

Index

a

2A/1A conical intersection (2A/1ACI(o))
21, 22, 58
acetophenone 4
achiral diarylethenes 82
activation energy 50, 52–53
1,4-addition radical polymerization 4
adhesion 198
aggregate induced enhanced emission
(AIEE) 74, 171
amorphous polyolefine (Arton) 126–127
antiferromagnetic interaction 142
aqueous phosphate buffer solution 197
aromaticity 18–19
aromatic stabilization energy 18–19
aryl groups 19–20, 49
atomic force microscope (AFM) 112, 130
aziridines 93
azobenzene 1, 4, 149, 175, 185–186

b

bending crystal 116
benzobis(thiadiazole) 41–42
benzothiadiazole (BTD) unit 74
benzothiophene 19
benzothiophene ring 81
bicyclic 5-*exo*-norbornene 174
biologically active diarylethene
derivatives 201–204
biological systems 1–2, 201
biological activity 201

bisarylbenzothiophenes 38–39
2,3-bis(2,5-dimethyl-3-thienyl)butadiene
4
1,2-bis(3-furyl)ethene 17–18
1,2-bis(cyclopenta-1,3-dien-2-yl)ethene
20
2,3-bis(2-methyl-1-benzothiophen-3-yl)
maleic anhydride 56–57
1,2-bis(2-methyl-1-benzothiophen-3-yl)
perfluorocycloalkenes 6
1,2-bis(2-ethyl-6-phenyl-1-benzothio-
phene-1,1-dioxide-3-yl)perfluoro-
cyclopentene 215, 217
1,2-bis(2,4-dimethyl-5-phenyl-3-thienyl)
perfluorocyclopentene 23, 112,
213, 214–215
1,2-bis(2-alkyl-5-aryl-1-benzothiophene)-
perfluorocyclopentene 109, 189
1,2-bis(2-alkyl-6-aryl-1-benzothiophen-3-
yl)perfluorocyclopentene 189
1,2-bis(2-alkyl-6-phenyl-1-benzothiophen-
3-yl)perfluorocyclopentene 192
1,2-bis(2-ethyl-1-benzothiophen-3-yl)
perfluorocyclopentene 215–216
1,2-bis(2-ethyl-5-phenyl-3-thienyl)-
perfluorocyclopentene 113
1,2-bis(2-ethyl-6-aryl-1-benzothiophen-3-
yl)perfluorocyclopentene 7
1,2-bis(2-ethyl-6-iodo-1-benzothiophene-
1,1-dioxide-3-yl)perfluorocyclo-
pentene 216

- 1,2-bis(2-ethyl-6-phenyl-1-benzothio-
phene-1,1-dioxide-3-yl)
perfluorocyclopentene 9, 11, 77,
190, 192
- 1,2-bis(5-ethyl-2-phenyl-4-thiazolyl)
perfluorocyclopentene 114
- 1,2-bis(2-methyl-1-benzothiophen-3-yl)
perfluorocyclopentene 6, 142,
173
- 1,2-bis(2-methyl-5-(1-naphthyl)-3-thienyl)
perfluorocyclopentene 118
- 1,2-bis(2-methyl-5-phenyl-3-thienyl)
perfluoro cyclopentene 28
- 1,2-bis(2-methyl-5-pyridyl-3-thienyl)
perfluorocyclopentene 37
- 1,2-bis(2-methyl-6-nitro-1-benzothio-
phen-3-yl)perfluorocyclopentene
95
- 1,2-bis(2-phenyl-4-methyl-5-oxazolyl)
perfluorocyclopentene 61
- 1,2-bis(3-methyl-2-thienyl)perfluorocy-
clopentene 108
- 1,2-bis(5-methyl-2-*p*-tolyl-4-thiazolyl)
perfluorocyclopentene 116
- bis(2-ethyl-6-(5-methyl-2-thienyl)-1-
benzothiophen-3-yl)-perfluoro-
cyclopentene 56
- bis(phenylethynyl)anthracene 71
- bistability 9, 137
- bistable molecules 2
- bridged imidazole dimer 1–2
- butadiene 4
- by-product 54–55, 58
- C**
- Caenorhabditis elegans* (*C. elegans*)
201
- carbohydrates 1
- CD spectra 81
- Chemical actinometry 45
- Chemical dosimeters 204–205
- chemical reactivity control 197–201
- chiral diarylethenes 82–85, 175
- cholestric liquid crystals 175, 178
- CH/ π interactions 39, 40
- cis-1,2-dicyano-1,2-bis(2,4,5-trimethyl-
3-thienyl)ethene 131
- cis-trans* photoisomerization 6
- coloration/decoloration cycles 56,
58–59, 93
- color dosimeters 204–209
- conformations 23–24, 31, 80
- complete active space self-consistent field
(CASSCF) method 20, 21, 57
- conical intersection 20–21, 44
- conrotatory cyclization reactions of
hexatriene 15–16
- conrotatory modes 16–18, 52
- copolymers 174
- Coulombic repulsion 37
- crystal shape 113, 115
- crystal twisting 121
- cyano-pyrrole groups 52
- cyclization reactions
- 1,2-bis(2,4-dimethyl-5-phenyl-3-thienyl)
perfluorocyclopentene 23–25
 - 1,2-bis(2-methyl-1-benzothiophen-3-yl)
perfluorocyclopentene 26–27
- cycloaddition 197
- cyclodextrin cavity 37
- cyclohexadiene (CHD) 15, 20–21
- cycloreversion reactions 16–18, 20, 27,
29
- d**
- diacetylene 205
- 2,7-dialkyl-benzothieno(3,2-*b*)benzothio-
phene (**BTBT**) 184
- diarylethene(s) 2, 52
- diarylethene-bridged nitronyl nitroxide
radicals 143–144
- diarylethene derivatives
- color changes of 8–9
 - development of 5, 7
 - maleic anhydride or maleimide bridge
6
- diarylethene dimer 145
- diarylethene-doped PMMA film 130
- diarylethene electrocyclic reactions 198
- diarylethene ligands 187

