

Spis treści

Part III Materials	381
10 Liquid Crystalline Polymers	383
<i>Beata Mossety-Leszczak and Maciej Kisiel</i>	
10.1 Introduction	383
10.2 Liquid Crystalline Polymers of Great Commercial Value	384
10.3 Rigid and Elastic Liquid Crystalline Polymer Networks	385
10.4 Liquid Crystalline Epoxy Resin	386
References	400
11 Polymer Nanocomposites and Hybrid Materials	409
<i>Subrata Mondal</i>	
11.1 Introduction	409
11.2 A Brief Overview of Polymer Nanocomposites and Hybrid Materials	411
11.3 Various Synthesis Routes of Hybrid Polymer Nanocomposites	414
11.3.1 Ex Situ Method of Hybrid Polymer Nanocomposite Preparation Method	414
11.3.2 In Situ Method of Hybrid Polymer Nanocomposite Synthesis	416
11.4 Thermal Properties of Hybrid Polymer Nanocomposites	416
11.4.1 Glass Transition Temperature of Hybrid Polymer Nanocomposites	417
11.4.2 Melting Point Temperature of Hybrid Polymer Nanocomposites	419
11.4.3 Thermal Stability of Hybrid Polymer Nanocomposites	420
11.5 Applications of Thermal-Resistant Hybrid Polymer Nanocomposites	421
11.6 Conclusions	421
References	422
12 Biocomposites and Biomaterials	429
<i>Aleksandra Lach, Piotr Szatkowski, and Kinga Pielichowska</i>	
List of Abbreviations	429
12.1 Introduction	430
12.2 The Application of Thermal Analysis Methods for Evaluation of Polymeric Biomaterials Properties	431
12.2.1 Thermogravimetry (TG) for Investigation of Polymeric Biomaterials	431
12.2.2 Hydrogels	432
12.2.3 Non-porous Polymeric-Based Structures	433
12.2.4 Drug-Delivery Systems	434
12.2.5 The Influence of Sterilization Process on Polymer-Based Biomaterials	436

12.3 Differential Scanning Calorimetry (DSC), Temperature-Modulated DSC (TMDSC), and Fast Scanning Calorimetry (FSC)	436
12.3.1 Phase-Change Materials (PCMs) as Thermal Energy Storage Systems in Injectable Bone Cements	438
12.3.2 The Influence of Sterilization on Biomaterials Properties	440
12.3.3 Hydrogels	441
12.4 Dynamic Mechanical Analysis (DMA)	443
12.4.1 Porous and Non-porous Polymeric Structures	445
12.4.2 Fibers and Surgical Sutures	448
12.4.3 Film and Layer-Like Implants - Skin Grafts, Proteins	449
12.4.4 Hydrogel-Based Materials	450
12.5 Application of Thermal Analysis to Study the Properties of Biomaterials According to ISO and ASTM Standards	451
Acknowledgments	451
References	451

13 Thermal Analysis Methods in Characterization of Polymer Additives **457**

Anna Kosmalska and Anna Masek

13.1 Polymer Additives: Anti-aging Stabilizers	457
13.2 Polymer Additives: Plasticizers	463
13.3 Polymer Additives: Flame Retardants	465
13.4 Other Polymer Additives	471
13.5 Conclusions	476
References	477

Part IV Application **485**

14 Thermal Analysis in Polymer Recycling **487**

Dimitris S. Achilias

14.1 Introduction	487
14.2 Plastics Recycling	488
14.2.1 General Recycling Routes in Plastic Wastes	488
14.3 Thermal Analysis Techniques	490
14.4 Thermal Analysis in Mechanical/Physical Recycling of Polymers	491
14.5 Thermal Analysis in Chemical Recycling of Polymers	496
14.6 Quality Control of Recycled Plastics with Thermal Analysis	502
14.7 Conclusions	505
Acknowledgments	506
References	506

15 Application of Thermal Analysis Methods for Lifetime Prediction **509**

Ignazio Blanco

15.1 Introduction	509
15.2 The Pioneers of Lifetime Prediction	510
15.3 Lifetime Prediction via Thermogravimetric Analysis	513
15.4 Lifetime Predictions Based on Long-Term Experiments	521

