

Contents

Chapter 1 Aqueous Colloidal Injection Molding of Ceramics Based on Gelation	1
1.1 Colloidal Injection Molding	2
1.1.1 The Concept of CIMC	2
1.1.2 The Flowchart of CIMC.....	3
1.1.3 The Machine of CIMC.....	4
1.2 Pressure Induced Forming	6
1.2.1 Effect of Hydrostatic Pressure on Solidification.....	6
1.2.2 Homogeneity of the Green Bodies.....	6
1.2.3 Controlling the Inner Stress in the Green Body	7
1.3 Storage Stability of Ceramic Slurries	9
1.3.1 The Importance of Storage Stability of Slurry	9
1.3.2 Chemical Stability.....	9
1.3.3 Inhibitor for Slurry Storage.....	11
1.4 To Prepare High Reliability Ceramic Parts with Complex Shapes: Aqueous Colloidal Injection Molding	12
References	14
Chapter 2 Gel-Tape-Casting of Ceramic Substrates.....	16
2.1 Fundamental Principle and Processing of Aqueous Gel-Tape-Casting	18
2.1.1 Tape Casting Types and the Raw Materials	18
2.1.2 Polymerization of the Monomer	22
2.1.3 Influence Factors on Polymerization of the Monomer	30
2.1.4 Processing of the Gel-Tape-Casting.....	36
2.2 The Characteristics of Slurries Used for Aqueous Gel-Tape-Casting	39
2.2.1 The Properties of the Aqueous Ceramic Slurries with Binder	39
2.2.2 The Influence of Dispersants on Stability and Rheology of Aqueous Ceramic Slurries with Organic Monomer	44
2.2.3 The Influence of Plasticizer on Properties of Aqueous Ceramic Slurry with Organic Monomer	47

2.2.4	The Influence of pH on the Properties of Slurries with Organic Monomer	49
2.2.5	The Effect of Surfactant on Wetting and Green Tape Releasing (Separating).....	49
2.2.6	Foam and Pore Elimination	50
2.2.7	Sintering of Green Tape Prepared by Slurry	52
2.3	Aqueous Gel-Tape-Casting with Styrene-Acrylic Latex Binder	53
2.3.1	The Importance of Binders in Gel-Tape-Casting Process.....	53
2.3.2	The Forming Film Mechanism of Latex Binder	55
2.3.3	Rheological Properties of the Alumina Slurries with Binder	57
2.3.4	The Physical Properties and Microstructure of Green Tapes with Latex Binder	57
2.4	A Gel-Tape-Casting Process Based on Gelation of Sodium Alginate....	59
2.4.1	Why Study on Tape Casting of Sodium Alginate	59
2.4.2	The Preparation of Aqueous Alumina Suspensions with Sodium Alginate and Calcium Phosphorus Tribasic	61
2.4.3	Control of the Gelation of Sodium Alginate	63
2.4.4	Characterization of Green Tapes.....	64
2.5	The Spray Trigger Fast-Curing for the Gel-Tape-Casting Process	66
2.5.1	The Idea of the Spray Trigger Fast-Curing	66
2.5.2	Outline of the New Process.....	66
2.6	The Features and Prospects of the Aqueous Tape-Casting	68
	References	70
Chapter 3	Gelation Forming Process for Low Toxicity System	74
3.1	Gelation Forming of Ceramic Suspension with Agarose.....	75
3.1.1	Characteristics of Agarose	75
3.1.2	The Effect of Agarose Contents on the Rheology of Aqueous Ceramic Suspensions.....	77
3.1.3	The Forming Courses of the Aqueous Ceramic Suspensions with Agarose.....	79
3.2	Alumina Casting Based on Gelation of Gelatine.....	83
3.2.1	Characteristics of Gelatine	83
3.2.2	The Gelation Process of the Ceramic Slurry with Gelatine Solution.....	86
3.2.3	The Preparation of Green Body Using Slurry with Gelatine Solution.....	88
3.3	A Casting Forming for Ceramics by Gelatine and Enzyme Catalysis.....	90
3.3.1	Research Background	90
3.3.2	The Gelation Mechanism of Gelatine Solution with Urea under Enzyme Catalysis.....	91

