

Contents

0	Introduction	1
1	Deformation and Fracture of Perfect Crystals	9
1.1	Ideal Strength of Solids	10
1.1.1	From Classics to Recent Concepts	11
1.1.2	Calculation Principles	16
1.1.3	Simple Loading Modes	26
1.1.4	Multiaxial Loading	36
1.1.5	Nanocomposites	46
1.1.6	Influence of Crystal Defects and Temperature	52
1.2	Intrinsic Brittleness and Ductility	54
1.2.1	Fundamentals	55
1.2.2	Calibration of Crystals	59
1.3	Multiscale Model of Nanoindentation Test	63
1.3.1	Description of Submodels	64
1.3.2	Simulation of Pop-in Effects	66
2	Brittle and Ductile Fracture	69
2.1	Brittle Fracture	73
2.1.1	Geometrically Induced Crack Tip Shielding	74
2.1.2	Pyramidal Model of Tortuous Crack Front	78
2.1.3	Fracture Toughness of Particle Reinforced Glass Composite	80
2.2	Quasi-brittle Fracture	88
2.2.1	Statistical Approach to Geometrical Shielding Based on Size Ratio Effect	90
2.2.2	Anomalous Fracture Behaviour of Ultra-high-strength Steels	93
2.2.3	Mixed Intergranular and Cleavage Fracture of Phosphorus-doped Fe-2.3%V Alloy	98
2.3	Ductile Fracture	108

2.3.1	Kinetics of Plastic Deformation During Uniaxial Ductile Fracture: Modelling and Experiment	111
2.3.2	Fracture Strain	116
2.3.3	Assessment of Fracture Toughness from Basic Mechanical Characteristics	121
3	Fatigue Fracture	125
3.1	Quantitative Fractography	126
3.1.1	Topological Analysis	127
3.1.2	Morphological Patterns in Fatigue	135
3.2	Opening Loading Mode	139
3.2.1	Discrete Dislocation Models of Mechanical Hysteresis .	141
3.2.2	Nucleation and Growth of Short Cracks	150
3.2.3	Discrete Dislocation Models of Mode I Growth of Long Cracks	155
3.2.4	Crack Closure Mechanisms	164
3.2.5	Unified Model of Crack-tip Shielding	175
3.2.6	Applications of the Unified Model	179
3.2.7	Influence of Shielding on Crack Growth Rate	185
3.3	Shear and Mixed-mode Loading	188
3.3.1	Models of Shear-mode Crack Growth	189
3.3.2	Propagation of Cracks under Cyclic Torsion	194
3.3.3	Propagation of Cracks under Cyclic Shear	203
3.3.4	Crack Growth and Fatigue Life under Combined Bending-torsion Loading	217
3.3.5	Formation of Fish-eye Cracks under Combined Bending-torsion Loading	227
3.4	Failure Analysis	237
3.4.1	Theoretical Background	238
3.4.2	Case Study	240
4	Final Reflections	243
4.1	Useful Results	243
4.2	Open Tasks	246
Appendixes		
A	<i>Ab initio</i> Computational Methods	249
A.1	TB-LMTO-ASA Code	251
A.2	Wien 95 – w2k Codes	252
A.3	VASP Code	253
B	Mixed-mode Criteria of Crack Stability	255
B.1	Energy Criterion	255
B.2	Criterion of Linear Damage Accumulation	256

Contentsxiii

B.3 Criterion of Minimal Deformation Energy

B.4 Criterion of Maximal Principal Stress

C Plastic Flow Rate Inside the Neck

C.1 Ideal Model

C.2 Real Model

List of Reprinted Figures

References

Index

256

257

259

259

261

265

269

283

Micromechanisms of Fracture and Fatigue

In a Multi-scale Context

Pokluda, J.; Šandera, P.

2010, XIII, 293 p., Hardcover

ISBN: 978-1-84996-265-0