

Index

a

- absorption velocity 384
- acrylonitrile butadiene styrene (ABS) 349
- active matter 278
- active particles 330
- actuate microsized robots 402
- actuation principles 234
 - photochemical phase transition 235–237
 - photothermal effect 239–242
 - Weigert effect 237–239
- actuators 5, 22, 30, 59, 86, 179, 209, 233, 242–251, 283, 289–292, 335, 348, 395
- adaptation capability 379
- adaptive strategies in plant, robot behaviour
 - circumnutation movements, natural and artificial roots 385–387
 - plant-inspired kinematics model 380–385
 - formalized properties 384
 - kinetic control steps 384
- additive manufacturing (AM) 278, 293, 347, 364, 366, 370
- adipic acid 161–163
- allyl sulfides 279
- α CD-Azo gels
 - chemical structures 182
 - photo-responsive property 184–187
 - photo-responsive volume change 181–184
 - UV and Vis light irradiation 181
- hydrogels
 - mechanical properties 188–191
 - preparation 188
 - radical copolymerization 180
 - xerogel, UV and Vis light-responsive actuation of 192
- American Society for Testing and Materials (ASTM) 349
- anisotropic morphology 356
- 9-anthracene carboxylate ester derivatives 34–35
- anthracene derivatives
 - advantages 33–34
 - and crystal shapes 48–49
 - synthesis of 46–47
- anthracene photomechanical crystals
 - advantages 33–34
 - types 34–46
- 9-anthraldehyde 38, 46
- artificial muscle
 - regulated by cross-linking density 180–187
 - regulated by sliding motion 187–192
- arylbenzofuranone (ABF) 309, 312, 317
- arylbenzothiophenonyl (ABT) radicals 317, 318
- attractive stimuli 369
- azlactone 281
- azobenzene
 - absorption spectra 84, 85
 - isomerization 84, 235
 - isomerization of 258

- azobenzene-based linear liquid crystalline polymer 248
- azobenzene-containing CLCP doped with gold nanorods 244
- azobenzene-containing polymers 257, 258
- azobenzene crystals 59
- crawling motion of 94–95
 - photomechanical bending 60
 - twisted bending 61
- azobenzene/GO/PVA composite film, UV-NIR-Vis induced bending of 271
- azobenzene–inorganic hybrids 257, 258, 270–271
- azo dyes, crystals of 61
- b**
- benzylidenedimethylimidazolinone (BDHF) 128, 129
- benzyl methacrylate (BMA) 353
- bilayer polysiloxane-based CLCP actuators 242
- biodegradable polymers 90, 287
- biohybrid robots
- actuation of 400
 - with monolayer of muscle cells 402–406
 - with muscle tissues 406–410
 - with single muscle cell 401–402 - muscle usable in 396
 - cardiomyocyte and cardiac muscle tissue 397–398
 - cell and tissue, other than mammals 399–400
 - skeletal muscle fiber 398–399
 - skeletal muscle tissue 398–399
- bioinspired soft actuators 242
- driven by photothermal effect 243–244
 - photoinduced actuation 245–251
- biomimetic “flower,” 244
- bis(8-hydroxyquinolinato)copper(II) tetracyanoquinodimethane 130
- bismaleimide 287, 294
- 1,8-bismaleimidotriethyleneglycol (M2) 290
- 1,2-bis(5-methyl-2-phenyl-4-thiazolyl)perfluorocyclohexane 7, 22
- 1,2-bis(2-methyl-5-(4-(*p*-toluyloxymethyl)phenyl)-3-thienyl)perfluorocyclopentene 16
- 1,2-bis(2-methyl-5-(4-octyloxyphenyl)-3-thienyl)perfluorocyclopentene 17
- 1,2-bis(2-ethyl-5-phenyl-3-thienyl)perfluorocyclopentene microcrystal 6, 12
- bisphenol A ethoxylate dimethacrylate (BPA) 353
- bond dissociation energy (BDE) 309
- bridging-type azobenzene-modified organoalkoxysilane precursors 264
- c**
- cardiac muscle tissues 397–399
- cardiomyocyte monolayer 397, 402–404, 406, 410
- [c2]AzoCD₂ hydrogel
- photo-responsive actuation 194–196
 - volume changes 192
- [c2]AzoCD₂ xerogel, photo-responsive actuation of 196–199
- cellular robotics 366
- cellulose nanocrystals (CNCs) 290, 292
- chemical-reaction-based systems 307, 308
- chemiluminescent mechanophores 308
- 5-chloro-2-nitroaniline, ferroelasticity of 159, 161
- ciliate-like microrobot 245
- ciliates 335, 342, 343
- circumnutation behavior 385
- CLCP-based actuator 244
- CLCP micro-arrayed surface 248
- clearing temperature 331
- “click” reactions 285
- cocrystals 14, 57, 61, 133
- computer-aided design (CAD) 348, 349

