

# Handbook of Polymers for Pharmaceutical Technologies

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# **Handbook of Polymers for Pharmaceutical Technologies**

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Edited by

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Manju Kumari Thakur**



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*To my parents and teachers who helped me become what I am today.*

Vijay Kumar Thakur

# Contents

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<b>Preface</b>	<b>xvii</b>
<b>1 Particle Engineering of Polymers into Multifunctional Interactive Excipients</b>	<b>1</b>
<i>Sharad Mangal, Ian Larson, Felix Meiser and David AV Morton</i>	
1.1 Introduction	1
1.2 Polymers as Excipients	3
1.3 Material Properties Affecting Binder Activity	6
1.3.1 Particle Size	6
1.3.2 Deformation Mechanisms	7
1.3.3 Glass Transition Temperature (T <sub>g</sub> )	8
1.4 Strategies for Improving Polymeric Filler-Binder Performance for Direct Compression	8
1.4.1 Interactive Mixing	12
1.4.2 Challenges to Interactive Mixing	13
1.4.3 Controlling Interparticle Cohesion	14
1.5 Preparation and Characterization of Interactive Excipients	14
1.5.1 Particle Size and Size Distribution of Excipients	15
1.5.2 Effect of L-leucine on Surface Morphology	16
1.5.3 Effect of L-leucine on Surface Composition	16
1.5.4 Effect of L-leucine on Surface Energy	17
1.5.5 Effect of L-leucine on Interparticle Cohesion	18
1.6 Performance of Interactive Excipients	18
1.6.1 Blending Ability	18
1.6.2 Effect on Flow	20
1.6.3 Binder Activity	20
1.7 Investigation of the Effect of Polymer Mechanical Properties	23
1.8 Conclusion	25
References	26
<b>2 The Art of Making Polymeric Membranes</b>	<b>33</b>
<i>K.C. Khulbe, T. Matsuura and C. Feng</i>	
2.1 Introduction	33
2.2 Types of Membranes	35
2.2.1 Porous Membranes	35
2.2.2 Nonporous Membranes	36
2.2.3 Liquid Membranes (Carrier Mediated Transport)	36
2.2.4 Asymmetric Membranes	36
2.3 Preparation of Membranes	36
2.3.1 Phase Inversion/Separation	37
2.3.2 Vapor-Induced Phase Separation (VIPS)	37
2.3.3 Thermally-Induced Phase Separation (TIPS)	37
2.3.4 Immersion Precipitation	38
2.3.5 Film/Dry Casting Technique	38

2.3.6	Track Etching	39
2.3.7	Electrospinning	39
2.3.7.1	Preparation of Electrospun Nanofiber Membranes (ENMs) with Single Component	40
2.3.7.2	Preparation of Nanofibers with Two Side-by-Side Components	40
2.3.7.3	Preparation of Core-Sheath and Hollow Nanofibers	41
2.3.8	Spraying	42
2.3.9	Foaming	42
2.3.10	Particle Leaching	43
2.3.11	Precipitation from the Vapor Phase	43
2.3.12	Emulsion Freeze-Drying	43
2.3.13	Sintering	44
2.3.14	Stretching	44
2.3.15	Composite/Supported	44
2.3.16	Mixed Matrix Membranes (MMMs)	45
2.3.17	Hollow Fiber Membranes	46
2.3.17.1	Methods for Spinning	46
2.3.18	Metal-Organic Frameworks (MOFs)	48
2.4	Modification of Membranes	49
2.4.1	Modification of Polymeric Membrane by Additives/Blending	49
2.4.2	Coating	50
2.4.3	Surface Modification by Chemical Reaction	50
2.4.4	Interfacial Polymerization (IP)/Copolymerization	50
2.4.5	Plasma Polymerization/Treatment	52
2.4.6	Surface Modification by Irradiation of High Energy Particles	52
2.4.7	UV Irradiation	53
2.4.8	Ion-Beam Irradiation	53
2.4.9	Surface Modification by Heat Treatment	53
2.4.10	Graft Polymerization/Grafting	53
2.4.11	Other Techniques	53
2.5	Characterization of Membrane by Different Techniques	54
2.5.1	Conventional Physical Methods to Determine Pore Size and Pore Size Distribution	55
2.5.1.1	Bubble Gas Transport Method	55
2.5.1.2	Mercury Intrusion Porosimetry	56
2.5.1.3	Gas Liquid Equilibrium Method (Permporometry)	56
2.5.1.4	Adsorption-Desorption Method: Baret-Joyner-Halenda (BJH) Method	57
2.5.1.5	Permeability Methods	57
2.5.2	Morphology	58
2.5.2.1	Microscopic Method	58
2.5.2.2	Spectroscopic Method	59
2.5.2.3	Positron Annihilation Spectroscopy (PAL)	59
2.5.2.4	X-Ray Analysis and Other Methods	59
2.5.3	Thermal Properties	60

