

Index

a

- absorbed moisture 182
- accelerated testing 143–144
- acrylonitrile butadiene styrene (ABS) 10, 11, 55, 97
- amorphous polymer 4, 12, 13, 15–18, 27–29, 31, 32, 37, 146, 149, 157, 163, 167, 195, 213
- strength properties 29
- amorphous thermoplastics 4, 12, 18, 31, 95, 148
- application temperature range 166
- Arrhenius equations 26, 143
- atactic polymer 11, 22, 32
- attenuated total reflection (ATR) 60

b

- backscattering electrons (BE) 210
- ball hardness measurement 107
- ball indentation hardness 106–107, 111–113
- ball/pin indentation method 179
- bending creep modulus 125
- bending stress 102–104, 125, 169, 177
- bending strip method 175, 177, 178
- bending test
 - four-point bending 102
 - stress-strain curves 104
 - three-point bending test 101
- Berkovich pyramid 108
- Birefringence 212, 213
- brittle and ductile polymer 98
- brittle polymers 93, 103
- bulk deformation 30
- Buoyancy method 54, 56–57

c

- calcination tests
 - determine, filler content 164
 - solution viscosity measurements 165
 - test setup 166
- calcium hydride (CaH_2) 183
- calliper 187
- capillary viscometer 69–71, 77, 78, 81, 84
- CARREAU model 68
- cathodic sputtering process 211
- Charpy impact test 116–118
- chemical reaction equation 184
- chemical testing
 - chemical resistance investigation 173
- ESCR
 - bending strip method 177–179
 - polymeric material 175
 - tensile creep test 176–177
- colour pigmented PA66 resin 38
- Complex modulus 33, 76, 152–154, 156
- complex shear modulus 71, 76, 112
- complex stiffness 154, 155, 158
- compression test
 - permissible length, compression test 99
- compressive modulus 100, 101
- compressive strain 100, 101
- compressive strength 100, 101
- compressive yield stress 100, 101
- computer tomography (CT) 48

- computer tomography (CT) (*contd.*)
 non-destructive measuring and testing procedure 191
 principle 192
 cone-plate measuring arrangements 71, 72
 contactless measurement methods
 CT 191–194
 light stripe projection method 191
 non-probing measurements 190
 X-ray tomography devices 189–191
 coordinate measuring technique 190
 copolymeric polyoxymethylene (POM) 20, 95
 copolymers 9–11, 20, 30, 32, 33, 55
 Cox–Merz relationship 76
 crash tests 118
 creep modulus 24, 27, 123–125
 curves 124
 creep rupture tests 121, 123, 129, 176, 177
 creep strain 121–123, 125
 cross-linked networks 31, 40
 cross-linked polymer 3, 18, 31, 173
 crystalline lamellae 18, 21, 29, 44
 crystallite melting temperature 18
 crystallization
 exothermal process 19
 isothermal 20
 crystallization process 4, 20
- d**
 degree of polymerization 6, 7
 density, polymers
 floating (suspension) method 54–56
 gradient method 57
 measurement, Buoyancy method 56–57
 physical properties, PE 54
 polymeric material, physical property 54
 pycnometer method 57–58
 differential scanning calorimetry (DSC) 48, 53
 dynamic differential calorimeter 146
 dynamic heat flux differential calorimetry 145
 semi-crystalline polymer 151
 specific heat capacity 144, 145
 thermogram, crystallisable
 thermoplastic material 150
 thermogram, of amorphous polymer 149
 thermogram, of curable polymer 149
 thermogram, of semi-crystalline polymer 150
 digital microscope 201, 207–208
 dilatometry 48, 161–164
 dioctylphthalate (DOP) 33, 34
 dipole-dipole interactions 15
 DMA measurements 140, 142, 153, 155, 156, 182
 drop test 114, 118
 DSC measurement 144, 146–150, 181, 182
 ductile amorphous polymer 28, 29
 ductile-brittle transition 113, 142
 ductile polymers 90, 93, 97, 98, 103
 ductile prismatic polymeric material 90
 dumbbell specimen 90
 durometer hardness Shore A *vs.*
 complex shear modulus 112
 durometer/shore hardness 110–112
 dynamic differential calorimeter 146
 dynamic mechanical analysis (DMA) 48, 74, 139, 152–158, 182
 geometry factor, measurements 153
 measurement modes 156
 multi-frequency measurements 155
 temperature sweep 156
 viscoelastic properties 152
 dynamic-mechanical-thermal analysis (DMTA) 152
 dynamic stress loading conditions 129
- e**
 elastic deformation (Hookean behaviour) 75
 elastic properties 30–32, 47, 48, 70, 71, 74, 152, 154