3.3.3	The Rheology and Zeta Potential of Alumina Suspension Containing Gelatine and Urea	93
3.3.4	The Coagulation Forming and Microstructure of Green Body.....	95
3.4	The Alumina Forming Based on Gelation of Sodium Alginate.....	96
3.4.1	Research Background	96
3.4.2	The Gelation Principle of Sodium Alginate.....	97
3.4.3	The Preparation Process of Alumina Green Bodies and Samples by Sodium Alginate.....	100
3.5	The Gel-Casting of SiC Based on Gelation of Sodium Alginate.....	103
3.5.1	Introduction of the Research.....	103
3.5.2	The Effect of Dispersant on the Colloidal Behaviors of the SiC Suspension.....	104
3.5.3	The Rheological Property of SiC Suspension.....	105
3.5.4	The Sedimentation Behavior of the SiC Suspension	107
3.5.5	The Gelation Principle and Process of the Alginate Solution.....	108
3.5.6	The Gelation of the SiC Suspension with Alginate.....	108
3.6	The Alumina Gel-Casting with a Low-Toxicity System of HEMA.....	111
3.6.1	The Academic Idea and Research Program	111
3.6.2	The Colloidal Chemistry and Rheological Property	111
3.6.3	The Binder Burnout and Application of the New System.....	113
3.7	The Synergistic Low-Toxicity Gel-Casting System by Using HEMA and PVP	115
3.7.1	The Academic Idea and Research Program	115
3.7.2	Zeta Potentials and Rheological Properties	116
3.7.3	The Activation Energy and Solidification.....	120
3.7.4	The Green Strengths and Microstructures.....	121
3.7.5	The Exfoliation Elimination Effect and Analysis of the Interaction between PVP and HEMA Molecules.....	123
	References	125

Chapter 4	Generation, Development, Inheritance, and Control of the Defects during the Transformation from Suspension to Green Body	129
4.1	The Rheological Behaviors of Aqueous Ceramic Suspensions	131
4.1.1	The Rheological Behaviors of Aqueous Alumina Suspensions	132
4.1.2	The Effect of Rheological Properties of Suspension on Mechanical Strength of Ceramics.....	135
4.1.3	The Effect of Solid Loading on Colloidal Forming	142
4.2	The Generation and Development of Defects.....	147
4.2.1	The Generation Mechanisms of Agglomerations in Ceramic Suspensions	147

4.2.2	The Influences of Idle Time on Microstructures and Mechanical Properties of Green Bodies by Direct Coagulation Casting	154
4.3	The Effect of Ionic Conductance on Preparation of Highly Concentrated Suspension.....	163
4.3.1	The Academic Idea and Research Program	163
4.3.2	The Relationship Between Ion Conductivity Constants and Solid Loading.....	165
4.4	Control of Inner Stress in Green Body	170
4.4.1	Origin, Transformation and Control of Inner Stress in Green Body.....	170
4.4.2	The Release and Control of Inner Stresses in Ceramic Green Body.....	175
4.5	The Suppression of Surface-Exfoliation with the Addition of Organic Agents	183
4.5.1	The Suppression of Surface-Exfoliation by Introducing PAM into Monomer System in Suspension.....	183
4.5.2	The Suppression of Surface-Exfoliation by Introducing Polyethylene Glycol into Monomer System in Suspension.....	190
4.5.3	The Suppression of Surface-Exfoliation by Introducing Poly-vinylpyrrolidone (PVP) into Monomer System in Suspension.....	198
	References	207
Chapter 5	The Gel-Casting of Non-Oxide Ceramics	211
5.1	The Effects of Powder Surface Modification on Concentrated Suspensions Properties of Si_3N_4	212
5.1.1	The Contributing Factor and Elimination of Macropores in Si_3N_4 Green Bodies	212
5.1.2	The Effect of Foreign Ions on Concentrated Suspension of Si_3N_4	217
5.1.3	The Effect of Acid Cleaning and Calcinations on the Suspension Properties of Si_3N_4	223
5.1.4	The Effect of Liquid Medium and Surface Group on Dispersibility of Si_3N_4 Powder.....	232
5.2	The Gel-Casting of Si_3N_4 Ceramics	238
5.2.1	The Preparation of Si_3N_4 Ceramics with Surface-Coated Si_3N_4 Powder	238
5.2.2	The Preparation of Si_3N_4 Ceramics with Surface-Oxidized Si_3N_4 Powder.....	248

