

Contents

Part I Concepts

1	Tilings and Coverings	7
1.1	1D Substitutional Sequences	9
1.1.1	Fibonacci Sequence (FS)	10
1.1.2	Octonacci Sequence.....	13
1.1.3	Squared Fibonacci Sequence	14
1.1.4	Thue–Morse Sequence	15
1.1.5	1D Random Sequences	16
1.2	2D Tilings	16
1.2.1	Archimedean Tilings	18
1.2.2	Square Fibonacci Tiling	19
1.2.3	Penrose Tiling (PT)	21
1.2.4	Heptagonal (Tetrakaidecagonal) Tiling	31
1.2.5	Octagonal Tiling	36
1.2.6	Dodecagonal Tiling	38
1.2.7	2D Random Tilings.....	42
1.3	3D Tilings	43
1.3.1	3D Penrose Tiling (Ammann Tiling)	43
1.3.2	3D Random Tilings.....	44
	References	45
2	Polyhedra and Packings	49
2.1	Convex Uniform Polyhedra	50
2.2	Packings of Uniform Polyhedra with Cubic Symmetry	54
2.3	Packings and Coverings of Polyhedra with Icosahedral Symmetry	56
3	Higher-Dimensional Approach	61
3.1	n D Direct and Reciprocal Space Embedding	63
3.2	Rational Approximants.....	68

3.3	Periodic Average Structure (PAS)	70
3.4	Structure Factor	72
3.4.1	General Formulae	72
3.4.2	Calculation of the Geometrical Form Factor	73
3.5	1D Quasiperiodic Structures	78
3.5.1	Reciprocal Space	78
3.5.2	Symmetry	80
3.5.3	Example: Fibonacci Structure	81
3.6	2D Quasiperiodic Structures	92
3.6.1	Pentagonal Structures	94
3.6.2	Heptagonal Structures	101
3.6.3	Octagonal Structures	108
3.6.4	Decagonal Structures	121
3.6.5	Dodecagonal Structures	147
3.6.6	Tetrakaidecagonal Structures	155
3.7	3D Quasiperiodic Structures with Icosahedral Symmetry	170
3.7.1	Reciprocal Space	171
3.7.2	Symmetry	174
3.7.3	Example: Ammann Tiling (AT)	177
	References	186

Part II Methods

4	Experimental Techniques	193
4.1	Electron Microscopy	196
4.2	Diffraction Methods	197
4.3	Spectroscopy	201
	References	202
5	Structure Analysis	205
5.1	Data Collection Strategy	207
5.2	Multiple Diffraction (<i>Umweganregung</i>)	208
5.3	Patterson Methods	210
5.4	Statistical Direct Methods	214
5.5	Charge Flipping Method (CF)	215
5.6	Low-Density Elimination	216
5.7	Maximum Entropy Method	218
5.8	Structure Refinement	222
5.9	Crystallographic Data for Publication	225
	References	226

6	Diffuse Scattering and Disorder	231
6.1	Phasonic Diffuse Scattering (PDS) on the Example of the Penrose Rhomb Tiling	235
6.2	Diffuse Scattering as a Function of Temperature on the Example of d-Al-Co-Ni	236
	References	241
Part III Structures		
7	Structures with 1D Quasiperiodicity	247
	References	248
8	Structures with 2D Quasiperiodicity	249
8.1	Heptagonal Phases	250
8.1.1	Approximants: Borides, Borocarbides, and Carbides ...	252
8.1.2	Approximants: γ -Gallium	254
8.2	Octagonal Phases	254
8.3	Decagonal Phases	256
8.3.1	Two-Layer and Four-Layer Periodicity	256
8.3.2	Six-Layer Periodicity	273
8.3.3	Eight-Layer Periodicity	275
8.3.4	Surface Structures of Decagonal Phases	277
8.4	Dodecagonal Phases	279
	References	283
9	Structures with 3D Quasiperiodicity	291
9.1	Mackay-Cluster Based Icosahedral Phases (Type A)	294
9.2	Bergman-Cluster Based Icosahedral Phases (Type B)	295
9.3	Tsai-Cluster-Based Icosahedral Phases (Type C)	300
9.4	Example: Icosahedral Al-Cu-Fe	305
9.5	Surface Structures of Icosahedral Phases	310
	References	313
10	Phase Formation and Stability	321
10.1	Formation of Quasicrystals	322
10.2	Stabilization of Quasicrystals	324
10.3	Clusters	328
10.4	Phase Transformations of Quasicrystals	333
10.4.1	Quasicrystal $\Leftrightarrow$ Quasicrystal Transition	334
10.4.2	Quasicrystal $\Leftrightarrow$ Crystal Transformation	337
10.4.3	Microscopic Models	345
	References	349

11 Generalized Quasiperiodic Structures	359
11.1 Soft Quasicrystals	360
11.2 Photonic and Phononic Quasicrystals	362
11.2.1 Interactions with Classical Waves.....	363
11.2.2 Examples: 1D, 2D and 3D Phononic Quasicrystals	366
References	370
Glossary	373
Index	377