Index

Ab initio calculations, 233
Ab initio MO method, 247, 251
Absolute helicities 268
Activation energies, 423–426,452, 454–456
Acryloyl residue, 11
Ag colloids, 387
Aggregates, 314
  head-to-tail mode, 314
  head-to-head mode, 315
Aggregates of the azo chromophore, 42
Alkali-metal cation, 402
Alkaline-earth metal cation, 404, 405
2-Alkoxy benzopyrans, 262, 274, 276, 278
Amino acid, 410
Amorphous polymer, 10
Amphiphilic azobenzene PVAS, 47
Anthracenopyran moiety, 320
Antibody, 401
Antigen, 401
Apparatus for fatigue resistance measurement, 130, 145–149
Apparent absorption coefficient, 74
Artificial receptor, 393
2-Aryl-2-methyl benzopyrans, 262, 274, 291
Atomic interaction energies, 251
Au electrode, 397, 399
Aza-crown ether, 403, 406
Azobenzene(s), 16,39,398
Azobenzene-attached acrylamide, 398
Azo-modified polymers, 45
1-Azonaphthalene, 29

Barriers energy to thermal racemization, 269, 271
Barriers to thermal enantiomerization, 273, 280, 281
Benzo-l,4-oxazines, 262, 273, 277
Benzopyrans, 262, 273
Benzopyran moiety, 301, 305
Benzothiazoline moiety, 360
Benzothiazolinic spiropyrans, 251
Benzothiazolino spiropyrans, 13,93–95, 359, 362, 363
Benzoxazolino spiropyrans, 359
Benzyl viologen, 213
Bianthrones, 451,453, 455
  folded form, 452
  twisted form, 452
Bibenzopyrans, 360
Bilayer membrane, 10
Bipyridinium salts, 213
Birefringence, 37
Bis-merocyanines, 419
Bispiropyran, 317
Bis-spiropyrans, 418–420
Bistable photochemical system, 189
Bithioxanthylidene, 455,456
Bovine serum albumine (BSA), 401
4-Bromo N-salicylidene aniline, 255

Canonical quinoid structure of merocyanine, 309
6-Carboxy-8-nitro spiropyran, 426
8-Carboxy spiropyran, 426
Charge transfer interaction, 445
Chemically Induced Dynamic Electron Polarization, (CICEP), 223
Cholesteric phases, 34
Cholesterol liquid crystal, 10, 31
Chromatography enantioselective liquid, 263, 265
Chromenes, 153, 184, 185, 187
2H-Chromene, 303, 314, 330, 331
  diphenyl and dimethyl chromenes, 330, 331
2H-Chromene moiety, 84, 360, 381, 388
Chromophores, 419, 420
α-Chymotrypsin, 399
Coherent anti-Stokes Raman scattering (CARS), 358, 366, 370, 371
Cinnamates, 39
Circular dichroism, 267, 268

Cis-cisoid X isomer, 68, 69, 71
Cisoid intermediate, 371
Cis-trans-cis (CTC) isomer, 372, 375
Classical (spontaneous) Raman spectroscopy, 358–360, 363–366
CNDO/S calculations, method, 253,303
CNDO/2 method, 251
Colorability, 74
"Commander molecules," 52
"Command surfaces," 39
Commercial spirooxazines and chromenes, 153, 154
Complementary hydrogen bond, 406
Concanavalin,397, 398
Configuration interaction (CI), 242
Conical intersection, 256
Conrotatory mode, 249
Continuous irradiation, 170, 175, 183, 194, 195
Crowned spirobenzopyrans, 404–406,410
Crowned spironaphthoxazine, 404
Crowned spiropyran, 402, 403
Cryptand spirobenzopyrans, 405
Cyclic voltammetry, 217
Cyclodextrin, 217
1.3-Cyclohexadiene, 255,256
Cytochrome c, 400
Cytochrome c oxidase, 400

