
Part I Disorder, Soft Matter and Biological Systems

Thermodynamics – Past, Present and Future

<i>Werner Ebeling</i>	3
1 Foundation of the Three Fundamental Laws	3
2 The Key Role of Thermodynamics in the 20th Century	8
3 Thermodynamics of Selforganization and Evolution Processes	9
4 Thermodynamics, Non-Linear Dynamics, Information Processing and Life	11
5 Exotic Applications	12
6 Open Problems, Conclusions	13
References	14

**Microscopy on Thermal Capillary Waves
in Demixed Colloid-Polymer Systems**

<i>Dirk G. A. L. Aarts, Matthias Schmidt, Henk N. W. Lekkerkerker, Klaus R. Mecke</i>	15
1 Introduction	15
2 Theoretical Background	16
3 Experimental Methods	20
4 Results and Discussion	22
5 Conclusions	25
References	26

**Linear Polymers in Networks:
Swelling, Diffusion, and Interdigitation**

<i>Mark Geoghegan</i>	29
1 Swelling of Polymer Networks	30
2 Diffusion	35
3 Interdigitation	39
4 Conclusions	43
5 References	43

Biomolecular Layers on Silicon Studied by Optical Spectroscopy	
<i>Dietrich R. T. Zahn, Simona D. Silaghi</i>	45
1 Introduction	45
2 Experimental and Data Analysis	46
3 Results	48
4 Summary	56
References	56

Lambert Diffusion in Porous Media in the Knudsen Regime	
<i>Stefanie Russ, Stephan Zschiegner, Armin Bunde, Jörg Kärger</i>	59
1 Introduction	59
2 The Self-Diffusion Problem	60
3 The Transport-Diffusion Problem	64
4 Summary and Conclusions	67
References	68

Dynamics of Membranes: From Passive to Active Systems	
<i>H.-G. Döbereiner, B.J. Dubin-Thaler, G. Giannone, C.K. Haluska, P.G. Petrov, A. Reinecke, K. Riske, M.P. Sheetz</i>	71
1 Classification of Membrane Dynamics	71
2 Passive Membranes	73
3 Reactive Membranes: Phospholipase Activity	77
4 Membranes and Active Gels	79
5 Towards Modular Cell Biology	81
References	82

Disentangling Noise and Fluctuations in Data Sets of Complex Systems	
<i>R. Friedrich, D. Kleinhans, J. Peinke</i>	83
1 Introduction	83
2 Nonlinear Time Series Analysis of Fluctuating Systems	84
3 Analyzing Stochastic Systems	85
4 Applications	86
5 Refined Procedure for Estimating Drift and Diffusion	87
6 Summary	93
References	94

Evolution in Complex Systems: Record Dynamics in Models of Spin Glasses, Superconductors and Evolutionary Ecology	
<i>Henrik Jeldtoft Jensen</i>	95
1 Introduction	95
2 Three Models	96
3 Record Dynamics and its Manifestation	99
4 Consequences	102

5 Summary and Conclusions	104
References	104

Part II Quantum Transport and Correlations

Flavor Degeneracy and Effects of Disorder in Ultracold Atom Systems	
<i>Walter Hofstetter</i>	109
1 Introduction and Overview	109
2 Optical Lattices and Strong Correlations	110
3 Multi-Component Systems	112
4 Disorder and Interaction	116
5 Summary and Outlook	119
References	120

Quantum Noise in Mesoscopic Systems	
<i>Wolfgang Belzig</i>	123
1 Introduction	123
2 Probability Distributions and Cumulant Generating Functions	124
3 Statistic of Transport in Normal and Superconducting Metal Contacts	125
4 Strongly Correlated Statistics	129
5 Number Statistics in Fermionic Quantum Gases	131
6 Conclusion	133
References	134

Dynamical Variational Principles for Strongly Correlated Electron Systems	
<i>Michael Potthoff</i>	135
1 Variational Principles and Approximation Strategies	136
2 Various Variational Approaches	137
3 New Approximations	143
4 Open Problems	145
References	146

Sol-Gel Approaches to Photonic Crystal Systems	
<i>Frank Marlow, Denan Konjhodzic, Helmut Brettinger, Hongliang Li</i>	149
1 Introduction	149
2 Inverse Opals	150
3 Low-n Films	154
4 Outlook: Ferroelectric PhC Films	158
References	160