15.5 Lifetime Prediction via Differential Scanning Calorimetry	525
15.6 Conclusion	527
References	528

16 Thermal Analysis in Energy 533

Kinga Pielichowska and Krzysztof Pielichowski

16.1 Introduction	533
16.2 Thermal Analysis in Photovoltaic and Solar Cells	534
16.3 Polymer Electrolytes and Batteries	538
16.3.1 Thermal Energy Storage	541
16.3.2 Energy Recovery from Polymer Wastes	548
16.4 Biofuels Production and Characterization	550
16.5 Conclusions	553
Acknowledgments	554
References	554

17 Thermal Analysis of Pharmaceutical Glasses Stabilized by Polymers 561

Kohsaku Kawakami

17.1 Introduction	561
17.2 Fundamental Properties of Polymers Used for Stabilizing Pharmaceutical Glasses	562
17.3 Manufacturing of ASDs	567
17.4 Miscibility Analysis of Drugs and Polymers Using DSC	569
17.5 Comparison with Solid-state NMR in Terms of Evaluation of Mixing State	574
17.6 Physical Stabilization of Pharmaceutical Glasses	576
17.7 Summary	580
References	580

18 Thermal Analysis in Aerospace and Automotive Sectors 583

Peter Kusch and Johannes Steinhaus

18.1 Introduction	583
18.2 Composite Materials in Aerospace and Automotive Sectors	583
18.3 Thermal Analysis of Polymers and Rubbers	585
18.3.1 Thermophysical Analysis of Polymers by Differential Scanning Calorimetry (DSC)	586
18.3.1.1 DSC Analysis of a PA6GF30 Automotive Lever Containing Polystyrene (PS)	588
18.3.2 Thermomechanical Analysis of Polymers by Dynamic Mechanic Analysis (DMA)	590
18.3.2.1 DMA of a Differently Annealed GFRP Aircraft Engine Part	592
18.3.3 Thermo-Analytical Methods Combined with Mass Spectrometry or Infrared Spectroscopy	593
18.3.3.1 Pyrolysis- Gas Chromatography/Mass Spectrometry (Py-GC/MS)	594
18.3.3.2 Pyrolysis-Mass Spectrometry (Py-MS)	606
18.3.3.3 Thermal Desorption - Gas Chromatography Mass Spectrometry	

(TD-GC/MS)	608
18.3.3.4 Headspace Solid-Phase Microextraction-Gas Chromatography /Mass Spectrometry (HS SPME-GC/MS)	610
18.3.3.5 Thermogravimetric Analysis Coupled to Mass Spectrometry (TGA-MS), to Gas Chromatography/Mass Spectrometry (TGA-GC/MS) or to the Fourier-Transform Infrared Spectroscopy (TGA-FTIR)	613
18.4 Conclusions	616
Acknowledgments	617
References	617
 19 Thermo-Analytical Techniques and Characterizations for Textile Fibers	 623
<i>Santanu Basak and Animesh Laha</i>	
19.1 Introduction	623
19.1.1 Limiting Oxygen Index (LOI)	624
19.1.2 Vertical and Horizontal Flammability Test	625
19.1.3 45° Flammability Test of Textile	626
19.1.4 UL94 Test for Synthetic Textile	626
19.2 Thermal Characterization Instruments	627
19.2.1 Thermo-Gravimetry(TG) Analysis	627
19.2.2 DSC Analysis	628
19.2.3 Cone Calorimeter Test	628
19.2.4 TG-FTIR-Integrated Thermal Analysis	629
19.2.5 Thermal Gravimetric Mass Spectroscopy (TG-MS)	630
19.2.6 Thermo-Mechanical Analysis (TMA)	631
19.2.7 Dynamic Mechanical Analysis (DMA)	632
19.2.8 Heat Conduction and Radiation Test of Textiles	633
19.3 Conclusion	633
References	634
 Index	 637