- elastomers 1, 3, 5, 22, 31, 40–43, 45, 65, 88, 95, 96, 105, 110, 112, 142, 152, 163, 166, 167, 197, 204, 206
- electric discharge machining (EDM) 188
- electromagnetic lenses 209
- energy dispersive X-ray spectroscopy (EDX) 210, 211
- engineering stress 28, 29, 90
- engineering stress-strain behaviour 28
- entropy elasticity 8
- environmental stress cracking resistance (ESCR)
- ball/pin indentation method 179
 - bending strip method 177–179
 - indicator properties 178
 - material resistance 174
 - polymeric material 175
 - tensile creep test 176–177
 - test methods 175
- epoxy resin (EP) 95
- equilibrium moisture content 182
- ethylene 6
- exothermic crosslinking reaction 149
- extrinsic plasticization 33, 34
- extrusion moulding processes 13
- f**
- falling dart test 118–120
- fatigue tests of polymers 127
- flexural creep strain 125
- flexural fatigue tests 130–131
- floating (suspension) method 54–56
- float-sink test 56
- force or displacement-controlled mechanical load 152
- Fourier transformation IR spectroscopy (FT-IR spectroscopy) 59, 60
- friction coefficient 133, 135–136
- friction law 136
- friction wheel method 136
- g**
- geometrical inspection
- processing and post-processing
 - shrinkage 195–197
- sizes and tolerance
- contactless measurement methods 189–191
- measurement techniques 189
- tactile measurement methods 188–189
- warpage 197–198
- glass transition temperature 3, 4, 11, 12, 15–18, 27–32, 34, 142, 144, 146–150, 156–158, 161–163, 167, 173, 183, 206
- h**
- Hagenbach time correction 83, 85, 86
- Hagen–Poiseuille law 81
- harmonic stress loading 153
- heat deflection temperature (HDT) 142, 169–171
- heteronucleation 4
- high density polyethylene (PE-HD) 95
- high pressure capillary viscometry (HPCV) 48
- capillaries, of different geometries 80
 - determined flow function 82
 - measuring methods 80
- homonucleation 4
- homopolymer 6, 9–11, 33, 97, 168, 169
- hydrogen bonds 15
- hydrolysis-sensitive hygroscopic polymer 79
- hygroscopic plastics 86
- hygroscopic polymer 79, 182, 183, 187
- hysteresis, development of 36
- i**
- identification of polymers 53
- impact loading
- bending impact tests 115–120
 - impact strength values 113
 - tensile impact test 114–115
- indentation hardness tests 105, 109, 110
- indenter geometry 106
- infrared spectroscopy (IR) 47, 53
- ATR 60

- infrared spectroscopy (IR) (*contd.*)
 - FT-IR spectroscopy 59
 - MIR 58
 - optical spectroscopy process 58
 - injection molding process 4
 - injection moulded thermoplastic components 44
 - injection moulding processes 4, 9, 13, 44, 45
 - interlaminar shear strength
 - measurement (ILS) 101, 103
 - intermolecular bonds 12, 15, 17, 21, 28, 33
 - International Rubber Hardness Degree (IRHD) 112–113
 - intramolecular chemical bonds 15
 - intrinsic viscosity 84
 - IR-Spectra, thermoplastics 61
 - isochronous stress-strain curves 25, 123, 124
 - isochronous stress-strain diagram 123–125
 - isotactic polymers 11
 - isotactic polypropylene (iPP) 4
 - isothermal crystallization 19, 20
 - isotropic materials 105
 - Izod impact test 118
- k**
- Knoop hardness test 108–110
- l**
- Lambert law 59
 - Lamellar shear flow 14
 - light microscope (LM) 48, 199, 201–208
 - digital microscope 207–208
 - reflection light microscopy 201
 - sample preparations
 - grinding and polishing 204–205
 - microtome slices / thin sections 205–207
 - morphology, of moulded parts 203
 - transmission light microscopy 201
 - light stripe projection method 191
 - linear polyethylene (PE) 21
 - linear viscoelastic materials 67, 95
 - long term dynamic test–fatigue test
 - flexural fatigue tests 130–131
 - tension-compression test 130
 - viscoelastic materials 126
 - long term static loading
 - creep and relaxation, polymeric materials 120
 - creep test
 - creep modulus curves 124
 - setup 121
 - tensile creep strength 123
 - tensile test 121
 - relaxation test 125–126
 - loss modulus 16, 76, 77, 154
- m**
- macro molecular 10
 - properties 50
 - macromolecule 6
 - macroscopic morphology 44
 - manometric moisture determination 184
 - mass, determination of 181–182
 - master curve 157
 - measurement of melt flow rate 48, 77–80, 168
 - mechanical deformation behaviour 25, 87
 - mechanical fatigue 37
 - mechanical testing
 - impact loading 113–120
 - mechanical properties, sample 87
 - normal stresses 87
 - quasi-static loading
 - mechanical strength 88
 - stress-strain behaviour 88
 - tensile test 89
 - shear stresses 87
 - melt flow behaviour 65, 77–79, 82
 - melting polymers 12–15
 - melt mass flow rate (MFR) 77–80