- concept of complication 365
 - conjugated anthracene derivatives 38–40, 48
 - continuous deposition (method A) 376–377
 - continuous liquid interface production (CLIP) 352
 - continuum actuator 342
 - controlled actuation
 - control parameters, role of 338–341
 - swimming microrobots 341–344
 - covalent adaptable networks (CANs) 279
 - associative 279–280
 - dissociative CANs 280
 - crawling motion (photo-induced), of azobenzene crystals
 - characteristics 95–98
 - experiments with light intensities 96
 - mechanism 98
 - under room temperature 98
 - on solid surface 94–95
 - crosslinked liquid-crystalline polymers (CLCPs) 209, 225
 - actuator 242, 244, 246
 - azobenzene moieties, concentration of 216
 - and carbon nanotube composite systems 220
 - chemical structure 212, 214
 - dynamic covalent bond incorporation 224–226
 - film deformation 210
 - films
 - bending behavior 235
 - circularly patterned 239
 - ferroelectric 236
 - laser beam influence 237
 - monodomain 235
 - polydomain 235
 - cross-linking mechanism 287
 - crystal bending 105
 - photochemical transformation 107
 - pure bending 105
 - residual stress 106
 - schematic presentation 113
 - structural strain 106
 - transformation 106
 - crystals 57
 - locomotion by thermal phase transition 67
 - fast rolling locomotion 71–72
 - inchworm-like walking 70–71
 - photo-triggered phase transition 59
 - thermal SCSC phase transitions 58
 - crystal-to-melt phase transitions
 - applications 92
 - characteristics 87–89
 - field of adhesives 92
 - mechanical motions from 92–94
 - rod-shaped amphiphilic azobenzene compound 90
 - schematic concept 87
 - schematic representation 87
 - $[\text{Cu}^{\text{II}}_2(\text{benzoic acid anion})_4(\text{pyrazine})]_n$ 152, 154
 - cyanodithioester (CDTE) 285
 - cyclodextrins (CDs) 179
 - cyclohexene adduct 282
 - cyclopentadiene 282, 285
- d**
- DA-activated monomers 297
 - DA-based SMPs, for soft-robotics application 292–293
 - DABBF-centered polystyrenes 310
 - DABBF-diol polystyrene 310
 - DABBF dissociation ratio 310
 - DABBF moiety 310–312
 - degree of mobility 379
 - dendrimer and dendronized polymers 283
 - deposition strategies
 - continuous deposition (method A) 376–377
 - reversing deposition (method B) 377–378
 - diaphragm pump 403, 404, 408, 409
 - diarylacetonitrile (DAAN) radicals 316
 - diarylbibenzofuranone (DABBF) 309–316, 319
 - diarylbibenzothiophenonyl (DABBT) 318, 319, 321

