

Glasses and Glass-Ceramics

Edited by

M. H. Lewis

*Centre for Advanced Materials Technology
University of Warwick, Coventry, UK*

Fachbereich Materialwissenschaft
der Techn. Hochschule Darmstadt

Inv.-Nr.: 538



London New York

CHAPMAN AND HALL

Contents

Contributors	ix
Preface	xi
1 MAS NMR: a new spectroscopic technique for structure determination in glasses and ceramics	1
<i>R. Dupree and D. Holland</i>	
1.1 Introduction	1
1.2 Glasses	7
1.3 Binary glasses	12
1.4 Ternary and mineral glasses	16
1.5 Devitrification	22
1.6 Phase separation	28
1.7 Ceramics	31
1.8 Materials produced by low-temperature processes	34
1.9 Conclusion	36
References	38
2 X-ray absorption studies of glass structure	41
<i>R. F. Pettifer</i>	
2.1 Introduction	41
2.2 Basic theory of EXAFS	45
2.3 Glass structure studies by EXAFS	50
2.4 Conclusions	56
References	56
3 Volume nucleation in silicate glasses	59
<i>P. F. James</i>	
3.1 Introduction	59
3.2 Summary of classical nucleation theory	60
3.3 Experimental studies in 'simple' one-component systems	63
3.4 Effect of glass composition on nucleation kinetics	80
3.5 Heterogeneous nucleation: experimental results	83
3.6 Non-metallic nucleating agents	87
3.7 Effects of amorphous phase separation on crystal nucleation kinetics	91

3.8 Summary and conclusions	100
References	103
4 Oxynitride glasses and their glass-ceramic derivatives	106
<i>G. Leng-Ward and M. H. Lewis</i>	
4.1 Introduction	106
4.2 Oxynitride glass formation	107
4.3 Oxynitride glass preparation	116
4.4 Oxynitride glass structure	123
4.5 Properties of oxynitride glasses	129
4.6 Crystallization	137
References	153
5 Optical properties of halide glasses	156
<i>J. M. Parker and P. W. France</i>	
5.1 Introduction	156
5.2 Glass formation and structure	156
5.3 Melting techniques	160
5.4 Optical transmission characteristics	164
5.5 Infra-red absorption	167
5.6 Ultraviolet absorption	176
5.7 Intrinsic scattering	177
5.8 Minimum intrinsic losses	180
5.9 Extrinsic losses	182
5.10 Refractive index and dispersion	187
5.11 Other properties	192
5.12 Fabrication	195
5.13 Conclusions	196
References	196
6 Applications of microporous glasses	203
<i>N. Ford and R. Todhunter</i>	
6.1 Introduction	203
6.2 Phase separation	203
6.3 The Vycor process	208
6.4 Reverse osmosis	210
6.5 Antireflection coatings and optical waveguides	216
6.6 Resistance thermometers and superconducting materials	219
6.7 Nuclear waste disposal	221
6.8 Refractory foams	221
6.9 Enzyme immobilization and catalyst supports	222
References	223

Contents

vii

7 Glass-ceramics in substrate applications	226
<i>G. Partridge, C. A. Elyard and M. I. Budd</i>	
7.1 Introduction	226
7.2 Bulk crystallized glass-ceramics	229
7.3 Bulk glass-ceramics via powder techniques	246
7.4 Glass-ceramic coated metal substrates	253
7.5 Conclusions	270
References	271
8 Glass-ceramics for piezoelectric and pyroelectric devices	272
<i>A. Halliyal, A. S. Bhalla, R. E. Newnham and L. E. Cross</i>	
8.1 Introduction	272
8.2 Ferroelectric and non-ferroelectric materials	273
8.3 Selection of glass compositions	277
8.4 Preparation of glass-ceramics	279
8.5 Compositions of glasses	284
8.6 Heat-treatment and microstructure	284
8.7 Dielectric properties	288
8.8 Pyroelectric properties	292
8.9 Piezoelectric properties	297
8.10 Surface acoustic wave (SAW) properties	303
8.11 Connectivity model for piezoelectric and pyroelectric properties of polar glass-ceramics and tailoring the properties	305
8.12 Summary	313
References	314
9 Interfacial electrochemical aspects of glass in solid state ion-selective electrodes	316
<i>R. E. Belford and A. E. Owen</i>	
9.1 Introduction	316
9.2 The glass–metal interface	321
9.3 The glass–solution interface	328
9.4 Conclusions	334
References	334
10 Fibre reinforced glasses and glass-ceramics	336
<i>K. M. Prewo</i>	
10.1 Introduction	336
10.2 Composite systems	336
10.3 Composite fabrication	338
10.4 Composite properties	343
10.5 Summary	363
References	366

Glass systems index	369
Glass-ceramic phases and other compounds index	371
Subject index	373