2.5.4	Mechanical Properties	60
2.5.4.1	Tensile Strength	60
2.5.4.2	Young's Modulus or Tensile Modulus of Elasticity	60
2.6	Summary	61
	References	62
<b>3</b>	<b>Development of Microstructuring Technologies of Polycarbonate for Establishing Advanced Cell Cultivation Systems</b>	<b>67</b>
	<i>Uta Ferkorn, Jörg Hampl, Frank Weise, Sukhdeep Singh, Justyna Tobola and Andreas Schober</i>	
3.1	Introduction	67
3.2	Material Properties of Polycarbonate	71
3.2.1	Physical Properties	71
3.2.2	Chemical Properties	72
3.2.3	Biological Properties	72
3.3	Use of Polycarbonate Foils in Structuration Processes	75
3.3.1	Hot Embossing	75
3.3.2	Thermoforming	77
3.4	Simulation of Microstructuring of a Polycarbonate Foil	79
3.5	Chemical Functionalization of Polycarbonate	81
3.6	Surface Micropatterning of Polycarbonate	84
3.7	Application Examples	86
3.7.1	3D Liver Cell Cultivation in Polycarbonate Scaffolds	86
3.7.2	3D Lung Cell Cultivation in Semi-Actively Perfused Systems	87
3.7.3	Guiding 3D Cocultivation of Cells by Micropatterning Techniques	87
3.8	Conclusion and Further Perspectives	88
	Acknowledgements	89
	References	89
<b>4</b>	<b>In-Situ Gelling Thermosensitive Hydrogels for Protein Delivery Applications</b>	<b>95</b>
	<i>Roberta Censi, Alessandra Dubbini and Piera Di Martino</i>	
4.1	Introduction	96
4.2	Polymers for the Design of Hydrogels	97
4.2.1	Polymer Architectures	97
4.2.2	Natural, Synthetic and Hybrid Hydrogels	97
4.2.3	Crosslinking Methods	99
4.2.4	Thermogelling Polymer Hydrogels	100
4.3	Pharmaceutical Applications of Hydrogels: Protein Delivery	107
4.3.1	Strategies for Protein Release from Hydrogels	109
4.3.1.1	Physical Entrapment of Proteins into Hydrogels: General Principles and Release Mechanisms	109
4.3.1.2	Covalent Binding	112
4.3.1.3	Dual/Multiple Delivery Systems	112
4.4	Application of Hydrogels for Protein Delivery in Tissue Engineering	112
4.5	Conclusions	113
	References	114



