

Contents

1	Introduction	1
	References	2
2	Thin Amorphous Fe–Tb Alloy Films	5
2.1	Phase Diagram	5
2.2	Intrinsic Magnetic Structure: Magnetic Anisotropy, Exchange Coupling, and Sperimagnetism	7
2.3	Magnetic Properties with Regard to Alloy Composition, Film Thickness, and Temperature	9
2.4	Magnetostriction	13
2.5	Fe–Tb Films for Application	14
	References	16
3	Co/Pt Multilayers	19
3.1	Origin of Magnetic Anisotropy	19
3.2	Magnetic Properties Depending on the Structure of the Multilayers	21
	References	23
4	Exchange-Bias Effect in F/FI Rare-Earth-Transition-Metal Heterostructures	25
	References	28
5	Experimental Techniques	31
5.1	Film Deposition Using Magnetron (Co-)Sputtering from Element Targets	31
5.2	The Fabrication of Nanodot Arrays by Pre-patterning	34
5.3	Structural Characterization Techniques	35
5.3.1	Estimation of Film Thickness by X-Ray Reflectometry	35
5.3.2	Stoichiometry Measurements by Rutherford Backscattering Spectrometry	36
5.3.3	Determining Crystal Structures by X-Ray Diffraction	37

5.3.4	Film Morphology, Crystal Structure, and Topography Investigations by Electron Microscopy	39
5.3.5	Surface Imaging by Atomic Force Microscopy	40
5.4	Investigation of Magnetic Properties	40
5.4.1	Magnetometry by Magneto-Optical Kerr Effect Measurements	40
5.4.2	X-Ray Magnetic Circular Dichroism: An Element Specific Probe for Magnetism	42
5.4.3	Integral Magnetic Measurements Using a Superconducting Quantum Interference Device	45
5.4.4	Stray Field Imaging with Magnetic Force Microscopy	48
	References	49
6	Magnetic Order in Thin $\text{Fe}_{100-x}\text{Tb}_x$ Films: A Temperature and Stoichiometry Dependent Study	51
6.1	Morphology and Structural Properties	51
6.2	Sperimagnetism and Its Properties at Room Temperature	54
6.2.1	Net Saturation Magnetization, Coercivity, and Magnetic Anisotropy with Respect to the Tb Content of the Fe–Tb Alloy Film	54
6.2.2	Magnetization Reversal in Fe–Tb Films Dominated by the Fe Sublattice	56
6.2.3	Magnetization Reversal in Fe–Tb Films Dominated by the Tb Sublattice	57
6.3	The Influence of Temperature on the Sperimagnetic Configuration	60
6.3.1	Magnetization Reversal for Various Temperatures in Fe–Tb Films Dominated by the Fe Sublattice	64
6.3.2	Magnetization Reversal for Various Temperatures in Fe–Tb Films Dominated by the Tb Sublattice	66
6.4	Reversal Mechanism in the Vicinity of the Compensation Point	68
6.5	Summary	74
	References	75
7	Percolated $\text{Fe}_{100-x}\text{Tb}_x$ Nanodot Arrays: Exchange Interaction and Magnetization Reversal	77
7.1	Morphology and Structural Properties of Thin Fe–Tb Films on Pre-patterned Substrates	78
7.2	Magnetization Reversal and Pinning Effects	79
7.3	Lokal Magnetic Properties and Domain Configuration	80
7.4	Angular Dependency of the Switching Field for Nanodots and Trench Material	84

7.5 Summary	85
References	86
8 Interfacial Exchange Coupling in Heterostructures of Fe–Tb Alloy Films and Co/Pt Multilayers	87
8.1 Morphology and Structural Properties	88
8.2 Interfacial Exchange Coupling with Regard to the Dominant Moment in the Fe–Tb Alloy System.	88
8.2.1 Interfacial Exchange Coupling in Fe Dominated Heterostructures	89
8.2.2 Interfacial Exchange Coupling in Tb Dominated Heterostructures	94
8.2.3 The Interfacial Exchange Energy as Function of the Composition of the Fe–Tb Layer	97
8.3 Interfacial Exchange Coupling Depending on the Thickness of the F Layer	97
8.4 Interfacial Exchange Coupling Depending on the Thickness of the FI Pinning Layer.	99
8.5 Training Effect in EB Heterostructures Dominated by an AF Exchange	101
8.5.1 Characteristic of the Training Effect with Respect to the Temperature.	103
8.5.2 Influence of the Cooling Field on the Training Effect	104
8.5.3 Cycle Field Dependence of the EB Training Effect	105
8.6 Summary	106
References	107
9 Interlayer Exchange Coupling Through Pt Spacer Layers in Fe–Tb/Pt/[Co/Pt] Heterostructures	109
9.1 Morphology and Structural Properties	109
9.2 Influence of Pt Spacer Layer Thickness on the EB Field.	113
9.3 Summary	115
References	115
10 Conclusions	117
Curriculum Vitae	119

Magnetic Order and Coupling Phenomena

A Study of Magnetic Structure and Magnetization

Reversal Processes in Rare-Earth-Transition-Metal

Based Alloys and Heterostructures

Schubert, C.

2014, XXI, 121 p. 74 illus., 18 illus. in color., Hardcover

ISBN: 978-3-319-07105-3