Afterword

Here, on the level sand,
Between the sea and land,
What shall I build or write
Against the fall of night?

Tell me of runes to grave
That hold the bursting wave,
Or bastions to design
For longer date than mine.

A.E. Housman, from "Smooth Between Sea and Land"

We have come to the end of our long journey of exploration of the role of chemistry in lithography. Our journey has led us to many important destinations that mark the trail of the story of lithography. We started off by exploring the events that led to the invention of lithography, and from there we wandered farther afield in search of its chemical and optical origins. There we discovered a long chain of connected roads, built with physical and chemical ideas and concepts, spanning over 3000 years, stretching all the way back to the Greek era, through the scientific revolutions of the eighteenth and nineteenth centuries, that made possible the invention and development of lithography.

Next, we explored the evolution of lithography into the myriad strands that are practiced today, aided in large part by advancements in chemistry and physics, especially optical physics. In particular, we explored the roles of chemicals in lithographic patterning. We went a step further and explored each major lithographic technology in depth, examining the chemical and physical basis of their imaging mechanisms, and highlighting in the process how each imaging mechanism is made possible by the successful marriage between chemistry and optics. In addition, we examined how lithography is implemented in the fabrication of IC devices, using as an illustrative example the case of a complementary metal-oxide semiconductor device built from a 90-nm technology node inverter. This semiconductor device uses transistors to mediate computational functions in microprocessors used in computers that have done so much to enhance our modern lives. Finally, we examined the main approaches of advanced resist

processing and resolution limit issues of resists in the context of the trade-offs between resolution, line edge roughness, and sensitivity.

I have enjoyed being your guide through this journey. I hope you have enjoyed it as well. If through the course of this book, you, dear reader, have gained a better appreciation of the important role of chemistry in mediating lithography, then the efforts that have gone into writing it have been well worth it.

Index

1,1-diphenyl-2-picrylhydrazyl (DPPH), 220
1,1-diphenylethylene, 237
1,1,3,3,5,5-hexamethylcyclotrisilazane, 393, 795
1,2-diazepines, 232–233
1,3-dimethyl-1-tetrahydropyrimidinone, 191
1,3-dimethyl-2-imidazolidinone (DMI), 191
1,3-dimethyl-2-imidazolinone, 191
1,4-di(acetoxymethyl) benzene, 240
1H,1H-perfluorooctyl methacrylate, 250, 251
1-mercapto hexadecanoic acid, 477
1-phenyl-1,2-propanedione-2-*O*-benzoyloxime (PPO), 261
1-vinylnaphthalene, 404
2,1,4-diazonaphthoquinone sulfonate, 295
2,1,5-diazonaphthoquinone sulfonate, 295
2,2,6,6-tetramethylpiperdine-1-oxyl , 350
2-(2-aminoethoxy) ethanol (AEE), 191
2,2′-azobis(isobutyronitrile) (AIBN), 259
2,2′-dimethoxy-2-phenylacetophenone (DMPA), 260
2,3,4-trihydroxy benzophenone, 293
2,6-bis(4-azidobenzal)-4 methylcyclohexanone, 212
2-benzyloxy-protected poly(*p*-hydroxystyrene) (BOP), 381–382
2-chlorothioxanthone, 265
2-diazodimedones, 317
2-ethoxyethanol, 323
2-ethoxymethyl acetate, 185
2-ethylethoxy propionate, 185
2-heptanone, 185
2-isopropylthioxanthone, 265
2-methoxyethylether, 185
2-methoxypropyl-protected poly(*p*-hydroxystyrene) (MOP), 381–382
3,3′-diazodiphenylsulfone, 217
3-β-acryloyloxyandrosterone, 247
4,4′-bis(dimethylamino)benzophenone, 264–265
4,4′-diazidobenzalacetone, 215
4,4′-diazidobenzophenone, 215
4,4′-diazidostilbene, 215
4,6-bis(trichloromethyl)-1,3,5-triazine, 341
4-acetoxystyrene, 244
4-(aminomethyl)benzoate, 264
4-azidochalcone, 217
4-(dimethylamino)benzaldehyde, 264
4-(dimethylamino)methylbenzoate, 264
4-dimethylaminophenyldiazonium chloride, 234
4-ethylphenol, 348
4-hydroxy-4-methyl-2-pentanone, 185
4-hydroxybenzaldehyde, 350
4-*tert*-butyl(dimethyl)siloxy styrene, 350
4-vinylbenzene acetate, 240
5-(2-trifluoromethyl-1,1,1-trifluoro-2-hydroxpropyl)-2-norbornene (NBHFA), 236
5-*tert*-butyl(dimethyl)silyloxystyrene, 352
5-trifluoromethyl-5-hydroxy-2-norbornene, 377–378

α chloroacrylate, 325
β-elimination, 357
γ-butyrolactone, 191
π-π* electronic transition, 314
σ-σ* transition, 796

A

Abbe sine condition, 89
aberration, 162, 554
aberration correction, 163
aberration-sensitive monitor, 553
absolute temperature, 67
absorbance, 490
absorption, 44
— bleachable, 552
— nonbleachable, 552
— of light, 58
absorption bands, 295

absorption coefficient, 58, 490
— molar, 58, 490
absorption cross section, 632
absorption edge, 710
absorption layer, 714
absorption lines, 72
absorption spectrum, 400
accelerating voltage, 744
acetal-protected chemical amplification resists, 381–383
acetic acid, 350, 626
acetone, 190
acetophenone derivatives, 261
achromatic lens, 86
acid generators, 336–343
— classification of, 337
acid sensors, 499
acid-catalyzed thermolysis, 226, 357
acidolysis, 341
acid-quencher annihilation, 828
acridine, 499
acridine dyes, 268
acridine orange, 276
acridine yellow, 276
acriflavin, 268
across-field line width variations, 561
acrylamide, 266
acrylated polyol-based negative resists, 219
acrylonitrile, 266, 325
actinic radiation, 285
action spectrum, 406
activation energy, 496
activity coefficients, 120
acyloximino groups, 326
acylsilane resists, 218
adhesion, 184
— work of, 468
adhesion promoters, 466
adsorption enthalpy, 724
advanced processing techniques, 797
aerial image, 490, 556
aerial image models, 563
aerosols, 696
affinities, 115
agar, 209
air, 102
airborne molecular base, 424
airborne molecular contaminants (AMCs), 630
albumin, 145
alchemy, 98–99
aldehyde, 207
alicyclic polymers, 183
alignment, 160, 488–489
aliphatic polymers, 183
alkane thiols, 177
alkoxymethylmelamine, 224
allyl methacrylate, 221
alpha rays, 64
alternating phase-shifting masks (PSMs), 622–623, 811
aluminum mirrors, 657–658
amidation, 135
ammonia, 104, 300, 424, 776
ammonium cyanate, 117
ammonium dichromate, 182, 209
ammonium hydroxide, 190
ammonium sulfate crystals, 628, 641
amorphous carbon, 431
amorphous silicon, 186
amplifier, 147, 767
amyl acetate, 185
angular momentum *l*, 75
anionic polymerization, 351
annealing, 775
anode, 788
antenna, 405
anthracene, 398, 428–429
anthraquinone, 263
antifoaming agents, 194
antioxidants, 182
antireflection coatings, 181, 186
— graded-index, 435
— organic and inorganic, 186
aperture function, 559
APEX-E™, 357
apodization, 729
ArF (193 nm) exciplex lasers, 94, 183
ArF (193 nm) line-narrowed exciplex lasers, 164
ArF (193 nm) lithography, 118
aromatic monazines, 499
aromatic monobenzoid, 428
aromatic multibenzoid, 428
aromatics, 428
arsenic, 778
arsenic acid, 103
arsenic anhydride, 103–104
aryldiazonium salts, 274

ascorbic acid, 268
aspect ratio, 532
asphaltum, 454
aspherical lens elements, 94
atmosphere, composition of, 103
atom lithography, 175–176
atomic bomb, 133
atomic energy levels, 78
atomic force microscopy (AFM), 165
atomic orbital, 131
atomic oxygen, 636
atomic theory, 99, 109, 111–113
— origin of, 111–113
atomic volume curve, 125
atomic weights, 125
atomic-scale resolution, 173
atoms, 5
attenuated phase-shifting mask (PSM), 165, 621–623
attenuation length of EUV radiation, 709
attenuation mechanism of fused silica, 653
Auger electrons, 415
average power, 613
Avogadro's hypothesis, 116–117
AZ Photoresist™, 291
azide resists, 208
azimuthal quantum number *l*, 131
azo compounds, 118
azobisisobutyronitrile (AIBN), 365

