

Contents

1.	<i>Introduction</i> By H. Ibach	1
1.1	Electron Spectroscopy and Its Importance in Surface Science	1
1.2	The Information Depth	4
1.3	Electron Spectroscopies	8
	References	11
2.	<i>Design of Electron Spectrometers for Surface Analysis.</i> By D. Roy and J.D. Carette	13
2.1	Specific Requirements of the Various Electron Spectroscopies for Surface Analysis	13
2.2	General Principles and Characteristics of Electron Spectrometers ..	16
2.2.1.	Basic Principles of Energy Analysis	16
2.2.2.	Characteristics Related to Energy Resolution and Sensitivity	17
2.2.3.	Figures of Merit	18
2.3	Design Principles of Electron Spectrometers	19
2.3.1	Electron Optics for Energy Analysis	20
2.3.2	Optimization of Electron Monochromators and Analyzers	22
2.3.3	Detection Methods and Data Processing	28
2.3.4	Further Practical Considerations	29
2.4	Description of the Electron Spectrometers and the Methods of Energy Analysis for Surface Studies	31
2.4.1	Electrostatic Deflection Spectrometers	31
2.4.2	Magnetic Deflection Spectrometers	43
2.4.3	Crossed-Field Deflection Spectrometers	43
2.4.4	Retarding Potential Spectrometers	44
2.4.5	Other Techniques	48
2.5	Comparison of Electron Spectrometers	48
2.6	List of Abbreviations and Acronyms	51
	References	52

3.	<i>Electron-Excited Core Level Spectroscopies. By J. Kirschner</i>	59
3.1	Basic Processes	60
3.1.1	Free Atoms	60
3.1.2	Surface Atoms	68
3.2	Threshold Spectroscopies	71
3.2.1	Oberserving the Excitation: Disappearance Potential Spectroscopy (DAPS)	74
3.2.2	Observing the Deexcitation.....	80
3.3	Ionization Loss Spectroscopy (ILS)	87
3.4	Auger Electron Spectroscopy (AES)	92
3.4.1	Influence of the Atomic Environment	92
3.4.2	Quantitative Auger Analysis	95
3.4.3	Auger Microanalysis	99
3.4.4	Combined Auger/X-Ray Microanalysis	102
3.5	Comparisons	104
3.5.1	Threshold Spectroscopies Inter Se	104
3.5.2	Threshold Spectroscopies Versus ILS	107
3.5.3	Elemental Analysis	108
	References	111
4.	<i>Electron Diffraction and Surface Defect Structure. By M. Henzler</i>	117
4.1	Principles of Defect Detection by Electron Diffraction	118
4.1.1	Validity of the Kinematical Approximation	118
4.1.2	Construction and Calculation of the Ideal LEED Pattern ..	119
4.1.3	Instrumental Limitations	120
4.1.4	Diffraction Pattern of Simple Defect Structures	121
4.1.5	The Kind of Information in the Diffraction Pattern	123
4.2	Point Defects	124
4.2.1	Variation of Scattering Factor	124
4.2.2	Variation of Atom Position	126
4.3	Atomic Steps	130
4.3.1	Regular Step Arrays on Primitive Lattices	130
4.3.2	Irregular Step Arrays	134
4.3.3	Nonprimitive Lattices	138
4.3.4	Examples of Stepped Surfaces	139
4.4	Domains and Facets	141
4.4.1	Superstructures and Domains	141
4.4.2	LEED Patterns of Domain Structures	142
4.4.3	Quantitative Description of LEED Patterns	143
4.4.4	Facets	145

4.5 The Interpretation of a LEED Pattern	146
4.5.1 Parameters to be Observed	146
4.5.2 Interrelation of Defects and Effects	148
References	149
 5. <i>Photoemission Spectroscopy</i> . By B. Feuerbacher and B. Fitton	151
5.1 Principles of Photoemission	152
5.1.1 Parameters and Ranges	154
5.1.2 Basic Processes	156
5.2 Instrumentation	159
5.2.1 Light Sources	159
5.3 Theoretical and Practical Aspects	162
5.3.1 Electron Excitation and Emission	163
5.3.2 Surface Sensitivity	168
5.3.3 Relaxation and Chemical Shift	171
5.3.4 Photoemission from Adsorbates	174
5.4 Measurement Methods	179
5.4.1 Energy-Resolved Spectroscopy	180
5.4.2 Angle-Resolved Photoemission	183
5.4.3 Yield Spectroscopies	189
5.4.4 Spin-Polarized Photoemission	194
References	197
 6. <i>Electron Energy Loss Spectroscopy</i> . By H. Froitzheim	205
6.1 Definition of ELS	206
6.2 Theory of Inelastic Scattering	207
6.2.1 The Classical Theory (Concept of the "Dielectric Theory")	207
6.2.2 Quantum Mechanical Description of the Dielectric Theory	210
6.2.3 The Excitation of Optical Surface Phonons in Infrared-Active Material	213
6.2.4 Excitation of Optical Surface Phonons on Noninfrared-Active Substrates	214
6.2.5 Excitation of Plasma Waves	216
6.2.6 Electronic Surface Transitions	217
6.2.7 Data Reduction	217
6.2.8 Anisotropic Effects of ELS	218
6.3 Experimental Studies of Surface Vibrations (Clean Surfaces).....	219
6.3.1 The Apparatus	219
6.3.2 Infrared Active Material	220
6.3.3 Noninfrared Active Material	222

6.4	Vibrational Modes on Gas-Covered Surfaces	223
6.4.1	Apparatus	223
6.4.2	Information	223
6.4.3	Oxygen Adsorption on Si(111) 2 × 1	226
6.4.4	Adsorption of Hydrogen on Si(111) 2 × 1	228
6.4.5	Hydrogen Adsorption on W(100).....	229
6.4.6	Adsorption of Oxygen on W(100)	230
6.4.7	The Adsorption of CO on Tungsten (100)	232
6.5	Experimental Studies of Electronic Transitions	233
6.5.1	The Apparatus	233
6.5.2	Relationship Between the Spectrometer and the Interpretation of the Loss Spectra	233
6.5.3	Excitations of Electronic Transitions at Clean Silicon Surfaces	234
6.5.4	Electronic Excitations at Ge(111) Surfaces	238
6.5.5	Gallium Arsenide	239
6.5.6	Selection Rule Effects Observed at Ge and GaAs	242
6.5.7	Electronic Transitions at SiO and SiO ₂	243
6.6	Conclusion	245
	References	246
	Subject Index	251