- melt processing 6, 39, 42, 78, 114, 134, 147, 182
 melt volume flow rate (MVR) 48, 77–80
 metallocene catalysts 9, 11, 21
 micro-and nano-hardness measurements 105
 micro indentation hardness testing 109
 microtome 207
 microtomy 206
 mid-infrared (MIR) spectra 58
 migration induced shrinkage 196–197
 modulus of elasticity 95
 Mohs scale 105
 moisture content
 manometric determination of 183
 molar mass distribution 69
 molecular weight distribution (MWD) 8–10, 17, 47, 65, 68
 monomeric repeat units (MUs) 5
 morphology 44
 moulding compounds, test methods 54
 multi-frequency measurements 155
 multiphase polymer systems 11
- n**
 Newtonian flow behavior 67
 Newtonian fluids 14, 67, 74, 81
 nitrogen atmosphere (N_2) 158, 159
 non-crosslinked polymers 173
 non-uniform material properties 4
 nucleation 4, 151
- o**
 optical testing methods
 light microscope
 optical imaging 201
 reflection light microscopy 201
 transmission light microscopy 201
 microscopic testing 199
 visual inspection 199–201
 orthotropic behaviour 49, 165
 oscillating rheometer 75
 oxidation reactions 79
- p**
 phenolic resin (PF) 95, 183
 phosphorus pentoxide (P_2O_5) 183
 physical-mathematical model 122
 physical testing
 mass, determination of 181–182
 water absorption, determination of
 equilibrium moisture content 182
 manometric method 185
 volatile content 183
 plastic deformation 15, 16, 28, 29, 42, 118
 plasticization methods 32–34
 plasticized polyvinylchloride (PVC-P) 55, 95
 plastics
 material selection 39–40
 melting polymers
 flow properties 14
 polymeric materials 2
 polymers
 cross-linked polymer 3
 elastomers 1
 thermoplastic 1
 thermoplastic elastomers 1
 principle of polymerization 5
 resins
 colour pigmented PA66 resin 38
 composition of 38
 pure polymers 37
 structure and behaviour
 homopolymer 6
 homopolymer and copolymer 9–11
 polymer blends 11–12
 synthetic/semi-synthetic organic solid 1
 plate-plate measuring arrangements 72, 73
 Poisson's ratio 31, 88, 96, 97
 polarization optics 212–213