B

back end of line (BEOL), 189
backbone scission, 411
backscattering, 743
Baekelite, 288
Balmer series, 77
barium fluoride, 649
barium platinocyanide, 63
base, 114, 769
base quenchers, 826–827
base-catalyzed esterification, 292
bas-relief master, 171
beam blanker, 748
beam-deflection unit, 748
beam-limiting apertures,748
Beer-Lambert law, 490
benzene, 118, 428–429
benzoflavin, 276
benzoin, 259–260
benzoyl peroxide, 258
benzyl acetate, 225
benzyltrimethylstannane, 268
bilayer resist (BLR), 391
bilayer resist (BLR) system, 796–797
bimetallic plates, 141
binary intensity masks (BIMs), 620
binders, 280
biochips, 172
bipolar junction transistor (BJT), 768
birefringence, 48, 649
— stress-induced, 652
biradical, 274
bis(4-*tert*-butylphenyl)iodonium cyclamate, 379
bis-diaminoalkyl-oligo-dimethlysiloxane, 805
bis(dimethylamino)dimethylsilane, 393, 795
bisphenol A, 289
bis-tetrafluoroborate-tetrakis (cyanomethane) palladium, 369
bit line contacts, 436
bitumen of Judea, 22, 182
blackbody radiation, 65, 66–69
— Planck's quantum hypothesis for, 67–69
bleachable absorbance, 552
bleaching, 295
blur, 757
Bodenstein pseudo-steady-state approximation, 574
Bohr frequency condition, 77
Bohr orbits, 76
Bohr radius, 76
Bohr's model of the hydrogen atom, 75
boiling point, 185
Boltzmann constant, 67, 652
bond pad metal formation, 773
bond scission, 5
bonds
— covalent, 129
— dative, 129
— ionic and nonionic, 129
— mixed double, 129
— valence, 132
boron difluoride (BF_2), 778, 779
boron implantation, 775
boron trifluoride (BF_3), 275

borosilicate glass, 620
Bossung plot, 677
bottom antireflection coating (BARC), 186, 428
— blobs, 696
— developer-soluble, 430
— graded, 798
— multilayer, 798
— organic and inorganic, 428
— photosensitive, 430
bound state, 77
Boyle's law, 99
Bragg equation, 711
Bragg relation, 508
branched polymers, 197
bridging defects, 696
bright-field mask, 620
Brillouin scattering, 477
broadband illumination, 163
bromine, 61
Brownian motion, 70
Brunner's formula, 420
bubbles, 696
buffer layer, 714
buffering agents, 142, 188, 194
burning glass, 60
butoxycarbonyloxystyrene (BOCST), 240
butyl carbitol, 190
butyl cellosolve, 190
butyllithium, 351

C

cache memories, 156
Caesalpiniaceae, 289
cage effect, 343
calcination, early theories of, 99–100
calcinations, 97
calcium carbonate, 454
calcium fluoride (CaF_2), 7, 163
calcogenide glass, 227
calixerenes, 241
C-alkylation, 240, 245
camera lucida, 10
camera obscura, 10
camphor, 118
camphor sulfonic acid, 503
canola oil, 194
capacitors, 147, 767
capillary pressure, 533
capping layer, 713
carbenes, 218, 296–297
carbohydrates, 133
carbon deposition on EUV optic, 721–725
carbon dioxide, 102
carbon growth on EUV optic, 722
carbon tetrafluoride, 546
carbon-carbon bond length, 830
carbonium ion, 343
carborundum grit, 452
carbo-*t*-butoxy norbornene (CBN), 367
CARL (chemical amplification of resist lines), 799, 804
Carl Zeiss Foundation, 92
Carruther's equation, 272
case II diffusion, 512
casein, 104, 209
casting solvents, 181
castor oil, 194
catadioptric systems, 163
catalyzed oxidation of sulfur dioxide, 642
cathode, 788
cathode ray, 61–63
cathode ray tube, 61–62
cationic polymerization, 208, 350
— coordination, 365
cationic ring-opening polymerization, 257
Catoptrica, Euclid, 34
catoptrics, early studies in, 34
ceiling temperature T_c, 387, 390
cell algorithm, 553
cell projection lithography, 752
cellosolve acetate, 187
centrifugal force, 468–469
ceric ammonium nitrate, 626
chain scission mechanism, 324
charged particle lithography, 741
charging, 745
charging effect, 224
chēmeia, 98
chemical amplification, 335–336
chemical amplification of resist lines (CARL), 799, 804
chemical amplification resist
— acetal-protected, 381–383
— based on Claisen rearrangement, 385–386

chemical amplification resist (*cont.*)
— based on depolymerization, 387–389
chemical contrast, 826
chemical development, 506–507
chemical effects of light, 33, 58–61
— on certain salts, 55
chemical equivalents, 109
chemical etching, 546
chemical mechanical polishing (CMP), 151, 772
chemical printing [*chemische druckerey*], 15
chemical reactions, laws of, 110–111
chemical transformations, 5
chemical vapor deposition (CVD), 432, 772
chemical-based shrink techniques, 799
chemically amplified resists, 226
chemische druckerey [chemical printing], 15
chemistry, 4
post-Lavoisian evolution of, 109–110
chlorine, 61, 103
chlorobenzene, 184
chlorofluorocarbons (CFCs), 186, 422
chloroform, 190
chloromethyltriazine, 240
chromatic aberrations, 86, 163, 752
chrome on a glass mask, 558
chromeless masks, 165
chromeless phase-shifting masks (PSMs), 622–623
chromic acid, 190
chromium (Cr), 119, 367
chromium (III) ions, 208
chromium oxide, 645
chromium-on-glass (COG) masks, 621
chromospheres, 72
cinnamic acid, 202
citric acid, 104
Claisen rearrangement, 286
cleaners, 142
clear-field mask, 620
CMOS (complimentary metal-oxide semiconductor), 149, 463–464
CO_2 laser, 717
coal gas, 102
coat-process-induced defects, 688
cobalt (Co), 782
cobalt silicide ($CoSi_2$), 782
coconut oil, 194
coherence length, 614
coherent illumination, 672
cold-set inks, 458
collector, 768
colligative properties, 133
colloids, naturally occurring, 145
collophonium, 288
color center formation, 655
colors of the rainbow, 39
combustion, early theories of, 99–100, 106
compaction, 652
complex refractive index, 424
complimentary metal-oxide semiconductor (CMOS), 149, 463–464
compound microscope, 86
compounds, 5, 113
— coordination, 129
— molecular, 130
computer, general-purpose, 154
computer clock speeds, 154
condensation/intermolecular dehydration, 208, 224
condenser lens, 557
conductive electron-beam resists, 224
conductive paste, 142
conductivity, 53
— electrical, 124
— specific, κ, 123
conductivity equivalent, 123
confinement effects in resists, 829–830
conjoining forces, 474
conjoining pressure, 473
conservation of energy, law of, 121
conservation of mass, 108
contact aligners, 659
contact formation process, 773
contact printing, 160, 658
— theoretical resolution of, 160
contacts, 463, 782
contamination mitigation strategies, 730–737
contamination processes, 721–728
contrast, 184, 673
contrast enhancement layers, 556
controllers, 138
conversion efficiency, 719
cooperativity length, 480

coordination cationic polymerization, 365
coordination compounds, 129
copper, electroplating of, 787
copper arsenite, 104
copper ferrocyanide, 122
copper interconnect, 784
copper interconnect wiring formation, 773
copper metallization, 143
copper seed layer, 787
copper sulfate ($CuSO_4$), 787
Coriolis force, 470
corn oil, 194
corrosion,
— lithographic mask degradation due to, 124
corrosion inhibitors, 194
cottonseed oil, 194
coulombic interactions, 396
cresols, 288
critical dimension (CD), 160, 463
critical dimension (CD) uniformity, 674, 677
critical deprotonation model, 518
critical ionization model, 518
critical modulation transfer function, 675
critical wave number, 475
Crookes tube, 92
cross-linking, 411
cross-linking reactions, 5
— radiation-induced, 200
cross-linking yield G_x, 413
crown glass, 86, 90
crystallinity, degree of, 477
crystallization, 97
crystal-originated pits (COPs), 474
cut mask, 811
cyclohexanone, 184, 185, 187
cyclopentadiene, 367
cyclopolymerization, 387