<b>5</b>	<b>Polymers as Formulation Excipients for Hot-Melt Extrusion Processing of Pharmaceuticals</b>	<b>121</b>
	<i>Kyriakos Kachrimanis and Ioannis Nikolakakis</i>	
5.1	Introduction	121
5.1.1	Overview of Hot-Melt Extrusion (HME)	121
5.1.2	Solubility/Dissolution Enhancement by Solid Dispersions	123
5.2	Polymers for HME Processing	127
5.2.1	Basic Requirements	127
5.2.2	Suitability – Examples	128
5.3	Polymer Selection for the HME Process	130
5.3.1	Thermodynamic Considerations – Drug-Polymer Solubility and Miscibility	130
5.4	Processing of HME Formulations	135
5.4.1	Physical Properties of Feeding Material – Flowability, Packing and Friction	135
5.4.1.1	Crystallinity	136
5.4.1.2	Molecular Weight and Viscosity	138
5.5	Improvements in Processing	141
5.5.1	Equipment Modifications	141
5.5.2	Plasticizers	142
5.5.2.1	Drugs Acting as Plasticizers	142
5.5.2.2	Extrusion Based on Use of Plasticizers	142
5.6	Conclusion and Future Perspective	144
	References	144
<b>6</b>	<b>Poly Lactic-Co-Glycolic Acid (PLGA) Copolymer and Its Pharmaceutical Application</b>	<b>151</b>
	<i>Abhijeet Pandey, Darshana S. Jain, Subhashis Chakraborty</i>	
6.1	Introduction	151
6.2	Physicochemical Properties	152
6.3	Biodegradation	153
6.4	Biocompatibility, Toxicity and Pharmacokinetics	154
6.5	Mechanism of Drug Release	155
6.6	PLGA-Based DDS	157
6.7	Bone Regeneration	158
6.8	Pulmonary Delivery	160
6.9	Gene Therapy	162
6.10	Tumor Targeting	162
6.11	Miscellaneous Drug Delivery Applications	164
6.12	Conclusion	165
	References	165
<b>7</b>	<b>Pharmaceutical Applications of Polymeric Membranes</b>	<b>173</b>
	<i>Stefan Ioan Voicu</i>	
7.1	Introduction	173
7.2	Obtaining Pure and Ultrapure Water for Pharmaceutical Usage	178

7.3	Wastewater Treatment for Pharmaceuticals	180
7.4	Controlled Drug Delivery Devices Based on Membrane Materials	183
7.5	Molecularly Imprinted Membranes	185
7.6	Conclusions	190
	References	191
<b>8</b>	<b>Application of PVC in Construction of Ion-Selective Electrodes for Pharmaceutical Analysis: A Review of Polymer Electrodes for Nonsteroidal, Anti-Inflammatory Drugs</b>	<b>195</b>
	<b>Joanna Lenik</b>	
8.1	Introduction	195
8.2	Properties and Usage of Poly(vinyl)chloride (PVC)	197
8.3	PVC Application and Properties in Construction of Potentiometric Sensors for Drug Detection	199
8.3.1	Role of Polymer Membrane Components	202
8.4	Ion-Selective, Classic, Liquid Electrodes (ISEs)	205
8.5	Ion-Selective Solid-State Electrodes	206
8.5.1	Ion-Selective Coated-Wire Electrodes (CWE)	206
8.5.2	Ion-Selective BMSA Electrodes	207
8.5.3	Electrodes Based on Conductive Polymers (SC-ISEs)	208
8.6	Application of Polymer-Based ISEs for Determination of Analgetic, Anti-Inflammatory and Antipyretic Drugs: Literature Review (2000-2014)	211
8.6.1	Electrodes for Determination of Narcotic Medicines	211
8.6.2	Electrode Sensitive to Dextromethorphan	211
8.6.3	Electrode Sensitive to Tramadol	212
8.6.4	Electrodes for Determination of Non-Narcotic Drugs	212
8.6.5	Salicylate Electrode	214
8.6.6	Ibuprofen Electrode	214
8.6.7	Ketoprofen Electrodes	216
8.6.8	Piroxicam Electrode	216
8.6.9	Tenoxicam Electrode	217
8.6.10	Naproxen Electrodes	217
8.6.11	Indomethacin Electrodes	217
8.6.12	Sulindac Electrode	218
8.6.13	Diclofenac Electrodes	218
8.7	Conclusion	218
	References	222
<b>9</b>	<b>Synthesis and Preservation of Polymer Nanoparticles for Pharmaceutical Applications</b>	<b>229</b>
	<b>Antonello A. Barresi, Marco Vanni, Davide Fissore and Tereza Zelenková</b>	
9.1	Introduction: Polymer Nanoparticles Production	229
9.2	Production of Polymer Nanoparticles by Solvent Displacement Using Intensive Mixers	238
9.2.1	Influence of Polymer-Solvent Type and Hydrodynamics on Particle Size	243

