

## Index

### a

- ab-initio methods 46, 202
- absorbing counter cation (ACC<sup>+</sup>) 88
- absorption intensity 37
- absorption of light 20, 21, 35, 36
  - and optical transitions 36–37
- absorption spectra 19, 42, 46, 48, 59, 89, 133, 175, 203, 264, 290, 360, 388, 449, 450, 541
- acetals 10, 122, 143
- acetone 91–92, 143, 214, 476
- acetonitrile 64, 68, 89, 128, 133, 140, 141, 203, 204, 206, 217, 218, 278, 347, 495
- acetophenone 63, 64, 214, 382, 406
- acridone derivative/Iod/NPG system 324, 401
- acrylamide 91, 275, 349–351, 479, 480, 490, 610
- acrylate (AC) 262, 327
  - formulations 671
  - photopolymerization 600
- acrylic radical 263
- acrylonitrile (AN) 168, 264, 275, 342, 343
- 4-acryloylmorpholine 352
- activation energy 46, 64, 65, 258, 336
- acylgermanes 80, 360, 437, 498
- acylperoxides 170
- acylphosphine oxides 73, 75, 271, 336, 375, 383, 532
- acylphosphonates 73
- acyl radicals 87, 122, 259, 262, 484
- acylsulfonium salts 207–208
- adiabatic ionization potentials 341, 342
- alcohols and THF 125
- aldehydes 122, 141, 143, 222, 387, 467
- aliphatic ketones 142
- alkoxyamines 86, 301, 562
- alkoxyl radicals 78, 148, 259, 283, 337, 409
- alkylaluminium porphyrin 242
- alkylperoxyls 284–286, 295
- alkyl phenyl glyoxylates (APG) 77, 141
- aluminate complexes 90
- aluminium enolate 242
- amine-boryls 292
- amine-imides 249
- amine/iodonium salt systems 80, 172–173
- amines 119, 120, 243, 282
  - containing structures 123
  - and oxygen inhibition 121
  - phenols 121
- $\alpha$ -aminoalkyl peroxy radicals 284
- $\alpha$ -aminoalkyl radicals 265, 270
- aminoalkyl radicals 302, 344, 355
  - amines 268
  - chain length effect 268–269
  - halogen abstraction reaction 270
  - hydrogen abstraction 265
  - interaction rate constants 266, 267
  - ketone triplet state 265
  - NPG derivatives 268
  - nucleophilic 268

- aminoalkyl radicals (*contd.*)  
 reactivity under air 270–271  
 regioselectivity, hydrogen abstraction  
 reaction 269  
 two-orbital-three electron 265
- aminobenzophenones 128
- amino ketones 66–67, 249, 346, 468
- $\alpha$ -aminoketone series 532
- $\alpha$  amino para morpholino benzoyl ketones  
 347
- aminosilyl radical 269
- aminyl radicals 268, 288–289
- ammonium tetraorganyl borate salts 88,  
 247
- amphiphilic hyperbranched surfactants  
 607
- anionic chromophore containing  
 ammonium salts 248
- anionic photoinitiators  
 amines 243  
 cyano derivative/amine system 243  
 inorganic complexes 241–242  
 ketoprofen 243  
 organometallic complexes 242
- anionic photopolymerization 4, 12, 171,  
 241, 242, 560, 577
- anthracene 153, 207, 215, 216, 482, 490,  
 664
- anthraquinone 117, 142, 151, 215, 220,  
 449
- 9,10-anthraquinone derivatives 500
- anthraquinones 117, 142, 151, 215, 220,  
 380, 498, 500
- $\text{ArCr}(\text{CO})_3$  297, 298, 441
- arene sulfonate derivatives 243
- aromatic amines 142, 265, 346, 347
- aromatic diketones 138
- aromatic ketones 61, 142, 291, 348, 400,  
 486, 668
- Arrhenius' plot 335
- Arrhenius's law 258
- aryl dialkyl sulfonium salts 209
- aryl diazonium salts 611, 612
- aryloxy radicals 262
- 5-arylthianthrenium salts 209
- atom transfer radical polymerization  
 (ATRP) 168, 540, 559
- Avogadro's number 22
- azahelicenes 163, 167, 219, 497
- azides and aromatic bis-azides 79
- azo compounds 533
- azo derivatives 82–83
- b**
- BAPO series and germyl ketones 382
- Barton's ester 87, 276
- bathochromic shift 37, 77, 81, 82, 89,  
 163, 383, 387
- Beer's law 36
- benzaldehyde 63, 68, 122, 141, 143, 247,  
 248, 467, 470
- benzil 63, 76, 117, 138, 151, 215
- benzodioxinone (BD)/amine/Iod 439
- benzoin ethers 333, 347  
 absorption of 62–63  
 $\alpha$ -cleavage process of 64  
 initiating radicals in 64  
 Lewis acids effect 65  
 photolysis of 63–64  
 series 532  
 substitution effects in 64–65
- benzoin scaffold 360
- benzophenazine dyes 148–149
- benzophenone (BP) 72, 85, 213, 327,  
 333, 341, 345, 350  
 absorption 127–128  
 BP/silane 322  
 derivatives 131  
 excited state interactions 128, 129  
 phenyl sulfides 72  
 photoinitiators 130–132  
 photolysis 128  
 series 533  
 styrene couple 341  
 substituted 128–129  
 sulfonyl ketones 73  
 thiobenzoates 73  
 and thioxanthone 73  
 (or thioxanthone)/iodonium salt  
 125–126

- benzophenone thio moiety (BP-S) 379
- benzothiophene iminophenylacetonitrile (BTIPA) 243
- benzoxazines (BOA) 121–122, 176, 644
- benzoyl/acylphosphineoxide chromophore based compounds 345
- benzoyl benzodioxolane derivatives 463–464
- benzoyl-benzoxazole 85
- benzoyl chromophore 59–72
- benzoylformamides (BFA) 170, 247, 600
- benzoyl group containing PIs 336
- benzoyl oxime esters 296, 347
- benzoyl phosphine oxides 73–76, 347, 470
- benzoyl radicals 61, 64, 67, 69, 75, 141, 171, 262–263
- benzoyl substituted cyclopentadienyl anion 242
- benzoyl substituted ferrocene 242
- benzoyl-tetrazole 85
- benzylidithiocarbamates 299
- benzyl esters 243
- biacetyl 138
- bichromophoric photoinitiators 383–384
- bicyclic guanidinium tetraphenylborates 248
- bifunctional acetal sesamin 500
- bifunctional ketone-sulfonyl ketone derivatives 276
- biomaterials 28, 566, 595, 663, 666–667
- bioprinting 663
- biradical generating ketones 76
- bis aryl silyl ketone 81, 82
- bis(cyclopentadienyl) dimethylzirconium 288
- bis-2 ethyl hexyl sodium sulfosuccinate 351  
micelles 350
- bis-imidazole 144, 147, 533, 671
- 1,3-bis(dicyanomethylidene) indane 152–162
- bisphenol A epoxy diacrylate oligomer 322
- bisphenol A-glycidyl methacrylate bis-GMA/triethyleneglycol dimethacrylate 327
- bis-pyridinium derivatives 467
- (*E*)-3-(2,2'-bithiophen-5-yl)-2-cyanoacrylic acid chromophore 249
- bleachable photoinitiators 642–643
- block co-polymers 611, 612
- blue-shift 37, 65, 80
- bond dissociation energy (BDE) 46, 57, 285, 291, 294, 301, 303, 337–340, 399
- borane 288, 347  
complexes 124, 293
- boron-nitrogen bond 84, 85
- boron-sulfur bond 84
- boryl radicals  
characteristics 292–293  
photoinitiation under air 295  
reactivity 293–295  
reactivity under air 295
- BP/monomer interaction 322
- BP/silane hydrogen abstraction reaction 322
- Brønsted acids 200
- bulk monomer/oligomer (EpAc) 353
- butylacrylate 267, 272, 298, 353
- butyldiisopropoxyborane 288
- butyl vinyl ether (BVE) 204, 206, 209, 342, 437
- C**
- Cage effects 17, 42, 44, 45, 353
- camphorquinone (CQ) 77, 117, 126, 133, 139, 323, 327, 334, 540
- camphorquinone (CQ)/amine (AH)/diaryliodonium salt (Iod) system 323
- carbamates 87, 125, 246, 249
- carbazoles 150, 163, 215, 219, 222, 439
- carbon centered radicals 55, 61, 77, 94, 120, 122, 259–261, 267, 270, 277, 285, 301, 343, 408, 438
- carbon-germanium bond 79–81
- carbon nanotubes 222, 610, 661

