Contents

Chapter 1  Soft Matter Nanotechnologies

1.1 Nanotechnology and Nanomaterials 1
1.2 Nanotechnology Routes from Inorganic to Organic Materials 7
  1.2.1 Lithographies 9
1.3 One-dimensional Structures and Nanostructures 13
1.4 Introduction to Polymer Physics and Engineering 15
  1.4.1 Glass Transition Phenomenology 17
  1.4.2 Rheology and Flow Behavior 26
    1.4.2.1 Linear Viscoelastic Response and Material Functions 27
    1.4.2.2 Modeling Linear Viscoelasticity. The Maxwell Model 35
  1.4.3 Polymer Solutions 39
References 43

Chapter 2  Electrospinning

2.1 Electrostatic Spinning 50
  2.1.1 Droplet Formation 51
  2.1.2 Jet Formation 54
  2.1.3 Jet Instabilities 57
  2.1.4 Solvent Evaporation 62
  2.1.5 Molecular Orientation 65
2.2 Process Parameters 68
2.3 Process Engineering 71
  2.3.1 Coaxial Architectures 78
## Chapter 3 Other Fabrication Technologies for Polymer Nanofibers

3.1 Self-assembly and Polymerization Methods 132  
3.1.1 Self-assembly from Marginal Solvents 133  
3.1.2 Casting Methods 137  
3.1.3 Other Self-assembly Examples 139  
3.1.4 Polymerization Methods 142  
3.2 Nanofluidics 144  
3.3 Template Synthesis 148  
3.3.1 Hard Templates 149  
3.3.2 Soft Templates 157  
3.4 Interfacial Polymerization 168  
3.5 Direct Writing Methods 172  
3.6 Phase Separation 174  
References 176

## Chapter 4 Structural and Surface Properties of Polymer Nanofibers and Their Applications

4.1 Structural and Mechanical Properties 189  
4.1.1 Carbon Nanofibers 195  
4.2 Porosity and Wettability Properties 197  
4.2.1 Porosity 197  
4.2.1.1 Porosity of Nanofibers Assemblies 197  
4.2.1.2 Internal Porosity of Single Nanofibers 201  
4.2.1.3 Surface Porosity of Single Nanofibers 201  
4.2.2 Wettability 202  
4.3 Applications 209  
4.3.1 Filtration, Catalysis and Energy Storage 209  
4.3.2 Micro- and Nanofluidics, Thermal Management and Sensing 218
Chapter 5  Optical Properties of Polymer Nanofibers and Their Applications

5.1 Organic Light-emitting Materials 236
  5.1.1 Excitations and Electronic Transitions 237
  5.1.2 Energy Transfer Mechanisms 241
  5.1.3 Stimulated Emission and Lasing from Organics 247
5.2 Light-emitting Nanofibers 249
  5.2.1 Molecular Aggregation and Orientation in Light-emitting Polymer Nanofibers 251
  5.2.2 Polarization Properties 254
  5.2.3 Light-emission Tunability 256
  5.2.4 Other Properties of Light in and from Nanofibers 262
5.3 Polymer Nanofiber-based Optoelectronics 266
  5.3.1 Organic Light-emitting Devices 266
  5.3.2 Photo-detectors and Solar Cells 270
5.4 Waveguiding 274
5.5 Lasing 279
5.6 Nanopatterned Nanofibers 282
References 286

Chapter 6  Electrical Properties and Their Applications

6.1 Transport Phenomena in Organic Semiconductors 295
  6.1.1 Supramolecular Organization and Electrical Conduction in Polymers 297
6.2 Nanofibers by Conductive Polymers 300
6.3 Applications in Nanoelectronics 310
  6.3.1 Polymer Nanofiber Field-effect Transistors 318
    6.3.1.1 P-type Devices 319
    6.3.1.2 N-type Devices 323
    6.3.1.3 Photo-transistors and Other Devices 323
6.4 Piezoelectricity and Thermo-electricity in Polymer Nanofibers 324
  6.4.1 Piezoelectric Properties 324
  6.4.2 Thermo-electric Properties 337
References 338