Contents

Introduction 1

1. Volume Plasmons 4

1.1 General Properties 4
1.2 The Eigenfrequency of Plasma Oscillations 5
1.3 The Dispersion Relation. The Loss Function 6
1.4 The Critical Wave Vector 10
1.5 Acoustic Plasmons 13

2. The Dielectric Function and the Loss Function of Bound Electrons 14

2.1 Elementary Remarks. The Plasma Frequency 14
2.2 The Loss Function 16
2.3 Anisotropic Excitations 18
2.4 The Dielectric Function $\varepsilon_{GG'}(\omega,q)$ 19

3. Excitation of Volume Plasmons 23

3.1 Excitation by Electrons 23
3.2 Excitation with X-Rays 30
3.3 Excitation by Light 33

4. The Energy Loss Spectrum of Electrons and the Loss Function 35

4.1 Evaluation of the Loss Spectrum 35
4.2 Mean Free Path Length 40
4.3 Multiple Losses 42

5. Experimental Results 45

6. The Loss Width 65

6.1 The Dispersion of the Loss Width 65
6.2 Influence of the Crystal Size on the Loss Width 67
6.3 Comparison with Theory 69

7. The Wave Vector Dependency of the Energy of the Volume Plasmon 74

7.1 Dispersion at Small Wave Vectors ($q < q_c$) 74
7.2 Dispersion at Large q Values 89
7.3 Excitation of Bound Electrons with Momentum Transfer 94
7.4 Anisotropy of the Intensity of Volume Plasmon Losses 102

8. Core Excitations. Application to Microanalysis 105

9. Energy Losses by Excitation of Cerenkov Radiation and Guided Light Modes 112

9.1 Cerenkov Radiation 112
9.2 Excitation of Guided Light Modes by Electrons 114

10. Surface Excitations 116

10.1 Surface Plasmons 116
10.2 Excitation of Surface Plasmons 128
10.3 Results on Radiative Plasmons 130
10.4 Results on Nonradiative Plasmons 136
10.5 Surface Waves 165
10.6 2D and 1D Plasmons 166

11. Different Electron Energy Loss Spectrometers 172

Notes Added in Proof 181

References 183

Subject Index 193