9.2.2	Dependence on Operating Conditions – Polymer and Drug Concentration, Solvent/Antisolvent Ratio, Processing Conditions	248
9.2.3	Process Design: Selection of Mixing Device, Scale Up and Process Transfer	256
9.3	Freeze-Drying of Nanoparticles	264
9.4	Conclusions and Perspectives	268
	Acknowledgements	272
	References	272
<b>10</b>	<b>Pharmaceutical Applications of Maleic Anhydride/Acid Copolymers</b>	<b>281</b>
	<i>Irina Popescu</i>	
10.1	Introduction	281
10.2	Maleic Copolymers as Macromolecular Drugs	283
10.3	Maleic Copolymer Conjugates	285
10.3.1	Polymer-Protein Conjugates	286
10.3.2	Polymer-Drug Conjugates	288
10.4	Noncovalent Drug Delivery Systems	291
10.4.1	Enteric Coatings	291
10.4.2	Solid Dispersions	292
10.4.3	Polymeric Films and Hydrogels	293
10.4.4	Microspheres and Microcapsules	294
10.4.5	Nanoparticles	295
10.4.6	Micelles	295
10.5	Conclusion	296
	References	296
<b>11</b>	<b>Stimuli-Sensitive Polymeric Nanomedicines for Cancer Imaging and Therapy</b>	<b>311</b>
	<i>F. Perche, S. Biswas and V. P. Torchilin</i>	
11.1	Introduction	311
11.2	Pathophysiological and Physical Triggers	314
11.2.1	Acidosis	314
11.2.1.1	pH-Sensitive Tumor Imaging	314
11.2.1.2	pH-Sensitive Prodrugs	315
11.2.1.3	pH-Dependent Change of Structure/Size or Shape	315
11.2.1.4	pH-Induced Exposure of an Internalization Moiety	315
11.2.1.5	pH-Sensitive Coordination Bonds	317
11.2.1.6	pH-Sensitive Dendrimer Nanoparticles	317
11.2.1.7	Drug Conjugated to Dendrimer via pH-Sensitive Linkages	318
11.2.2	Reductive Stress	319
11.2.2.1	Reduction-Sensitive Prodrug	319
11.2.2.2	Reduction-Induced Exposure of an Internalizing Moiety	320
11.2.2.3	Reduction-Sensitive Crosslinking	320
11.2.3	Tumor Hypoxia	320
11.2.3.1	Hypoxia-Induced Drug Release or Exposure of Positive Charge	321

11.2.4	Cancer Associated Extracellular Enzymes	322
11.2.4.1	Activatable Cell Penetrating Peptides for Tumor Imaging	322
11.2.4.2	MMP-Induced Exposure of Internalization Moiety	322
11.2.4.3	MMP-Induced Exposure of Positive Charge	323
11.2.4.4	Combination Therapy	324
11.2.4.5	Enzyme-Sensitive Dendrimers	324
11.2.5	Magneto-Responsive Polymers	324
11.2.6	Temperature-Sensitive Dendrimers	325
11.2.7	Photoresponsive Polymers	326
11.2.7.1	Photodynamic Therapy	326
11.2.7.2	Photosensitive Dendrimers	327
11.2.7.3	Photoimmunotherapy	327
11.3	Stimuli-Responsive Polymers for Patient Selection and Treatment Monitoring	327
11.3.1	Selection of Patients Amenable to Nanomedicine Treatment	328
11.3.2	Selection of Patients for pH-Sensitive Nanocarriers	329
11.3.3	Selection of Patients for Redox-Sensitive Nanocarriers	329
11.3.4	Mapping of Dominant Active Pathways Using Enzyme-Sensitive Probes	330
11.3.5	Selection of Patients for Molecularly-Targeted Therapies	330
11.3.6	Evaluation of Response to Treatment	331
11.4	Conclusions and Future Perspectives	331
	Acknowledgments	333
	References	333
<b>12</b>	<b>Artificial Intelligence Techniques Used for Modeling of Processes Involving Polymers for Pharmaceutical Applications</b>	<b>345</b>
	<i>Silvia Curteanu</i>	
12.1	Introduction	345
12.2	Artificial Neural Networks	347
12.2.1	Elements and Structure	347
12.2.2	Working Methodology	349
12.2.3	Variants of ANN Modeling	350
12.3	Support Vector Machines	352
12.3.1	General Aspects	352
12.3.2	SVM Modeling Methodology	353
12.4	Modeling of Processes Involving Polymers for Pharmaceutical Applications	354
12.4.1	Neural Networks Used for Modeling of Processes Involving Pharmaceutical Polymers	354
12.4.2	Support Vector Machines Used for Modeling of Processes Involving Pharmaceutical Polymers	359
12.5	Conclusion and Future Perspective	360
	References	361