- diarylethene molecular photoswitches
discovery of 4–11
- diarylmaleic anhydride 42–43
- diarylmaleimide(s) 42–44
- diastereomer 81
- diastereomeric excess (*de*) 81
- diastereoselective photocyclization
reaction 81, 83
- diastereospecific photoisomerization
reactions 83, 86
- dichroism 93, 95
- 2,3-di(2,5-dimethyl-3-thienyl)-2-butene
5, 15, 16
- 2,3-di(2,5-dimethyl-3-thienyl)butene
units 6
- Diels-Alder adduct formation 200
- Diels-Alder cycloaddition 198
- Diels-Alder reaction 197–200
- Diels-Alder units 198
- difference Fourier electron density map
98–100
- 1,2-di(3-pyrrolyl)ethene 18
- 1,2-di(3-thienyl)ethane 22
- 1,2-di(3-thienyl)ethene 18, 21
- digital *on/off* photoswitching 11
- dihydrophenanthrene units 4
- 2,3-dimesitylbutadiene 4, 6
- 2,5-dimethyl-3-acetylthiophene 4
- 4-(dimethylamino)azobenzene 205
- 2,4-dimethyl-3-bromo-5-phenylthiophene
214
- 2,4-dimethyl-3,5-dibromothiophene
214
- 2,4-dimethylthiophene 213
- 2,5-dimethylthiophene 4
- 2-(2',4'-dinitrobenzyl)pyridine 93
- 2,3-diphenylbutadiene 4
- 2,3-diphenyl-2-butene units 4, 15
- 1,2-diphenylethene 17–18
- diphenylmaleonitriles 93
- 2,4-diphenylphenyl substituents 134
- dipole moment 1, 43
- disrotatory cyclization reactions of
hexatriene 15–16
- disrotatory modes 16–18, 50
- 2,3-dithienyl-2-butene units 5
- dithienylethene 21
- dithienylethene (DTE) units 71, 73, 106
- dithienylperfluorocyclopentenes 58–59
- dithienylperhydrocyclopentenes 59
- e**
- elastic modulus 120
- electrocyclic reactions 4, 16–17
- electrocyclic reactions of diarylethenes
15–16
- electrocyclic rearrangements 1
- electrocyclization 197
- enantiomers 41–42, 80, 85–86
- enantioselective photo-isomerization
82
- enantiomeric excess (*ee*) 82
- ensemble system 9, 126
- ESR spectra 143–145
- exchange interaction 143–144
- 5-*exo*-norbornene 174
- f**
- facial chirality 83
- fatigue resistance
absorption spectra of the closed-ring
isomer 60
- bis(benzothienyl)ethenes 56
- 2,3-bis(2-methyl-1-benzothiophen-3-yl)
maleic anhydride 56–57
- bis(2-ethyl-6-(5-methyl-2-thienyl)-1-
benzothiophen-3-yl)-perfluoro-
cyclopentene 56
- closed-ring isomer/open-ring isomer
ratio 59
- condensed-ring by-product 59
- of diarylethene derivatives 56–57
- dithienylethenes 58
- dithienylperfluorocyclopentenes
58–59
- dithienylperhydrocyclopentenes
58–59
- fluorescent diarylethenes 196–197
- molecular photoswitches 58
- molecular structure 54