D

daguerreotype process, 17, 25
dampening solutions, 455
dark reaction, 211
dark-field mask, 620
debris-mitigation schemes, 718, 737
decompaction, 652
decomposition temperature, 369
deep ultraviolet (DUV), 183
deep ultraviolet (DUV) lithography, 792
defectivity control, 422
defects, 473
definite proportions, law of, 110
degree of coherence, 616–617
degree of crystallinity, 477
degree of polymerization, 272
degree of spectral purity, 163
degrees of freedom, 122
dehydrogenation, 348
deionized water, 189
dendrimers, 241
Dennard's scaling rules, 155
DEPICT, 554
depolymerization, 286
— chemical amplification resists based on, 387–389
deprotection, 5, 286
deprotection kinetics, 493
deprotection temperature, 369
depth of focus, 674
desensitizing gums, 142
desilylation, 351
developer selectivity, 360
developers, 181
— metal-ion-free (MIF), 504
development, 504–511
— chemical, 506–507
— physical, 507
— puddle, 505
— resist, 505–506
development models, 589–599
development rate r, 576
development rate monitor (DRM), 552
develop-processed-induced defects, 688
device miniaturization, 153
device technology node, 463
dewetting, 474
di(α-methylbenzene)ether, 245
diacetone alcohol, 185
dialkyldisulfides, 177
dialkylphenacylsulfonium salts, 279
diaryiodonium sulfonates, 340
diazo compounds, light-sensitive, 141
diazo plates, 141
diazo resists, 233–234
diazo-Meldrum's acid, 316

diazo-Meldrum's acid-based resists, 316–317
diazonaphthoquinone (DNQ), 182
— chemistry of, 292
— photolysis of, 296
diazonaphthoquinone (DNQ) ballast compounds, 294
diazonaphthoquinone (DNQ) sensitizer, 118
diazonaphthoquinone-4-sulfonate, 292
diazonaphthoquinone-5-sulfonate, 290, 292
diazonaphthoquinone/novolak, 145
diazonaphthoquinone/novolak resists, 286–292
diazonium salts, 287
diazopiperidine dione, 317
diazopyrazolidine dione (DPD), 317
diazoresin, 233
diazotetramic acid, 317
diazotization, 292
dichlorosilane gases, 776
dichromate resists, 208
dichromated gelatin, 209
dielectric constant, 53, 409
dielectric material, 53
dielectric optical coatings, 658
Diels-Adler reaction, 367
diethylene glycol dialkyl ether, 191
diethylene glycol monobutyl ether, 191
diethylene glycol monoethyl ether, 191
diffraction, 42
diffraction limitations, 30
diffraction order, 713
diffraction patterns, 559
diffraction-limited system, 94
diffusion, 772
— case II, 512
diffusion barrier, 783
diffusion coefficient, 478, 580
diffusion lengths, 502, 823
diffusion promoter, 795
digital waterless plates, 141
diglyme, 185
Dill model, 552
Dill papers, 551
Dill parameters *A*, *B*, and *C*, 552
dimethyl formamide, 190
dimethylsilyldimethylamine, (DMSDMA), 393, 794
diode-pumped fiber laser, 717
diodes, 147, 767
dioxane, 190
dioxycyclopentadiene, 275
dip coating, 468
diphenyl hexafluoroarsenate, 387
diphenylbenzofuran, 270
diphenyliodonium hexafluoroarsenate, 389
dipolar interaction, 400
dipole, oscillating, 400
dipole radiation, 705
dipole resonance transfer, 400
dipole-dipole interactions, 135
dipotassium hexachloroiridate, 369
dip-pen lithography, 175
Dirac delta function, 823
direct oxidation of sulfur dioxide, 642
direct photoexcitation processes, 727
direct-current (DC) magnetron sputtering, 713
directed self-assembly lithography, 177
directed valencies, theory of, 132
discharge-produced plasma (DPP) sources, 716, 718–719
discrete electronic components, 147
discrete transistors, limits of, 147
disjoining pressure, 475
dispersion relation, 475
dissociative electron attachment (DEA), 418
dissolution inhibition behavior 183
dissolution inhibition resists, 286–292
dissolution inhibitor, 293
dissolution properties, 507
dissolution rates, 308
distillation, 97
di-*tert*-butyl dicarbonate, 352
di-*ter*t-butyl peroxide, 351
di-*ter*t-butyl peroxide initiators, 365
di(*tert*-butylphenyl) iodonium perfluorobutanesulfonate (nonaflate) (DTBPIONf), 340
Döbreiner's triads, 125
dose to clear, 577
dosimetry, 411
double patterning, 794, 797
double-exposure techniques, 797
drain, 769

DRAM (dynamic random access memory), 150
dry ArF (193-nm) lithography, 678–692
dry etching, 151, 545–546
dry resists, 280–282
drying stimulators, 194
dual damascene processes, 429, 773, 784
dualistic theory, 113–115
DUV (deep ultraviolet), 183
dwell time, 749
dynamic random access memory (DRAM), 150

E

edge sharpening, 230
egg albumin, 209
Einstein mass-energy equivalence law, 85
Einstein's theory of relativity, 83
elastic collisions, 742
elastoplastic model for pattern collapse, 535
electric charge density ρ, 52
electric current density *J*, 52
electric displacement *D*, 52
electric field, 54
electric permittivity of vacuum, 54
electric switch, 147
electric vector, 425
electric-field-induced metal (EFM) migration, 628
electrochemical series, 115
electrochemical theory, 113–115
electrode potentials, 115
electroless copper deposition, 143
electrolysis, 52, 115
— Faraday's law of, 788
— laws of, 116
electrolytic dissociation, theory of, 123–124
electromagnetic induction, 116
electromagnetic spectrum, 55–57
electromagnetic theory, 50–55
electromagnetic units, 54
electromagnetism, 50
— equations of, 47
electromigration, 152
— of chromium ions, 124
electromotive force, 115
electron, 5, 127
— Auger, 415
— discovery of, 61–62
— low-energy, 415
— outer-shell, 5
— secondary, 415
— thermalization distance of, 417
— valence, 127
electron acceptor, 398
electron affinities, 398
electron donor, 398
electron microscopy, 80
electron optical column, 746
electron optical components, 748
electron projection lithography, 749, 751–753
electron scattering, 742–746
electron source, 746
electron-beam (e-beam) curing, 540–543
electron-beam (e-beam) direct-write lithography, 750
electron-beam (e-beam) evaporation, 713
electron-beam (e-beam) heating-induced reflow, 799
electron-beam (e-beam) lithography, 167–169, 741, 746–749
electron-beam (e-beam) machines
— mask-based, 168
— maskless direct-write, 168
electron-beam (e-beam) resists, conductive, 224
electron-beam (e-beam) system cell-projection, 168
electron-beam (e-beam) writers, 623, 624–625
electron-electron interaction, 743
electronic charge, 409, 743
electronic orbit, 82
electronic shells, 78
electrophile, 238
electrophilic aromatic substitution, 225
electrophilic substitution reaction, 226, 238
electrophotographic plates, 141
electroplating of copper, 787
electrostatic chucks, 757
electrostatic discharge (ESD), 628
electrostatic lenses, 763

