

CONTENTS

PREFACE	vii
ACKNOWLEDGMENTS	xi
Chapter 1	
Emulsion as an Instrument of Research	
1.1 Tasks for Emulsion	1
1.2 Limitations of Emulsion	8
1.3 Types of Nuclear-Track Emulsion	12
Chapter 2	
The Latent Image and Its Development	
2.1 Silver Halide Sensitivity	23
2.2 The Behavior of the Latent Image	24
2.3 Development and Discrimination	37
2.4 Recent Theory of the Latent Image	49
Chapter 3	
Physical and Chemical Constitution of Nuclear-Track Emulsions	
3.1 General Description	59
3.2 The Silver Halide Microcrystals	59
3.3 Idiosyncrasies of Gelatin	62
3.4 Mechanical Properties	66
3.5 Chemical Composition	69
3.6 Atomic Averages for Standard Emulsion	73
3.7 Characteristic Lengths for Processes in Emulsion	74
3.8 Emulsion of Altered Composition	76
3.9 Emulsion Statistics	79
Chapter 4	
Preliminary Processing Procedures	
4.1 Conditions of Shipping, Handling, and Storage	87
4.2 Erasing of Unwanted Tracks	92
4.3 Preparation of Plates for Exposure	96
4.4 Preparation of an Emulsion Stack for Exposure	96
4.5 Pouring Emulsion Received in Gel Form	105
4.6 Humidity Measurement and Control	109
4.7 Theory of Diffusion in Emulsion	111
4.8 Thermal Lags in Processing	116

4.9	Measurement of Emulsion Density and Pellicle Thickness	116
4.10	Emulsion Loading	120
4.11	Sources of Ionizing Particles for Testing Emulsion Sensitivity	129
4.12	Hypersensitization	131

Chapter 5

Processing Procedures

5.1	General Considerations	133
5.2	Processing Thin Emulsion Layers	136
5.3	Mounting Pellicles on Glass	139
5.4	Equipment for Developing Large Emulsion Stacks	144
5.5	Development of Thick Emulsion Layers	153
5.6	Stopping and Fixing	162
5.7	Dilution and Washing	166
5.8	Drying	167
5.9	Processing Unmounted Pellicles	170
5.10	Test of Development	173
5.11	Track Intensification	175
5.12	Clearing Solutions	175
5.13	Test for Hypo	176
5.14	Measurement of the Silver Ion Concentration	176
5.15	Recovery of Silver from Fixer	177
5.16	Discrimination between Heavy Ion Tracks by Controlled Development	179

Chapter 6

The Processed Emulsion

6.1	Fog and Foreign Matter in Emulsion	181
6.2	Track Visibility	183
6.3	The Optical Characteristics of Processed Emulsion	186
6.4	Shrinkage and Stretching of Emulsion	186
6.5	Shears and Nonlinear Distortions	189
6.6	The Measurement of Distortion	192
6.7	The Distortion Vector	193
6.8	Distortion of Angles	200
6.9	Rotation of a Plane Caused by Distortion	201
6.10	Destruction of Coplanarity Caused by Distortions	201
6.11	Spurious Scattering of Tracks Caused by Emulsion Distortion	202
6.12	Effects of Emulsion Distortion on Particle Range and Range Straggling	203
6.13	Range Error Caused by Tilt of Shrunken Emulsion	205
6.14	Mechanical Behavior of Tracks	206

Chapter 7

Emulsion Microscopy and Scanning Technique

7.1	Visual Measurements Techniques	211
7.2	The Microscope and Its Accessories	213
7.3	Adjustment and Use of the Microscope	233

7.4	Automatic Methods	236
7.5	Counting Measurements	239
7.6	Geometric Measurements in Emulsion	243
7.7	Area and Strip Scanning	249
7.8	Photomicrography of Particle Tracks	253
7.9	Record Keeping and Data Reduction	256
7.10	Techniques for Discerning Tracks of Low Grain Density and Track Tracing	257

Chapter 8

Particle Scattering in Emulsion

8.1	Scattering of Point Charges by Point Charges	263
8.2	Electron Screening	265
8.3	Nuclear Scattering	268
8.4	Multiple Scattering	283
8.5	Correlation between Track Direction and Track Displacement	290
8.6	Scattering Caused by Electrons	292
8.7	The Scattering Factor	293
8.8	Measurement Procedure	302
8.9	Track Noise and Its Elimination	305
8.10	Evaluation of Error in Multiple Scattering Measurements	315
8.11	Scattering Behavior of Stopping Particles	321
8.12	Equipment for Scattering Measurements	327
8.13	Special Measurement Methods	337
8.14	Statistical Geometry of Tracks	338
8.15	Track to Track Scattering Measurements	341
8.16	Uncertainty in Direction of Particle Motion	342
8.17	Measurement of Magnetic Rigidity in Emulsion	344

Chapter 9

Ionization and Track Structure

9.1	Delta Rays in Emulsion	349
9.2	Energy Loss by Collision with Electrons	359
9.3	Energy-Loss Rates of Electrons and Positrons	364
9.4	Energy-Loss Rate of a Heavy, Multiply Charged Ion	366
9.5	Restricted Rate of Energy Loss	382
9.6	Energy-Loss Rate in Nonstandard Emulsion	385
9.7	The Grain Density and Linear Track Structure	387
9.8	Secondary Grain Density	400
9.9	Relativistic Rise of Grain Density	402
9.10	The Track Width	405
9.11	Automatic Measurement of Grain Density	413
9.12	Theory of the Primary Grain Density	418

Chapter 10

Ranges and Range Straggling in Emulsion

10.1	Particle Ranges in Matter	425
10.2	The Residual Range and Its Measurement	426

<i>10.3</i>	Ranges of Slow Protons and Alpha Particles	433
<i>10.4</i>	Ranges of Singly Charged Particles	436
<i>10.5</i>	Electron Ranges	443
<i>10.6</i>	Ranges of Multiply Charged Nuclei	446
<i>10.7</i>	Ranges in Emulsion of Nonstandard Composition	449
<i>10.8</i>	Range Stragglings in Emulsion	452
<i>10.9</i>	Automation of Range Measurements	458
<i>10.10</i>	Ranges of Very Slow Particles	461
<i>10.11</i>	Range Spectra	463
Appendix I: Note on Emulsion Making		467
Appendix II: Note on Mounting and Processing for Kodak Nuclear-Track Pellicles, Type NTB 4, 600 Micron		473
Appendix III: Mathematical and Physical Data		479
Bibliography		483
Author Index		499
Subject Index		511