

Contents

Preface	v
Contributors	xiii
CHAPTER 1	
Introduction to High-Pressure Shock Compression of Solids	1
R.A. Graham	
1.1. Shock-Compression Science	1
1.2. Shock-Compression Events	2
1.3. Responses of Shock-Compressed Solids	3
1.4. Reviews	5
1.5. References	5
CHAPTER 2	
Basic Principles of Shock Compression	7
M.B. Boslough and J.R. Asay	
2.1. Shock-Wave Concept	7
2.2. Conservation Equations	8
2.3. The "Beads on a Wire" Model	12
2.4. Thermodynamic Effects of Shock Compression and the Hugoniot Curve	15
2.5. Hugoniot Differential Equation	16
2.6. Graphical Representations and the Rayleigh Line	17
2.7. Shock Stability	18
2.8. Expansion Waves	21
2.9. $x-t$ Diagrams	22
2.10. Eulerian and Lagrangian Coordinates	24
2.11. Flow Equations in One Dimension	26
2.12. $P-u$ Diagrams	28
2.13. Surface-Surface Interactions	30
2.14. Wave-Surface Interactions	32
2.15. Wave-Wave Interactions	34
2.16. Entropic Effects	36
2.17. Riemann Integral	37
2.18. Summary	38
2.19. Acknowledgments	39

2.20. Problems	39
2.21. Glossary	40
2.22. References	42

CHAPTER 3

Experimental and Diagnostic Techniques	43
L.M. Barker, M. Shahinpoor, and L.C. Chhabildas	

3.1. Introduction	43
3.2. Experimental—Production of Planar Shock Compression	44
3.3. Explosives	44
3.4. Guns	45
3.5. Energy Deposition	53
3.6. Prompt Shock-Wave Diagnostics	54
3.7. Arrival-Time Gauges	54
3.8. Particle Velocity Gauges	56
3.9. Stress Gauges	62
3.10. Temperature Gauges	66
3.11. Delayed Shock-Wave Diagnostics	66
3.12. Optical Photography	68
3.13. Flash X-Ray Photography	68
3.14. Post-Mortem Examinations	68
3.15. Summary	69
3.16. Problems	69
3.17. References	70

CHAPTER 4

Equation of State	75
T.J. Ahrens	

4.1. Introduction	75
4.2. Shock-Wave Equations of State	76
4.3. Finite-Strain Equations of State	82
4.4. Pressure—Particle Velocity Curves	83
4.5. Shock-Induced Dynamic Yielding and Phase Transitions	90
4.6. Dynamic Yielding	93
4.7. Equation of State of Porous Materials	95
4.8. Sound Speed Behind Shock Fronts	98
4.9. Shock Temperatures	102
4.10. Acknowledgments	110
4.11. Problems	110
4.12. References	110

CHAPTER 5

Inelastic Constitutive Relations	115
W. Herrmann	

List of Symbols	115
5.1. Introduction	118

5.2. Small Deformation Theory	121
5.3. Classical Plasticity	142
5.4. Large Deformation Theory	148
5.5. Acknowledgments	169
5.6. References	170
5.7. Appendix: Kinematics	171

CHAPTER 6

Influence of Shock-Wave Deformation on the Structure/Property Behavior of Materials	187
G.T. Gray III	

6.1. Introduction	187
6.2. Influence of Shock-Wave Propagation on Materials	188
6.3. Shock-Recovery Techniques	194
6.4. Shock Parameter Effects on Material Response	202
6.5. Summary	212
6.6. References	213

CHAPTER 7

Micromechanical Considerations in Shock Compression of Solids ...	217
J.N. Johnson	

7.1. Introduction	217
7.2. Microscale, Mesoscale, and Macroscale	218
7.3. Micromechanical Plasticity in Shock Compression	222
7.4. Shock-Amplitude/Pulse-Duration Hardening	234
7.5. Internal Stresses: Micromechanical Effects upon Release from the Shocked State	237
7.6. Heterogeneous Micromechanics	241
7.7. Other Micromechanics	245
7.8. Summary	250
7.9. Problems	250
7.10. References	256
7.11. Appendix: The Shock-Change Equation	260

CHAPTER 8

Dynamic Fracture and Fragmentation	265
D.E. Grady and M.E. Kipp	

8.1. Introduction	265
8.2. Spall Strength of Condensed Matter	266
8.3. Fragment Size Predictions in Dynamic Fragmentation	278
8.4. Fragment Size Distributions in Dynamic Fragmentation	295
8.5. Continuum Modeling of Dynamic Fracture and Fragmentation	312
8.6. References	319

CHAPTER 9	
Large Deformation Wave Codes	323
J.M. McGlaun and P. Yarrington	
9.1. Introduction	323
9.2. Governing Equations	325
9.3. Spatial Meshes	327
9.4. Temporal Mesh	330
9.5. Discrete Forms of Governing Equations	330
9.6. Lagrangian Codes	331
9.7. Eulerian Codes	337
9.8. Arbitrary-Lagrangian-Eulerian (ALE) Codes	340
9.9. Example Problems	341
9.10. Summary	349
9.11. References	349
 CHAPTER 10	
Concluding Remarks	355
J.R. Asay and M. Shahinpoor	
 APPENDIX A	
A Chronological Bibliography on Shock Compression of Solids	361
J.R. Asay and M. Shahinpoor	
 APPENDIX B	
Tables and Hugoniot of Different Materials	377
 APPENDIX C	
GMX-6 Hugoniot Data	379
 Author Index	 383
Subject Index	389