electrostatic units, 54
elements [*stoicheia*], 95, 99
— transmutation of the, 96
embossing, 165
emission bands, 295
emitter, 769
empirical formula, 133
encapsulation of IC devices, 207
end cap pull back, 689
end-to-end distance, 830
energy migration
— down-chain, 405
— in resist polymer, 403–406
energy transfer, 399–403
— sensitization by, 407–409
energy-curable inks, 458
enhanced kinetic development rate model, 590
epilayer, 774
epitaxial silicon, 774
epitaxy, 772
epoxy-based negative resists, 219
equilibrium contact angle θ, 467
equilibrium reaction, 120
equivalents, law of, 111
ESCAP (environmentally stable chemically amplified photoresist), 358
esterification, 135, 208, 246
— base-catalyzed, 292
ester-protected chemical amplification resists, 357–360
ester-protected poly(hydroxy styrene)-based resists, 357–360
ester-protected poly(methacrylate)-based resist platform, 360–364
etch resistance, 184
etching of mask-making resists, 626
etching process, 544, 772
— chemical, 546
— dry, 151, 545–546
— physical, 546
— plasma, 546–547
— reactive-ion, 232, 547–548
— wet, 544–545
etch-stop layer, 787
ethanol, 323
ether winds, 46
ether-protected chemical amplification resists, 344–345
ethyl cellusolve acetate, 185
ethyl lactate, 185
ethyl pyruvate, 185
ethylacrylate, 221
ethylene glycol, 194
ethylenediamine, 191
EUV (extreme ultraviolet) lithography, 164
evaporation, 772
exchange transfer, 401–403
excimer laser sources, 609
excimer-binding energy *B*, 397
excimers, 397–398
exciplex laser sources, 7, 609
exciplexes, 398–399
excitation schemes, 612–613
excited chromophore, 201
excited state, 77
excited state complexes, 397–399
exciton, 403
exciton traps, 405
exothermic reaction, 402
exponential attenuation of radiation, 490
exposure, 489–491
exposure latitude, 576, 673
exposure mechanism of resists, 415–418
exposure models, 570
exposure optics system, 628–629
exposure rate constant, 552
exposure-defocus window, 674, 677
extended source method, 556
extra pattern defects, 696
extreme ultraviolet (EUV) emission spectrum, 718
extreme ultraviolet (EUV) exposure system, 715–716
extreme ultraviolet (EUV) lithography, 164, 170, 703
— sources for, 716–719
extreme ultraviolet (EUV) mirrors, 710–713

F

F_2 excimer laser (157 nm), 7
— line-narrowed, 164
F_2 excimer laser (157-nm) lithography, 700–701
Faraday's law of electrolysis, 788

far-field diffraction, 666
fermentation, 102
fiber optics, 94
Fick's second law of diffusion, 580
field emission, 747
field oxide, 770
field-effect transistors (FETs), 768
field-emission sources, 747
film-forming resin, 181
filtration, 97
fine art printing, 5
first-order scalar model, 564–565
fish glue, 209
fixed air (CO_2), 102
FLEX, 554
flare, 654
— long-range and short-range, 655
flint glass, 86, 90
flip-flops, 767
floating gate, 150
flow temperature, 537
fluorescein, 266, 268
fluorescence, 396
— delayed, 404
— emission, 397
— lifetime, 400
— spectroscopy, 498–501
fluorescent screen glow, 63
fluorine-doped fused silica, 621
fluorocarbons, 184
fluorspar, 103
fly's eyes, 617
focused ion beam (FIB), 761
focused-ion-beam (FIB) writers, 623
footing defects, 430, 503
formamides, 190
forward scattering, 743
fountain solutions, 141, 194, 455
four-element theory, 95–96
Fourier optics, 93
Fourier transform, 558
— inverse, 559
Fourier transform infrared (FTIR) spectroscopy, 310
Fraunhofer diffraction, 666
Fraunhofer diffraction integral, 558
Fraunhofer diffraction pattern, 667
Fraunhofer lines, 72
free energy, 409
free radical polymerization, 257, 365
freezing point, depression of the, 123
— molecular projection of the, 122
Fresnel diffraction, 665
Fresnel equations, 440
fringes, 43
front end of line (FEOL), 189
Fujita-Doolittle equation, 586
full scalar model, 565–566
full width half maximum (FWHM), 648
full-wafer printing, 163
fungicides, 194
furans, 275
fused silica, 163, 621, 649
— attenuation mechanism of, 653
— degradation mechanisms, 652
— thermal properties of, 651
fusion, 97

G

gallic acid, 104
gallium, 126
galvanic cells, theory of, 124
gamma rays, 64
gate, 463, 769
gate length, polysilicon, 463
Gaussian beam, 749
Gaussian distribution function, 580
gel curve, 254
gel point, 252
gelatin, 145, 209
gelation theory, 254
germanium, 126
germinate recombination, 410
ghost images, 657
glass prism, 37
glass temperature transition T_g, 350
glasses, planed and curved, 36
glassmaking technologies, 33
g-line, 183, 608
glycerol, 104
glycidyl ether bisphenol-A novolak, 414
glycidyl methacrylate, 220
glycol ethers, 188, 190, 194
glycol monoalkyl ethers, 191
gold, 706
graded bottom antireflection coating (BARC), 798
gravure painting, 455
grazing-incidence mirrors, 720
Grignard reagent, 31

ground state, 77
Grun's formula, 541
gum arabic, 453
G-value, 411

H

Hamaker constant, 475
hard bake, 536
hard mask (HM), 391, 435
hard mask (HM) resist system, 794
Hartley band, 630
haze defects, 641
HCl (hydrogen chloride), 350
heat-set inks, 458
heat theorem, 124
Heisenberg's uncertainty principle, 81
heliography, 22
heptanone, 187
Herzberg continuum, 623
Hess's law, 121
heterojunction bipolar transistor, 149
heterolysis, 343
hexafluoroalcohol, 376
hexafluoroantimonic acid, 495
hexahydroxy benzophenone derivatives, 294
hexamethyldisilazane (HMDS), 466
Hg (mercury) arc lamps, 164
high-activation-energy resists, 823
high-numerical-aperture (NA) scalar model, 565
high-pressure arc lamp, 608
high-repetition-rate laser sources, 163
h-line lithography, 183
holography, 94
homolytic cleavage, 495
Hopkins' method, 556
Hückel diagram, 401–402
Hund's rule of maximum multiplicity, 396
hydrazine, 369
hydrocarbon cracking model, 724
hydrocarbons, polynuclear aromatic 276
hydrofluoric acid (HF), 103, 191
hydrogen, 102
hydrogen bonds, 135
hydrogen peroxide, 190
hydrogen silsesquioxane (HSQ), 245
hydrogen sulfide, 104
hydrolytic stability, 336
hydrophilic over layer (HOL) process, 800
hydrophobic–hydrophilic interactions, 137
hydroquinone, 266
hydroxyethyl methacrylate, 221
hydroxymethyl melamine, 224
hyper-numerical-aperture imaging, 50, 435, 797
hypsochromic spectral shifts, 500

I

IC (integrated circuit), 3, 148, 605
IC devices, fabrication of, 767
Icelandic spar, 47
i-line (365 nm), 183, 608
i-line (365-nm) lithography, 183, 677–678
illumination system, 557, 616–618
image formation, 554, 665–673
— theory of, 93
image log-slope, 576
image quality, 673–677
image reversal, 218, 300
image spreading, 819
imaging theory, 557–560
imidazole, 300
imides, 340
immersion optics, 165
impression, 455
in situ cleaning, 720
incoherent illumination, 672
incoherent sources, 608
indene carboxylic acid, 238, 295
indene-1-carboxylic acid and indene-3-carboxylic acid, 297
indenone, 327
indestructibility of matter, law of, 107
index of refraction, 37
indirect excitation processes, 727
inductors, 147, 767
inelastic collisions, 742
inelastic scattering, 416
inertial resistance, 84
inflammable air (H_2), 102
infrared radiation, 55
infrared spectroscopy, 493
initiators, 258
inks, 137, 181
inspection and measurement, 543–544

insulated gate field-effect transistor (IGFET), 769
integrated circuit (IC), 3, 148, 605
integrated circuit (IC) devices, fabrication of, 767
intensity match conditions, 427
interconnects, 29
interfacial tension, 137
interference phenomenon, 40
interferometer, 46
interferometric lithography, 47
interlayer dielectric (ILD), 783
intermolecular forces, 134–135
internal conversions, 396
International Technology Roadmap for Semiconductors (ITRS), 8
intersystem crossings, 396
intramolecular dehydration, 208, 236
intramolecular esterification, 246–247
intramolecular potentials, 479
intrinsic defects, 687
intrinsic viscosity, 252
inverse Fourier transform, 559
inverters, 767
iodine, 61
iodonium, 275
ion beams, 760
ion implantation, 760, 772
ion milling, 760
ion projection lithography (IPL), 763
ion-beam lithography, 169–170, 741, 759–766
ion-beam polishing, 715
ion-beam sputtering, 713
ionization, 124
— degree of, 124
ionization energy, 410
ionizing radiation, 409
ions, 5
Ir (iridium), 367
Ir(IV)-based catalysts, 365
isobenzofurane, 268
isomerism, 130
— optical, 130
isoprene, 133
isopropyl alcohol, 194
isothermal compressibility, 652

