

Contents

Preface to the second edition	<i>xi</i>	
Preface to the first edition	<i>xiii</i>	
Units and conversion tables	<i>xv</i>	
Chapter 1	Introduction	1
1.1	Introduction and synopsis	1
1.2	What is a cellular solid?	2
1.3	Making cellular solids	3
1.4	Properties of cellular solids	6
1.5	Applications of cellular solids	8
1.6	Outline of the book	11
1.7	The literature	11
	References	13
Chapter 2	The structure of cellular solids	15
2.1	Introduction and synopsis	15
2.2	Cell structure	16
2.3	Shape, size and topology	24
2.4	Calculating relative density	38
2.5	Characterizing cellular materials	43
2.6	Conclusions	47
	References	50
Chapter 3	Material properties	52
3.1	Introduction and synopsis	52

3.2	Polymers and elastomers	55
3.3	Metals	74
3.4	Ceramics and glasses	82
3.5	Summary	89
	References	90
	General references	91

Chapter 3 The mechanics of honeycombs 93

4.1	Introduction and synopsis	93
4.2	Deformation mechanisms in honeycombs	94
4.3	The in-plane properties of honeycombs: uniaxial loading	98
4.4	The in-plane properties of honeycombs: biaxial loading	135
4.5	The out-of-plane properties of honeycombs	148
4.6	Conclusions	158
	Appendix 4A: Elastic moduli of square and triangular honeycombs	159
	Appendix 4B: Small strain calculation of the moduli, including axial and shear deformations	160
	Appendix 4C: The elastic buckling of a honeycomb	167
	Appendix 4D: Mechanical properties of non-uniform commercial honeycombs	169
	References	173

Chapter 5 The mechanics of foams: basic results 175

5.1	Introduction and synopsis	175
5.2	Deformation mechanisms in foams	176
5.3	Mechanical properties of foams: compression	183
5.4	Mechanical properties of foams: tension	217
5.5	Summary of mechanical behaviour of foams: stress-strain maps	224
5.6	Conclusions	231
	References	231

Chapter 6 The mechanics of foams: refinements 235

6.1	Introduction and synopsis	235
6.2	The effect of temperature and strain-rate	236
6.3	Anisotropy of foam properties	257

6.4	Multiaxial loading	264
6.5	Conclusions	279
	References	281
Chapter 7	Thermal, electrical and acoustic properties of foams	283
7.1	Introduction and synopsis	283
7.2	Thermal properties	283
7.3	Electrical properties	295
7.4	Acoustic properties	300
7.5	Conclusions	306
	References	307
Chapter 8	Energy absorption in cellular materials	309
8.1	Introduction and synopsis	309
8.2	Energy-absorption mechanisms	311
8.3	Methods of characterizing energy absorption in foams	315
8.4	Energy-absorption diagrams	319
8.5	The design and selection of foams for packaging	331
8.6	Case studies in the selection of foams for packaging	335
8.7	Conclusions	343
	References	343
Chapter 9	The design of sandwich panels with foam cores	345
9.1	Introduction and synopsis	345
9.2	The stiffness of sandwich structures and its optimization	348
9.3	The strength of sandwich structures	356
9.4	Optimization of sandwich design: stiffness, strength and weight	366
9.5	Case studies in sandwich design	370
9.6	Conclusions	383
	Appendix 9A: Results for stiffness-optimized sandwich structures	383
	References	385
Chapter 10	Wood	387
10.1	Introduction and synopsis	387
10.2	The structure of wood	390

10.3	The mechanical properties of wood	394
10.4	Modelling wood structure and properties	414
10.5	Conclusions	426
	References	428

Chapter 10 **Cancellous bone** 429

11.1	Introduction and synopsis	429
11.2	The structure of cancellous bone	432
11.3	The mechanical properties of cancellous bone	438
11.4	Modelling the structure and properties of cancellous bone	444
11.5	Conclusions	449
	References	450

Chapter 11 **Cork** 453

12.1	Introduction and synopsis	453
12.2	The structure of cork	454
12.3	The mechanical properties of cork	458
12.4	Uses of cork	463
12.5	Conclusions	467
	References	467

Chapter 12 **Sources, suppliers and property data** 468

13.1	Introduction and synopsis	468
13.2	The compilation of materials and suppliers	468
13.3	Property ranges for available cellular materials	469
13.4	Case studies	477
13.5	Conclusions	482
	Appendix 13A: Commercially-available foams and their suppliers	483
	References	495

Chapter 13 **The linear-elasticity of anisotropic cellular solids** 496

	The formal description of elastic anisotropy	496
	References	502

Chapter 14 **503**