- diarylethene crystals 4
 bending behavior on irradiation
 wavelength 11–13
 crystal shape deformation 7
 illumination direction 20
 optical photographs 22
 as photoactuators 15
 photoinduced bending behavior 15
 photoinduced crystal twisting 20
 photomechanical behavior 14, 19
 photomechanical motion 15–20
 photoresponsive bending of 7–11
 photosalient effect 20–22
 space group 7
- dibenzobarrelene derivatives 67
- 4,4'-dicarboxydiphenyl ether 163, 164
- di(ethylene glycol) dimethacrylate (DEGDMA) 353
- Diels–Alder (DA) reactions 279
- dienophiles 285
- 1,4-diethoxybenzene 167
- differential deposition 370, 378
- differential elongation 370, 373, 374
- 3,5-difluorobenzoic acid single crystal 149
 mechanical twinning state 150
 shear force on 149
 twinning deformation 152
- digital light processing (DLP) systems 351
- digital micromirror device (DMD) 337, 351
- 3,3'-dimethylazobenzene 94, 95
- direct ink write (DIW) 278
- distributed actuation 335
- dorsal vessel tissues (DVTs) 399, 400, 409, 410
- driving system 247, 401, 402, 407
- dumbbell-shaped segmented polyurethane elastomer 313
- dynamically reconfigurable robotic system (DRRS) 365
- “dynamic” mechanochromophores 310
- e**
- eco-sustainable environmental monitoring 369
- Eiffel tower model 354
- electrical stimulation 395–400, 404, 411
- electron paramagnetic resonance (EPR) 309, 310, 312, 321
- elongation velocity 374
- elongation zone 367, 387
- embedded 3D printing, growing robots 375
 deposition strategies 376
 continuous deposition (method A) 376–377
 reversing deposition (method B) 377–379
- embryonic stem cells 397
- epoxy-based system, photoresponsive properties of 226
- ethylene crystals 295
- evolutionary robotics 366
- extracellular matrices (ECMs) 397, 399, 400
- extrusion printing 355–357
- f**
- ferroelasticity 139–141, 145, 158, 161
- ferroelectric CLCP films 236
- filament melt 297
- filament tip, displacement of 402
- first growing mechanism 371–373
- fluorescent-dye-based systems 307, 308
- 4-fluoro-9-anthracene carboxylic acid 42–44, 47
- 4D printing, soft robotics 358
 of responsive materials 352
 hydrogels 355–356
 liquid crystalline elastomers 356–357
 SMP 352–355
- 3D printing techniques
 CAD 348, 349
 material extrusion based techniques 349–350

vat photopolymerization
 techniques 350–352
 VAT techniques 350–352
 fulgides 64–66
 fused deposition modeling (FDM) 278,
 349, 350, 354, 365, 375

g

glass transition temperature (T_g) 93,
 188, 210, 283, 318, 349, 353
 gold-coated diarylethene crystals 15,
 18
 gold nanoparticles 220, 285
 graft copolymers 283
 growing robots 364–367, 375, 381,
 382, 387, 388

h

heliotropism 243
 heterogeneous microstructuration
 294
 high impact polystyrene (HIPS)
 349–350
 homo and block copolymers 283
 hybrid photomechanical membranes
 77
 hydrogel structure actuation 356
 hydroxypropyl β -cyclodextrin (CD)
 287
 4-hydroxy-2,2,6,6-tetramethylpiperidine-
 1-oxyl (TEMPOL) 310

i

“indeterminate” mechanism 363
 induced pluripotent stem cells (iPSCs)
 397
 intercalation compounds 270
 interfilamentous adhesion 294, 298
 interpenetrating polymer network (IPN)
 films 220, 222
 iris-like CLCP actuator 246
 IR light-driven inchworm walker 243
 iron oxide (Fe_3O_4) nanoparticles
 355
 isocyanates 281
 isolated muscles 399