J

junction field-effect transistor (JFET), 768
junction transistors, 146

K

k_1 as a process-dependent parameter, 7
Kellheim limestone, 12, 452
ketal resist system (KRS), 381
ketal-protected chemical amplification resists, 381–383
ketene, 296–297
ketocoumarins, 265–266
ketones, 190
ketoxime esters, 261
kinematic viscosity, 470
kinetic chain length, 272
kinetic development rate model, 590
kinetics, 120
Kirchoff's law, 73
Kodak positive resists, 145
Kodak Thin Film™ resist (KTFR), 212
Köhler illumination, 616, 672
kopals, 289
KrF (248-nm) exciplex lasers, 94, 183
KrF (248-nm) line-narrowed exciplex lasers, 164
KrF (248-nm) lithography, 678

L

lactic acid, 104
Lambert's law, 58, 490
lampblack, 12
lanthanum hexaboride (LaB_6), 747
Laplace pressure, 475
laquer, 288
laser, 94
laser interferometry, 310, 507
laser plates, 141
laser sources, 608
laser writers, 623, 625–626
laser-produced plasma (LPP) sources, 716–718
latent electrophile, 238
latent heat, 102
latent image, 489
lawrencium, 126

leakage current, 925
lens heating, 650
leveling agents, 182
levigator, 452
Lewis acid, 275
lift-off processes, 299
light
— nature of, 38
— polarization of, 47–50
— speed of, 37, 67
— velocity of, 44–47
— wavelength of, 44
light and color, 39
light as a wave or particle, 40
light waveguides, 94
light waves, 50
light-field mask, 620
lightly doped drain (LDD) implant process, 773
line edge roughness (LER), 804, 825
line slimming, 691
line spectra, dark and light, 71–74
line spread function, 823
line thinning, 696
line width roughness (LWR), 804
linear polymers, 197
linear stability analysis, 475
line-narrowed F_2 excimer laser, 164
line-narrowed KrF and ArF exciplex lasers, 164
liner oxide, 777
linseed oil, 184, 194
liquid contact potentials, 124
liquid phase silylating agents, 794–795
liquification of gases, 116
lithium, (Li), 717
lithium fluoride, 649
lithographic crayon, 451
lithographic imaging equation, 576
lithographic modeling, 551
lithographic pencil, 452
lithographic simulator, first, 553
lithographic simulators, 582
lithographic stones, 16
lithographic uncertainty principle, 832
lithographie [writing with stone], 19
lithography, 3, 772
— fine art, 451
— immersion, 50
— invention of, 4, 10
— stone, 451
— stone plate, 5
lithography-etch-lithography-etch (LELE) double-patterning process, 813
lithography-freeze-lithography-etch (LFLE) double-patterning process, 813
logic circuits, 147
London forces, 135
longitudinal wave, 49
long-range and short-range flare, 655
Lorentz space and time transformations, 83
low-activation-energy resists, 823
low-energy secondary electrons, 727
low-pressure chemical vapor deposition (LPCVD), 776
low-thermal-expansion glass, 713
Lucifer lacca, 288
luminescent effect, 63
luminiferous ether, 43, 50
lumped parameter model, 590
Lyman series, 77

M

Mack model, 553, 590–593
magnesium fluoride, 649
magnetic field, 54
magnetic induction *B*, 52
magnetic permeability, 53
magnetic quantum number *m*, 131
malic acid, 104
manganese, 103
mask, 463, 557, 618–623
mask bias, 620
mask error enhancement factor (MEEF), 619, 791
mask making, 745
mask-making resists, 626–627
— etching of, 626
mass action, law of, 120
matter waves, 79
McLaurin series, 444
mean free path, 547
measurement and inspection, 543–544
MEBES (multiple electron-beam exposure system), 749
melamine cross-linker, 239
membrane model, 518

memory bottleneck, 155
memory chips, 138
mercury (Hg) arc lamps, 164
metacresol, 303
metal interconnects, 463
metal-chalcogenide resists, 227, 230
metal-ion-free (MIF) developers, 504
metal-organic chemical vapor deposition (MOCVD), 151
metal-oxide semiconductor field-effect transistor (MOSFET), 149, 768, 769
meta-PHOST isomers, 351
methides, 340
methyl isobutyl ketone (MIBK), 190, 245
methylamylethanol, 191
methylene, 268
methylene chloride, 190
methylethyl ketone, 190
methylmethoxy propionate, 185
Michelson-Morley experiment, 47
Michler's ketone, 264
microcontact printing, 171
microelectronics, 29
microfluidics, 172
microloading effects, 689
micromolding in capillaries, 171–172
microprocessors, 138
microscope, invention, 38
minimum resolvable pitch, 673
mirrors, 36
modern chemistry, foundation of, 104–109
modulation transfer function, 673, 674–675
molar absorption (extinction) coefficient, 58, 490
molarity, 256
molding, 165
molecular beam epitaxy, 151
molecular contaminants, 628
— airborne, 630
molecular self-assembly lithography, 176–177
molecular theory of matter, 64, 65
molecular weight, 830
molecules, 5
molybdenum (Mo), 710
molybdenum silicide (Mo-Si), 714
molybydic acid, 103
momentum *p*, 79
monazoline, 300
monobenzoid aromatics, 428
monoethanolamine (MEA), 191
monolithic integrated circuit (IC), 148
monopropanolamine, 191
Moore's law, 6
MOSFET (metal-oxide semiconductor field-effect transistor), 149, 768, 769
mucic acid, 104
multibenzoid aromatics, 428
multilayer bottom antireflection coating (BARC), 798
multilayer resist systems, 792–793
multilevel metallization, 152
multiple proportions, law of, 111
multiplexers, 767

N

N-(9-acridinyl acetamide (ACRAM), 499
nanofluids, 172
nanoimprint lithography, 172–173
nanoskiving, 171, 172
naphthol, 287
natural calcite, 47
near-field diffraction, 665
near-UV lithography, 792
negative resist, 159
— radiation-induced, 200–224
negative resist composition, 280
negative resist developers, 187
negative/positive process, 17
network polymer, 197
neutron scattering, 477
neutrons, 75
Newtonian fluid, 469
Newton's rings, 41
N-iminopyridinium ylides, 232–233
nitrene, 214
nitric acid, 453
nitric oxide, 92
nitrogen, 106
nitromethane, 190, 369
N-methoxymethylated melamine, 238
N-methylacetamide (Mac), 191
N-methyldiethanolamine, 264
N-methyl-N-ethylpropionamide, 191
N-methylpyrrolidone (NMP), 356, 424, 795

nMOS (*n*-channel MOSFET), 149, 770
N,N-diethylbutylamide, 190
N,N-dimethylacetamide (DMAc), 191
N,N-dimethylpropionamide, 191
nonbleachable absorbance, 552
non-chemically amplified negative resists, 226
non-radiation-based negative resists, 199–200
nonradiative transition, 396
nonvolatile semiconductor memory (NVSM), 150
norbornene, 367
norbornene hexafluoroisopropanol, 373
norbornene-derived monomers, 183
normal butyl acetate, 187
normal parafins, 194
normal-incidence multilayer mirrors, 720
normalized image log-slope (NILS), 576, 647
Norrish-type I process, 323
Norrish-type II process, 331
notch development, 554
novolak, 288
nuclear energy, 133
nuclear model of the atom, 74
nucleic acids, 133
nucleophilicity, 274
nucleus, 78, 127
numerical aperture (NA), 7