Degradation products, 382, 386, 388
Dialkoxyanthracenes, 254
Diamino anthraquinone moiety (residue), 35
Diarylethene(s), derivatives, 244, 247, 249, 255, 256
1.4-Diazabicyclo [2,2,2] octane (DABCO), 110, 129, 131
Dichroic dyes, 41, 48
Dicyano diphenyl barbaralane, 458
Dicyano semibullvalene, 458
1,2-Di (3-furyl) ethene, 250, 251
Dihydroindolizines, 178, 254
Dimethylene succinic anhydride, 339
3′,3′-Dimethyl-6-nitro spiro[indoline-2,2′-[2H-1]benzothiopyran], 315
3,3-Dimethyl oxindole, 76, 123, 129, 387, 388
6,8-Dinitro spiropyran (merocyanine), 401
Dioctadecydimethyl ammonium chloride, 221
Dipalmitoyl-phosphatidylcholine, 221
1,2-Diphenyl ethene, 250, 251
1-Diphenylmethylene anthrone, 455
Diphenyl methylene xanthene, 455
7,7-Diphenyl[7H]pyrano[3,2-e]indole, 183
Diphenyl viologen, 214
2,2′-Dipyridinium salts, 218
4,4′-Dipyridinium salts, 217
Disrotatory mode, 249
Dixanthenylidene, 455
Dodecyltrimethylammonium chloride, 221
Doublet state, 212
Durability, 66
Dynamical method, 177

Electron Nuclear Double Resonance (ENDOR),214,222
Electron Paramagnetic Resonance (E.P.R)., 211–217, 219–228, 230, 233, 235, 253
Electron Spin Echo Modulation (ESEM), 221, 222
Electron spin resonance spectrometry, 139
Electron transfer, 211, 217, 219, 222, 223, 229
Egg phosphatidylcholine (egg PC), 410
Enantiomeric purities, 265
Enantiomerization,271–273, 280
Enantiomers, separation, 262,265
Energy of intermolecular interactions, 314
Enol-keto tautomeric, 436
Equilibrium constants, 431, 432, 434, 435, 450
1-Ethyl-1′-cetyl-4,4′-bipyridinium dibromide, 223
Ethyl viologen, 213, 217
Extended Hückel method, 251
E-Z photoisomerization of azobenzenes, 17
E-Z photoisomerization of doped azobenzene, 34
E-Z thermal isomerization of azobenzenes, 16

Fatigue resistance, 115
Ferrioxalate, 168, 173
Fischer's method, 198, 199
Flash photolysis, 167, 195, 432
9,9'-Fluorenylidene anthrone, 455
1-Formyl imino-2(lH)-naphthalenone, 133
1-Formyl-β naphthol, 123
Free radicals, 212
Free volume, 44, 45
Fulgides, 21, 338
  adamant-2-ylidene-(1′-methyl-3′-indolyl-ethylidene) succinic anhydride, 348,349
  arylidene derivatives, 339–343
  furyl fulgides, 20
  indole series, 343–347
  isomers, 341
Fulgide derivatives, 253, 255

Glucose oxidase (GOD), 400
Grafted spiropyrans on PS, PMMA, PHMA, PI polymers, 92
Guanine, 407, 408
Guanosine, 407, 408
Guest-host cells, 41

Hammett equation, 81
1,3,5-Hexatriene, 255,256
p-Hexyl azobenzene, 44
Homeotropic alignment, 39
Host-guest chemistry, 52
α-Hydrazones-β keto esters, 39
Hydrogen transfer, 436
2-Hydroxymethyl pyridine, 53
2-(2′-Hydroxy phenyl) benzothiazole, 255
6-Hydroxy-1′,3′,3′-trimethyl spiro[2H-1-benzopyran-2,2′ indoline], 69