- carbon-nitrogen bond 83
  - carbon-silicon bond 81
  - carbon-tin bond 81
  - cationic and vinyl functionalities 360
  - cationic monomers 10, 11, 126, 202, 218, 219, 222, 354
  - cationic photoinitiators 119, 200, 219, 480
  - cationic photopolymerization 11, 15, 199
    - monomers/oligomers in 10–11
  - cationic polymerization 4, 77, 168, 199, 257, 302, 385–386, 435–452
  - chain length effect 268–269
  - charge transfer complex (CTC) 12, 43, 118, 209, 337, 390–391, 420, 469
  - charge transfer photopolymerization 12
  - charge transfer (CT) transitions 37
  - 1-chloro-4-propoxy-thioxanthone (CPTX) 134, 641
  - 2-chloro thioxanthone 134, 216
  - chromium amine thiocyanate complexes 241
  - chromium complexes 90
  - cleavable photoinitiators 129, 139, 346, 486, 603, 604
  - cleavage processes 59, 64, 66, 67, 69, 70, 72, 73, 85, 86, 203, 297, 301, 328, 335–336
  - cleavage rate constant 46, 62, 64, 65, 67, 70, 322, 335, 336
  - cleavage yield 335, 345, 348, 409
  - cobalt complexes 568
  - cobalt-mediated radical polymerization (CMRP) 560, 572
  - controlled/living polymerization reactions
    - cobalt complexes 568
    - copper (I) complexes 565
    - copper (II) complexes 564–565
    - dithiocarbamate 560–561
    - gold complexes 569
    - iridium complexes (IrC) 563–564
      - metal free compounds
      - iodine containing compounds 572
  - ketones 574
  - organic dyes 570
  - organic type I photoinitiators 572
  - thiocarbonylthio compounds 573
  - methodologies for 559
  - nobium based compounds 570
  - O-alkoxyamines 562
  - ruthenium complexes 564
  - zinc complexes 567
  - iron complexes 566
  - magnesium complexes 568
  - manganese carbonyls 569
  - metal free compounds
    - benzaldehyde/N,N-dimethylaniline/perfluoro-1-iodohexane system 574
    - hydrocarbons, phenazines and phenothiazines 572–573
  - conventional photopolymerization reactions 7
  - copper-catalyzed azide-alkyne cycloaddition (CuAAC) 670
  - copper complex/iodonium salt 168
  - coumarin 140, 210, 248, 334
  - coumarin-based iodonium salt 211, 340
  - coumarin (or ketone)/HABI/amine (or thiol) 334
  - CQ/amine couple 667
  - Curcumin (Cur) 163, 499
  - cyano acrylate monomer (CAcr) 242
  - cyanoacrylates 12
  - cyano derivative/amine system 243
  - cyclic acetals 122
  - cyclohexylamine 268
- d**
- decarboxylation reaction 259, 268
  - density functional theory methods 46
  - dialkoxy acetophenones 65, 333, 347
  - di-alkyl arylsulfonium salts 208
  - diaryliodonium salt 210, 214, 576
  - 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) 243
  - diazonium salts 199–200, 611, 612
  - dibenzothiophenes 93

- dibenzoyldiethylgermane 360, 601  
 dichromophoric hemicyanines 149  
 diethoxyacetate salts 127, 499  
 diethylamine 268, 289  
 diethylamino benzophenone 128  
 diethyleneglycol divinylether (DVE) 15  
 diffusion rate constant 44, 218, 322, 323, 328  
 difunctional photoinitiators 384  
 digermanes 92  
 1,8-dihydroxyanthraquinone 500  
 diiodated boron-dipyrromethene (BODIPY) 243  
 diketones 76, 77  
   aromatic 138  
   camphorquinone 139–140  
 diketo pyrrolo-pyrrole derivatives (DKPP) 401  
 dimethoxybenzyl radical 259, 452  
 dimethyl-(2,2'-bipyridyl)platinum(II) (DMBP) 441  
 2,4-dimethyl-1,2,4-triazol-3-ylidene borane 349  
 diode lasers 25, 26, 325, 445, 486  
 diphenylacetophenones 65  
 $\alpha,\alpha$ -diphenylacetophenones 65, 348  
 diphenylditelluride derivatives 85  
 diphenylquinoxaline 86  
 direct detection of radicals 257  
 direct laser writing (DLW) 245, 609, 664–665  
 direct micelles 350  
 direct photoinitiation process 40  
 diselenide derivatives 85  
 disilane derivatives 84–85  
 dispersion 6, 8, 29, 350, 477, 496, 564, 567, 572, 607, 608  
 dissociation quantum yield 47, 62, 73, 77, 147, 283, 335, 352, 360, 361, 409  
 distannanes 92  
 disulfides 86, 248, 421, 607  
 $\alpha$ -disulfones 245  
 dithiocarbamyl radicals 299, 300  
 dithienophosphole derivatives 162, 164, 401  
 dithiocarbamate 87, 299, 560–561, 576  
 donor/acceptor systems 172  
 double bond radicals 258  
 D- $\pi$ -A arrangements 211  
 D- $\pi$ -A oxime sulfonates 211  
 D- $\pi$ -D core linked sulfonium salts 211  
 dye/amine systems  
   additives 146  
   Eosin/Rose Bengal models 143–144  
   kinetic data 144, 145  
   overview 144–146  
 dye/ferrocenium salt 148, 420–422  
 dye (or ketone)/H-donor/iodonium salt 334  
 dye linked additive ion-pairs 149  
 dye linked photoinitiator 149–150  
 dye/*N*-vinylcarbazole/iodonium salt 413  
 dyes 117, 140, 142–144, 150, 151, 153, 158, 165, 168, 217, 219, 220, 334  
 dye-sensitized solar cells (DSSC) 674  
 dyes, reactivity 165, 167
- e**
- $E_{\text{enth}}$  258–259  
 electromagnetic radiation 22–23  
 electron and hydrogen transfer reactions 336–337  
 electron deficient monomers 64, 143, 260, 261, 274, 279, 343, 344  
 electron donor couples 209  
 electronic affinity (EA) 46, 259  
 electron poor monomers 273, 292, 341, 343, 344  
 electron/proton donors 117–125  
 electron/proton transfer process 337, 464  
 electron rich monomers 86, 260, 261, 268, 274, 276, 279, 293, 341, 343, 344  
 electron transfer rate constant 118, 125, 216–218, 336  
 electron transfer reactions 41, 168, 216–222, 337