<b>13</b>	<b>Review of Current Pharmaceutical Applications of Polysiloxanes (Silicones)</b>	<b>363</b>
	<i>Krystyna Mojsiewicz-Pieńkowska</i>	
13.1	Introduction	363
13.2	Variety of Polysiloxane – Structure, Synthesis, Properties	364
13.2.1	Basic Silicone Chemistry	364
13.2.2	Properties of Silicones	364
13.3	Polysiloxanes as Active Pharmaceutical Ingredient (API)	368
13.3.1	Mechanism of Action of Dimethicone and Simethicone	370
13.3.2	Current Legislative Standards Related to Oral Application of Dimethicone and Simethicone (PDMS)	370
13.3.3	Admissible Doses for Dimethicone and Simethicone (PDMS)	372
13.4	Polysiloxanes as Excipients	373
13.4.1	Skin Adhesive Patches	375
13.4.2	Carrier for Controlled-Release Drugs	375
13.4.2.1	Transdermal Drug Delivery System	377
13.5	Conclusion and Future Perspective	377
	References	378
<b>14</b>	<b>Polymer-Doped Nano-Optical Sensors for Pharmaceutical Analysis</b>	<b>383</b>
	<i>M. S. Attia and M. S. A. Abdel-Mottaleb</i>	
14.1	Introduction	383
14.1.1	Sol-Gel Process	383
14.1.1.1	Mechanism of Sol-Gel Formation	384
14.1.1.2	Hybrid Nanomaterials	385
14.1.2	Molecular Imprinting Nanomaterial Polymer	386
14.1.2.1	Approach of Molecular Imprinted Polymer Formation	387
14.1.3	Poly(methyl methacrylate) Polymer (PMMA)	390
14.2	Processing	392
14.2.1	Sol-Gel Technique	392
14.2.1.1	Preparation of Optical Sensor Doped in TEOS	392
14.2.1.2	Preparation of Thin Film Nano-Optical Sensor Doped in Sol-Gel Matrix	393
14.2.2	Molecular Imprinted Nanomaterials	394
14.2.2.1	Imprinted Nanoparticles (Imp-NPs)	394
14.2.2.2	Imprinted Nanospheres	394
14.2.2.3	Imprinted Nanoshells	395
14.2.2.4	Imprinted Nanofibers	396
14.2.3	Preparation of Optical Sensor Doped in PMMA Matrix	396
14.2.4	Determination of Pharmaceutical Drug in Pharmaceutical Preparations	396
14.2.5	Determination of Pharmaceutical Drug in Serum Solution	397
14.3	Application of Optical Sensor for Pharmaceutical Drug Determination	397
14.3.1	TEOS-Doped Nano-Optical Sensor for Pharmaceutical Determinations	397
14.3.1.1	Determination of Ramipril by Using Sm <sup>3+</sup> -Doxycycline Doped in TEOS matrix	397

