

# CONTENTS

LIST OF CONTRIBUTORS	v
PREFACE	vii

## Chapter 1. **Structure of Solids**

*R. M. Thomson and F. Seitz*

I. Introduction	2
II. Crystallography	3
III. Lattice Vibrations	13
IV. Lattice Defects	24
V. Electron Bands and Solid Types	46
VI. Electron Structure of Imperfect Crystals: Alloys	76
VII. Physical Properties of Surfaces	86
VIII. Recommended Research	94
IX. Summary	95
Symbols	95
References	96

## Chapter 2. **Dislocations and the Theory of Fracture**

*B. A. Bilby and J. D. Eshelby*

I. Introduction	100
II. Dislocations	101
III. Arrays of Discrete and Continuously Distributed Dislocations	105
IV. Cracks and Dislocations	115
V. Energy Considerations	140
VI. Applications to Fracture Mechanics and to Dislocation Models of Crack Initiation	147
VII. Recommended Research	167
VIII. Summary	168
Appendix A. Elements of the Theory of Elasticity	169
Appendix B. The Force on a Dislocation	171
Appendix C. Solution of Certain Integral Equations	173
Symbols	177
References	178

**Chapter 3. Experimental Observations of Dislocations***Richard L. Patterson and Heinz G. F. Wilsdorf*

I. Introduction	184
II. Etching Techniques	185
III. Decoration Techniques	199
IV. Diffraction Electron Microscopy	206
V. X-ray Techniques	220
VI. Applications to Fracture Studies	225
VII. Summary and Recommended Research	236
Symbols	238
References	239

**Chapter 4. Microscopic Fracture Processes***C. D. Beachem*

I. Introduction	244
II. The Interpretation of Transmission Electron Microscope Fractographs	250
III. Microscopic Fracture Mechanisms	298
IV. General Relationships between Microscopic and Macroscopic Fracture Appearances	338
V. Mixture of Fracture Modes	342
VI. The Present State of the Art	344
VII. Summary	346
References	347

**Chapter 5. Metallographic Aspects of Fracture***N. J. Petch*

I. Introduction	351
II. Truly Brittle Solids	352
III. The Fracture of Semibrittle and Ductile Solids	369
IV. The Ductile-Brittle Transition	381
V. Recommended Research	388
VI. Summary	389
Symbols	389
References	390

**Chapter 6. Structural Modes of Fracture***V. F. Zackay, W. W. Gerberich, and E. R. Parker*

I. Introduction	396
II. Fractures below the Ductile-Brittle Transition	396
III. Some Ductile Fracture Concepts	408

IV. Fatigue Fractures	416
V. Environmental Fractures	424
VI. Fractures at High Temperatures	428
VII. Some Observations on the Fracture of Two-Phase Materials	431
VIII. Recommended Research	433
IX. Summary	435
Appendix	436
Symbols	438
References	439

## Chapter 7. Some Physical Aspects of Fracture

*B. L. Averbach*

I. Introduction	441
II. Theoretical Strength	443
III. Microcrack Formation	449
IV. Formation of Macroscopic Cracks	456
V. Recommended Research	470
VI. Summary	470
Symbols	470
References	471

## Chapter 8. Macroscopic Fundamentals in Brittle Fracture

*D. C. Drucker*

I. Introduction	474
II. Plastic Limit Loads	479
III. Fracture at or above Limit Load	489
IV. A Simplified Picture of Fracture Initiation	495
V. Initiation Barrier in Materials	506
VI. Preconditioning and Environment of Laboratory Specimens	507
VII. Specimen Design and Dimensional Considerations	512
VIII. Energy Balance Considerations	515
IX. Size Effect	520
X. Nonmetallics—Glasses, Ceramics, and Polymers	523
XI. Recommended Research	524
XII. Summary	526
Symbols	528
References	528

## Chapter 9. Stress Waves and Fracture

*H. Kolsky and D. Rader*

I. Introduction	533
II. Fractures Produced by the Reflection of Compression Pulses	536

III. Time Dependence in Fracture	547
IV. Crack Propagation in Brittle Materials	553
V. Cavitation and Fracture	560
VI. Recommended Research	566
VII. Summary	566
Symbols	567
References	568
AUTHOR INDEX	571
SUBJECT INDEX	579