Theory of Surface Optical Properties

<i>Olivia Pulci, Maurizia Palummo, Margherita Marsili, Rodolfo Del Sole</i>	161
1 Introduction	161
2 Reflectance Anisotropy Calculations	163
3 DFT Single-Particle Approach	164
4 GW: Single Quasi-Particle Approach	164
5 Application to InAs(110)	166
6 BSE: Excitonic Effects	167
7 Application to C(001)2x1	169
8 Conclusion	170
References	171

Manipulations of a Qubit in a Semiconductor Quantum Dot

<i>Artur Zrenner, Stefan Stufler, Patrick Ester, Max Bichler</i>	173
1 Introduction	173
2 Single Quantum Dot Photodiodes	174
3 Incoherent Spectroscopic Results	175
4 Coherent Manipulations	178
5 Summary	182
References	183

The Integrable $sl(2/1)$ Superspin Chain and the Spin Quantum Hall Effect

<i>Holger Frahm, Fabian H. L. Essler, Hubert Saleur</i>	185
1 Introduction	185
2 The Integrable Vertex Model	187
3 Spectrum of the Supersymmetric Spin Chain	188
4 Continuum Limit of the Lattice Model	193
5 Summary and Conclusions	195
References	196

Intrinsic Spin Hall Effect

<i>Shuichi Murakami</i>	197
1 Introduction	197
2 Intrinsic Spin Hall Effect	198
3 Disorder Effect and Extrinsic Spin Hall Effect	202
4 Discussions	203
5 Experiments	206
6 Summary	206
References	207

Part III Superconductivity

Point-contact Spectroscopy on Conventional and Unconventional Superconductors

<i>Gernot Goll</i>	213
1 Introduction	213
2 Experimental	214
3 Conventional Superconductors	215
4 Unconventional Superconductors	219
References	224

Ordering Phenomena in Cuprates

<i>Rudi Hackl, Leonardo Tassini, Francesca Venturini, Christine Hartinger, Andreas Erb, Naoki Kikugawa, Toshitsu Fujita</i>	227
References	237

Two-Gap Superconductivity in Magnesium Diboride

<i>Thomas Dahm</i>	239
1 Introduction	239
2 Two-Gap Superconductivity	240
3 Upper Critical Field Anisotropy	241
4 Microwave Conductivity Peak	243
5 Nonlinear Microwave Response	245
6 Conclusions	247
References	248
References	248

Part IV Semiconductors

Electron Spin Relaxation in Semiconductors

<i>Daniel Hägele, Stefanie Döhrmann, Jörg Rudolph, Michael Oestreich</i>	253
1 Introduction	253
2 Anisotropic Dyakonov Perel Spin Relaxation	254
3 Experiments	255
4 Intersubband Spin Relaxation	257
5 Conclusion	260
References	261

Donor Levels in ZnO

<i>Holger von Wenckstern, Swen Weinhold, Gisela Biehne, Rainer Pickenhain, Heidemarie Schmidt, Holger Hochmuth, Marius Grundmann</i>	263
1 Introduction	263
2 Samples	264

3	Transport Properties of ZnO	264
4	ZnO Schottky Diodes	268
5	Summary	272
	References	274

Excitonic Properties of ZnO

<i>C. Klingshirn, H. Priller, M. Decker, J. Brückner, H. Kalt,</i>		
<i>R. Hauschild, J. Zeller, A. Waag, A. Bakin, H. Wehmann K. Thonke,</i>		
<i>R. Sauer, R. Kling, F. Reuss, Ch. Kirchner</i>		
1	Introduction and Historic Remarks	275
2	Growth, Doping, Transport, and Deep Centers	276
3	Band Structure, Excitons, and Polaritons	277
4	High Excitation Phenomena	281
5	Conclusion and Outlook	284
	References	284

Incorporation of Acceptors in ZnO

<i>B. K. Meyer, J. Sann, A. Zeuner</i>		
1	Introduction	289
2	Experimental Details	290
3	Experimental Results	290
4	Discussion	296
5	Conclusions	298
	References	298

Optical Analysis of Monolayers at Surfaces and Interfaces

<i>Veit Wagner</i>		
1	Introduction	301
2	Inorganic Surfaces and Interfaces	303
3	Organic Surfaces and Interfaces	309
	References	311