l

lamellar siloxane-based hybrids
 with bridging azobenzene groups
 264–265
 with pendant azobenzene groups
 262–264
 light-controlled soft microrobots 330
 controlled actuation 338–344
 structured light 337–338
 light-driven bioinspired actuators 245
 light-sensitive artificial flytrap 246
 linear liquid crystalline polymer-coated
Morpho butterfly wing
 composite 251, 252
 linear liquid crystalline polymers 223,
 248–250
 linear thermoplastic 282
 liquid crystal (LC)
 elastomers 210, 218, 268
 films, bending of 258
 phase transitions in 86
 liquid crystalline elastomers (LCEs)
 329, 330, 352, 356, 357
 photothermal actuation of 331–335
 thermal response of 330–331
 low critical solution temperature
 (LCST) 330
 low-density polyethylene 93, 294

m

machine learning techniques 343
 macroscopic crystal motion 57
 main-chain crosslinked
 liquid-crystalline polymers 212
 maleimide moieties 283, 290, 292, 294
 material extrusion based techniques
 349–350
 mature zone 367
 mechanically responsive molecular
 crystals 76
 mechanical response, of irradiated
 crystals 112–116
 mechanical stress 307, 308, 314,
 316–318, 320, 321, 364

- mechanochromic elastomers,
 dynamic covalent
 mechanochromophores 314
 mechanochromic polymers 307, 308
 based on dynamic covalent chemistry
 mechanochromic elastomers,
 dynamic covalent
 mechanochromophores
 312–314
 polystyrenes, with
 mechanochromophores 310
 polyurethane elastomers, with
 mechanophores 310–312
 classification of 307–308
 mechanochromophores, based on
 dynamic covalent chemistry
 309
 mechanofluorescence 315–316
 multicolor mechanochromism
 318–321
 rainbow mechanochromism
 316–318
 mechanochromic polystyrenes 318
 mechanochromic properties 308, 310,
 314, 318
 mechanochromism 307–309, 316–319
 mechanofluorescence 315–316
 mechanophores 308, 310–312, 314,
 315
 mechanosalient crystals 118
 mechanosalient effect 128–130
 melting temperature (T_m) 88, 90, 289
 meristematic region 367, 368
 meristematic zones 363
 metachronal waves 342
 9-methylanthracene 36–37
 methylene diphenyl 4,4'-diisocyanate
 290
 1-(2-methyl-5-(4-(1-naphthoxyloxymethyl)
 phenyl)-3-thienyl)-2-(2-methyl-5-
 phenyl-3-thienyl)perfluorocyclo-
 pentene 18
 2-methyl-5-nitrobenzoic acid 164–166
 Michaelis–Menten equation 384
 micro hand, with color recognition
 ability 244
 micro/nanomotors 330
 micro swimming robot 245
Mimosa pudica, 364
 miniature flying robots 246
 mobile microrobots 329, 330, 335
 molecular crystals 30–33, 37, 47–50,
 57, 59, 76
 multicolor mechanochromism
 318–321
 multi-furan monomer 294
 multi-head printing 297
 multi material gripper 358
- n**
- nanoclays 350
 nanocomposite, fabrication of 292
 nematic director 331, 341
N-[4-(formyl polyethylene glycol ester)
 bismaleimide 287
N,N-dimethylformamide 37, 287
N,N-dimethyl-4-nitroaniline single
 crystal 156, 157
N,N-phenylenedimaleimide 290
 non-holonomic system 379
 Norrish type II hydrogen abstraction of
 carbonyl compounds 57, 66
N'-2-propylidene-4-hydroxybenzo
 hydrazide 121, 125
 NR-type (non-reversible) anthracene
 derivatives
 9-anthracene carboxylate ester
 derivatives 34–35
 9-anthraldehyde 37–38
 conjugated anthracene derivatives
 38–39
 9-cyanoanthracene 37–38
 9,10-Dinitroanthracene crystals
 37–38
 9-methylanthracene 36–37
 NR-type (non-reversible)
 photomechanical crystals 33
N-salicylideneanilines 125
 nucleophilic addition reaction 280
- o**
- on-board actuator 342
 optical manipulation 83
 ordered siloxane-based hybrids 261

