

Contents

Preface	V
Acknowledgements	VII
1 The Science of Testing	1
1.1 Why Test?	1
1.2 Meeting the Standard – American Society for Testing and Materials International (ASTM)	1
2 Understanding Polymers and Their Behavior	5
2.1 Basic Polymer Science	5
2.2 Polymer Chemistry	6
2.3 Molecular Weight and Molecular Weight Distribution	8
2.4 Polymer Architecture or Morphology	9
2.5 Polymer Rheology	12
2.5.1 Deformation, Stress, and Strain	12
3 Mechanical Properties	17
3.1 Mechanical Testing in the Solid State	17
3.2 The Tensile Test (ASTM D638, ISO 527)	19
3.3 Flexural Testing (ASTM D790, ISO 178)	21
3.4 Dynamic Mechanical Testing (ASTM D5279)	23
3.5 Impact Testing	27
3.5.1 Falling Dart Impact ASTM D5420 (No ISO Method)	27
3.5.2 Instrumented Impact Testing ASTM D3763 (ISO 6603.2)	29
3.5.3 Izod – Charpy Impact (ASTM D256, D4812, ISO 179)	31
3.6 Compression Tests – ASTM D695 (ISO 604)	32
3.7 Solid State Creep Test – ASTM D2990 (ISO 899)	34

4 Thermal Testing	37
4.1 Introduction	37
4.2 Heat Deflection Test (ASTM D648, ISO 75)	38
4.3 Vicat Softening (ASTM D1525, ISO 306)	39
4.4 Differential Scanning Calorimetry, DSC (ASTM D3417, D3418)	40
4.5 Thermogravimetric Analysis (TGA)	40
4.6 Thermomechanical Analysis (TMA)	42
4.7 Thermal Conductivity, K-Factor (ASTM C177)	42
4.8 Thermal Expansion (ASTM D696, ISO 3167)	43
4.9 Orientation, Shrinkage (ASTM D2732, ISO 11501, D2838)	44
4.10 Free Standing Orientation Test (ASTM D1204)	44
5 Viscous Flow Properties	45
5.1 Introduction	45
5.2 Melt Index Test (ASTM D1238, ISO 1133)	48
5.3 Capillary Rheometry (ASTM D3595)	49
5.4 Rotational Rheometry (ASTM D4440)	52
5.4.1 Cone and Plate	55
5.4.2 Parallel Plates	56
5.4.3 Concentric Cylinder – Couettes	57
5.5 Solution Rheometry (ASTM 2857, ISO 1628)	58
5.6 Creep Test for Molten Polymers	59
6 Quality in the Testing Laboratory	61
6.1 What is Quality?	61
6.2 Quality Management	62
6.3 Cultural Diversity and Quality	63
6.4 Accuracy, Precision, and Bias	66
6.5 Review of Basic Statistics	67
6.6 Reasons for Data Variability	69
6.7 Statistical Process Control (SPC)	69
6.8 Quality Accreditation and Sanctioning Organizations	72
6.8.1 American Association of Laboratory Accreditation (A2LA)	72
6.8.1.1 Conditions for Accreditation	73
6.8.1.2 A2LA Accreditation Process	74
6.8.2 International Standards Organization Sanctioning (ISO/IEC 17025)	74

Reference Materials	77
Appendix 1	79
Appendix 2	81
Appendix 3	83
Appendix 4	85
Index	87