Chemistry and Morphological Properties of Metal Interfaces to Organic Semiconductors

<i>D.R.T. Zahn, G. Salvan, G. Gavrila, B.A. Paez</i>		
1	Introduction	313
2	Experimental	314
3	Interaction of Metals with Perylene Derivatives	315
4	Morphology of the Metal Film	317
5	Structural Properties of the Metal/Organic Interfaces	319
6	Summary	322
	References	323

Part V Materials and Applications

The Role of Ion Irradiation Induced Viscous Flow in Thin Film Structuring: Hard Matter Going Soft

<i>S. G. Mayr</i>		
1	Introduction	327
2	Phenomenology of Radiation Induced Viscous Flow in Metallic Glasses	328
3	Atomic-Scale Mechanism of Radiation Induced Viscous Flow	333
4	Generalization to Crystalline Systems	335
5	Conclusions	337
	References	338

Atomic-Scale Properties of High-k Dielectrics:

Ab Initio Study for Pr-Based Materials

<i>Jarek Dąbrowski, Andrzej Fleszar, Gunther Lippert, Grzegorz Lupina,</i>		
<i>Anil Mane, Hans-Joachim Müssig, Thomas Schroeder, Roland Sorge,</i>		
<i>Hans Thieme, Christian Wenger, Peter Zaumseil</i>		
1	Introduction	339
2	Theoretical Approach	339
3	Fixed Charges	341
4	Native Point Defects	343
5	Si-related Nitrogen-Coordinated Oxygen	345
6	Impurities as Fixed Charges	348
7	Summary and Conclusions	349
	References	350

Size Effects in Ba(Pb)TiO₃ Nanopowders by EPR and NMR

<i>Emre Erdem, Rolf Böttcher, Hans Jürgen Gläsel, Eberhard Hartmann,</i>		
<i>Gert Klotzsche, Dieter Michel</i>		
1	Introduction	351
2	Experimental	352
3	Results and Discussion	353
4	Conclusion	358
	References	360

AlGaN/GaN Electrolyte-Gate Field-Effect Transistors as Transducers for Bioelectronic Devices

<i>Georg Steinhoff, Barbara Baur, Hans-Georg von Ribbeck,</i>		
<i>Günter Wrobel, Sven Ingebrandt, Andreas Offenhäusser,</i>		
<i>Martin Stutzmann, Martin Eickhoff</i>		
1	Introduction	363
2	Device Structure and Processing	364

3	Ion-Sensitivity of GaN Surfaces	365
4	Electronic Characteristics of AlGaN/GaN EGFETs	367
5	Recording of Cell Action Potentials	369
6	Summary	372
	References	372

**Advanced MOSFET Gate Dielectrics
for High-Performance Microprocessors:**

Materials Selection and Analytical Challenges

<i>E. Zschech, H.J. Engelmann, S. Ohsiek, B. Tracy, E. Adem, S. Robie, J. Bernard, D. Schmeisser</i>		
		375
1	Introduction	375
2	High- <i>k</i> Materials Selection, Materials Properties, Integration Challenges and Analytical Needs	377
3	Silicon Oxynitride	379
4	Aluminum Oxide	382
5	Metal Oxides	383
6	Summary and Outlook	386
	References	387

**Neutron Tomography as Tool for Applied Research
and Technical Inspection**

<i>Eberhard H. Lehmann, Peter Vontobel, René Hassanein</i>		
		389
1	Introduction	389
2	Neutron Interaction with Matter in Comparison to X-ray	390
3	Set-Up of a Neutron Tomography Device	393
4	Principles and Features of the PSI Reconstruction Tools	395
5	Neutron Scattering Artefacts and Their Correction with the Help of Monte-Carlo Simulations	398
6	Examples for Practical Applications from Science and Industry	401
7	Options for Further Improvements	402
8	Conclusions	404
	References	404

**Absorption- and Phase-Based Imaging Signals
for Neutron Tomography**

<i>W. Treimer, N. Kardjilov, U. Feye-Treimer, A. Hilger, I. Manke, M. Strobl</i>		
		407
1	Introduction	407
2	Theoretical Background	408
3	Phase Contrast	411
4	Refraction Contrast	413
5	Small Angle Contrast	414
6	Some Experiments	415

References	419
------------------	-----

Index	421
--------------------	-----