5.2.3	The Preparation of Si_3N_4 Ceramics with Combination Processing	253
5.3	The Gel-Casting of SiC Ceramic and Si_3N_4 Bonded SiC Ceramic.....	262
5.3.1	The Gel-Casting of Concentrated Aqueous SiC Ceramic	262
5.3.2	The Gel-Casting of Aqueous Slurry with Si_3N_4 Bonded SiC....	268
	References	279
Chapter 6 Application of New Colloidal Forming		283
6.1	Ceramic Microbeads.....	283
6.1.1	The Forming Principle of Ceramic Microbeads Based on Gel-Casting	283
6.1.2	The Processing of Microbeads.....	286
6.1.3	The Properties of Ceramic Microbeads	287
6.2	Improving the Breakdown Strength of Rutile Capacitor	298
6.2.1	The Influence of Sintering Additives on the Flow Behavior ..	299
6.2.2	The Calcining of the Rutile Mixture	301
6.2.3	The Rheological Behavior of the Calcined Rutile Mixture	303
6.2.4	The Gel-Casting of the Calcined Rutile Mixture	304
6.3	The Thin-Wall Rutile Tube for Ozone Generator with High Dielectric Constant	306
6.3.1	The Experiment Results.....	306
6.4	The Refractory Nozzle of Zirconia.....	309
6.4.1	The Rehological Behaviors of ZrO_2 Suspensions with Different Dispersants.....	310
6.4.2	The Sediment Stability of ZrO_2 Suspension with Different Dispersants.....	312
6.4.3	The Preparation of ZrO_2 Refractory Nozzles.....	313
6.5	Water Based Gel-Casting of PZT	314
6.5.1	The Colloidal Chemistry and Rheological Behavior	316
6.5.2	The Microstructure and Properties.....	319
	References	323
Chapter 7 The New Methods and Techniques Based on Gel-Casting		325
7.1	Development Overview and Application of SFF.....	327
7.1.1	Development Overview of SFF	327
7.1.2	Application of SFF.....	328
7.2	Development Overview and Application of Freeze-Gel-Casting	336
7.2.1	The Combination of Gel-Casting and Freeze-Casting Technique	336
7.2.2	Fabrication of Ceramics with Special Porous Structures	338
7.2.3	The Microstructure and Properties of Porous Alumina Ceramics	343

7.2.4 The Mechanical Properties and Applications of Alumina Ceramics with Ultra Low Density	350
7.3 The Solidification of Concentrated Si_3N_4 Suspensions for Gelcasting by Ultrasonic Effects	352
7.3.1 Gelcasting by Ultrasonic Effects	352
7.3.2 The Preparation of Concentrated Si_3N_4 Suspensions.....	354
7.3.3 The Ultrasonic Accelerated Solidification	355
7.3.4 The Comparison between Thermal and Ultrasonic Activated Solidifications	358
7.4 Novel Laser Machining Technology for Al_2O_3 Green Ceramic.....	360
7.4.1 Laser Machining Technology.....	360
7.4.2 Practical Application of Laser Machining Technology.....	361
References	368
Appendix 1 The Testing and Analyzing Methods Used in Authors' Research.....	371
Appendix 2 The Raw Materials Used in Authors' Research	372
Index of Terms.....	373
Index of Scholars.....	377
Postscript	384