

# Contents

<b>1</b>	<b>Domain Boundary Engineering in Ferroic and Multiferroic Materials: A Simple Introduction .....</b>	<b>1</b>
	Ekhard K.H. Salje and Jason C. Lashley	
1.1	Introduction .....	1
1.2	Multiferroic Domain Boundaries .....	2
1.3	Highly Conducting Interfaces .....	7
1.4	The Dynamics of Domain Movement and Ferroic Switching .....	9
1.5	Conclusions .....	15
	References .....	16
<b>2</b>	<b>Phase Diagrams of Conventional and Inverse Functional Magnetic Heusler Alloys: New Theoretical and Experimental Investigations .....</b>	<b>19</b>
	P. Entel, M.E. Gruner, A. Hucht, A. Dannenberg, M. Siewert, H.C. Herper, T. Kakeshita, T. Fukuda, V.V. Sokolovskiy, and V.D. Buchelnikov	
2.1	Introduction and Computational .....	20
2.2	Crystal Structures of Half- and Full-Heusler alloys .....	21
2.3	Phase Diagrams of $Ni_2Mn_{1+x}Z_{1-x}$ ( $Z = Ga, In, Sn, Sb$ ) Heusler alloys .....	25
2.4	Phase Diagrams of $Ni_{2+x}Mn_{1-x}Z$ ( $Z = Ga, In, Sn, Sb$ ) Heusler alloys .....	30
2.5	Phase Diagrams of $Co_2Ni_{1-x}Z_{1+x}$ ( $Z = Ga, Zn$ ) Heusler alloys .....	33
2.6	Conclusions and Future Aspects of Magnetic Heusler alloys .....	41
	References .....	43

<b>3 Ni-Mn-X Heusler Materials .....</b>	<b>49</b>
Ryosuke Kainuma and Rie Y. Umetsu	
3.1 Introduction .....	49
3.2 Atomic Ordering and Magnetic Properties in $\text{Ni}_2\text{Mn}(\text{Ga}_x\text{Al}_{1-x})$ Alloys .....	50
3.2.1 Atomic Ordering .....	51
3.2.2 Magnetic Properties .....	52
3.3 Magnetic Properties in Off-Stoichiometric $\text{Ni}_2\text{Mn}_{1+y}\text{In}_{1-y}$ Alloys .....	55
3.4 Martensitic Transformation and Magnetic Properties in $\text{NiMnIn}$ Alloy .....	58
3.5 Concluding Remarks .....	62
References .....	63
<b>4 Magnetic Interactions Governing the Inverse Magnetocaloric Effect in Martensitic Ni-Mn-Based Shape-memory Alloys .....</b>	<b>67</b>
S. Aksoy, M. Acet, T. Krenke, E.F. Wassermann, M. Gruner, P. Entel, L. Mañosa, A. Planes, and P.P. Deen	
4.1 Introduction .....	68
4.2 The Inverse Magnetocaloric Effect Around a Structural Transitions in a Ferromagnetic System .....	68
4.2.1 Conventional and Inverse Magnetocaloric Effects in $\text{Ni}_{50}\text{Mn}_{34}\text{In}_{16}$ .....	70
4.2.2 Magnetic Coupling in Ni-Mn-Based Martensitic Heusler Alloys .....	71
4.2.3 Magnetic Exchange Constants in Ni-Mn-Based Martensitic Heusler Alloys .....	74
4.3 Conclusion .....	75
References .....	76
<b>5 Magnetic Field-Induced Strain in Ferromagnetic Shape Memory Alloys Fe-31.2Pd, <math>\text{Fe}_3\text{Pt}</math>, and <math>\text{Ni}_2\text{MnGa}</math> .....</b>	<b>79</b>
Takashi Fukuda and Tomoyuki Kakeshita	
5.1 Introduction .....	79
5.2 Martensitic Transformation in Fe-31.2Pd, $\text{Fe}_3\text{Pt}$ , and $\text{Ni}_2\text{MnGa}$ .....	81
5.3 Magnetic Field-Induced Strain in Fe-31.2Pd, $\text{Fe}_3\text{Pt}$ , and $\text{Ni}_2\text{MnGa}$ .....	82
5.4 Condition for Rearrangement of Martensite Variants by Magnetic Field .....	86
5.5 Origin of Martensitic Transformation in $\text{Fe}_3\text{Pt}$ .....	90
5.6 Summary .....	93
References .....	93

<b>6</b>	<b>Soft Electronic Matter: Inhomogeneous Phases in Strongly Correlated Condensed Matter.....</b>	<b>95</b>
	Peter B. Littlewood	
6.1	Introduction.....	95
6.2	A Microscopic View .....	96
6.3	Example 1: $\text{La}_2\text{NiO}_4$ .....	99
6.4	Example 2: Colossal Magnetoresistance in Manganites.....	100
6.4.1	The Basics: Double Exchange and Jahn–Teller .....	100
6.4.2	Competing and Cooperating Phases in Manganites.....	103
6.4.3	Ginzburg–Landau Theory for Manganites .....	105
6.5	Example 3: Superconductivity and Magnetism in $\text{CeCoIn}_5$ .....	108
6.6	Concluding Remarks .....	110
	References.....	110
<b>7</b>	<b>Defects in Ferroelectrics .....</b>	<b>113</b>
	Wenwu Cao	
7.1	Introduction.....	113
7.2	Vacancies in Perovskite Ferroelectric Materials .....	115
7.3	Doping of Aliovalent Defects.....	117
7.4	Defects and Dielectric Properties.....	119
7.5	Grain Boundary and Positive Temperature Coefficient Resistor ...	122
7.6	Domain Walls as a Type of Mobile Defects.....	125
7.7	Size Effects and Surface in Ferroelectric Materials .....	129
7.8	Summary.....	131
	References.....	132
<b>8</b>	<b>High-Resolution Visualization Techniques: Structural Aspects .....</b>	<b>135</b>
	D. Schryvers and S. Van Aert	
8.1	Earlier Results on Tweed Patterns in Ni–Al .....	136
8.2	Matrix Deformation and Depletion from Precipitation in Ni–Ti...	137
8.3	Minimal Strain at Austenite – Martensite Interface .....	140
8.4	Internal Strain Control in Ni–Ti Micro-Wires .....	142
8.5	Strain Effects in Metallic Nano-beams .....	142
8.6	Future Prospects .....	144
	References.....	148
<b>9</b>	<b>High-Resolution Visualizing Techniques: Magnetic Aspects .....</b>	<b>151</b>
	Yasukazu Murakami	
9.1	Introduction.....	151
9.2	Magnetic Imaging by TEM .....	152
9.2.1	Lorentz Microscopy .....	153
9.2.2	Electron Holography .....	154
9.2.3	Instrumentation for Magnetic Domain Observations .....	156
9.3	Study of Magnetic Microstructure in Colossal Magnetoresistive Manganite .....	157
9.3.1	Ferromagnetic Domain Nucleation and Growth .....	158

