

Optical Absorption of Impurities and Defects in Semiconducting Crystals

Hydrogen-like Centres

Bearbeitet von
Bernard Pajot

1. Auflage 2010. Buch. xix, 470 S. Hardcover
ISBN 978 3 540 95955 7
Format (B x L): 15,5 x 23,5 cm
Gewicht: 984 g

Weitere Fachgebiete > Technik > Werkstoffkunde, Mechanische Technologie >
Werkstoffkunde, Materialwissenschaft: Forschungsmethoden

Zu Leseprobe

schnell und portofrei erhältlich bei

The logo for beck-shop.de features the text 'beck-shop.de' in a bold, red, sans-serif font. Above the 'i' in 'shop' are three red dots of increasing size. Below the main text, 'DIE FACHBUCHHANDLUNG' is written in a smaller, red, all-caps, sans-serif font.

beck-shop.de
DIE FACHBUCHHANDLUNG

Die Online-Fachbuchhandlung beck-shop.de ist spezialisiert auf Fachbücher, insbesondere Recht, Steuern und Wirtschaft. Im Sortiment finden Sie alle Medien (Bücher, Zeitschriften, CDs, eBooks, etc.) aller Verlage. Ergänzt wird das Programm durch Services wie Neuerscheinungsdienst oder Zusammenstellungen von Büchern zu Sonderpreisen. Der Shop führt mehr als 8 Millionen Produkte.

Contents

1	Introduction	1
1.1	Basic Concepts	1
1.2	A Short Historical Survey	3
1.3	General Properties of the Hydrogen-Like Centres	5
1.3.1	What are the Hydrogen-Like Centres	5
1.3.2	Electrical Activity	6
1.3.2.1	Compensation	8
1.3.2.2	Passivation	11
1.3.3	Optical Transitions	11
1.3.4	Bound Excitons	14
1.3.5	Spin Effects	16
1.4	Notations for Centres and Optical Transitions	17
	References	18
2	Origins and Atomic Properties of H-Like Centres	21
2.1	Origins	21
2.1.1	Occurrence in Nature	21
2.1.2	Contamination	22
2.1.3	Doping	25
2.1.4	Thermal Treatments and Irradiation	29
2.1.5	Concentration Measurements	30
2.2	Structural Properties	31
2.2.1	Global Atomic Configurations	31
2.2.2	Solubilities and Diffusion Coefficients	35
2.2.2.1	Solubility	35
2.2.2.2	Diffusion Coefficients	37
2.2.3	Lattice Distortion and Metastability	38
	References	42

3	Bulk Optical Absorption	45
3.1	Refractive Index and Dielectric Constant	45
3.2	Intrinsic Lattice Absorption	50
3.2.1	One-Phonon Effect	50
3.2.2	Multi-Phonon Absorption and Anharmonicity	55
3.3	Electronic Absorption	57
3.3.1	Energy Gap and Fundamental Absorption	57
3.3.2	Excitons	74
3.3.3	Free-Carrier Effects	77
	References	81
4	Methods and Techniques of Absorption Spectroscopy of Solids	85
4.1	Introduction	85
4.2	Radiation Sources and Spectrometers	89
4.2.1	Tunable Sources	89
4.2.2	Broadband Sources	90
4.2.3	Spectrometers	91
4.2.3.1	Dispersive Monochromators	91
4.2.3.2	Fourier Transform Spectrometers	94
4.3	Filtering and Polarization	99
4.4	Radiation Detection	100
4.4.1	Thermal Detection	100
4.4.2	Photoconductive Detection	103
4.4.2.1	Intrinsic Photoconductors	103
4.4.2.2	Extrinsic Photoconductors	104
4.4.3	Limits to Detectors Sensitivity	106
4.5	Conditioning the Samples	110
4.6	Cooling the Samples	111
4.7	Compressing the Samples	115
4.7.1	Uniaxial Stresses	115
4.7.2	Hydrostatic Stresses	116
4.8	Magneto-optical Measurements	119
	References	121
5	Effective-Mass Theory and its Use	125
5.1	Initial Assumptions	125
5.1.1	Selection Rules	127
5.2	Donor Centres	128
5.2.1	The One-Valley Approximation	128
5.2.2	Conduction Band Degeneracy	140
5.2.3	The Quasi-Hydrogenic Case	145
5.3	Acceptor Centres	148

