CONTENTS

	From the preface to the first edition (1972)	vii
	From the preface to the second edition (1976)	ix
	Preface to the third edition (1990)	xi
	Introduction of the present author	xiii
	Preface to the fourth edition (2008)	XV
	Acknowledgements	xix
a	rt I. General introduction: A bird's-eye view of polymer science and engineering	
Ch	apter 1 Polymer properties	3
	1.1 Approach and objective	3
	Bibliography	5
Ch	apter 2 Typology of polymers	7
	2.1 Introduction	7
	2.2 Polymer structure	8
	2.3 Molar mass and molar mass distribution	17
	2.4 Phase transitions in polymers	25
	2.5 Morphology of solid polymers	29
	2.6 Polymeric liquid crystals	34
	2.7 Multiple component polymer systems	36
	2.8 Relaxation phenomena	38
	Appendix I. Milestones in the history of polymer science	40
	Appendix II. Chronological development of commercial polymers	44
	Bibliography	45
h	apter 3 Typology of properties	49
	3.1 The concept "polymer properties"	49
	3.2 Physical quantities and their units	52
	3.3 Categories of physical quantities	54
	3.4 Dimensionless groups of quantities	55
	3.5 Types of molar properties	57
	3.6 Additive molar functions	60
	Bibliography	66
ar	rt II. Thermophysical properties of polymers	
h	apter 4 Volumetric properties	71
	4.1 Introduction: mass and packing of matter	71
	4.2 Fundamental quantities of mass and volume	72
	4.3 Standard molar volumes at room temperature (298 K)	76

4.4 Thermal expansion	89
4.5 Isothermal compression: Equations of state	101
Bibliography	107
Chapter 5 Calorimetric properties	109
5.1 Heat capacity	109
5.2 Latent heat of crystallization and fusion (melting)	118
5.3 Enthalpy and entropy	123
Bibliography	127
Chapter 6 Transition temperatures	129
6.1 Introduction	129
6.2 The glass transition temperature	130
6.3 The crystalline melting point	152
6.4 Relationship between glass transition temperature and melting point of polymers	167
6.5 Relationship between $T_{\rm g}$, $T_{\rm m}$ and other transition temperatures	170
6.6 Transitions in thermotropic liquid crystal polymers	172
Appendix I. Rules of thumb for substituting an H-atom by a group X	182
Appendix II. Similarities and differences between \mathbf{Y}_{g} and \mathbf{Y}_{m}	183
Bibliography	187
Chapter 7 Cohesive properties and solubility	189
7.1 Introduction	189
7.2 Cohesive energy	190
7.3 Solubility	201
7.4 Internal pressure	222
Bibliography	225
Chapter 8 Interfacial energy properties	229
8.1 Introduction	229
8.2 Surface energy of liquids and melts	230
8.3 Surface energy of solid polymers	234
8.4 General expression for the interfacial tension	239
8.5 Polymer adhesion	242
Bibliography	244
Chapter 9 Limiting viscosity number (intrinsic viscosity)	245
and related properties of very dilute solutions	
9.1 Introduction	245 246
9.2 Molecular dimensions of the conformational state	246
9.3 The limiting viscosity number (intrinsic viscosity)	280
9.4 Interrelationships of "limiting" diffusive transport quantities	283
Bibliography	203

15.5 Extensional viscosity of polymer melts	564
15.6 Elastic effects in polymer melts	573
15.7 Rheological properties of thermotropic liquid crystalline polymers	581
Appendix I. Flow of polymer melts through narrow tubes and capillaries	591
Appendix II. Analysis of flow in processing operations	592
Bibliography	595
Chapter 16 Rheological properties of polymer solutions	599
16.1 Introduction	599
16.2 Dilute polymer solutions	600
16.3 Concentrated polymer solutions	604
16.4 Viscoelastic properties of polymer solutions in simple shear flow	619
16.5 Extensional flow of polymer solutions	630
16.6 Solutions of lyotropic liquid crystalline polymers	634
Bibliography	643
Chapter 17 Transport of thermal energy	645
17.1 Thermal conductivity	645
17.2 Appendix	651
Bibliography	652
Chapter 18 Properties determining mass transfer in polymeric systems	655
18.1 Introduction	655
18.2 Permeation of simple gases	656
18.3 Permeations of a more complex nature	681
18.4 Dissolution of polymers as a case of permeation	696
Bibliography	701
Chapter 19 Crystallisation and recrystallisation	703
19.1 Crystallinity, nucleation and growth	703
19.2 Spherulitic crystallisation of polymers from the melt	706
19.3 Induced crystallisation of flexible polymeric molecules by pressure and stress	726
19.4 Crystallisation phenomena in uniaxial drawing: fibre spinning	728
Bibliography	743
Part V. Properties determining the chemical stability and breakdown of polymers	
Chapter 20 Thermochemical properties	749
20.1 Thermodynamics and kinetics	749
20.2 Calculation of the free enthalpy of reaction from group contributions	752
20.3 Thermodynamics of free radicals	758
Bibliography	761

	Contents	XXV
Chapter 21 Thermal decomposition		763
21.1 Introduction		70.
21.2 Thermal degradation		763
21.3 Char formation		763
21.4 Kinetics of thermal degradation		772
Bibliography		776
		776
Chapter 22 Chemical degradation		779
22.1 Introduction		779
22.2 Degradation under the influence of light		779
22.3 Oxidative degradation		787
22.4 Photo-oxidation		781
22.5 Thermal oxidation		783
22.6 Effects of oxidation degradation 22.7 Stabilisation		783
		783
22.8 Hydrolytic degradation		785
22.9 Stress relaxation as a measure of chemical degradation Bibliography		785
		786
Part VI. Polymer properties as an integral concept Chapter 23 Intrinsic properties in retrospect		789
23.1 Introduction		789
23.2 Reference values of intrinsic properties expressed as a function of additive quantities		790
23.3 Effect of structural groups on properties		792
23.4 Dependence of intrinsic properties on process variables		792
23.5 Outlook		796
Chapter 24 Processing properties		799
24.1 Classification of processes		799
24.2 Some important processing properties		800
24.3 Implementation of processing research		816
Bibliography		817
Chapter 25 Product properties (I): Mechanical behaviour and failure		819
25.1 Introduction		819
25.2 Failure mechanisms in polymers		820
25.3 Deformation properties		824
25.4 Toughness and endurance		829
25.5 Hardness		836
25.6 Friction and wear		840
25.7 The mechanical shortcomings of homogeneous materials and the need for composites		841

Bibliography

Chapter 26 Product properties (II): Environmental behaviour and failure	
26.1 Introduction	847
26.2 Thermal end use properties	847
26.3 Flammability and combustion of polymers	850
26.4 Environmental decay of polymers	864
Bibliography	872
Chapter 27 An illustrative example of end use properties:	
Article properties of textile products	
27.1 Introduction	875
27.2 Aesthetic properties	875
27.3 Use or performance properties	877
27.4 Maintenance or care properties	882
27.5 Integral evaluation of fibre polymers, fibres and yarns by the criteria mentioned (profile method)	884
Bibliography	885
Part VII. Comprehensive tables	
I International system of units (SI)	889
II Survey of conversion factors	891
III Values of some fundamental constants	903
IV Physical constants of the most important solvents	904
V Physical properties of the most important polymers	920
VI Published data of "high performance" polymers	934
VII Code symbols for the most important polymers	938
VIII Trade names and generic names	941
IX Survey of group contributions in additive molar quantities	946
Indexation	
Symbol index	957
Author index	979
Subject index	989