9.3.2	Determination of Magnetic Parameters of a Nanoscale Region .....	162
9.4	Magnetic Imaging of Ferromagnetic Shape-Memory Alloys .....	164
9.4.1	Impact of APBs on the Local Magnetization Distribution .....	165
9.4.2	Magnetic Pattern Formation Triggered by Premartensitic Lattice Anomaly .....	169
9.5	Concluding Remarks .....	172
	References .....	173
10	<b>Understanding Glassy Phenomena in Materials</b> .....	177
	David Sherrington	
10.1	Introduction .....	177
10.2	Spin Glasses: A Brief Review .....	178
10.3	Martensites .....	181
10.4	Relaxors .....	188
10.5	Models, Simulations and Analysis .....	193
10.6	Conclusion .....	195
	References .....	197
11	<b>Strain Glass and Strain Glass Transition</b> .....	201
	Xiaobing Ren	
11.1	Disorder–Order and Disorder–Glass Transition in Nature: Anticipation of a Strain Glass Transition and Strain Glass .....	201
11.2	Phase Diagram of Strain Glass: Crossover from LRO to Glass Due to Point Defects .....	204
11.3	Signatures of Strain Glass and Analogy with Other Glasses .....	207
11.4	Novel Properties of Strain Glass .....	211
11.5	Origin of Strain Glass and Theoretical Modeling/Simulations .....	214
11.6	Strain Glass as a Solution to Several Long-Standing Puzzles About Martensite .....	219
11.7	Summary .....	223
	References .....	223
12	<b>Precursor Nanoscale Textures in Ferroelastic Martensites</b> .....	227
	Pol Lloveras, Teresa Castán, Antoni Planes, and Avadh Saxena	
12.1	Introduction .....	227
12.2	Structural Precursor Textures in Cubic Ferroelastics .....	230
12.2.1	Tweed Textures .....	230
12.2.2	Effect of Elastic Anisotropy on the Morphology of Structural Precursor Nanostructures .....	232
12.3	Phenomenological Modeling .....	235

<b>12.4</b>	<b>Numerical Simulation Results .....</b>	<b>237</b>
12.4.1	Effect of the Elastic Anisotropy on Structural Precursors: From Cross-Hatched to Mottled Morphology .....	238
12.4.2	Effect of the Disorder: Frozen Glass State .....	240
12.4.3	Thermomechanical Behaviour .....	242
12.5	Conclusions.....	243
	References.....	244
<b>13</b>	<b>Metastability, Hysteresis, Avalanches, and Acoustic Emission: Martensitic Transitions in Functional Materials .....</b>	<b>249</b>
	Martin-Luc Rosinberg and Eduard Vives	
13.1	Introduction.....	249
13.2	What Can We Learn from Simple Models? .....	251
13.2.1	Relationship Between Hysteresis and the Distribution of Metastable States .....	252
13.2.2	Influence of the Driving Mechanism and the Effect of Long-Range Forces .....	256
13.3	What Can We Learn from Acoustic Emission Detection? .....	258
13.3.1	Pulse-Counting Technique .....	259
13.3.1.1	Transition Temperature .....	260
13.3.1.2	Athermal and Adiabatic Character of the Transition.....	260
13.3.1.3	Learning .....	261
13.3.1.4	Dependence on the Driving Mechanism.....	262
13.3.1.5	Correlation with Calorimetry.....	263
13.3.2	Statistical Analysis of Single Events .....	264
13.3.2.1	Exponent Universality Classes .....	265
13.3.2.2	Learning Process .....	266
13.3.2.3	Influence of the Driving Mechanism.....	268
13.3.3	Future Trends for the AE Technique in the Study of Structural Transitions.....	269
13.4	Concluding Remarks .....	269
	References.....	270
<b>14</b>	<b>Entropy-Driven Conformations Controlling DNA Functions .....</b>	<b>273</b>
	A.R. Bishop, K.Ø. Rasmussen, A. Usheva, and Boian S. Alexandrov	
14.1	Introduction.....	274
14.2	Transcription Initiation, Transcriptional Start Sites, and DNA Breathing Dynamics .....	275
14.3	DNA Repair .....	283
14.4	Bioinformatics and DNA Breathing Dynamics .....	286
14.5	Conclusions.....	288
	References.....	289

<b>15 Conclusion and Outlook .....</b>	<b>293</b>
Per-Anker Lindgård	
15.1 Outlook .....	299
References.....	300
<b>Index.....</b>	<b>303</b>