

Contents

List of Contributors	xi
Preface	xiii
1 Introduction	1
<i>James Zhijian Shen and Tomaž Kosmač</i>	
2 Teeth	
<i>Haifeng Chen and Yihong Liu</i>	
2.1 Introduction	5
2.2 Microstructure of Teeth	6
2.3 Optical Properties of Teeth	14
2.4 Mechanical Properties of Teeth	18
2.5 Common Defects and Damage	18
Acknowledgments	20
References	20
3 Dental Prostheses	
<i>Jing Zhao and Xinzhi Wang</i>	
3.1 Introduction of Prosthodontics and Dental Prostheses	23
3.2 Restoration of Tooth Defects	25
3.3 Restoration of Partial Edentulism	36
3.4 Restoration of Complete Edentulism	43
Acknowledgments	48
References	48
4 Dental Implants	
<i>Belinda Reinhardt and Thomas Beikler</i>	
4.1 Principle Structure of Dental Implants	52
4.2 Implants	60
4.3 Abutments	62
4.4 Suprastructure	65
4.5 Clinical Procedures	66
4.6 Fitting and Bite Force	69
4.7 Infection Management	71
4.8 Osseointegration	72
References	73

5 Clinical Failures of Ceramic Dental Prostheses*Yihong Liu and James Zhijian Shen*

5.1 Fractographic Analysis of Ceramics and Glasses	78
5.2 Failures of Ceramic Dental Prostheses	84
Acknowledgment	101
References	101

6 Advanced Ceramics*David Salamon*

6.1 Introduction	104
6.2 Hierarchical Structures	108
6.3 Structure–Property Relations	112
6.4 Optical Properties	118
Acknowledgments	121
References	121
Further Reading	122

7 Advanced Ceramic Processes*Martin Trunec and Karel Maca*

7.1 Introduction	124
7.2 Powder Treatment	124
7.3 Shape-forming Processes	126
7.4 Drying and Binder Removal	139
7.5 Sintering	142
References	147

8 Microstructure Characterization of Advanced Ceramics*Saso Sturm and Boštjan Jančar*

8.1 Surface Topography	151
8.2 Porosity and Pore Structure	158
8.3 Microscopic Defects	160
8.4 Interfacial Bonding Structures	164
References	170

9 Mechanical Properties and Reliability of Advanced Ceramics*Tanja Lube and Robert Danzer*

9.1 Introduction	174
9.2 Fracture Mechanics	174
9.3 Sub-critical Crack Growth	183
9.4 Fatigue	187
9.5 Other Reasons for Damage	188

9.6	Mechanical Testing of Advanced Ceramics	189
9.7	Fractography	194
9.8	Concluding Remarks	194
	References	195
10	Interfaces Between Tissues and Ceramics	
	<i>Peter Schüpbach</i>	
10.1	Introduction	201
10.2	Methodologies	202
10.3	Interface between Ceramic Implants and Bone	202
10.4	Interface between Porous Ceramic Implants and Bone	208
10.5	Interface between Ceramics and Soft Tissues	212
	Conclusions	215
	Acknowledgments	215
	References	215
11	Alumina- and Zirconia-based Ceramics for Load-bearing Applications	
	<i>Corrado Piconi, Saverio Giovanni Condo and Tomaž Kosmač</i>	
11.1	Introduction	220
11.2	Alumina in Dentistry	220
11.3	Zirconia in Dentistry	227
11.4	Alumina-zirconia Composites in Dentistry	240
11.5	Adhesion	244
	References	248
12	Dental Glasses and Glass-ceramics	
	<i>Simon Jegou Saint-Jean</i>	
12.1	Introduction	255
12.2	Classes of Dental Glass-ceramics	257
12.3	Limitations and Challenges	270
12.4	Future Development	274
	Conclusion	275
	Acknowledgments	275
	References	275
13	Requirements of Bioactive Ceramics for Dental Implants and Scaffolds	
	<i>James Zhijian Shen and Jenny Fäldt</i>	
13.1	Introduction	280
13.2	Osseointegration	281
13.3	Phenomenological View of Bioactivity	283
13.4	Biological View of Bioactivity	287

13.5	Load-bearing Dental Implants	291
13.6	Morphogenetically Active Scaffolds for Bone Tissue Engineering	295
	Acknowledgments	297
	References	297
14	Surface Modifications of Load-bearing Ceramics for Improved Osseointegration	
	<i>Martin Stefanic and Tomaž Kosmač</i>	
14.1	Introduction	301
14.2	Modifications of Surface Topography	303
14.3	Modifications of Surface Chemistry	309
	References	320
15	Industrial-scale Production of Customized Ceramic Prostheses	
	<i>Dag Henrik Bergsjö, Matts Andersson, Rikard Söderberg and Johan Carlson</i>	
15.1	Introduction	327
15.2	The History of Customized Production from the Procera Perspective	329
15.3	Ceramic Versus Metallic Materials	331
15.4	CAI/CAD/CAM	332
15.5	Production of Dental Prosthetics	334
15.6	Simulation Tools	338
15.7	Quality Control	340
	References	341
16	Advanced Dental-restoration Materials: Concepts for the Future	
	<i>James Zhijian Shen and Tomaž Kosmač</i>	
16.1	Introduction	343
16.2	Strong Glasses and Glass-ceramics	345
16.3	Functional Gradient Materials	347
16.4	Thin and Multilayered Coatings	348
16.5	Translucent Load-bearing Ceramics	351
16.6	Polymer Ceramic Hybrids	353
16.7	Strong Porous Ceramics	354
16.8	Biomimetic Materials	355
	Acknowledgments	356
	References	357

17 Defect Minimization in Prosthetic Ceramics*Erik Adolfsson and James Zhijian Shen*

17.1	Introduction	359
17.2	The Decisive Role of Defects	360
17.3	Minimizing Defects in Powders	361
17.4	Minimizing Defects in Materials Processes	362
17.5	Evaluation of the Presence of Defects	370
17.6	Summary	372
	References	372

18 Advanced Direct Forming Processes for the Future*Danjela Kuscer and James Zhijian Shen*

18.1	Introduction	375
18.2	Ink-jet Printing Technologies	377
18.3	Laser Sintering	387
	Acknowledgments	388
	References	389

Index

391