- electrospray ionization mass spectrometry  
46, 61, 360
- emulsions 8, 56, 350, 606, 607
- end capped polyenic structures 220
- energy barrier 57, 64, 68, 335, 389
- energy transfer measurements 341
- enthalpy effects 261, 267, 274, 275, 279,  
343
- Eosin (EO) model 143–144
- Eosin Y 401, 480, 546, 570, 571, 607, 609
- $E_{\text{pol}}$  259
- epoxide (EPOX) photopolymerization  
485
- epoxyacrylate (EpAc) 85, 123, 152, 328,  
352, 355, 489
- epoxy acrylate/hexanediol diacrylate  
327
- epoxy acrylate oligomer/monomer matrix  
322
- 3,4-epoxycyclohexyl methyl methacrylate  
345, 360
- Erythrosine B 570
- ESR-spin trapping 260, 261, 265, 269,  
271, 273, 276, 277, 283, 285, 289,  
297
- esters of sulfonic 243
- 2-(2-ethoxy-ethoxy) ethyl acrylate 299
- ethyldimethylaminobenzoate (EDB)  
265, 287, 322, 323, 355
- ethylene 343
- ethylvinylether (EVE) 260, 261
- excited stated processes 334
- exothermicity 78, 258, 259, 266, 267,  
270, 279, 289, 291, 343, 600
- experimental electron transfer rate  
constant 336
- exposure reciprocity law (ERL) 38
- f**
- femtosecond transient absorption  
spectroscopy 45, 64, 360, 362
- ferrocenes  $\text{FeCp}_2$  242
- ferrocenium salts 146, 148, 169, 212,  
213, 222, 407, 420
- first monomer radical yield 335
- flavones 400, 500
- fluid media 41, 45, 202, 323, 327, 334,  
335, 345–350
- fluorenones 141, 142, 152, 387, 472, 486
- fluorinated photoinitiators 489
- fluorone dyes 533
- four-component systems  
cyanine/borate/iodonium  
salt/phosphine 422–423  
dye/ferrocenium salt/amine/  
hydroperoxide 421–422  
ketone/HABI derivative/amine/  
iodonium salt 422  
NIR dye/iodonium salt/phosphine/  
thermal initiator 423
- 4D polymer micropatterning 665
- $\beta$ -fragmentation process 274, 294
- fragmentation reaction 275, 452
- free radical photopolymerization (FRP)  
4, 9, 56, 257, 270, 324, 354, 361,  
666, 673
- free radical promoted cationic  
photopolymerization (FRPCP)  
56, 302, 324  
addition/fragmentation reaction 452  
copper complex/*N*-vinylcarbazole/  
iodonium salt 449–450  
cyclic monomers 436  
decatungstate/silane/iodonium salt  
447  
generated peroxy radicals 435  
iron complex/*N*-vinylcarbazole/  
iodonium salt 450–451  
keggin-type anion/silane/iodonium salt  
447  
metal carbonyl/silane/iodonium salt  
441  
multicolor photoinitiators and  
panchromatic cationic  
formulations 449  
perovskite/*N*-vinylcarbazole/iodonium  
salt 451  
photoinitiator/alcohol/iodonium salt  
447–448

- photoinitiator/alkylhalide/iodonium salt 451  
 photoinitiator/amine/iodonium salt 439  
 photoinitiator/CARET/iodonium salt 451  
 photoinitiator/germane/iodonium salt 447  
 photoinitiator/metal salt/additive based systems 452  
 photoinitiator/*N*-vinylcarbazole/iodonium salt 448  
 photoinitiator/silane/iodonium salt ketone/silane/iodonium salt systems 440  
     mechanism 439–440  
     novel dye/silane/iodonium salt systems 440–441  
 Pt(II) complex/silane/iodonium salt 441–445  
 titanocene/silane/iodonium salt 441  
 type II photoinitiator/iodonium salt three-component systems 439  
 type I photoinitiator/pyridinium salt 438  
 type I photoinitiator/sulfonium salt 438  
 type I photoinitiator/zinc salt 438  
 type I PIs  
     acylgermane/iodonium salt 437  
     ketone/iodonium salt 436–437  
     organo tellurium compound/iodonium salt 438  
     polysilane/iodonium salt 437  
     vinyl halide/iodonium salt 437  
 upconversion nanoparticle based systems 451–452  
 UV and visible lights 448–449  
 vinyl ethers 436  
 zinc complexes/silane/iodonium salt 441  
 free radical promoted cationic polymerization 199, 257, 435–452  
 fullerenes 245  
 fused iodonium salts 210–211
- g**
- germane-ene chemistry 594  
 germanes 124, 141, 171, 172, 291, 347, 407, 410, 415, 478  
 germyl and stannyl radicals  
     characteristics 290  
     reactivity 290, 320  
     reactivity under air 290–291  
 germylperoxyls 288, 291, 292  
 germyl series 533
- h**
- halogen abstraction reaction 259, 270  
 halogenated ketones 65, 92  
     dialkoxyacetophenones and diphenylacetophenones 65  
     morpholino and amino ketones 66–67  
 heteroatom doped carbon 94  
 heterogeneous media 21, 350–352  
 hexafluoroantimonate 83, 217, 305, 361, 534  
 hexafluorophosphate 83, 148, 149, 298, 303, 361, 476, 534  
 hexanediol diacrylate (HDDA) 298, 322, 352, 595  
 highest occupied molecular orbital (HOMO) 36, 74, 76, 80, 82, 85, 205, 258, 381, 465  
 highly conjugated ketones 220–221  
 highly reactive monomers (HRAM) 125  
 highly stable peroxy radicals ROO 324  
 high molecular weight amines (HmWA) 120  
 high-performance blue light sensitive PISs 355  
 high-resolution electrospray ionization-mass spectrometry (ESI-MS) 46  
 hindered amine (HALS) 19, 120  
 holography 26, 28, 673  
 homolytic substitution reactions ( $S_H2$ ) 288