- organic crystals 49, 59, 131, 139, 158, 166
- organic materials 139, 145, 156, 257
- organosuperelasticity
discovery 141–149
twinning 149–156
- organosuperplasticity 156–158
- Oryza sativa* L. 368
- over-excitation 339, 340
- oxitropium bromide 118, 119, 123
- p**
- PEGDA-based hydrogel substrate 407
- pendant-type azobenzene-modified organoalkoxysilane precursors 262–264
- penetration cavity 387
- peripheral friction 373
- phase transitions
in crystal phase 87–94
in liquid crystals 86
- photoalignment technique, CLCP films 216
- photochemical transformation 107
kinetic model 108–112
in quasistatic mode 107
synchronous bending 108
- photochromic chiral salicylideneamine crystal 59, 77
- photochromic compounds 3, 61, 64, 72, 84
- photochromism, defined 3
- photocrosslinkable poly(lactic acid)-based inks 355
- photo-induced bending, of azobenzene–siloxane hybrid film 265–268
- photo-induced crawling motion, of azobenzene crystals
characteristics 95–98
experiments with light intensities 96
mechanism 98
under room temperature 98
on solid surface 94–95
- photo-induced crystal-to-melt transition 89
- photolithography techniques 365
- photomechanical bending
amino-substituted azobenzene (*trans*-2) crystal 60
chiral *vs.* racemic crystals 64
trans-4-(dimethylamino)azobenzene 59
- photomechanical LCPs in bioinspired actuators 251
- photomechanical molecular crystals 30
anthracene derivatives 33–34
interfacing with other materials 49–50
modeling reaction dynamics 47–48
reversible photochromic reactions 31
- photomobile liquid-crystalline polymers 211
CNT/CLCP composites 220–222
linear liquid crystalline polymers 223
polyacrylate elastomers 218
polyacrylates 213–218
polysiloxanes 211–213
- photopolymerization 35, 90, 214, 349, 357
- photoresponsive azobenzene–siloxane hybrid materials
azobenzene groups, arrangements of 268–270
with bridging azobenzene groups 264–265
nanostructural control 261–262
with pendant azobenzene groups 262–264
- photoinduced bending, of azobenzene–siloxane hybrid film 265–268
- photoresponsive bending, of diarylethene crystals 7–11
- photoresponsive fiber arrays, for object transport 246
- photoresponsive polymers 233, 242, 247, 344
- photoreversible macroscopic crystal deformation 6
- photosalient crystals 118, 128

- photosalient effects 124, 128
 photo-switchable properties, of
 azobenzene–inorganic hybrids 270
 photothermal transducer 354
 photo-triggered phase transition 59, 72
 stepwise bending of crystal 75
 trans-keto molecules production 74
 photo-tunable photonic crystals 249
 plant-inspired autonomous behavior 379
 plant-inspired growing mechanisms
 challenges 369
 evolution, of plantoids 369–370
 first growing mechanism 371–373
 growing robots, embedded 3D printing 375–379
 sloughing mechanism 371
 plantoid evolution 371
 plantoids, evolution, of 370
 plants as model 365
 plasticity 156, 279, 290, 292, 364, 382, 387
 pneumatic pressure 277–278
 poly(2,5-furandimethylene succinate) (PFS) 290
 poly(ϵ -caprolactone) 285
 poly(ethylene-co-methacrylic acid) 295
 poly(*N,N*-dimethylacrylamide-co-furfuryl methacrylate) 287
 poly(*N*-isopropylacrylamide) (PNIPAM) 289, 330, 397
 poly(*N*-isopropylacrylamide) (PIPAAm) 289, 330, 397
 poly(styrene-*block*-butadiene-*block*-styrene) 285
 polycaprolactone (PCL) semicrystalline macromers 353
 polycarbonate (PC) 350
 poly(ethylene glycol) dimethacrylate (PEGDMA) 353
 poly(siloxane-urethane) elastomers 285
 polylactic acid (PLA) 294, 349
 polymer chains carrying maleate 281
 polymer network synthesis 285
 polyphenylenes 282
 polyrotaxanes 179, 187
 polysiloxane-based CLCP 235, 242
 polystyrene chains 310
 polyurethane elastomers, with
 mechanophores 310–312
 polyurethanes (PUs) 283, 310, 312
 powder-bed technology 365
 producing thermo-reversible networks 282
 projection microstereolithography 353, 354
 P-type (photon-reversible) anthracene photomechanical crystals 44
 P-type (photon-reversible) photomechanical crystals 32
 PU-based filaments 295
 pumping biohybrid robot 404
- r**
- radical-type mechanochromophore 316–318
 radical-type mechanophores 315, 320
 rainbow mechanochromism 316–319
 relative radial deformation 342
 repulsive stimuli 369
 retro Diels–Alder (rDA) 280, 282, 286, 287, 292
 reversible $4\pi+4\pi$ photodimerization 39
 reversing deposition (method B) 377–379
 ring-opening chemistry 281
 robotic mechanism 375
 room temperature (RT) 3, 33, 39–41, 43, 87, 90, 98, 120, 144–146, 156, 157, 353
 root cap 367, 368, 371, 382
- s**
- salicylideneamine 61
 salicylideneaniline 61–63
 salicylideneaniline crystals, photomechanical bending 64