INDO calculations, 214, 215, 218
Indoline moiety, 81, 301, 381
Indoline spirothiopyrans, 315
Indolino-nitrospiropyrans, 363–365
Indolino-spirobenzoxazines, 265
Indolino-spironaphthopyrans, 288, 360,371, 380
Indolino-spironaphthoxazines, 284, 360, 371, 372, 373, 380
Indolino spiropyrans, 298, 359, 372
Inductive effects, 81
Infrared (IR) spectroscopy, 358–364
IR, Raman spectroscopy, 445
In-plane alignment photocontrol, 39,47
Intramolecular hydrogen bonding, 447, 449
Intramolecular proton transfer, 436
Isotactic copolymer, 13

Laser flash photolysis (LFP), 227, 228
Length of the C spiro-O bond, 304
Leucohydroxyde, 398
Leucohydroxyde-attached acrylamide, 398
L-glutamic acid, 396
Linearly-polarized light, 24,38, 39
Liposomal bilayers, 410
Liquid crystal, 10
Liquid-crystal-induced circular dichroism (LCICD), 34
Liquid-crystalline polyesters, 35
Lone electron pair (LEP), 298, 299,301,317, 318, 322, 327, 330
Long-chain alkyl silylating reagents, 39
Low-mass liquid crystals, 33
L-lysine, 394

Marbled texture, 44
McConnell relation, 213
Mechanism of photooxidation of spirooxazines, 124
Merocyanine, 226, 228, 229
Merocyanines, 129, 133, 141
Mesoionic coumpound, 253
Mesomeric effects, 81
3-Methacryloxymethyl-5-nitro salicylaldehyde, 52, 53
Methacryloxy thiosalicylaldehyde, 53
Methacryloyl residue, 11
2-Methacryloyloxymethyl pyridine, 53
8-Methoxy-6-nitro BIPS, 126, 131, 366, 382, 385
Methylmethacrylate (MMA), 25,28, 53
Methyl viologen, 213, 214
Micelle, 10
Micelles, 220–222
Micro Raman spectrometer, 373
MNDO-AM1 calculations, 253
MNDO calculations (semi empirical), 249, 253
MNDO method (MOPAC), 325
MNDO/3 method, 254
MNDOC/MRSDCI method, 249, 255
MO calculations, 213, 218
Molar absorptivity, 432,454
Molar extinction coefficient, 75, 79
Molecular packing, 314
Molecular recognition, 393
Monoclonal antibody, 401
Multifunctional artificial receptor, 408
Multiplicity of the photoreactive state, 67

NAD(P)H, 399
Nafion,217
4H-Naphthalenoneperimidines, 333, 338
Naphthopyran moiety, 320
o-Naphthoquinone, 133
Naphthoquinonemethido dyes, 243
Naphth[1,2-d]oxazole, 123
Nematic liquid crystals, 39, 44
Nematic-isotropic transition temperature (T_{NI}), 33
Nematic phases, 31
N-ethyl-N'-trimethylaminopentyl-4,4′-bipyridine, 217
N-formyl-3′,3′-dimethyl oxindole, 129
Ni(II) phthalocyanine complex, 242, 243
6-Nitro BIPS, 366, 369
6-Nitrospiro benzopyran, 11

6-Nitrospiro [indoline-benzopyran], 15
8-Nitro spiro[indoline-benzopyran], 426
6-Nitrospiropyrans, 39
Nitro-substituted spiropyrans, 68, 72
Nitroxides,212, 227, 228, 234
5-Nitro-o-vanillin, 76, 387, 388
N-methylated guanine, 408
N-methyl pyridinium chloride, 214
1H, ^{13}C, NMR421, 425, 436, 443, 445, 448–452
^{1}H NMR Nuclear Overhauser Effect (NOE), 247
NMR, solid state, 421, 446
N,N′-bis (salicylidene) diamines, 446
N,N′-dihydro-4,4′-dipyridiniutn dichloride, 213
N,N'-dihydro-4,4'-dipyridyl, 213
N→N proton transfer, 316
Non-azaheterocyclic spiropyrans, 111
Non linear optics, 253
1H Nuclear magnetic resonance (NMR) spectroscopy enantioselective, 266,267
Nucleobase, 406
Nucleobase receptor, 406
Nucleoside, 407