- hot lithography 663  
H-transfer reaction 258, 410  
hybrid organic-inorganic amines 120–121  
hybrid sol-gel photopolymerization 244, 602  
hydrocarbons 136, 146, 170, 200, 215, 337, 410, 439, 481, 482, 484, 572–573  
hydrogel synthesis 29, 605–606  
hydrogen abstraction rate constants 91, 119, 268, 278, 286, 290  
hydrogen donors 39, 46, 69, 70, 117–125, 334  
hydroperoxides 56, 78, 122, 125, 167, 170, 171, 219, 270, 281, 297, 324  
hydroperoxydes ROOHs 283  
hydrophilic acyl phosphine oxide derivatives 477  
hydroquinone methylether (HQME) 264, 265  
hydrosilylation 277, 601–602  
hydroxamic acids 87  
hydroxy alkyl acetophenones 67–69, 348  
hydroxy alkyl conjugated ketones 92  
hydroxy alkyl/cyclohexyl acetophenones 347  
hydroxy alkyl heterocyclic ketones 72  
hydroxyalkyl ketones 333, 377  
2-hydroxy-4'-(2-hydroxyethoxy)-2-methylpropiofenone (wHAP) 477  
hydroxyimide sulfonates 243  
2-hydroxy-isopropyl radicals 302  
 $\alpha$ -hydroxyketone series 532  
2-hydroxy-2-methylpropiofenone 324, 603, 605  
hydroxyphenyl dialkyl sulfonium salts 208  
hypsochromic shift 37
- i**
- imidazole 140, 147, 275  
iminosulfonates 241, 243, 244  
iminyl radicals 296  
industrial photo initiators  
  cationic industrial photoinitiators 534  
  commercial radical PIs 532  
  tailor made formulations 534–535  
  toxicity and REACH registration 535  
initiation quantum yield 14, 43, 45, 47, 141, 205, 219, 334, 473  
inorganic complexes 91, 241  
inorganic transition metal complexes 214  
interaction rate constants 46, 61, 67–69, 124, 129, 134, 136, 338  
interactions of initiating radicals with hydrogen donors 344  
interpenetrating polymer networks (IPN)  
  one-step production 595–596  
  two-color responsive initiating systems 598  
  two-step production 596  
  visible light induced one-step formation 596  
intersystem crossing (ISC) 39, 40, 57, 62, 68, 128, 133, 147, 334  
iodo-ene chemistry 594  
iodonium-naphthalimide 210  
iodonium-polyoxometalate 210  
iodonium salts (Iod) 89, 125, 126, 148, 150, 151  
  absorption properties 202, 203  
  amine couples 209  
  compounds 200  
  decomposition processes 202–205  
  phenylethynyl or alkynyl phenyl 209  
  photoinitiation step 205  
  photopolymerization reaction 201–202  
  substitution effects in 207  
ionization potential (IP) 46, 212, 259, 303, 304, 336, 341, 420  
ion pair photoinitiators 87  
iron complexes 566  
isobornyl acrylate 563  
2-isopropyl thioxanthone 133, 134  
isopropylthioxanthone (ITX) 126



**j**

Jablonski's diagram 39–40

**k**

ketocoumarin 117, 139, 140, 334, 533

ketoesters 142

ketone 333, 439

based systems 168

chromophore 283

sulfonic esters 69

as type II photoinitiators 143

ketone/amine systems 347

ketone/electron acceptor couples 125

ketone/ketone based systems 169–170

ketone/novel iodonium salts 126

ketone (Ket)/NVK/Iod system 412

ketone/triazine 126–127, 421

ketoprofen 243, 577

ketosulfoxides 72

ketyl radicals 119, 121, 125, 128, 134,

139, 141, 261, 265, 278, 290, 293,

302, 347, 355, 407, 438

ketyls 349

dye radical anions 349

radical quantum yields 278, 290, 294,

347

radicals 119, 121, 141, 261, 265, 291,

294, 302

kinetic-ESR 284, 287

kinetics polymerization reaction 17

**l**

labile hydrogen 75, 118, 125, 278, 290,  
337

laser direct imaging (LDI) 16, 26, 28, 671

laser flash photolysis 57, 61, 74, 84, 86,  
169, 257

laser induced polymerization 16, 17

laser sources 9, 25, 26

leucocarbinols 249

leucoethers 249

leuconitriles 249

light absorbing transients (LAT) 128

light emitted diode (LED) 25, 325, 400,  
539, 662

light intensity 15, 17, 24, 38, 48, 128,  
324–326, 334, 387

light penetration 641, 642, 644, 646

light sensitive alkoxyamines 340

light sources 325

available 23, 24

characteristics of 23

intensity 325

light stabilizers 6, 18–20, 120, 348

linear combination of atomic orbitals  
(LCAO) 36

LIPAC measurements 341

living anionic photopolymerization 577

lophyl radicals 147, 269, 295–296

lowest unoccupied molecular orbital  
(LUMO) 74, 76, 80, 82, 85, 205,  
258, 381

low molecular weight (LmwA) 119

**m**

MABLI complex/iodonium

salt/phosphine 599

macrophotoinitiators

copolymerizable photoinitiators

475–476

polymeric crosslinkable photoinitiators

476

polymeric onium salts 476

reactivity/efficiency 473

supported and immobilized

photoinitiators 474–475

type II macrophotoinitiators 471

type I macrophotoinitiators 470–471

magnesium complexes 568

maleimides 12, 93, 408, 472

manganese carbonyls 569

Marcus and Rehm/Weller theories 336

Marcus theory 336

mechanosynthesized photoinitiators

391–392

mercaptobenzimidazole (MBI) 121, 274

mercaptobenzothiazole (MBT) 274

mercaptobenzoxazole (MBO) 85, 119,  
121, 274, 337, 338

mercury lamps 24–25, 498, 545, 563

- metal acetylacetonate bidentate ligand
    - interaction (MABLI) 417
  - metal carbonyl/additive 165–167
  - metal carbonyls 165, 212, 420–421
  - metal centered radicals 92, 296–298, 568
  - metal complex/olefin 168
  - metal functionalized photoinitiators 605
  - metallic salt complexes 91
  - metallocene/additive 165
  - metallocenes 242
  - metal-organic frameworks (MOFs) 415, 451, 565, 658
  - metal salt complexes 91
  - methacrylate (MAC) 8, 10, 12, 93, 126, 142, 172, 210, 299, 327, 382
  - methacrylic acid 94, 566, 602
  - methoxynaphthalen-1-ylmethyl
    - chromophore 245
  - 1-(methoxynaphthalen-1-ylmethoxy)
    - pyrenes 245
  - 6-methoxynaphthoyl-methyl unit 247
  - methylacrylate (MA) 261, 275, 298, 343
  - 2-methylbenzothiazolium (MBT) 206
  - methylene blue 144, 150, 152, 334, 406, 489, 570
  - methylmethacrylate (MMA) 168, 264, 327, 342, 346, 540, 565
  - methyl radicals 64, 90, 259, 262, 343
  - Michler's ketone series 380
  - micro-emulsions 350
  - micro-heterogeneous media 350
  - microlithography process 670
  - micro-optical devices 543, 674
  - migrated photoinitiators 489
  - molecular orbital (MO) 46
    - and energy levels 36
  - mono-, bis-, and tetra-acylgermanes 360
  - monochromatic radiation 22
  - monomers 125
    - matrix 322, 327–328
    - and oligomers 4, 5
      - in cationic photopolymerization 10–11
      - in radical photopolymerization 8–9
    - quenching 341
  - morpholino 66, 67
    - ketones 333
  - $\alpha$ -morpholino ketones 347
  - multi-component photoinitiating systems 295, 334, 375, 465
  - multifunctional photoinitiators (mPI)
    - behaviour of typical difunctional compound 385
    - bichromophoric photoinitiators 383–384
    - difunctional radical photoinitiators 384–385
    - radical and cationic polymerization 385
    - specific reactivity of 388–389
  - multiphotonic absorption 38–39, 664
  - multiwalled carbon nanotubes (MWCNT) 222, 545
- n**
- naphthalene 134, 144, 151, 171, 212, 213, 384
  - naphthalimide-iodonium salt ion-pairs 89
  - naphthalimides 244, 245
    - aryl sulfide 86
  - naphthodioxinone 132
  - naphthoquinones (NQ) 142, 464
  - N*-arylsulfonimides 244
  - N*-benzylated structure based photobase 246–247
  - N*-benzylidenebenzylamine 247
  - N*-centred naphthalimide radical 245
  - N*-dibenzylamine 247
  - neat monomers 347
  - N*-ethoxy-2-methylpyridinium EMP<sup>+</sup> 305
  - N*-ethoxy-2-methylpyridinium salts 438
  - N*-heteroaryl-boryls 292
  - N*-heterocyclic carbene boranes 124, 292, 479, 493
  - N*-heterocyclic carbene-boryls 292
  - NIR photosensitive dyes 150, 151
  - nitrophenylpropyloxycarbonyl (NPPOC) 243