- salient crystals 119
 directionality of motion 124–125
 effect of crystal habit 127–128
 intermolecular interactions, effect of 125–127
 mechanosalient crystals 118
 photosalient crystals 118
 thermosalient crystals 118
- salient effects 118
 applications 130–131
 mechanosalient effect 128–130
 photosalient effects 128–130
 thermosalient 123–124
- seeding cardiomyocyte suspensions 397
- segmented polyurethanes (SPUs) 310, 313
- selective laser sintering (SLS) 278, 293
- self-growing adaptable soft robots
 adaptive growth in plants, mechanisms 367–369
 applications 387–388
 growing robots, evolution of 365–367
 plant-inspired growing mechanisms
 artificial roots, with SSBA 373–375
 challenges 369
 evolution, of plantoids 369–370
 first growing mechanism 371–373
 growing robots, embedded 3D printing 375
 sloughing mechanism 371
- self-healing crystals 119, 131–133
- self-healing materials 90, 131, 132, 283, 285, 286
- self-healing mechanism 294
- self-reproductive automata 365, 366
- self-tightening knots 292
- shape fixity ratio [R_f] 289
- shape memory effect (SME) 76, 141, 145, 286, 289, 290
- shape memory polymers (SMP) 289, 352–355
- shape recovery ratio [R_r] 289
- side-chain functionalization 283
- silicon-based scaffold 403
- siloxane-based organic–inorganic hybrid materials 258
 ordered 261
 properties 258
 self-assembly process 260
 sol–gel method 259
 structural control 260
- silver nanoparticles (AgNPs) 292
- single-walled carbon nanotube (SWNT) 243, 244, 270
- skeletal muscle tissues 398–400, 406–411
- SLA technique 296
- sloughing mechanism 371, 372
- small angle X-ray scattering (SAXS) 331, 332
- smart polymer materials 233, 279
 “smart” polymers 233, 278
- soft actuators 209, 242, 289, 290, 292
 deformations 278
 photoinduced actuation 245–251
 photothermal effect 243–244
- soft caterpillar robot 245
- soft microrobots, photoresponsive materials
 LCEs
 photothermal actuation of 331–335
 thermal response of 330–331
 light-controlled soft microrobots
 controlled actuation 338–341
 structured light 337–338
 soft robotics, micro scale 329–330
- soft robotics 179
 DA-based thermo-reversible networks 293
 micro scale 329–330
- soft spring-based actuation (SSBA) 373–375
- soil monitoring 369
- solid-state photoreactions 38, 57
- stem-twinning 368
- stereolithography (SLA) 278, 293, 350
- Sti-based [c2]daisy chain complex (α CD-Sti)₂
 dry gels 202–204