O

O_2 ashing, 190
o-(α-methylbenzyl)phenol, 245
O-alkylation, 240, 245
objective lens, 556
off-axis illumination, 165, 554
offset lithographic inks, 193, 458
offset lithography, 3, 455
— waterless, 460–461
offset lithography rollers, 456
offset printing press, 455
oil paints, 289
oleic acid, 454
oleomagnate of lime, 454
onium salts, 273
optical activity, 118, 119
optical coatings, 657–658
optical density, 490
optical fingerprints, 86
optical lithography, 160–166, 605
— elements of, 606–608
optical materials used in UV lithography, 649
optical path difference (OPD), 562
optical pattern generators, 623, 624
optical proximity correction (OPC), 165
optical proximity effects, 684
optics, 4
— early studies in, 34
Optics, Euclid, 34
optics lifetime, 719–720
organic chemistry, 4
— development of, 117–118
— ortho-nitrobenzyl chemistry, resists based on, 318–322
ortho-PHOST isomers, 351
osmium (Os), 367
osmotic pressure, 122
overlay, 489
overpriming, 467
oxalic acid, 104
oxidation, 720, 721, 725–728, 772
oxidation potential, 409
oxidation-resistant capping layers, 731
oxycyclohexene, 275
oxygen, 102, 106
oxygen plasmas, 193
ozalid process, 285
Ozatec™, 290
ozone, 636

P

packaging process, 773
para-PHOST isomers, 351
partial coherence, 553, 560
particle accelerator, 772
particle defects, 687
particle (corpuscular or emission) theory, 40–42
passive components, 768
path difference, 561
pattern collapse, 532–536, 686
— elastoplastic model for, 535
pattern distortion, 689
pattern generators, 618
Pauli's exclusion principle, 130
Pd(II)-based catalysts, 365
pellicles, 627–628

perchloric acid, 626
percolation model, 518
perfluorinated compounds, 421
perfluoroalkanesulfonic acids (PFAS), 421
perfluoroalkanoic acid (PFAA), 421
perfluorooctane sulfonate photoacid, 822
perfluorooctanesulfonate, 340
perfluorooctanesulfonic acid, 421
perfluorooctanoic acid, 421
perfluorooctyl sulfonate, 340
periodic law, 124–129
periodic table, 124–129
— theory of the, 130–132
permeability of vacuum, 54
permittivity of free space, 744
peroxides, 258
Perrin formula, 402–403
persistence length, 480
perspective, laws of, 34
perylene, 276
pewter plate, 22
phase defects, 714
phase edges, 811
phase error, 562
phase match condition for zero reflectivity, 426
phase rule, 122
phase-contrast microscope, 93
phase-shifting masks (PSMs), 165, 553, 620–623, 798
phenols, 190
phenylene diacrylates, 205
phenylsilanediol, 245
philosopher's stone, 98
phlogiston theory, 100
phosphorescence, 396
phosphoric acid, 777
phosphorous, 103
phosphorous implantation, 774
photoacid generation monitoring, 498–501
photoacid generator, 181
photoactive compound, 73
photobleaching, 230
photocathode projection lithography, 752
photochemical oxidation of sulfur dioxide, 62
photochemistry, 33
photodecomposable base, 380
photodimerization reaction, 203
photodissociation of molecular oxygen, 632–636
photodoping, 227
photoelastic constant, 652
photoelectric effect, 69–71, 416, 647
photoelectricity, 65
photoelectron yield, 722
photoelectrons, 415
photofragmentation, 258
photo-Friess rearrangement, 286
— resists based on, 322
photogeneration of radicals, 258–262
photograph
— the first, 22
— the first permanent, 17
photography, 4
photoimageable polyimides, 206
photoinitiation, 258
photoinitiator, 181, 182
photoionization, 409
photolithography, 4, 160–166, 605
— invention of, 17
— limits of, 165
— step-and-repeat, 163
photolysis, 274
photomasks, fabrication of, 623–626
photomechanical reproductions, 287
photometry, 33
photonic devices, 151
photons, 5
photon-stimulated desorption, 727
photo-oxidative degradation, 633
photo-oxygenation of polymers, 640–641
photopolymer plates, 141
photopolymer printing plate, 256
photopolymer resins, 141
photoreduction, 210
photorepeaters, 618
photoresist, inorganic, 55
— dyed, 553
photosensitization, 406
photospeed, 315
photosphere, 72
photosynthesis, 103
physical chemistry, development of, 120–133

physical development, 507
physical etching, 546
physical vapor deposition (PVD), 782
pinacol rearrangement, 208, 234–235
pinacol-pinacolone rearrangement reaction, 208
pinholes, 473
pitch, 6
planarizing layer, 421
Planck's constant, 69
Planck's distribution law, 69
Planck's quantum hypothesis for blackbody radiation, 67–69
planographic printing technique, 17, 455
plasma etching, 546–547
plasma stripping, 193
plasma-assisted shrink techniques, 799
plasma-deposited polymers, 796
plasticization, 808
plasticizer, 808
pMOS (*p*-channel MOSFET), 149, 770
p-n junction, 147
p-n junction transistors, 146
point de vue du Gras [view from the window at Le Gras], 22
poisoning from airborne molecular bases, 356
polarity changes
— radiation-induced, 226
— reverse, 235
polarization, 44
polarization plane, 49
poly(1,3-cyclopentylenevinylene), 367
poly(2-methyladamantyl methacrylate-*co*-gamma butyro lactone), 361
poly(2,7,-bicyclo[2.2.1]hept-2-ene), 368
poly[3-methyl-2-(4-vinylphenyl)-2,3-butanediol], 235
poly(3-methyl-4-hydroxy styrene), 478
poly[4-(1-hydroxyethyl)styrene], 244
poly[4-(2-hydroxy-2-propyl)styrene], 236
poly(4-hydroxy-α-methylstyrene), 352
poly[4-hydroxystyrene-*co*-4-(3-furyl-3-hydroxypropyl)styrene], 243
poly(4-hydroxystyrene sulfone), 352
poly(4-*tert*-butoxy-α-methylstyrene), 353
poly(4-*tert*-butoxycarbonyloxystyrene sulfone), 353
poly(4-vinyl benzoate), 358
poly(4-vinylbenzoic acid), 358
poly(acrylamide), 217
polyacrylics, 145
poly(allyl methacrylate-*co*-hydroxyethyl methacrylate), 221
polyamic acids, 206
polyamides, 135
poly(butene sulfone) (PBS), 329, 332
poly(carbo-*t*-butoxynorbornene-*co*-maleic anhydride, 493–494
poly(carbo-*t*-butoxynorbornene-*co*-norbornene carboxylic acid), 493
poly(chloromethyl styrene-*co*-vinyl naphthalene), 223
poly(chloromethylstyrene), 222
poly(*cis*-isoprene) rubber, 208
poly(*cis*-isoprene)-bisazide negative resists, 208
polydimethylsiloxane, 165
poly(dinorbornene-*alt*-maleic anhydride), 373
polydispersity, 350
polyesters, 135, 205
polyfluoroalkylethers, 186, 422
poly(fluorobutyl-*co*-maleic anhydride), 330
polygate process, 773
poly(glycidyl methacrylate) (PGMA), 220
poly(glycidyl methacrylate-*co*-ethylacrylate), 221
poly(hexafluoro methacrylate), 328, 330
polyhydroxybenzophenone, 293
poly(hydroxyphenyl methacrylate), 353
polyhydroxystyrene (PHOST), 348–349
polyhydroxystyrene (PHOST) resists, 183
poly(hydroxystyrene-*co*-*tert*-butyl acrylate), 359
polymer chemistry, development of, 133–135
polymer cooperative dynamics, 473
polymer degradation, 411
polymer grains, 827
polymer relaxation-controlled mass transfer, 512