- nitroxide mediated photopolymerization (NMP2) 86, 299, 562
- nitroxides 20, 86, 299, 301, 362, 559
- N*-(2-methylpropyl)-*N*-(1-diethylphosphono-2,2-dimethylpropyl)-*N*-oxyl (SG1) 300
- N*-methyl-2-pyrrolidone (NMP) 567
- N,N*-diaryl-5,10-dihydrophenazines 573
- N,N*-diethyl-1,1-dimethylsilylamine (DEDMSA) 269, 347
- N,N,N',N'* tetramethylbenzidine 243
- non-ionic photoacid generators systems
- N*-arylsulfonimides 244
  - $\alpha$ -disulfones 245
  - fullerenes 245
  - naphthalimides 245
  - non salt pyrene derivatives 245
  - sulfonates 244
  - terarylene-based self-contained PAGs 246
- non salt pyrene derivatives 245
- non transition metal complexes 214
- non vertical energy transfer (NVET) 341
- Norrish I cleavage 65, 67, 141, 336, 386
- $n\pi^*$  carbonyl triplet states 341
- N*-phenyl glycine (NPG) derivatives 209, 268
- N*-substituted diazabicyclononanes 83
- N*-(trifluoromethanesulfonyloxy)-1,8-naphthalimide (NIOTf) 245
- nucleophilic radical 260, 293, 343
- N*-vinylcarbazole (NVK) 10, 209, 215, 219, 390, 412, 482
- O**
- O*-acyl-*N*-hydroxy-pyridine-2(1*H*)-thione derivatives 276
- O*-acyl-*N*-hydroxy-thiazole-2(3*H*)-thione derivative 276
- O*-acyloximes 150, 241
- oil-in-water SDS micelles 350
- oil soluble photoinitiating systems 345–348
- oligomeric and polymeric series 533
- oligomers 4–10, 17, 21, 35, 56, 277, 347
- one component type II photoinitiators (ocPI)
- aldehydes 467
  - benzoyl benzodioxolane derivatives 463–464
  - bis-pyridinium derivatives 467
  - charge transfer complex (CTC) systems 469
  - masked photoinitiators 467–468
  - naphthoquinone (NQ) derivative 464
  - photoinitiator-amine 465–466
  - photoinitiator-amine-monomer 466
  - photoinitiator-monomer 466
  - photoinitiator-onium salt system 468
  - photoinitiator-photosensitizer 468
  - photoinitiator-polymer chain ionic pair 466
  - photoinitiator-protonated base 468–469
  - photoinitiator-thiol 466–467
  - thioxanthenes derivatives 464
- one-step production 595–596
- onium salts 206, 241, 534
- electron transfer reaction 216–218
  - photoinitiation step 218–219
  - photosensitization through energy transfer 214–215
- organic electronics 657, 674
- organo borates 88, 248
- organo metallic complexes 242, 533
- organo metallic compound 90, 168
- organo silanes 244, 288
- organozirconium 18, 168, 489, 494
- orthogonal photoinitiators 495–496
- oxime esters 71–72, 246, 296, 347, 361, 532
- oxime sulfonates 243, 534
- oxyamines 86
- oxygen inhibition 9, 12, 18, 26, 55, 121, 170, 270, 281, 287, 290, 325, 420, 436, 490, 491, 493
- oxygen self consuming photoinitiators
- aldehydes derivatives 491
  - boranes, uses of 493
  - phosphines 493–494

- oxygen self consuming photoinitiators  
(*contd.*)  
 SH<sub>2</sub> reaction 492  
 silanes, uses of 491–492  
 oxyl radicals 170, 281, 283–284
- P**
- panchromatic photoinitiators 388  
 paprika 500  
 para amino phenyl ketones 347  
*para*-substituted  
 monoacyltrimethylgermane  
 derivatives 362
- p*-chlorophenyl  
*o*-nitrobenzylether/titanium  
 tetraisopropoxide 242
- pentacarbonyl M(CO)<sub>5</sub>L complexes 242  
 pentaerythritol tetra(3-mercap-  
 topropionate)/divinyl sulfone  
 blends 248
- penultimate unit effect 269  
 peresters 78, 147, 148  
 perfluoroaryl sulfonates 244, 672  
 perovskites, nanocrystals 94, 95  
 peroxides 77, 78  
 ROOR's 283  
 peroxylation process 281  
 peroxy radicals 283  
 amine interaction 270  
 characteristics 284–286  
 germylperoxyls 288  
 interaction with H-donors 286–287  
 interaction with monomers 287  
 interaction with triphenylphosphine  
 287–288  
 S<sub>H</sub>2 substitution 288  
 silylperoxyls 288
- peroxyls 18, 20, 123, 124, 127, 170, 270,  
 281, 283, 286, 287
- perylene 215, 216, 219, 573  
 PET-RAFT polymerization 564, 567,  
 568, 571, 574, 576
- phenacyl ethyl carbazolium derivatives  
 83  
 phenacyl pyridinium derivatives 83
- phenacyl sulfone derivatives 244  
 phenols 21, 42, 121, 244, 261, 268, 281,  
 288, 289  
 phenothiazines 150, 163–164, 215, 217,  
 220, 222, 387, 483, 486, 573  
 phenyl-dimethyl phosphine oxide 336  
 phenylglycines 120  
 phenyl glyoxylate 78, 141, 532  
 phenyl radicals 65, 78, 88, 89, 146, 148,  
 152, 164, 261  
 phenyl thioacetic acid 121  
 (4-phenylthiophenyl) diphenylsulfonium  
 triflate 244
- pheophorbide 568  
 phosphane-ene chemistry 594  
 phosphazene bases 249, 660  
 phosphine oxides 17, 74, 92, 169, 287,  
 333  
 phosphinoyl radicals 75, 114, 171, 273,  
 303  
 phosphonyl radicals 271  
 phosphoranyls 287, 288  
 phosphorescence measurements 340  
 phosphorus centered radicals 271–273  
 phosphorus containing compounds  
 124–125  
 photoacid generators (PAG) 147, 243,  
 534  
 photoactivated hydrosilylation reactions  
 12  
 photoactivated redox polymerization 9,  
 29, 591, 598–600  
 photobase generators (PBG) 534  
 amine-imides 249  
 aminoketones 249  
 ammonium tetraorganyl borate salts  
 247  
 anionic chromophore containing  
 ammonium salts 248  
 benzoylformamides 247  
 carbamates 246  
 N-benzylated structure based  
 photobase 246–247  
 oxime esters 246  
 phosphazene bases 249