- Sti-based [c2]daisy chain complex
 $(\alpha\text{CD-Sti})_2$ (*contd.*)
 hydrogel 199–202
 structure 199–200
- stimuli-responsive polymers 209, 288,
 330, 359
- strain-stress curve
 ferroelastic behaviors 141
 of superelastic materials 140
- structural-color-based systems 307,
 308
- styrene-*b*-(ethylene-*co*-butylene)-
b-styrene 294
- superelasticity 140, 141, 144
 in metal alloys 149
- superelastic materials, strain-stress
 curve 140
- superhydrophobic surfaces 247
- superior supramolecular interactions
 278
- superplasticity 139, 141, 156, 157, 159
- supramolecular actuator-like artificial
 molecular muscle system 204
- surfactant-directed self-assembly
 process 260, 261
- surfactant-free self-directed assembly
 261
- swimming biohybrid robot 402, 404,
 406
- swimming microrobots 341–343
- synchronous bending 108
- t**
- telechelic polymers 282
- terephthalamide crystals 141
- 9-*tert*-butyl-anthracene ester (**9TBAE**)
 30
- tetraarylsuccinonitrile (TASN) 316,
 321
- 1,2,4,5-tetrabromobenzene (TBB) 119,
 123
- tetrabutyl-*n*-phosphonium
 tetraphenylborate
 actuation 148
 deformability 146
 mechanical responses 147
 phase diagram 148
- reversible thermal transformation
 148
- shape memory effect 145
- single-crystal X-ray diffraction
 analysis 145
- thermal shape recovery 145
- thermomechanical diagram 147
- tetraethoxysilanes 285
- thermal-responsive CLCPs 239
- thermoplasticity 310
- thermoreponsive CLCPs 224
- thermo-reversible chemistry 280–282
 challenges 295–298
 3D printing 293–295
- thermo-reversible networks, DA
 reactions
 basic definitions 282
 for polymer synthesis 282–283
- thermo-reversible polymer network, DA
 reactions
 hydrogels 287–289
 self-healing materials 283–286
- thermosalient crystals 118, 124, 125
- thermosalient effect 118–121,
 123–125, 128, 130
- thermosalient transition mechanism
 120–123
- thermosetting polymers 282
- 3D printing 278, 347
 multimaterial grippers 359
 techniques
 material extrusion based
 techniques 349–350
 vat photopolymerization
 techniques 350–352
- Timoshenko's bimetal model 11
- topochemistry 30
- trans-*cis* isomerization, of azobenzene
 210, 258
- trans*-1,4-cyclohexanedicarboxylic acid
 171, 172
- transition temperature 59, 77, 93, 119,
 124, 125, 146–148, 235, 283, 331,
 353
- translational motion 29, 37, 46, 83, 94
- traveling waves 335, 342
- tropisms 369, 379, 382

- T-type (thermally-reversible)
 photomechanical crystals 33,
 39
- tubular LLCp microactuator 249
- twinning ferroelasticity
 adipic acid 161, 163
 5-chloro-2-nitroaniline 159, 161
 4,4'-dicarboxydiphenyl ether 163,
 164
 1,4-diethoxybenzene 167, 168, 170
 2-methyl-5-nitrobenzoic acid 164,
 166
 trans-1,4-cyclohexanedicarboxylic
 acid 171, 172
- two-photon photopolymerization (2PP)
 351
- two-photon polymerization (2PP) 293
- u**
- uptake kinetics 385
- UV and Vis light-responsive actuation,
 of α CD-Azo xerogel 192
- UV light induced photosalient effect
 22, 23
- v**
- Vat photopolymerization techniques
 350–352
- Vegard's law 112
- visible-light-driven fully plastic
 microrobot 247
- w**
- walking biohybrid robot 403, 405, 407,
 408, 410
- water-air-interface robotic swimmer
 243
- Weigert effect 233, 237–239
- y**
- Young's modulus *vs.* strain, of actuation
 materials 76