14.3.1.2	Determination of Metoclopramide Hydrochloride by Using Europium Doped in TEOS Matrix	398
14.3.1.3	Nano-Optical Sensor for Chlorzoxazone and Ibuprofen Determination	399
14.3.1.4	Nano-Optical Sensor for Norfloxacin and Gatifloxacin Determination	399
14.3.2	Molecular Imprinted Nano-Polymer	401
14.3.2.1	Hollow Molecular Imprinting Polymer for Ofloxacin Determination	401
14.3.2.2	Molecular Imprinted Solid-Phase Extraction for Determination of Ofloxacin (OFL) and Lomefloxacin	401
14.3.2.3	Ofloxacin-Imprinted Polymer Using Poly(glycidyl methacrylate-co-ethylenedimethacrylate) Particles as a Support	402
14.3.2.4	Molecular Imprinted Polymer Nanoparticles for Ofloxacin Determination	402
14.3.2.5	Molecular Imprinted Polymer for Ciprofloxacin Determination	403
14.3.2.6	Molecular Imprinted Polymeric Membrane on a Porous Silica-Gel for Norfloxacin Determination	403
14.3.2.7	Electrochemical Sensor Combined with Molecular Imprinted Polymer for Paracetamol Determination	403
14.3.3	Sensor Embedded in Polymethymethacrylate	404
14.3.3.1	Metoclopramide Hydrochloride Determination by Using an Optical Sensor Tb <sup>3+</sup> Embedded in PMMA	404
14.3.3.2	Hydrochlorothiazide Determination by Using an Optical Sensor Eu <sup>3+</sup> Embedded in PMMA	404
14.4	Conclusion	405
	References	405
<b>15</b>	<b>Polymer-Based Augmentation of Immunosuppressive Formulations: Application of Polymer Technology in Transplant Medicine</b>	<b>411</b>
	<i>Ian C. Doyle and Ashim Malhotra</i>	
15.1	Introduction	411
15.2	Polymer-Based Immunosuppressive Formulations	414
15.2.1	Sirolimus	414
15.2.1.1	Oral and Injectable Formulations	414
15.2.1.2	Device Slow-Release Formulations	415
15.2.2	Cyclosporine A	424
15.2.2.1	CsA Delivery via Polymeric Micelles	425
15.2.2.2	CsA Delivery via Nanoparticles	426
15.2.2.3	CsA Delivery via Biodegradable Matrices	428
15.2.2.4	Ophthalmic CsA Delivery Systems	429
15.2.3	Tacrolimus	429
15.2.3.1	Polymer Applications for Oral Tacrolimus Formulations	430
15.2.3.2	Other Polymer Applications for Tacrolimus	431

15.2.4	Mycophenolic Acid	431
15.3	Conclusion and Future Perspective	433
	References	434
<b>16</b>	<b>Polymeric Materials in Ocular Drug Delivery Systems</b>	<b>439</b>
	<i>M. E. Pina, P. Coimbra, P. Ferreira, P. Alves, A. I. Figueiredo and M. H. Gil</i>	
16.1	Introduction	439
16.2	A Brief Description of Ocular Anatomy and Physiology	440
16.2.1	Anatomy of the Human Eye	440
16.2.2	Routes of Ocular Drug Delivery	441
16.2.3	Barriers in Ocular Drug Delivery	444
16.2.3.1	Lacrimation, Drainage and Blood Vessels	444
16.2.3.2	Corneal–Aqueous Barrier	444
16.3	Polymeric Ocular Drug Delivery Systems	445
16.3.1	Non-Biodegradable Polymeric Ocular Drug Delivery Systems	446
16.3.1.1	Non-Biodegradable Synthetic Polymers	446
16.3.2	Biodegradable Polymeric Ocular Drug Delivery Systems	449
16.3.2.1	Biodegradable Synthetic Polymers	450
16.4	Conclusion and Future Perspective	455
	References	455
<b>Index</b>		<b>459</b>