- piperidine derivatives 249
  - super-bases 248–249
  - tertiary amine releasing systems 249
- photobase/peroxide 170–171
- photobleaching 81, 534, 571, 591
- photochemical thiol-alkyne reaction 592
- photocrosslinking 3, 667
- photogenerated copolymers 352
- photoinduced copper-catalyzed azide-alkyne cycloaddition 12, 601
- photoinduced electron transfer reactions 345, 672
- photoinduced polymerization reaction 4, 5, 45
- photoiniferters 85, 86, 200, 298–300, 560, 561
- photoinitiated polymerization 18, 132, 607
- photoinitiating system 4, 41, 257
  - absorption intensity 37
  - absorption of light 35–39
  - characteristics of 35–45
  - efficiency vs. reactivity 48–49
  - and energy levels 36
  - Jablonski's diagram 39–40
  - kinetics excited state 40
  - molecular orbitals 36
  - multiphotonic absorption 38–39
  - optical transitions 36–37
  - photoinitiator 40–42
  - photosensitive system absorption 42
  - photosensitive system reactivity 46–48
  - photosensitizer 40–42
  - reciprocity law 38
- photoinitiator-free gelatin methacrylamide biopolymer 664
- photoinitiator-onium salt system 468
- photoinitiator-photosensitizer 468
- photoinitiator quenching by monomers 340–342
- photoinitiators (PI) 40, 41, 55, 56, 125
  - amine/benzoyl peroxide (BPO) redox system 408
  - amine free and peroxide free systems 600
  - amine or phosphine/iodonium salt charge transfer complexes 390–391
  - amine/phosphine/iodonium salt/benzoyl peroxide 598–599
  - aromatic ketone/amine/iodonium salt 400
  - benzoyl chromophore 59–72
  - bleachable photoinitiators 642–643
  - charge transfer complexes (CTC) 420
  - copper complex/amine/organic halide 403–404
  - cyanine dye/borate salt/thiol system 409
  - for dentistry applications
    - acylsilanes 669
    - camphorquinone/germane/iodonium salt system 668
    - dental composites 670
    - dyes 669
    - NIR photoinitiating systems 669
    - silyl ketone based systems 668
  - dye/arylsulfinate/iodonium salt 419
  - dye/dihydropyridine/iodonium salt 419
  - dye/ferrocenium salt/hydroperoxide 420
  - ecofriendly photoinitiators
    - natural or modified natural compounds 499–500
    - safe photoinitiators 498–499
  - efficiency/reactivity of
    - in bulk 352–354
    - fluid media 345–348
    - heterogeneous media 350–352
    - polymerization efficiency in bulk 354–359
  - epoxy-amine polyaddition reactions 614
  - ferrocene derivative/iodonium salt/phosphine/ammonium persulfate 600

- photoinitiators (PI) (*contd.*)  
   ferrocene derivative/triphenylphosphine derivative/iodonium salt 418  
   free radical promoted cationic photopolymerization (FRPCP) 435–436  
   host-guest supramolecular-structured photoinitiators 494–495  
   hybrid sol-gel photopolymerization 602  
   interpenetrating polymer networks synthesis 595–598  
   iridium complex/amine/organic halide 404–406  
   iron complex/amine/organic halide 404  
   ketocoumarin/amine/ferrocenium salt 407  
   ketone/amine/organic halide 403, 404  
   ketone or dye/thiol/iodonium salt 419  
   laser diode irradiation conditions 541–542  
   latent superbase/peroxide 600  
   in living anionic polymerization 577  
   living cationic polymerization 575–577  
   mechanosynthesized photoinitiators 391–392  
   metal carbonyl compound/silane/hydroperoxide 420–421  
   migrated photoinitiators  
     fluorinated photoinitiators 489  
     oxygen tolerant systems 489–490  
     siloxane group 489  
   NIR light induced polymerization 542–543  
   NIR light induced thermal polymerization 544–545  
   ocPI 463–469  
   organic electronics 674  
   organo metallic compound 411  
   organo metallic compound/*N*-vinylcarbazole/iodonium salt 413–415  
   orthogonal photoinitiators 495–496  
   oxidation cycles  
     amine/alkyl bromide 483  
     amine/alkyl halide 484  
     amine/iodonium salt 483  
     dye/silane/iodonium salt 484  
     iodonium salt/tin derivative 483  
     *N*-vinylcarbazole (NVK) 482–483  
     photoinitiator/silane/iodonium salt 481–482  
     sulfonium salt 482  
     thiol-ene reactions 483  
   oxygen inhibition  
     highly reactive photoinitiators 489  
   oxygen self consuming photoinitiators 490–491  
   phosphane-ene chemistry 594  
   photoactivated redox polymerization 598–600  
   photoinitiator structures vs. the irradiation wavelengths 549, 551  
   photoinitiator/tin derivative/iodonium salt 418–419  
   photoinitiator/triphenylphosphine derivative/iodonium salt 417–418  
   for polymerization of self assembled systems 606–609  
   pulsed light irradiation 545–546  
   reactivity and structure/properties relationships 359–362  
   reactivity of  
     addition to double bond 342–344  
     bond dissociation energy 337–340  
     cleavage processes 335–336  
     electron and hydrogen transfer reactions 336–337  
     electron transfer reactions 337  
     excited stated processes 334–335  
     interactions of initiating radicals with hydrogen donors 344  
     quenching by monomers 340–342

- self healing reactions 614
- self initiated monomers 497–498
- semiconductor nanoparticles 646–647
- silane-ene chemistry 593–594
- silyl ketone/amine/iodonium salt 400
- simultaneous oxidation and reduction cycle 484–485
- in situ generation of nanoparticles
  - cleavable photoinitiators 603–604
  - metal centred photoinitiators 605
  - metal functionalized photoinitiators 605
  - one-component photoinitiators 604
  - type II photoinitiators 604
- soft irradiation conditions 539–540
- styrylbenzothiazolinium salt/borate/pyridinium salt 409
- sulfonium salt 420
- under sunlight 540–541
- temperature effects
  - light induced temperature 643
  - room temperature dual curing 644–645
  - temperature control 644
  - thermal curing in dual cure strategies 644
- thermally activated delayed
  - fluorescence (TADF) 389, 390
  - benzophenone derivatives 130–132
  - for biomaterials 666–667
  - camphorquinone/amine/Iod 400
  - CARET/iodonium salt 415–416
  - catalytic photoredox processes 645–646
  - charge transfer complexes 647
  - chiral photoinitiators 497
  - Cl-HABI ( $L_2$ )/thiol couple 409
  - composite 647–650
  - control of gel time 600
  - cyanine/borate/picolinium salt 409
  - cyanine/borate/triazine 408
  - dye/amine/bromocompound 406
  - dye/amine/iodonium salt 400–402
  - dye/amine/ketone 406
  - dye/amine/metal salt 407
  - dye/amine/organic halide 402–403
  - dye/silane/iodonium salt 410–411
  - in (micro) electronics 670–672
  - germane-ene chemistry 594
  - grafting-to processes 610–614
  - in graphic arts 661–662
  - high irradiances 643
  - for hydrogel synthesis 605–606
  - hydrosilylation reactions 601–602
  - iodo-ene chemistry 594
  - in ionic liquids 609
  - ketone/amine/bromocompound 406
  - ketone/amine/germane 407
  - ketone/amine/imide derivatives 408
  - ketone/amine/ketone 406
  - ketone/amine/metal salt 407
  - ketone/amine/silane 407
  - ketone/borate/ruthenium salt 409
  - ketone/silane/iodonium salt 411
  - ketone/sulfinate/iodonium salt 419
  - for NIR lights 646
  - in optics area 672–674
  - in photo-CuAAC reactions 601
  - in radiation curing area 657–661
  - for thiol-ene reactions 591–593
- in 3D printing technologies
  - direct laser writing (DLW) 664–665
  - 4D polymer micropatterning 665
  - stereolithography 662
  - 3D printers 662–664
  - two-photon 3D printing 664
- two-photon absorption 485
  - cationic photoinitiators 487
  - leavable photoinitiators 486
  - photobases 488
  - type II photoinitiators 486–487
- UCNP-assisted photopolymerization 645
- vanadium or manganese
  - complex/triphenylphosphine derivative/iodonium salt 417
- visible lights 546–550
- wavelength-selective initiation 496–497