- polyacetal (POM) 20, 21, 39, 95
 - polyamide (PA) 38, 42, 71, 95, 160, 161, 168, 183
 - poly-butylene-terephthalate (PBT) 30, 89, 205
 - polycarbonate (PC) 11, 95, 157, 177
 - polydispersion index (PI) 8, 9, 77
 - polyester resin (UP) 95
 - Polyethylene (PE) 3, 6, 7, 18, 56, 95, 134
 - properties 7
 - polymer blends 11–12
 - Polymeric macromolecules 3
 - Polymeric materials 1, 5, 8, 15, 25, 26, 30, 32, 35, 37, 40–45, 47, 54, 55, 78, 79, 95, 101, 103, 105, 111, 113, 119, 120, 124, 125, 129, 130, 134, 136, 141, 142, 167, 174, 176, 182, 197
 - Polymer melt 8, 13–15, 66–70, 74, 77, 82, 195
 - Polymer processing methods 65
 - Polymers
 - elastomers 1
 - mechanical behaviour
 - glass transition temperature 17–18
 - melting 18
 - relaxation process 15
 - solidification 18–22
 - time dependence and thermal activation 26–28
 - time dependent deformation 22–26
 - Molecular structure of 12
 - processing
 - effects of quality 43–44
 - preconditioning 41–42
 - production process 42–43
 - testing
 - objectives 48–49
 - sample extraction/sampling 49–50
 - sample preparation 49
 - sample, types of 50–51
 - test implementation 51
 - test methods 47
 - test procedure 49
 - test report 51–52
 - thermoplastic elastomers 1
 - thermoset 3
 - Polymethyl methacrylate (PMMA) 95, 101
 - Polyoxymethylene (POM) 95
 - Polypropylene (PP) 11, 19, 32, 56, 70, 95, 97, 158, 168
 - Polystyrene (PS) 10, 11, 16, 21, 22, 95, 157
 - Polytetrafluoroethylene (PTFE) 134
 - Polyvinyl chloride (PVC) 5, 6, 33, 95, 143
 - Potassium bromide (KBr) 60
 - Principle of polymerization 5
 - processing and post-processing
 - shrinkage 187, 195–197
 - projection method 191, 193
 - Pseudo plastic behaviour 68
 - Pseudo plasticity 68, 69
 - puncture test 114, 118, 119
 - pycnometer method 57–58
- q**
- quasi-static loading
 - bending test 101–105
 - compression test 98–101
 - hardness test
 - durometer/shore hardness 110–112
 - hardness of, polymeric materials 105
 - Knoop hardness test 108–110
 - methods 106
 - technological test 105
 - Vickers hardness measurement 107–108
 - tensile test
 - ductile materials 95
 - ductile polymers 93
 - modulus of elasticity 95–97
 - nominal strain rate 91
 - polymers, under tensile load 97

- rubber-like materials 95
 stress-strain diagram 92
 tensile stress 90
 yield stress 93
 quasi-static tests 89
- r**
- rate of crystallization 20
 reflection-light microscopy 199, 201, 205, 207
 relaxation process 15, 16, 26, 27, 157
 rheological testing
 polymer melt 66
 rheometry
 advantage and disadvantage, capillary viscometer 71
 measurement principle 71
 rheological measurement 71
 rotational method 71–72
 viscometry
 HPCV 80–82
 MFR 78–80
 solution viscometry 82–86
 rheometry 70
 measurement 70
 oscillation method
 deformation and torque behaviour 75
 rotational method
 cone-plate measuring
 arrangements 72
 plate-plate measuring
 arrangements 72
 rotational rheometer 71–73, 75
 rubber-like materials 95
 rubbery property 31
- s**
- scanning electron microscopy (SEM) 20
 sputtering device 211
 secondary electrons (SE) 210
 self-nucleation of the material 151
 semi-crystalline plastics 134
- semi-crystalline polymers 4, 150, 151, 163, 167, 195, 201, 202
 semi-crystalline thermoplastics 4, 5, 163, 166
 shear deformation 66, 67, 74, 75
 shear flow 14, 66, 67
 shear loading 66, 155
 shear stress 13, 14, 66, 67, 69, 73–76, 81, 87, 88, 101, 103, 104
 shear thinning 9, 14, 15, 39, 65, 67, 68, 78
 behaviour 68
 shear velocity 9, 13, 14, 39
 shish-kebab-like oriented crystallinity 19
 shore hardness testing 111
 shrinkage values 196
 singlephase polymer systems 11
 size exclusion chromatography (SEC) 47
 sliding process 133, 134
 softening behaviour 161, 168
 solidification
 isothermal crystallization 19
 partially crystalline polymer 21
 rate of crystallization 20
 reverse, of solid melting 19
 symmetrical spherulites 19
 solution viscometry
 hygroscopic plastics 86
 intrinsic viscosity 84
 thermogravimetric analysis 86
 viscosity, polymer 82
 spherulite 19, 20, 169
 Staudinger index 84
 stereoregularity 21
 stereoregular polymers 11
 stereospecific polymerization reaction 11
 steric hindrance 21, 22
 steric order, types 12
 storage modulus 76, 154
 strain-controlled fatigue test 127, 128
 strain, determination of 179
 stress-controlled fatigue test 127

