. Wernsdorfer</i>	
9.1	Introduction	263
9.2	Single-particle measurement techniques	265
9.3	Mechanisms of magnetization reversal at zero kelvin	268
9.4	Influence of temperature on the magnetization reversal	280
9.5	Conclusions	294
INDEX		299