- fatigue resistance (*contd.*)
 super-resolution fluorescence
 microscopy 191–192
- femtosecond laser pulse 24, 27–28,
 131
- fluorescence dosimeters 208–209
- fluorescence photoswitching 11,
 125–126
- fluorescence quantum yield 61
- fluorescence quenching mechanism
 127
- fluorescent bis(phenylethynyl)anthracene
 71
- fluorescent diarylethene dyad 126
- fluorescent metal complexes 207
- fluorescent perylenebisimide derivative
 127, 129
- Förster-type resonance energy transfer
 (FRET) 71, 125
- Frank–Condon state 21, 43, 57
- Friedel–Craft alkylation 173
- Friedländer condensation 157, 172
- furan/maleimide pair 198
- furylfulgides 2, 15
- μ -fuses 152
- g**
- γ -irradiation 205–208
- gel aggregate 82
- graphene-diarylethene-graphene
 junction 138
- Green's function theory 139
- h**
- heat-mode recording 125
- hexaaryl-bisimidazoles 52
- 1,3,5-hexatriene (HT) 15, 20–21
- high-performance liquid chromatography
 (HPLC) 54, 115
- ^1H NMR spectrum of 1,2-bis(2-methyl-1-
 benzothiophen-3-yl)perfluoro-
 cyclopentene in CDCl_3 37
- Horiuti–Polanyi rule 18, 50
- Horner reaction 157, 172
- hot bands 194
- human serum albumin (HAS) 82
- hydrocarbon model system 21
- hyperfine coupling constant 142, 146
- i**
- infrared (IR) absorption 133
- inhibition effect 203
- inner filter effect 97
- in situ X-ray crystallography 50
- intramolecular electron transfer (IET)
 mechanism 71, 127
- intramolecular magnetic interactions
 141
- intramolecular noncovalent interactions
 40
- isobutyl substituents 46, 48, 78,
 189–191
- k**
- Knoevenagel polycondensation 157,
 171–172
- l**
- laser diode (LD) 130
- Lewis lung carcinoma (LLC) 204
- liquid crystals 175–178
- m**
- Mach-Zehnder modulator 141
- maleic anhydride 42
- maleimide 42
- maleimide-based drugs 201
- merocyanine 2
- metal organic cages 187–188
- metal organic frameworks (MOFs)
 185–186
- methoxy groups 46
- 2-methyl-2,3-dihydro-1-benzothiophene
 56
- 3-methylpentane solution 45
- 5-methyl-2-phenyl-4-thiazolyl group
 38
- 1-(5-methyl-2-phenyl-4-thiazolyl)-2-(5-
 methyl-2-*p*-tolyl-4-thiazolyl)-
 perfluorocyclopentene 116

MINFLUX microscopy 197
 mode-locked Ti-sapphire laser 130
 modified neglect of diatomic overlap
 (MNDO) calculation 15
 molecular-mechanics-valence bond
 (MMVB) computation 21
 molecule semiconducting matrices
 185
 multi-colour copolymers 174
 multilocal minima model 127–128
 multiphoton absorption 131
 mutagenic test 201

n

nanometer-scale photoswitching
 reactions 130
 nanoparticles 74–75, 171
 naphopyrans 52
 near-field optical memory 128–130
 needle-shaped fibrils 151
 nematic liquid crystals 175, 177–178
 6-nitro-1',3',3'-trimethylspiro[2H-1-
 benzopyran-2,2'-indoline] 1
 nondestructive readout 128, 134
N-salicylideneanilines 93