## Preface

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The modern pharmaceutical market is under relentless pressure from slowing new drug product approvals, blockbuster drug patent expiry, price pressure and global competition. In addition, new opportunities exist due to an evolving patient population, numerous unmet medical needs and growing disease awareness. In order to sustain performance, the pharmaceutical industry must evolve and improve product development and processing efficiencies. Therefore, efficient and cost-effective product development and processing are continually being explored to meet the challenge of not only reducing cost, but also the risk of product recalls. In the last few decades, much importance has been given to the use of polymers in pharmaceutical systems. Huge opportunities in the design, synthesis and modification of the physical and chemical properties of polymers have made them the most rapidly growing group of materials with great importance and possible applications in pharmacy, medicine and cosmetology. Polymeric materials having biomedical applications can be classified into different groups depending upon the application. For example, they are generally divided into two major groups according to use: those employed in prosthetic devices such as cardiovascular and orthopedic prostheses; and those employed as therapeutic systems such as drug carriers. Among the prosthetic systems, polymeric materials can be used as coatings or as cemented prostheses. Some of the major advantages in using polymeric materials for biomedical applications are their flexibility, biocompatibility, the possibility of tailoring their mechanical properties and their ability to incorporate therapeutic agents into their matrix in order to allow drug administration at a specific site.

Both natural and man-made polymers have been widely utilized as tablet binders and filler-binders in the pharmaceutical industry. The physico-chemical and mechanical properties such as particle size, shape and deformation behavior of polymeric binders are key to their effective use. Polymeric membranes are also becoming increasingly important in the field of separation processes in the pharmaceutical industry and artificial organs. Some polymers are obtained from natural sources (natural polymer) and then chemically modified for various applications, while others are chemically synthesized (synthetic polymer). Polymeric membranes can be fabricated in different configurations, such as flat sheet, tubular hollow fibers, nanofibers, etc., via different techniques. Since the performance of the membrane is largely controlled by its surface (active layer), the design of membrane surface and its characterization, either by chemistry or morphology, are extremely important. Hence, emphasis is being placed on the membrane surface. Hot-melt extrusion (HME) technique is used to create a dispersion of the active pharmaceutical ingredient (API) in a polymer matrix in order to achieve solubility enhancement, release rate modulation, mask taste, or to develop a new dosage form. However, polymers must fulfill a number of requirements in order to be suitable for HME processing. The relatively recent introduction of



HME in the pharmaceutical industry has opened new areas of applications for old and newly synthesized polymers, and enabled drug manufacturers to scale up the production of solid dispersions. A variety of chemically diverse polymers with different physico-chemical properties are available, which enable formulators to fine-tune the solid form of the extruded product by the selection of suitable polymer, drug-polymer ratio and operating conditions. Scientists in collaboration with pharmaceutical industries are extensively developing new classes of pharmaceutical materials. This second volume of *Handbook of Polymers for Pharmaceutical Technologies* is primarily focused on the pharmaceutical polymers and deals with the processing and applications of these polymers. Numerous critical issues and suggestions for future work are comprehensively discussed in this book with the hope that it will provide a deep insight into the state-of-art of pharmaceutical polymers. The prime topics extensively described in this book include: particle engineering of polymers into multifunctional interactive excipients; the art of making polymeric membranes; pharmaceutical applications of polymeric membranes; development of microstructuring technologies of polycarbonate for establishing advanced cell cultivation systems; *in-situ* gelling thermosensitive hydrogels for protein delivery applications; polymers as formulation excipients for the hot-melt extrusion processing of pharmaceuticals; poly lactic-co-glycolic acid (PLGA) copolymer and its pharmaceutical application; application of PVC in construction of ion-selective electrodes for pharmaceutical analysis; a review of polymer electrodes for nonsteroidal, anti-inflammatory drugs; synthesis and preservation of polymer nanoparticles for pharmaceutical applications; pharmaceutical applications of maleic anhydride/acid copolymers; stimuli-sensitive polymeric nanomedicines for cancer imaging and therapy; artificial intelligence techniques used for modeling of processes involving polymers for pharmaceutical applications; a review of current pharmaceutical applications of polysiloxanes (silicones); polymer-doped nano-optical sensors for pharmaceutical analysis; and finally, polymer-based augmentation of immunosuppressive formulations – application of polymer technology in transplant medicine.

Several critical issues and suggestions for future work are comprehensively discussed in this book with the hope that it will provide a deep insight into the state-of-art of processing and applications of pharmaceutical polymers. We would like to thank the publisher and Martin Scrivener for their invaluable help in the organization of the editing process. Finally, we would like to thank our parents for their continuous encouragement and support.

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