polymer surface dynamics, 473
polymer-bound dyes, 429
polymerization length distribution, 830
polymers, synthetic, 145
polymer-tethered photoacid generators, 738
poly(methyl methacrylate) (PMMA), 323, 330
poly(methylisopropenyl ketone), 313
poly(methylpentene sulfone) (PMPS), 334
poly(methylpropyl bicyclo[2.2.1]-hept-5-ene-2-carboxylate-*co*-bicyclo[2.2.1]hept-5-ene-2-carboxilic acid, 493
poly(methylpropyl bicyclo[2.2.1]-hept-5-ene-2-carboxylate-*co*-maleic anhydride, 493
poly(N-hydroxyphenyl methacrylate), 353
polynuclear aromatic hydrocarbons, 276
poly(N-vinyl pyrrolidone), 234
poly(*p*-acetoxystyrene), 322
poly(perfluorobutyl methacrylate), 327–328
poly(propargyl methacrylate-*co*-hydroxyethyl methacrylate), 221
polysilanes, 393, 796
polysilicon gate length, 463
polysilynes, 393, 796
polystyrene, cross-linking of, 222
poly(styrene-*co*-maleimide), 352
poly[styrene-*co*-N-(4-hydroxyphenyl)maleimide], 352
poly(*t*-BOC-styrene-*co*-4-acetonxystyrene-*co*-styrene sulfone), 353
poly(*tert*-butoxycarbonyl oxystyrene) (PBOCST), 322, 346
poly(trifluoromethyl-*o*-chloroacrylate), 328
poly(vinyl alcohol), 145, 209
poly(vinyl butyral), 145, 209
poly(vinyl cinnamate), 145, 201
poly(vinyl cinnamate) resist system, 203
poly(vinyl cinnamylidene acetate), 203, 205
poly(vinyl ether-*alt*-maleic anhydride (VEMA), 364
poly(vinyl naphthalene), 223
poly(vinyl phenol), 217
poly(vinyl pyridine), 208
poly(vinyl pyrrolidone), 145, 209, 217
popping, 467
population inversion, 612
portable conformable mask (PCM), 796
positive resist, 159
positive resist developers, 187
positive-working reprographic plates, 287
positron annihilation lifetime spectroscopy, 477
postbake, 536–537
postdevelopment bake, 536–537
postexposure bake (PEB), 491
postexposure bake (PEB) delay stability, 696
postexposure bake (PEB) diffusion, 554
postexposure bake (PEB) models, 579
postexposure bake (PEB) sensitivity, 493, 684–685
postexposure critical dimension (CD) shrink techniques, 797
postexposure thermal processing, 5
potassium carbonate, 104
potassium hydroxide, 189
potential diagram, 397
potential energy, 397
potential well, 397
power density, 156
power spectrum, 668
p-phenylenediacrylic acid (PDDA), 205
p-polarization, 569
prebake, 485
precoated lithographic printing plates, 205
presensitized lithographic plate, 211
PREVAIL (projection reduction exposure with variable axis immersion lens), 759
principal quantum number *n*, 130
principle of continuity, 68
printed circuit board (PCB), 138, 142–145
printing modes, 658
process-induced defects, 687
processing speed, 156
projection imaging system, 557
projection printing, 162, 658

projection reduction exposure with variable axis immersion lens (PREVAIL), 759
projection soft x-ray lithography, 707
PROLITH, 553
propargyl methacrylate, 221
propyleneglycol monoethylether acetate (PGMEA), 185
proteins, 133
protons, 75, 127
proximal probe lithography, 173–175
proximity effects, 744, 803
proximity ion-beam lithography, 762
proximity printing, 162, 658
— theoretical resolution of, 162
proximity projection lithography, 752
prussic acid, 104
puddle development, 505
pulse energy, 609, 613
pulse repetition rate, 609
pulse width, 613
pulsed Nd-YAG laser, 717
pulsed photomagnetic curing, 306
pupil function, 559
pyréolophore, 19
pyridine, 218
pyrogallic acid, 104

Q

quantum effect devices, 151
quantum theory, 64–65
— of light, 79–83
quantum yield, 255, 500
quartz crystal, 119
quartz crystal microbalance, 308, 507
quaternary pyridinium salts, 207
quenching sphere, 403

R

radiation, exponential attenuation of, 490
radiation absorption, 184
radiation chemical yield, 411
radiation-induced cross-linking reactions, 200
radiation-induced negative resists, 200–224
radiation-induced polarity changes, 226
radical polymerization, 350
radical scavengers, 220
radicals, 219
radio frequency (RF) field, 193
radio waves, 64
radioactivity, 62–64
radius of gyration R_g, 477, 830
Raoult's law, 124
rarefaction, 652
rare-gas halide exciplex lasers, 610
rare-gas monohalides, 609
raster scan, 749
raster scanning, 751
rate constant, 494
Rayleigh scattering, 652
Rayleigh-Jeans law, 66–67
Rayleigh's resolution criterion, 7
reactions, law of, 109, 124
reactive-ion etching (RIE), 232, 547–548
reciprocal portions, law of, 111
reciprocity failures, 575
rectilinear propagation of light, 41
red shift, 397
reduction optics, 163
reduction potential, 409
reduction projection printing, 163, 661
reflecting telescope, 86
reflection, law of, 34
reflection amplitudes, 425
reflection coefficients r_{12}, 425
reflective notching, 420
reflective systems, 163
reflectivity R, 425
reflow-based shrink techniques, 799
refracting telescope, 86
refraction, 35
— degrees of, 39
— double, 48
— laws of, 36, 37
refractive index, complex, 424
refrangibility, degrees of, 39
registration, 160
RELACS (resolution enhancement of lithography assisted by chemical shrink), 799
relativistic mechanics, 84
relativity, theories of, 70
repetition rate, 613
residence times, 724
resist, 181

resist (*cont.*)
— acetal-protected chemical amplification, 381–383
confinement effects in, 829–830
— dry, 280–282
— ester-protected chemical amplification, 357–360
— ester-protected poly(hydroxy styrene)-based, 357–360
— ester-protected poly(methacrylate)-based, 360–364
— ether-protected chemical amplification, 344–345
— high-activation-energy, 823
— ketal-protected chemical amplification, 381–383
— low-activation-energy, 823
— manufacture of, 184–186
— mask-making, 626
— multicomponent, 182
— one-component, 182
— poly(chloroacrylate-*co*-α-methylstyrene), 334–335
— poly(hydrostyrene) (PHOST), 183, 346–357
carbonate-protected, 346–348
— poly(methyl isopropenyl ketone), 331
— poly(olefin sulfone), 331–334
— polyphthaldehyde, 387
— poly(tetrahydrofuran-*co*-novolak), 344–345
— resolution limit issues of, 792
— single-layer (SLR), 360
— sulfone/novolak system (SNS), 334
resist based on ortho-nitrobenzyl chemistry, 318–322
resist based on photo-Friess rearrangement, 322
resist blur, 819
resist classifications, 182
resist contrast γ, 576
resist developers and rinses, 187–189
resist development, 505–506
resist exposure, 415–418, 554
resist sensitizer, 73, 398
resist solvents, 184
resist stabilization treatments, 536–543
resist strippers and cleaners, 189–193
resist stripping, 775
resist stripping solutions, broad-spectrum, 190
resistors, 147, 767
resolution, 184
resolution enhancement of lithography assisted by chemical shrink (RELACS), 799
resolution enhancement techniques, 165, 798
resolution limit issues of resists, 792
respiration, 102
rest mass, 85
reticle, 164, 463
reticulation, 540
reverse polarity switch, 235
rework/stripping, 438, 548–549
rheological properties, 468
riboflavin, 268
rim phase-shifting masks (PSMs), 622–623
ring-opening metathesis polymerization, 365, 367
ring-shaped image field, 162
Riston®, 145, 219
Riston LUV®, 282
Riston LV®, 268, 282
rose bengal, 266, 268
rosin, 454
rubber, 133
rubylith, 618
ruthenium (Ru), 367
Rutherford scattering, 540
Rutherford's planetary model of the atom, 75