o

one-way conductance photoswitching
 137
 optical lithography 154
 optical memory
 halographic recording 131–132
 infrared (IR) absorption 133
 near-field 128–130
 refractive index changes 134
 single molecule 125–128
 three-dimensional optical memory
 130–132
 order parameter 95, 96
 organic field-effect transistors (OFETs)
 183–185
 organic ligand-to-metal coordinations
 187
 oxazole 19
 oxidation polymerization 173

p

PALM/STORM 194
P- and **M**-helical open-ring conformers
 80
 paracyclophanes 93
 π -conjugation 9, 171
 π -conjugation polymers 157
 perfluorocycloalkanes 6
 perfluorocyclopentene 118
 perfluorocyclopentene derivatives 7
 pericyclic reactions 197–201
 Perrin model 71, 74
 pharmacology 201
 phase diagram 150–151
 phenanthrene units 4
 phenyl and heterocyclic rings 18, 19
p-phenylenevinylene (PPV) 157, 171
 photoactivatable cytotoxic agents 204
 photoactivated localization microscopy
 (PALM) 188
 photochemical optical memory 125
 photochromic molecules 1
 photocontrollable OFET 183
 photocyclization of dithienylmaleic
 anhydride 43–44
 photocyclization/photocycloreversion
 reactions 44, 101
 photocyclization quantum yields
 of bisarylbenzothiophenes 38–39
 of diarylethene derivative having
 benzobis(thiadiazole) bridge
 41–42
 of diarylethene derivative having bulky
 ethene bridges 40
 of diarylethenes in *n*-hexane 32–36,
 48
 photocycloreversion quantum yields
 of bisarylbenzothiophenes 38–39
 of diarylethene derivative having
 benzobis(thiadiazole) bridge
 41–42
 of diarylethene derivative having bulky
 ethene bridges 40
 of diarylethene having isobutyl
 substituents 46, 48, 78, 189–191

- photocycloreversion quantum yields (*contd.*)
 - of diarylethene having methoxy substituents 48
 - of diarylethenes in *n*-hexane 32–36, 48
 - photoirradiation wavelength dependence 45
 - temperature dependence 46, 47
- photodynamic therapy 204
- photoexcited cyclohexadiene 55
- photoinduced coloration/decoloration cycles 2, 3, 9, 93
- photoinduced electron transfer 1
- photoisomerization reaction 1
- photon-mode recording 125
- photoresponsive biological systems 1
- photoresponsive enzyme inhibitor 203
- photoresponsive polymers 4, 198, 199
- photostationary state (PPS) 71
- photoswitchable crystals
 - color changes 93
 - dichroism 93–99
 - fluorescent crystals 108–112
 - multicolored systems 106–109
 - nano-layered periodic structures 106–109
 - photomechanical response
 - bending response of mixed crystals 116–121
 - reversible shape change 113–118
 - surface morphology change 112–113, 115
 - quantum yield 101–106
 - thiophene oligomers 93–94
 - UV irradiation 93–95
 - X-ray crystallographic analysis 97–102
- photoswitching component 185
- photoswitching of conductance 137
- photoswitching performance
 - chiral property 80–86
 - dithienylperfluorocyclopentenes 58–59
 - fatigue resistance 53–60
 - fluorescence property 62–70
 - turn-off mode 61–75
 - turn-on mode 76–80
 - quantum yield 31
 - photocyclization 31–42
 - photocycloreversion 44–49
 - solvent effect of cyclization 42–44
 - thermal stability 49–53
- photosynthesis systems 1
- phototaxis 1
- phototropism 1
- polarization holographic recording 132
- polarized absorption spectra 94, 95
- polarizing microscope 110
- polar poly(methyl acrylate) film 128
- poly(2,3-bis(2,5-dimethyl-3-furyl)butadiene) 5
- poly(2,3-bis(2,5-dimethyl-3-thienyl)butadiene) 4
- poly(2,3-di(2,5-dimethyl-3-furyl)butadiene) 6
- poly(2,3-di(2,5-dimethyl-3-thienyl)butadiene) 6
- poly(2,3-diphenylbutadiene) 4, 5
- poly(3-hexylthiophene) (**P3HT**) 184
- poly(2-hydroxymethacrylate) 149
- poly(methyl methacrylate) (PMMA) 126
- poly (n-butyl methacrylate) (PnBMA) 126
- polymers
 - applications 157
 - having diarylethene units in the main chain or pendant groups 158–170
 - polyurethane 175, 176
- polymer film dosimeters 205
- potential energy surfaces, diarylethenes 20, 21, 127
- p*-phenylene spacers 143
- prodrugs 200
- protags 200
- P-type molecular photoswitches 2
- P-type photoswitching reactions 52
- Pyridinium cations 37