- photoinitiator-thiol 466–467
- photomaterial 7
- photopolymerizable formulation 6, 15, 19
- photopolymerization
  - activity 132
  - efficiency 347
  - rate 15–16
  - reactions 4, 5, 55, 257, 645
    - conventional 7
    - implementation of 22–29
    - kinetic laws in 13–17
    - light sources for 22–27
    - monitoring 13
    - monomers and oligomers in 7–12
    - studies 673
- photosensitive system absorption 42
- photosensitizer (PS) 40, 41, 56
  - linked cationic monomer 219
- photosensitizer/photoinitiator (PS/PI) interaction 348
- pigmented thin films 641
- PI/hydrogen donor (HD) abstraction reaction 337
- piperidine derivatives 249
- PI/polymer chain hydrogen abstraction 612
- PI-Si1 283
- PI-Si3 283
- PI-Si4 283
- PI-Si6 283
- platinum acetylacetonate complexes 241
- polar effects 61, 124, 258, 260, 272, 274, 275, 280, 287, 343
- polar solvent 37, 133, 139, 245
- poly(4-vinylpyridine) 571
- poly(methyl methacrylate) 361
- poly(butadiene)-b-poly(ethylene oxide) giant polymersomes 607
- polychromatic light 23, 48, 345, 354, 355, 385, 445, 481, 489
- poly(dimethylsiloxane) elastomer substrates 613
- polymeric amines 120
- polymeric fullerene 245
- polymeric iodonium salt 172, 202, 476
- polymeric PAG 244
- polymeric photoinitiators 476
- polymerization efficiency 19, 61, 169, 295, 321, 327, 334, 347, 354–359, 390
- polymerization-induced self-assembly (PISA) 490, 567, 572, 606, 608–609
- polymerization profiles 127, 130, 171, 297, 326, 593
- polymerization reactions 299–301
  - dithiocarbamyl radicals 299–300
  - environment role 21
- polymer substrates 125
- polymethine borates 533
- polymethine dyes 149–151, 543
- polymethylferrocene 242
- polyoxometalates (POMs) 88
- polyoxometallate-onium salt ion-pairs 88, 89
- polysilanes 282, 302
- positively and negatively charged benzophenones 350
- potential energy surface (PES) 46, 63, 336
- proazaphosphatrane cation 248
- propagation rate constant 14, 15, 65, 299, 327
- propionic acid-protected amine 248
- protic solvent 37, 94, 213
- pulsed-laser polymerization, electrospray-ionization mass spectrometry (PLP-ESI-MS) 46
- pulsed laser polymerization (PLP) methods 17, 46, 269, 333, 360, 362
- pulsed laser polymerization with subsequent electrospray-ionization mass spectrometry (PLP-ESI-MS) 360
- pulsed light irradiation 545–546
- pulse laser polymerization techniques 298



- push pull photoinitiators 387–388  
 pyrene 151, 207, 212, 215, 217, 245  
 pyridine 83, 275  
 pyridine-thiyl radical 276  
 pyridinium salt 83, 140, 144, 206, 209,  
 438  
 pyrromethene dyes 147  
 pyrylium salt 123, 144, 147, 219, 576
- q**
- quantum yields 35, 40, 57, 124, 244, 282,  
 290, 294, 325, 334, 347
- r**
- radiation curing area 212, 321, 657–661  
 radical photoinitiator  
   light source 325–327  
   monomer matrix 327–328  
   peroxide interactions 170  
   surrounding atmosphere role 324–325  
   viscosity role 322–324  
 radical photopolymerization 8, 9, 13–15  
   bulk monomer or oligomer 43, 44  
   Cage effect 44–45  
   excited states 43  
   initiating species 43  
   photochemical and chemical reactivity  
     45–46  
 radical reactivity  
   acrylate 263–265  
   alkyl 259–261  
   aminoalkyl 265–271  
   aminyl radicals 288–289  
   aryl 261–262  
   benzoyl radicals 262–263  
   boryl radicals 292–295  
   carbon centered radicals 260, 261  
   direct detection 257  
   double bond 258–259  
   FRPCP 302–305  
   germyl and stannyl radicals 290–292  
   iminyl radicals 296  
   lophyl radicals 296  
   metal centered radicals 296–298  
   metal salts 302  
   methacrylate radicals 263–265  
   oxyl 283–284  
   peroxyl 284–288  
   phosphorus centered radicals 271–273  
   polymerization reactions 299–301  
   propagating radicals 298–299  
   silyl radicals 277–283  
   sulfonyl 276–277  
   sulfonyloxy 276–277  
   thiyl 273–276  
 radical trapping agent (RX) 559, 600  
 RAFT method 472  
 rate constants 15, 17, 46, 47, 124, 128,  
 134–136, 144, 204, 206, 261, 262,  
 264, 265, 334, 360  
 rate of absorption 37  
 REACH registration procedure 535  
 reactant concentrations 325, 334  
 reaction enthalpy 46, 57, 64, 70, 258,  
 259, 343  
 reaction rate constant 57, 204, 268, 270,  
 272, 287, 291, 335  
 reciprocity law 17, 38  
 redox polymerization 9, 29, 417, 543,  
 591, 598–600  
 red-shift 37, 65, 74, 77, 80, 84, 207, 211,  
 264  
 Rehm-Weller equation 165, 216, 336  
 relative initiation quantum yields 345,  
 360, 361  
 responsive photonic crystals 673  
 reverse micelles 350, 351  
 riboflavin/tetraalkyl borate 149  
 Rose Bengal (RB) model 143, 144, 334  
 Ruthenium complexes 409, 564
- S**
- safranine dye/borinate derivative 148  
 Sandros' model 341  
 S-aryl-S,S-cycloalkyl sulfonium salts 209  
 Schiff bases 242  
 selenides 244  
 self-assembled Ag nanoclusters 604  
 self assembled photoinitiator monolayers

- self healing reactions 614
- self initiated monomers 93, 497–498
- self quenching 39, 128, 134, 141, 144, 350
- self-reporting and refoldable
  - profluorescent single-chain nanoparticles 361
- semiconductor nanoparticles 93–94
- silane-ene chemistry 593–594
- silanes 122–124, 271, 278, 287, 297, 337, 347
- silicon bridged ferrocenophanes 242
- silicon-hydride terminated surface 93
- silver-epoxy nanocomposites 302
- silylamines 123, 281
- silyl, germyl/boryl initiating radicals 347
- silyl/germyl radical generating PIs 355
- silyl glyoxylate/iodonium salt 126, 437
- silyl glyoxylates 77, 78, 141
- silyl ketone/iodonium salt 126
- silyl ketones 141, 400
- silyloxyamines 86–87, 123
- silylperoxylys 278, 288, 291
- silyl radicals
  - characteristics 277–279
  - disilane 282
  - organic precursors 282
  - reactivity and photoinitiation under air 280–281
  - silylamines 281–282
  - tris(trimethylsilyl)silyl radical 279–280
- single occupied molecular orbital (SOMO) 258, 259, 262, 265, 277
- singlet-singlet energy transfer 41, 214, 486
- Si-Si photodissociation 282
- size exclusion
  - chromatography-electrospray ionization-mass spectrometry (SEC/ESI-MS) 46
- sodium bis (acyl)phosphine oxide 572
- sodium dodecyl sulphate (SDS) 350
- soft-ionization mass spectrometry techniques 46
- solvatochromic comparison method (SCM) 37
- spiropyran dyes 146
- squaraine dye 151
- stannanes 124, 287
- stannyl radicals, characteristics 290
- state correlation diagram 258, 337, 343
- stereolithography 16, 27, 662
- styrene 8, 71, 83, 299, 352, 478, 607
- styrene-butadiene rubber 326
- substituent effects, in radical photoinitiators
  - benzophenone (BP)-sulfonyl ketone (SK) series 378
  - 1,4-diamino substituents 380
  - economic requirements 377
  - heterocyclic extended thioxanthenes 379
  - interaction rate 378
  - novel aryldiphenylphosphine oxide derivatives 379
  - and novel properties 381–382
  - and reactivity 381
  - $S_0$ - $S_1$  transition 378
- substituted 1-chloro substituted thioxanthenes 244
- sulfinic/carboxylic acids 243
- sulfonates 211, 243, 244
- sulfonium salts 303
  - absorption properties 202, 203
  - compounds 200
  - decomposition processes 202–205
  - D- $\pi$ -D core linked 211
  - photoinitiation step 205
  - photopolymerization reaction 201–202
  - substitution effects in 207
- $\beta$ -sulfonyl 276
- sulfonyl ketones 70, 333, 339, 375
- $\beta$ -sulfonyloxy 276
- sulfonyloxy radical 276–277
- sulfonyl radical 70, 245, 276
- sulfur-carbon bond 85, 86
- sulfur-silicon bond 92