Oligooxyethylene diacetate (OOEAc), 410
Optical, kinetic and fatigue resistance, properties of commercial pigments, 154–164
Orbital interactions, 300, 303, 318
Out-of plane alignment photocontrol, 331
Oxaindan moiety, 320
2-Oxaindan spiropyrans, 320
  photochromism, 324
Oxaindano-spirobenzopyrans, 283
Oxaindano-spironaphthopyrans, 283
Oxazine moiety, 325
Oxidation in dark solutions, 136

Pariser–Parr–Pople method, (PPP), 241, 242, 253
Permanent merocyanines, molecular structure, 306–311
  crystals,314
  hydrogen bond, 311
  solvation, 310
  trans-cisoid isomer, 311, 313, 314
  trans-transoid isomer, 311, 313, 314
Permanent (open form) merocyanine, 372, 373
Photobirefringence, 36, 37
Photochemical fatigue, 110, 112–114. 145
Photochemical properties of spiropyrans, 315
Photochemical rate equation, 170
Photochromic liquid crystalline polymer, 31
Photochromic polymers, 9
Photochromic Schiff bases, 254
Photochromism of sydnone, 253
Photocoloration, 68, 73, 78
Photocoloration quantum yields, 74
Photocontrol of antigen-antibody reaction, 401
Photocontrol of ionic conduction, 408
Photocontrolled transport, 410
Photodegradation, 68, 73, 75, 78, 101–110, 168,182,183,191-193,195,203
Photodichroism, 25, 36, 48, 49
Photoexcitation, 66, 84, 110
Photofunctionality, 9
Photoinduced birefringence, 25, 37
Photokinetic factor, 168, 197
Photoinduced ionic conductivity change, 408
Photomerocyanines (open forms), 361, 364, 366, 372, 375
Photomodulation of peptide conformation, 394
Photon-heat mode, 247
Photon-photon mode, 249
Photooxidation, 68, 73, 382, 386, 388
Photoreceptor, 397
Photoregulation for cation-binding of spiropyran, 408
Photoregulation of enzyme activity, 398
Photoregulation of protein characteristics, 397
Photoresponsive liquid-crystal, 39
Photostability of fulgides, 151–153
Photostability, 74
Photostationary method, 177, 195, 198
Photostationary state, 175, 177, 189, 197
Pimers, 216
Polarization holography, 25
Polarization photochromism in polymer solids, 24
Polarization photochromism of liquid-crystalline polymers, 35
Polarized light induced dichroism, 24
Poly[4′-(2-acryloyloxy ethyl) ethylamino]-4-nitro azobenzene, 53
Poly carbonate, 20
Poly (L-glutamate) film, 34, 35
Polymeric Langmuir–Blodgett films, 10, 33, 39, 44
Polymeric materials, 9
Polymeric matrix, 9
Polymeric mesophases, 31
Polymers doped with photochromic compounds, 24
Polymethyl (ethyl) methacrylate (PM(E)MA), 25, 28
Poly (N-vinyl-2 pyrrolidone), 18, 19

Poly (perfluorosulfonate (PPFS-Li), 410
Polyphosphazenes, 15
Polysiloxanes, 15
Polystyrene (PS), 20
Poly (tetrahydrofuran), 19, 53
Poly (trityl methacrylate) on silica, 265, 269
Polyurethane films, 382
Polyvinyl alcohol (PVA) 25, 40
Poly (vinyl chloride) (PVC), 408
Positive and negative thermochromism, 432,443
Potassium tert-butoxide, 230, 231
Previtamine D_3, 255, 256
3-i-Propyloxy-8-methoxy-3´methyl6-nitro-[benzo-thiazolino-[2,2´][2H-l]-benzopyran], 180–182
Pyrroles, 220
Pyrroloquinolinoquinone (PPQ), 399

Quantum yield, 170, 177, 181, 195, 255
Quinoidal structure, 369, 370, 372, 374
Quinoid structure of merocyanine, 308, 309
Quinone derivatives, 254