r

racemization reactions 80
 radiation dosimetry 204
 radiation-induced coloration of
 diarylethene 205, 207
 radical polymerization 172
 radical-substituted diarylethenes 143
 radiochromic film dosimeters 204
 Raman spectra 133, 175
 refractive index changes 131, 134, 141
 reversible photoisomerization reactions
 1
 reversible saturable (switchable) optical
 linear fluorescence transition
 (RESOFT) 188
 RESOFT image 195
 rhombus-shape single crystal 94, 96
 ring-opening and ring-closing reactions of
 diarylethenes 21, 23
 ring-opening methathesis polymerization
 174
 ring-opening reaction coordinate 20
 rose petals 150–151

s

scanning tunneling microscopy (STM)
 140
 selective metal deposition 151–154
 self-assembled monolayer 140
 sigmatropic rearrangements 1
 single-molecule level 11, 71, 126, 138,
 188
 single molecule optical memory
 125–128
 single-walled carbon nanotubes (SWNTs)
 137
 solvent effect 42–43
 spirobenzopyran 1, 4, 149
 spironaphthoxazines 52
 spiropyrans 52
S,S-dioxide thiophene ring 44
 stepwise assembly method 121
 stereoselective photoisomerization
 reactions 81,83
 stilbene 4

Stille coupling 157, 172
 stimulated emission depression (STED)
 188
 stochastic optical reconstruction
 microscopy (STORM) 61
 STORM (stochastic optical reconstruction
 microscopy) 188
 STORM images of Vero cells 196
 strain energy 18
 structure-switch relationship 58
 2-substitutes indols 61
 subwavelength nanopatterning 154–155
 sulfone derivatives of
 bis(benzothienyl)ethene 76–77,
 190, 208
 super-resolution fluorescence microscopy
 control of cycloreversion quantum yield
 189–191
 fatigue resistance 191–192
 photoswitching with single-wavelength
 visible light 192–195
 super-resolution bioimaging 195–197
 supramolecular chirality 82
 surface properties
 selective metal deposition 151–154
 subwavelength nanopatterning
 154–155
 superhydrophobicity 150
 surface morphology 112
 surface topology 149
 surface wettability 149–151
 surface wettability 149–151
 Suzuki-Miyaura coupling 157, 172
 switches
 magnetism 141–146
 refractive index 141
 single-molecule conductance
 photoswitch 137–141

t

Tg 127, 151, 174
 thermal cycloreversion reaction of
 cyclohexadiene derivatives 50, 52
 thermal irreversibility 15, 16
 thermal fading rate 52

- thermally irreversible diarylethenes 19
thermally irreversible photoswitching
 diarylethenes 49
thermally reversible photoswitching
 chromophores 52–53
thermal stability of diarylethene
 derivatives 20
thiazole 19
thiophene 9, 19
thiophene rings of diarylmaleimide 44
three-dimensional erasable optical
 recording 108
three-dimensional optical memory
 130–132
toluene 8, 9
three photon absorption 131
toxicity test study (Ames-test) 201
1,8-TPID-naphthalene (TPID) 2
trans-cis photoisomerizable azobenzene
 175
trans-cis photoisomerization 4
transient absorption spectra 24–28
triarylimidazoleare dimers 93
triazines 93
2,4,6-trimethylacetophenone 4
T-type (thermally reversible) molecular
 photoswitches 1, 52–53
turn-off mode photoswitching 61–75
turn-on mode fluorescent diarylethenes
 80, 189–191
turn-on mode photoswitching 76–80
twisted intramolecular charge transfer
 interaction (TICT) 43
two-photon absorption (TPA)
 130–131
- U**
Ulbach rule 195
Ulbach tails 196
- V**
vibrational excess energy 22, 44
viscosity 4
vision 7
- W**
water contact angle (CA) 149
wavepacket 21, 44
Wittig condensation 157, 172
Woodward–Hoffmann rule 15, 50
- X**
X-ray crystallographic analysis 54, 86,
 93, 97–101, 106, 109, 112, 115
- Y**
Young's modulus 116, 120
- Z**
Zeonex polyolefin film 11, 126, 133