- super-bases 248  
 surrounding atmosphere 321, 324–325
- t**
- Tandem graft polymerization 613  
 terarylene-based self-contained PAGs 246  
 termination rate constants 14, 15, 327  
*tert*-butylperoxide 170, 257, 280, 294  
 tertiary amine releasing systems 249  
 tetraacylgermanes 80, 81, 362, 387  
 tetraacylsilanes 82  
 tetrabenzoylgermane 360  
 tetrafunctional photoinitiators 387  
 tetrakis (6-naphthyl borate) 248  
 tetramethyl guanidine 248  
 2,2,6,6, tetramethylpiperidine *N*-oxyl radical (TEMPO) 262, 264  
 tetrapropylene glycol diacrylate (TPGDA) 8, 322, 352, 472, 643  
 tetrazole 275  
   derived thiyl radical 275, 344  
 theoretical (ab initio calculations) techniques 360  
 thermally activated delayed fluorescence (TADF) 389–390  
 thiadiazole 142, 146, 275  
 thianthrene skeletons 244  
 thianthrenium-naphthalimide 210  
 thianthrenium-polyoxometalate 210  
 thiazole thione derivatives 276  
 thiobenzoates 70, 73  
 thiocarbonylthio compounds 563, 567, 573–574  
 thio derivatives 121  
 thiohydroxamic acids 87  
 thiol-ene photopolymerization 11–12, 29, 147, 541  
 thiol-ene polymerization (TEP) reactions 591  
 thiol-ene resins 665, 670  
 thiol-Michael addition reactions 591  
 thiol-promoted epoxide photopolymerization 248  
 thiophene derivatives 221, 605  
 thiophosphinoyl radicals 272  
 thiopyrylium salts 144, 147, 440  
 thioxanthone (TX) 72, 85, 132, 215, 216, 327, 333, 341, 345, 533  
   absorption and excited states 132–134  
   based moiety 248  
   compound 134  
   derivatives 135, 137, 341, 464  
   interaction rate constants 134–136  
   photolysis 134  
   sulfonates 244  
 thiyl/boryl radical addition 344  
 thiyl radicals 70, 84, 273–276  
 three-component systems  
   dye/disulfide/NHC borane 421  
   ketone/triazine/thiol 421  
   phosphine oxide/silane/borane 421  
 3D printers 662, 663  
 TiO<sub>2</sub>-graphitic carbon nitride composite 574  
 titanocenes 90, 297, 533, 539  
 toluene 135, 136, 353  
 4-tolyl methyl disulfone 245  
 transition organo-metallic complexes 212, 213  
 trialkylamines 265  
 triarylamine dialkylsulfonium salts 209  
 triaryl phosphate derivatives 244  
 triaryl sulfonium salts 209, 438, 498  
 1,5,7-triazabicyclo[4.4.0]dec-5-ene 248  
 triazole 275  
 trichloromethyl triazines 76, 386, 402  
 triethylamine 268, 337  
   derived aminoalkyl radical 279  
 triethylaminoalkyl (TEA) 264, 265  
 trifluoroacetophenone 211  
 trifunctional benzoinether 386–387  
 tri-functional photoinitiators  
   tetrafunctional photoinitiators 387  
   trifunctional benzoinether 386–387  
   type II systems 386  
   type I systems 386  
 triisopropylamine 267  
 trimethylolpropane triacrylate (TMPTA) 8, 142, 210, 322, 473, 540, 597

- 2,2,5-tri-methyl-4-phenyl-3-azahexane-3-nitroxide (TIPNO) 300
- triphenylphosphine 18, 286, 287, 493
- triplet annihilation 39, 128, 144, 350
- triplet state energy 46, 62, 135, 139, 278, 340
- tris(trimethylsilyl)silane (TTMSS) 87, 271, 322
- two-photon absorption (TPA) 9, 17, 38, 439, 485–488
- two-photon absorption induced polymerization (TPAP) 9, 29, 485
- type II ketone 142
- type II photoinitiators 333
- type II thioxanthone-benzothiophene 383
- type I macrophotoinitiators 470–471
- type I photoinitiators 171–172, 333, 438
- U**
- unconventional cationic systems
- carbon nanotubes 222
  - upconversion nanoparticles 222
- upconversion nanoparticles 222
- UV curing 6, 9, 19, 20, 24, 27, 28, 134
- UV irradiated xanthone (Xa) structure 248
- UV nanoimprint lithography (UV-NIL) 671
- V**
- vertical energy transfer (VET) 341
- vesicles 350
- vinylacetate (VA) 343
- vinyl benzyl trimethyl ammonium chloride 610
- vinylether (VE) 245, 343
- vinyl radical 263
- 2-(2-vinyloxyethoxy) ethyl acrylate (VEEA) 345, 360
- vinylpyrrolidone (VP) 299, 342, 602, 603
- vinyl sulfonate ester (VSE) 665
- viscosity 6, 17, 41, 43–45, 206, 321, 322, 324, 327
- viscous photopolymerizable media 334
- viscous polymer matrices 326
- visible light mediated thiol-ene reactions 144, 593
- W**
- water based hydrogels 421
- water compatible visible light PIs 669
- water-diluted polyurethane 93, 94
- water soluble carbene-borane 349
- water soluble photoinitiating systems 349–350
- water soluble photoinitiator
- cationic photoinitiators 480
  - heterogeneous environment 480
  - type II photoinitiator 478–480
  - type I photoinitiators 477–478
- wavelength-selective initiation 496–497
- X**
- xanthenic dyes 144, 150, 349, 673
- xanthone 134, 139, 142, 341
- xenon lamps 24, 325
- Z**
- zinc based metal complexes (ZnC) 412
- zinc chloride 65, 119, 202
- zinc complexes 91, 412, 441, 567–568
- zinc porphyrins 220
- zinc propylthio *N*-methyl tetraphenyl porphyrin 242
- zinc tetraphenylporphyrin (ZnTPP) 146, 567, 665
- zirconium 123, 288, 381
- zirconocene dichloride 91
- ZnO-graphene composites 659