

Contents

Introduction	1
1 Geometrical Features of the Crystal and the Reciprocal Lattices	4
1.1 Crystal Structure and Crystal Lattice	4
1.2 The Bragg Equation. Reciprocal Lattice. Relationships Between the Indices of Lines and Planes in the Direct and Reciprocal Lattices	6
1.3 The Ewald Sphere and the Geometrical Interpretation for Diffraction Patterns	11
2 The Kinematical Theory of Scattering of Electrons by Crystals. Intensity of Diffraction Reflections	14
2.1 Wave-Like Properties of Electrons	14
2.2 The Kinematical Theory of Scattering of Waves by Crystals	14
2.3 Behavior of Electrons in Medium, the Schrödinger Equation, Its Solution in the Kinematical Approximation	24
2.4 Atomic Scattering Amplitudes, or f -Curves	29
2.5 Structure Amplitude and Structure Factor	32
2.6 Reflection Intensities in Point Electron Diffraction Patterns in Terms of the Kinematical Approximation	34
3 Geometrical Analysis of Point Electron-Diffraction Patterns	43
3.1 Raypath in a Transmission Electron Microscope for Imaging and Selected Area Diffraction	43
3.2 Methods for Interpretation of Point Diffraction Patterns: Indexing and Determination of Unit Cells	45
3.3 Simulation of Diffraction Patterns for Objects with Known Unit Cell and Space Symmetry	47
3.4 Interpretation and Simulation of Diffraction Patterns for Triclinic Lattices with a Fixed Coordinate Plane	48

3.5	Determination of the Bravais Cell and the Space Group. Secondary Diffraction Effects	53
4	Diffraction Methods in Structure Analysis	55
4.1	Fourier Series and Integrals: Their Role in the Theory of Diffraction	55
4.2	Fourier Series: Representation for the Electrostatic Potential and Use in Structure Analysis	59
4.3	The Trial-And-Error Method	64
4.4	Interatomic Vector Space. Patterson Function: Properties and Application to Structure Analysis	65
4.5	Direct Phasing Methods	68
4.6	Refinement of Atomic Coordinates by the Least-Squares Method	69
5	Dynamical Theory of Electron Diffraction (Two-Beam Approximation)	70
5.1	Quantum-Mechanical Solution	70
5.2	Integrated Diffraction Intensity in Terms of the Two-Beam Dynamical Theory	81
5.3	Criteria for the Range of Validity of the Kinematical Approximation	83
6	Dynamical n-Beam Scattering of Electrons	85
6.1	The "Physical Optics" Approach	85
6.2	Numerical Methods for Calculation of Diffraction Patterns	96
7	Electron Diffraction and High-Resolution Electron Microscopy	102
7.1	Diffraction Effects and Formation of High-Resolution Electron-Microscopic Images	102
7.2	Fraunhofer Diffraction: An Intermediate Stage in the Transfer of Information Between the Object and the Image	103
7.3	Factors Defining the Contrast in Electron-Microscopic Images	107
7.4	Contrast in Electron-Microscopic Images of Thin Crystals ..	118
7.5	Direct Crystal Structure Determination Methods Under the WPOA	135
7.6	High-Resolution Electron Microscopy (HREM) of Crystals ..	137

7.7	HREM and Real Structure of Crystals	142
7.8	Simulation of HREM Images	144
7.9	High-Resolution High-Voltage Electron Microscopy (HRHVEM)	147
8	Oblique-Texture Electron Diffraction	149
8.1	General	149
8.2	OTED Patterns: Peculiarities of Geometrical Arrangement of Reflections and Integrated Intensities	150
8.3	Two-Dimensional Intensity Distribution in OTED Patterns	154
8.4	Factors Affecting Diffracted Intensities	157
8.5	A Technique for OTED Intensity Measurements	159
8.6	Crystal Structure Refinements of Mica Polytypes on the Basis of Electronometric Intensity Measurement	161
8.7	Determination of Hydrogen Positions in Mica Structures by OTED	166
8.8	Study of Octahedral Cation Distribution in 2:1 Layers of Diocahedral Smectites	167
9	SAED and HREM Study of Mixed-Layer Minerals	177
9.1	Hybrid-Structure Minerals	177
9.2	Structure Analysis of Hybrid Minerals	178
9.3	Crystal Structure of Tochilinite	179
9.4	Structure Analysis of Minerals Related to Tochilinite	188
9.5	The Crystal Structure of Valleriite	193
9.6	A Three-Component Hybrid Mineral Containing Brucite- Like, Sulfide and Silicate Layers	197
9.7	Forms of Structural Heterogeneity	197
9.8	Structure Study of Asbolanes	203
9.9	Analysis of Basal Reflection Intensities in SAED Studies of Mixed-Layer Minerals	208
9.10	Structure Studies of Mixed-Layer Minerals by HREM	213
10	SAED and HREM Study of Order/Disorder and Structural Heterogeneity in Layer Minerals	217
10.1	A New Mica $\text{NaMg}_3(\text{Si}_{3.5}\text{Mg}_{0.5})\text{O}_{10}(\text{OH})_2$ Having a Talc- Like Stacking Sequence	218
10.2	Diffraction Effects from Layer Structures Having Partially Ordered Cation Distribution	220
10.3	Structural Modulations Resulting from the Lateral Misfit of Octahedral and Tetrahedral Sheets in Phyllosilicates	233

11	Chain Silicates. New Structural Types: Multiple-Chain and Mixed-Chain Minerals	239
11.1	New Problems in the Structure Study of Chain Silicates ...	239
11.2	Pyroxenes and Amphiboles: Idealized Structures	240
11.3	Fluorocupfferite $\text{Mg}_7[\text{Si}_8\text{O}_{22}\text{F}_2]$, a New Amphibole Variety	245
11.4	Crystal Structures of Triple-Chain Silicates	248
11.5	New Minerals Having Regular Mixed-Chain Structures	252
11.6	Some Methodological Aspects in the Interpretation for Point SAED Patterns from Chain Silicates	256
11.7	Direct HREM Observation of the Structural Motif of Asbestiform Chain Silicates	269
11.8	Chain-Width Disorder in Chain Silicates	274
11.9	Contrast Distribution in <i>a</i> -Axis HREM Images for Chain-Silicate Crystals Having Chain-Width Disorder	275
11.10	Structural Features of Chain Silicates Revealed in <i>c</i> -Axis HREM Images	281
	References	285
	Subject Index	295