

Contents

Preface	xi
Chapter 1. Preliminary Remarks	1
1.1. References	4
Chapter 2. Prerequisites for the Irradiation of Materials	5
2.1. Materials and purity, an old story	5
2.1.1. Materials and disorder in ancient history	5
2.2. Discovering the particles behind irradiation.	14
2.2.1. High-voltage generation	15
2.2.2. Vacuum control	19
2.2.3. Cathode rays	24
2.2.4. Discovery of X-rays	27
2.2.5. Discovery of the electron	28
2.2.6. Discovery of radioactivity	29
2.3. First irradiation experiments	30
2.3.1. Pleochroic halos	34
2.4. Secondary effects of radiation	35
2.5. Chapter 2 references	38
2.5.1. A brief chronology	38
2.5.2. Biographies of some of the chapter's personalities	39
2.6. References	40

Chapter 3. Particle Transport	47
3.1. It all started with collision experiments	47
3.2. Slowing down in the matter	50
3.3. Particle stopping power.	60
3.3.1. Electronic stopping power.	60
3.3.2. Nuclear stopping power	64
3.4. Particle range.	67
3.5. Transport simulation	68
3.5.1. First simulations.	70
3.6. Channeling effects.	74
3.7. Chapter 3 references	79
3.7.1. Short chronology	79
3.7.2. Biographies of some of the chapter's personalities	79
3.8. References	81
Chapter 4. First Notions of Defects	89
4.1. First observations of defects	89
4.1.1. Photographic processes	89
4.1.2. First experiments: an approach guided by sight	92
4.1.3. Defects, a useful concept for diffusion	96
4.2. Notions of defects	98
4.3. Chapter 4 references	100
4.3.1. Biographies of some of the chapter's personalities	100
4.4. References	103
Chapter 5. Defect Creation Mechanisms	107
5.1. Production of defects by irradiation	109
5.1.1. Creation of defects by electronic excitations and ionizations	109
5.1.2. Models for the creation of defects by elastic collisions.	114
5.2. Determination of threshold displacement energy.	120
5.2.1. Threshold displacement energy mapping	122
5.3. Numerical simulations	124
5.3.1. Creation and stability of point defects.	124
5.3.2. Thermal spike	126
5.4. Irradiation-induced sputtering.	128
5.4.1. Metal sputtering	129
5.4.2. Uranium sputtering	130

5.5. Chapter 5 references	132
5.5.1. Biographies of some of the chapter's personalities	132
5.6. References	134
Chapter 6. Metals Under Irradiation	139
6.1. Notions shared with other disciplines	141
6.1.1. Self-diffusion in metals	141
6.1.2. Cold metalworking	142
6.1.3. Dislocation theory	145
6.2. Creation of defects in metals by irradiation	146
6.2.1. Irradiation of pure metals	147
6.2.2. Irradiation of ordered alloys	149
6.3. Displacement threshold.	151
6.4. Description of defects.	154
6.4.1. Experimental observations of point defects.	155
6.5. Defect annealing.	159
6.6. Chapter 6 references	167
6.6.1. Biographies of some of the chapter's personalities	167
6.7. References	168
Chapter 7. Semiconductors Under Irradiation	175
7.1. First irradiation of semiconductors	176
7.2. Defect generation and counting	181
7.2.1. Determining the displacement threshold	181
7.2.2. High-energy deposits.	183
7.2.3. Description of defects	184
7.3. Diffusion in semiconductors.	187
7.3.1. Smart Cut process.	188
7.4. Chapter 7 references	189
7.4.1. Laboratories and personalities in this chapter	189
7.5. References	191
Chapter 8. Iono-covalent Insulators Under Irradiation	195
8.1. Iono-covalent materials under irradiation	195
8.1.1. Defects in iono-covalent materials	197
8.1.2. Threshold displacement energy in inorganic insulators.	200
8.1.3. Phase transformation under irradiation	202

8.2. Biographies of some of the chapter's personalities	203
8.3. References	203
Chapter 9. Polymers Under Irradiation	207
9.1. First irradiations of polymers	207
9.2. Research into degradation mechanisms	211
9.3. Radio-oxidation of polymers	217
9.4. Research and development, an active field	218
9.5. Chapter 9 references	219
9.5.1. Biographies of some of the chapter's personalities	219
9.6. References	219
Chapter 10. Radiolysis of Liquids	223
10.1. Upstream of the notion of radiolysis	223
10.2. Activated water	227
10.3. Free radicals	228
10.4. Solvated electrons	229
10.4.1. Solvated electrons, an old story	230
10.5. Effects of the spatial structure of energy deposits	234
10.6. Radiolysis yields	237
10.7. Chapter 10 references	237
10.7.1. Biographies of some of the chapter's personalities	237
10.8. References	239
Chapter 11. Irradiation Tools	243
11.1. Accelerators	244
11.1.1. Radio-frequency cavity accelerators	244
11.1.2. Electrostatic accelerators	249
11.1.3. Tandem electrostatic accelerators	252
11.1.4. Pulsed electron accelerators	254
11.2. Nuclear reactors	255
11.3. Recent developments	260
11.4. Chapter 11 references	260
11.4.1. Biographies of some of the chapter's personalities	260
11.5. References	262

Chapter 12. Irradiation Applications	267
12.1. Medical applications	269
12.1.1. Radiography	269
12.1.2. Radiotherapies	271
12.1.3. Nuclear medicine	273
12.1.4. Radiosterilization	274
12.2. Food processing	274
12.3. Polymer irradiation applications	277
12.4. Semiconductor doping	278
12.4.1. Doping by implantation	279
12.4.2. Transmutation doping	281
12.5. Radiation resistance of electronic components	282
12.6. Ion track technology	283
12.7. Cultural and historical heritage materials	287
12.8. References	289
Conclusions	293
C.1. An active community	293
C.2. Future prospects	295
C.3. References	297
Index	299