5.4	Oscillator Strengths	159
5.4.1	Donor Transitions	160
5.4.2	Acceptor Transitions	163
	References	165
6	Donor and Donor-Like EM Spectra	169
6.1	Introduction	169
6.2	Group-V and Li Donors in Group-IV Crystals	171
6.2.1	Silicon	171
6.2.2	Germanium	186
6.2.3	Silicon Carbide	193
6.2.4	Diamond	196
6.3	Group-VI- and Mg Donors in Group-IV Crystals	198
6.3.1	Silicon	198
6.3.1.1	The Neutral Charge State	198
6.3.1.2	The Singly-Ionized Charge State	208
6.3.1.3	Other Chalcogen-Related Donors	215
6.3.2	Germanium	218
6.4	O-Related Donors in Group IV Crystals	220
6.4.1	The Thermal Double Donors	220
6.4.1.1	Silicon	221
6.4.1.2	Germanium	231
6.4.2	The Shallow Thermal Donors in Silicon	236
6.4.3	The Ultrashallow Thermal Donors in Silicon	241
6.5	Other Shallow Donors Involving Hydrogen	242
6.6	TMs, Group-I Elements and Pt in Silicon	243
6.6.1	Interstitial Iron	243
6.6.2	Ag, Au, and Pt	247
6.7	Pseudo-Donors and Isoelectronic Donors	249
6.7.1	The “ <i>C</i> ” and “ <i>P</i> ” Centres in Silicon	250
6.7.2	The (S,Cu) Centre in Silicon	253
6.7.3	Pseudo-Donor BEs in Germanium	254
6.8	Donors in III-V and II-VI Compounds	255
6.8.1	Quasi-Hydrogenic Effective-Mass Donors	257
6.8.1.1	Cubic Semiconductors	257
6.8.1.2	Non-Cubic Semiconductors	261
6.8.2	Semiconductors with CB Degeneracy	263
6.9	The D^- Ion and Hopping Absorption	269
6.9.1	The Donor Equivalent of H^- : the D^- Ion	269
6.9.2	Photon-Induced Hopping	270
	References	272

7	EM Acceptor Spectra	281
7.1	Introduction	281
7.2	Group-III Acceptors in Group-IV Crystals	282
7.2.1	Silicon	282
7.2.1.1	The $p_{3/2}$ Spectra	283
7.2.1.2	The $p_{1/2}$ Spectra	298
7.2.2	Germanium	300
7.2.2.1	Single Acceptor Complexes	304
7.2.3	Diamond and SiC	307
7.3	Groups-II and -I Acceptors in Group-IV Crystals	311
7.3.1	Germanium	312
7.3.1.1	The A^0 Charge State	312
7.3.1.2	The A^- Charge State	315
7.3.2	Silicon	317
7.4	An Isoelectronic Acceptor: the Be_2 Pair in Silicon	323
7.5	An Acceptor Equivalent of H^- : the A^+ Ion	327
7.6	Acceptors in III-V and II-VI Semiconductors	328
7.6.1	Groups-II and -IV Acceptors in III-V Compounds	328
7.6.2	The B_{As} (78-meV/203-meV) Double Acceptor in GaAs	334
7.6.3	TMs Acceptors in III-V Compounds	335
7.6.4	Acceptors in II-VI Compounds	337
	References	339
8	Effects of Perturbations	347
8.1	Introduction	347
8.2	Mechanical Stresses	348
8.2.1	Effects on Electronic Transitions	349
8.2.1.1	EM Donors with CB Degeneracy	350
8.2.1.2	EM Acceptors	373
8.2.1.3	Stress-Induced Inhomogeneous Broadening	382
8.2.2	Uniaxial Stress and Orientational Degeneracy	384
8.3	Effect of Magnetic Fields	388
8.3.1	Shallow Donors in Multi-Valley Semiconductors	389
8.3.1.1	Silicon	391
8.3.1.2	Germanium	394
8.3.1.3	Diamond	397
8.3.2	Shallow Acceptors	397
8.3.2.1	Silicon	402
8.3.2.2	Germanium	405
8.3.2.3	Diamond	409
8.3.2.4	Compound Semiconductors	409
8.4	Effect of Electric Fields	411
8.4.1	Homogeneous Electric Fields	411
8.4.2	Internal Electric Fields	415

8.5	Line Widths and Lifetimes	418
8.5.1	Phonon Broadening	419
8.5.2	Concentration Broadening	422
8.5.3	Lifetimes	422
	References	424
Appendix A Energy Units Used in Spectroscopy and Solid-State Physics		431
Appendix B Bravais Lattices, Symmetry and Crystals		433
B.1	The Reciprocal Lattice	435
B.2	Lattice Planes and Miller Indices	436
B.3	A Toolbox for Symmetry Groups	437
B.3.1	The Abstract Groups	437
B.3.2	The Symmetry Point Groups	438
B.3.3	Representations and Basis Functions	439
B.3.4	The Symmetry Space Groups	442
B.4	Some Crystal Structures	444
B.4.1	Cubic Structures	444
B.4.2	Hexagonal Structures	445
B.4.3	Other Crystal Structures	447
	References	448
Appendix C Optical Band Gaps and Crystal Structures of Some Insulators and Semiconductors		449
Appendix D Table of Isotopes		451
Appendix E Some Tensor Properties		461
	References	462
Index		463