- stress distribution 98, 102, 105, 114, 212
 stress relaxation 24–26, 125, 126
 stress-strain curve 94
 styrene-acrylonitrile (SAN) 97, 213
 styrene butadiene (SB) 10
 syndiotactic polymer 11, 21, 32
- t**
- tacticity, of polymer 11
 tactile measurement methods 188–189
 temperature and pressure effects 13
 temperature-dependent deformation 16
 temperature-dependent mechanical properties 167
 temperature-frequency sweep 156–158
 temperature sweep 156
 tensile impact test
 bending impact test
 Charpy impact test 118
 Charpy or Izod test 115
 falling dart test 118
 Izod impact test 118
 tets arrangement 115
 notch intensity 114
 test arrangement 115
 tensile test 89
 tension-compression test 130
 thermal ageing behaviour 144
 thermal analysis methods 53, 139, 164
 thermal dimensional stability
 thermo-analytical tests 167
 VST 167–169
 thermal fatigue 35, 37
 thermal linear expansion 162
 thermal testing
 calcination tests 164–166
 classification 139
 DMA
 measurement modes 156
 temperature sweep 156
 viscoelastic properties 152
- DSC
 dynamic differential calorimeter 146
 measurement principle 144
 specific heat capacity 144
 thermogram, of amorphous polymer 148
 testing possibilities, thermal analysis 141
 test under thermal loading
 accelerated testing 143–144
 thermo-oxidative ageing process 141
 TGA 158–161
 thermal ageing behaviour 144
 thermo-analytical methods 139, 142
 thermogravimetric analysis (TGA) 48, 53, 86, 158–161, 164
 measurement, methods 160
 polymeric sample 158
 principle of TGA 159
 type and grades, polyamide materials 160
- thermomechanical analysis (TMA) 48
 measurements 164
 principle of 161
 thermal linear expansion 162
 thermo-oxidative ageing process 141
 thermoplastic 1
 polyethylene 6
 polyurethane 197
 thermoplastic elastomers (TPE) 1, 5, 45, 65, 110, 206
 thermoplasts 65
 thermoset 1, 3, 35, 149, 166
 time dependent deformation
 creep modulus 24
 elastic constants, two springs 23
 Hooke's law 24
 viscoelastic material model 23
- time-temperature superposition
 principle 27, 28, 143, 152, 155, 156, 158
 torque moment $M(t)$, 71, 74
 total shrinkage (S_T) 195, 196

- transmission electron microscope (TEM) 48
- transmission light microscope 48, 199, 201, 202
- transmission microscopic investigations 204
- tribological testing
- friction coefficient 135–136
 - sliding process 134
 - wear testing method 136–137
- tribology 133
- types of polymers 1
- 2D tomography 193
- u**
- Ubbelohde type capillary viscometer 83, 84
- uniaxial stress-strain behaviour
- ductile amorphous polymer 28
 - ductility, effects on 32–35
 - effect of time and temperature 35
 - elastic properties 30–32
 - fatigue behaviour 35
 - intermolecular bonds 28
 - stiffness, effects on 32
- v**
- van der Waals forces 15
- Vicat softening temperature (VST) 168
- principle, of measurement 168
 - on test sample 167
- Vicat softening temperature 169
- Vickers hardness measurement 108
- viscoelastic deformation 26, 27, 45, 75, 88, 152
- behaviour 88
- viscoelastic material model 23, 24, 36, 37, 67, 95, 126, 154
- viscometer 47, 48, 69–71, 77, 78, 80–85, 165
- viscosity number (VN) 47, 77, 83, 84, 86
- viscous deformation (Newtonian behaviour) 75
- volatile content 181–183
- w**
- wall adhesion 66
- warpage 142, 187, 188, 190, 195–198
- wavenumber 58, 60–62
- wear testing method 137
- Weißenberg–Rabinowitsch correction 82
- Williams–Landel–Ferry (WLF) equation 27
- Wöhler curve 128, 129
- x**
- X-ray radiographic testing 48
- y**
- yield stress 28, 35, 93, 100, 101
- Young's modulus 87, 92
- z**
- zero-viscosity 14, 68, 69, 77
- Ziegler–Natta catalyst 9

