

Contents

1 The Interaction of X-Rays (and Neutrons) with Matter	1
F. de Bergevin	
1.1 Introduction	1
1.2 Generalities and Definitions	2
1.3 From the Scattering by an Object to the Propagation in a Medium .	14
1.4 X-Rays	26
1.5 X-Rays: Anisotropic Scattering	47
1.A Appendix: the Born Approximation	54
References	56
2 Statistical Aspects of Wave Scattering at Rough Surfaces	59
A. Sentenac and J. Daillant	
2.1 Introduction	59
2.2 Description of Randomly Rough Surfaces	60
2.3 Description of a Surface Scattering Experiment, Coherence Domains	67
2.4 Statistical Formulation of the Diffraction Problem	72
2.5 Statistical Formulation of the Scattered Intensity Under the Born Approximation	79
References	84
3 Specular Reflectivity from Smooth and Rough Surfaces	85
A. Gibaud and G. Vignaud	
3.1 The Reflected Intensity from an Ideally Flat Surface	85
3.2 X-Ray Reflectivity in Stratified Media	98
3.3 From Dynamical to Kinematical Theory	107
3.4 Influence of the Roughness on the Matrix Coefficients	111
3.A Appendix: The Treatment of Roughness in Specular Reflectivity . .	113
3.B Appendix: Inversion of reflectivity data	117
References	131

4 Diffuse Scattering	133
J. Daillant, S. Mora and A. Sentenac	
4.1 Differential Scattering Cross-Section for X-Rays	134
4.2 First Born Approximation	141
4.3 Distorted Wave Born Approximation	145
4.4 From the Scattering Cross-Section to the Scattered Intensity	153
4.5 Examples	160
4.A Appendix: The Reciprocity Theorem	170
4.B Appendix: Verification of the Integral Equation in the Case of the Reflection by a Thin Film on a Substrate	172
4.C Appendix: Interface Roughness in a Multilayer Within the Born Approximation	173
4.D Appendix: Quantum Mechanical Approach of Born and Distorted-Wave Born Approximations	175
References	181
5 Neutron Reflectometry	183
C. Fermon, F. Ott and A. Menelle	
5.1 Introduction	183
5.2 Schrödinger Equation and Neutron–Matter Interactions	185
5.3 Reflectivity on Non-Magnetic Systems	188
5.4 Neutron Reflectivity on Magnetic Systems	193
5.5 Non-Perfect Layers, Practical Problems and Experimental Limits .	206
5.6 The Spectrometers	211
5.7 Non-Magnetic Reflectivity	213
5.8 Polarized Neutron Reflectometry on Magnetic Systems	218
5.9 Off-Specular Scattering	225
5.10 Grazing Incidence Scattering	228
5.11 Conclusion on Neutron Reflectometry	229
References	231
6 X-Ray Reflectivity by Rough Multilayers	235
T. Baumbach and P. Mikulík	
6.1 Introduction	235
6.2 Description of Rough Multilayers	237
6.3 Set-Up of X-Ray Reflectivity Experiments	240
6.4 Specular X-Ray Reflection	243
6.5 Non-Specular X-Ray Reflection	253
6.6 Interface Roughness in Surface-Sensitive Diffraction Methods . . .	266
6.7 X-Ray Reflection from Multilayer Gratings	269
6.A Appendix: Reciprocal Space Constructions for Reflectivity	277
References	281

7 Grazing Incidence Small-Angle X-Ray Scattering from Nanostructures	283
R. Lazzari	
7.1 Introduction	283
7.2 The GISAXS Scattering Geometry	285
7.3 Scattering from Density Inhomogeneities in DWBA: The Case of Isolated Particles	287
7.4 Scattering from Collections of Particles	306
7.5 Experimental Considerations in GISAXS	329
7.6 Examples of GISAXS Experiments in Hard Condensed Matter: Islands on Surfaces	330
7.7 Soft Condensed Matter GISAXS Studies: A Nanometer Scale Crystallographic Study of Self-Organization in Templated Silica Thin Films	337
References	340
Main Notation Used in This Book	343
Index	345

X-ray and Neutron Reflectivity

Principles and Applications

Daillant, J.; Gibaud, A. (Eds.)

2009, XIV, 350 p., Hardcover

ISBN: 978-3-540-88587-0