Radical anion, 211,218, 230, 231, 233, 234
Radical cation, 211, 212, 214, 217-219, 223
Radical ions, 212
Random coil α-helix conversion, 396
Regulation of liquid crystal alignment, 39
Relative configurations, 267
Reorientation of azobenzenes, 29
Ring-opening process (step), 361, 371
Rubling treatment, 47

Salicylaldehydes, 76
Salicylidene-meta aminopyridines, 439
Salicylidene-para aminopyridines, 439
Salicylidene Schiff bases, 445,446
Salicyl-Schiff bases, 436
Saturated five-membered ring azaheterocyclospiropyrans, 96–99
Saturated six-membered ring azaheterocyclospiropyrans, 99, 100
Schlieren texture, 44
Self-organization of liquid crystals, 50
Semi bullvalenetetracarboxylates, 458
Side-by-side interaction, 47
Single-ionic conducting system, 410
Singlet oxygen reactivity, 124
Smectic phases, 31
Sodium 1,2-bis (2 ethylhexyl carbonyl)-1-ethanesulfonate (AOT)reversed micelles, 411
"Soldier molecules," 52
Sol-gel inorganic matrices, 21
Solvatochromism, 374,385,418
Specific rotation [α], 267
Spin-coated films, 40
Spin -coating of amorphous azopolymers, 37, 39
Spin density and spin density distribution, 212-215, 230, 231, 234
Spin-probes, 234, 235
Spin trapping, 227, 234
Spiro [benzopyran-naphthopyrans], 283
Spirobenzopyrans, 262, 278, 280, 282
Spiro benzoselenazolino benzopyran, 12, 53
Spiro[bibenzopyrans], 115, 117,360
Spirobinaphthopyrans, 281
Spiro center, 301, 306, 315, 317, 322, 325, 329
Spiro compounds, 226, 227
Spirocyclic cyclohexadienone perimidine, 333, 338
Spiro cyclopropene fluorene, 53
Spiro [dithiolene-benzopyrans], 118
Spiro [fluorene-benzopyrans], 330, 331
Spiro fluorenyl indolizines, 14, 53
Spiro[indoline-benzoxazines], 262, 284, 285, 287, 290, 420
Spiro [indoline-benzopyrans], 186, 190, 203, 212, 226, 229, 262, 288–290,426
Spiro [indoline-naphthopyrans], 127, 135, 149, 212, 234,416
Spiro [indoline-naphthoxazines], 132, 149, 212, 233, 234, 286, 287,416, 420,432
Spiro[indoline-oxazines], 430
Spiro[indoline-phenanthrolinooxazines], 420
Spiro[indoline-phenanthroxazines], 420, 432
Spiro[indoline-pyrans], 416,425
Spiro indolino benzopyrans, 52
Spiro-2H-naphtho[1,8-bc]-oxepins, 318
Spironaphthoxazines, 245
  ^{13}C NMR shift, 245
  relative energy of open forms calculation, 248
  visible absorption of the colored forms, 245
Spiro[oxaindane-pyrans], 425, 426
Spiro[oxazepine-naphthoxazines], 420
Spirooxazines, 359, 364,372
Spirooxazine-doped polymer films, 253
Spirooxazines, 324, 326
  benzoxazines, 325
  naphthoxazines, 325
  quinolinoxazines, 325

Spirooxazines photodegradation, 115, 120
effect of solvent polarity on photodegradation and colorability, 119
effect of structure on photodegradation and colorability, 119
effect of wavelength irradiation on photodegradation and colorability, 119
Spiropyran(s), 298, 302, 323, 357, 364
colorability, 324, 329
Spiropyran-assembled Au electrode, 399
Spiropyran-attached acrylamide, 398
Spiropyran-containing polypeptide, 394, 395
Spiropyran(s) (derivatives), 247,251
Spiropyran-modified concanavalin, 397, 398
Spiropyran-modified poly (L-lysine), 394
Spiropyran-modified poly(L-glutamic acid), 396
Spiropyran-modified polypeptides, 395–397
Spiropyridopyrans, 406, 408
Spiro [oxaindane-benzopyrans], 262, 283, 284
Spirothiopyran, 11
Stack packing, 439
Stilbenes, 39
Structural studies, 297
6-and-8-Substituted spirobenzodithiolane, 111, 116
6-and-8-Substituted spirobenzoxathiolane, 111, 117
Substituted spirobenzopyrans, 84–93
Substituents effects, 82
6-Sulfonato spiropyran, 429
Supramolecular aggregates, 49
Supramolecular chemistry, 393
Surfaces-assisted liquid crystal alignment control, 39
Surface-assisted phenomenon, 44
Surface enhanced (resonance) Raman spectroscopy (SE(R)RS), 358, 378-383, 385-388
Surface photochromism, 39
Sweep volumes for isomerization, 30

Taft equation, 94
Tautomeric prototropic equilibrium, 439, 446, 448
Transition state of Csp^3-O bond cleavage, 271
Triacetyl cellulose (TAC), 263
Tert-butoxy radicals, 211, 234
Tetrabutylammonium borohydride, 231–233
2,3,4,4-Tetrachloro-1-oxo-dihydronaphthalene, 224
7,7,8,8-Tetracyano quinodimethane (TCNO), 136,228
1,2,3,4-Tetrahydro-2,3-dioxo-4,4-dimethyl quinoline, 123
Tetrakis [3,5-bis (trifluoromethyl) phenyl] borate anion ($TFPB^-$), 19, 54
Tetramethyl indoleninium iodide, 383,386
4-(2,2,6,6-Tetramethyl piperidinyl-1-oxyl) (TEMPO), 235
2,4,6,8-Tetraphenyl barbaralane, 458
Theoretical calculations, 422,423,438,450, 452, 453
Theoretical MO calculations (transition state), 271
2,4,6,8-Tetraphenyl barbaralane, 458
Thermal degradation of photochromes, 75
Thermal isomerization, 422
Thermal racemization, 261, 269
Thermal relaxation, 199
Thermal ring-opening reaction, 286
Thermal stability, 247
Thermal valence isomerization, 323
free energies of activation, 323
Thermochromic perimidine spirocyclohexadienones, 421, 458
Time-resolved resonance Raman **(TR^3)spectroscopy**, 358, 366–370, 372–377
TiO_2, 216
2-(Thioxanthene-9-ylidene) indane-1,3-dione, 455
β-TKN, 224, 225
Trans isomers, 372, 375
Trans-trans-cis isorner (TTC), 372, 373, 375-378
Triads DDD, MDD, MDM, 29
Trianions, 233, 234
Tribenzoyl cellulose, 263
1′,3′,3′-Trimethyl-5′-nitrospiro[indoline-2,2'[2H-1]benzopyran], 304
1′,3′,3′-Trimethyl-8-nitrospiro[indolino-benzopyran], 226
1,3,3-Trimethyl oxindole, 76, 123, 129,387, 388
TR^3 instrumentation, 367, 368
Triphenylgermyl radicals, 234
Triphenyl imidazolyl radical, 191-194
Triplet biradicals, 212, 227
Triplet diradical, 227
Triplet spectra, 212
Triplet spectrum, 226, 228
α-Tocopherol, 223

Unsubstituted spiropyrans and spirooxazines, 70

Violagens, 212–214, 216–223
Viologen polyionenes, 19, 53

Water-soluble azo dyes, 48, 50
Watson–Crick base pair, 408
Woodward–Hoffmann rules, 249

Xanthylidene anthrone, 455
X-Ray diffraction, 297
X-Ray diffraction, 439, 445, 446, 451, 456–459

Zeolites, 218
Zindo method, 242
Zwitterionic,416,49
Zwitterionic structure (form), 364, 366, 369, 370
Zwitterionic structure of merocyanine, 308, 309