S

safflower oil, 194
salt, 113–114, 188
SAMPLE, 553
sapphire, 649
Sauerbrey equation, 510
scalar diffraction theory, 556
SCALPEL (scattering with angular limitation projection electron-beam lithography), 752
SCALPEL mask, 754
scandium, 126
scanner-generated defects, 698
scanning probe lithography, 165
scanning strategies, 751

scanning tunneling microscopy (STM), 165, 173
scattering processes, 743
scattering with angular limitation projection electron-beam lithography (SCALPEL), 752
Schiemann reaction, 274–275
Schrödinger equation, 130
Schumann-Runge band, 614–615, 630
scintillation counting, 356
scission yield, determination of, 412
screen printing, 144
scumming, 420
secondary structure model, 518
second-harmonic generation, 625
second-harmonic generators, 94
selenium, 119
self-aligned double patterning, 813
self-aligned gate process, 151
self-assembled monolayer (SAM), 171
self-developed images, 387
self-propagating chain reaction, 272
semiconductor lithography, 3, 157–160
semipermeable membrane, 122
Senefelder, Alois, 11
sensitivity, 184, 577
sensitization
— direct and indirect, 416
— spectral, 406
— triplet, 407
sensitization by electron transfer, 408–409
sensitization by energy transfer, 407–408
sensitizer, 181, 182
separability assumption, 564
shadow mask proximity printing, 752
shallow trench isolation process, 773
shaped beam, 749
shear rate, 469
shear stress, 469
sheet-fed system, 457
shelf life, 212
shellac, 145, 209
short-wavelength imaging, 797
shot noise, 758, 828
shot noise limit, 828
sidewall erosion, 803
sidewall formation, 803
sidewall spacer formation process, 773
sighting tubes, 36
silane (SiH_4) gas, 778
silane-coupling agent, 466
silanol, 465
silanol polymers, 184
silicon dioxide (SiO_2), 464
silicon fluoride (SiF_4), 103
silicon nitride (Si_3N_4), 776
silicon oxynitride, 186, 431
siloxane, 394, 796
siloxycarbenes, 218
silsesquioxanes, 245
silver halide plates, 141
silver metal, 227
silver nitrate, darkening of, 55
silylating agents, 794
— liquid and vapor phase, 393
silylation processes, 795
SiN, 787
single-electron memory cell (SEMC), 150
single-exposure techniques, 797
single-layer resist (SLR), 360
singlet oxygen, 636
singlet S_1, 395
singlet-triplet splitting, 408
Snell's law, 37
sodium ammonium racemate, 119
sodium fluoride, 649
sodium metasilicate, 504
soft bake, 485
soft lithography, 165, 170–171
soft x rays, 170
soft x-ray lithography, 703
softening point, 212
solar cell, 149
solar spectrum, 74
solder mask, 283
solid state electronics, 146
solid state photodimerization, 202
solid-film resists, 145
solubility, 184
solubility parameter, 356
solution, 97
solution pressure, 124
solutions, theory of, 122–123
solvation, 507
solvent, 181
sorting, 773
sound wave, 49

source, 768
source/drain (S/D) implant process, 773
soy oil, 194
space velocity, 470
space-charge effects, 169, 753
spark discharge plates, 141
spatial coherence, 613
spatial filtering, 93
spatial frequencies, 558
specific conductivity κ, 123
specific heats, 102
speckles, 613
spectral bandwidth, 609
spectral sensitization, 203, 406
spectroscopic ellipsometry, 477
spherical aberration, 36
spherical wavefront, 561
spin coating, 468
spin-forbidden plane vibrations, 396
spinodal decomposition, 474
SPLAT, 554
s-polarization, 569
spray coating, 468
sputtering, 546, 772
stabilizers, 182
stamping, 165
standing-wave effects, 166
standing-wave models, 566–570
standing waves, 419, 556
— reduction of, 557
starch, 209
state-mixing effects, 396
statistical mechanics, 65
statistical theory of heat, 65
statistical thermodynamics, 64
steady state approximation, 270–271
steam lithographic press, 16
steindruck [stone printing], 13
stencil masks, 752
step-and-flash imprint lithography, 172
step-and-repeat systems, 691
step-and-scan systems, 164, 619
step-and-scan tools, 661
steppers, 661
stereochemistry, 119
stereolithography, 176
stochastic blur, 766
stochastic scattering, 743
Stockmayer's rule, 255
stoicheia [elements], 95
stone lithography, 451
stone plate lithography, 137
stone printing [*steindruck*], 13
stone wall model, 518
storage cell, 436
storage stability, 184
STORM, 554
stress-induced birefringence, 652
string algorithm, 553
strippers, 181
stripping issues, 438, 548–549
strutted mask, 754
styrylpyridine, 206
styrylpyridinium, 208
styrylquinolinium, 208
SU8™, 277
sublimation, 97, 428
subsidiary quantum number *l*, 131
substitution, theory of, 117
substrate preparation, 5
substrate priming, 466
sugars, 118
sulfinic acids, 341
sulfonal ester of cumylphenol, 293
sulfone/novolak system (SNS) resists, 334
sulfonic acid, 190, 341
sulfonic acid chloride, 292
sulfonium salts, 275
sulforane, 191
sulfur, 119
sulfuric acid, 190
sunflower oil, 194
supercritical (SC) carbon dioxide (CO_2), 247, 536
superposition principle, 823
surface contamination, 720
surface dynamics, 473
surface energy, 467
surface inhibition effects, 593
surface inhibition function, 553
surface tension, 467
surfactants, 182
sweet PAG, 379
swelling, 507, 696
swing amplitude *S*, 420
swing curve effects, 420
switching delay, 155, 156
synchrotron sources, 705–706
synchrotron storage ring, 705

Syrian asphalt, 182

T

tactile and emission theories of light, 33
talc powder, 454
tantalum (Ta), 706, 787
tantalum boride (Ta_4B), 706
tantalum nitride (TaN), 706, 787
tantalum silicide ($TaSi_2$), 186, 431
tantalum silicide nitride (TaSiN), 706
target materials, 717
tartaric acid, 104, 118
t-butoxycarbonyl oxystyrene, 352
t-butyl methacrylate, 250
technology computer-aided design (TCAD), 554
Teflon-based materials, 186, 422
telescope, invention of, 36
TEMPEST, 554
temporal coherence, 613
temporally coherent sources, 608
tert-butyl acrylate, 367
tert-butyl-2-trifluoromethylacrylate (TBTFMA), 377
tetrabromobisphenol A, 341
tetracene, 398
tetrachloroethylene, 190
tetrafluoroethylene (TFE), 375
tetrahydropyranal ether, 344
tetrahydropyranal methacrylate, 250
tetramethylammonium hydroxide (TMAH), 188, 504
thermal expansion coefficient, 745
thermal oxidation, 464
thermal properties of fused silica, 651
thermal stability, 184
thermalization distances of electrons, 417
thermally induced reflow, 799
thermionic emission, 747
thermionic sources, 747
thermochemistry, 121–122
— foundations of, 107
thermodynamics, third law of, 124
thermogravimetric analysis (TGA) profile, 369
thermolysis, acid-catalyzed, 226
thermoplastics, 197
thermosets, 198
thiazines, 268
thiol-ene system, 272–273
thionyl chloride, 292
thiourea, 306
thioxanthones, 265
thoriated tungsten, 747
thyristor, 149
time constant, 475
tin (Sn), 119, 717
titanium (Ti), 782
titanium nitride, 186, 431
titanium silicide ($TiSi_2$), 782
TMAH (tetramethylammonium hydroxide), 188, 504
top antireflection coatings, 186
— theory of, 424
— water-based, 423
top surface imaging (TSI), 391
top surface imaging (TSI) resist system, 794–795
topcoats, 694–696
transesterification, 247
transfer functions, 93
transistor, 138, 767
— bipolar, 147
— first point contact, 146
— invention of, 146–147, 605
transistor action, 146
transistor effect, 146
transistor gate width, 156
transition dipole moments, 400
transmission amplitudes, 424–427
transmission coefficients, t_{12}, 425
transmittance, 490
transmutation of elements, 133
transport number *n*, 123
transuranium elements, 133
transverse electric (TE) field, 448
transverse electric (TE) field polarization, 569
transverse magnetic (TM) field, 448
transverse magnetic (TM) field polarization, 569
transverse wave, 49
trench isolation, 151
trenches, 463
trench-first approach, 787
triarylsulfonium salts, 276
triazines, 261–262
trichloroethylene, 190
trichromatic theory of color vision, 43

triethanolamine, 300
triethylamine, 264
trifluoromethane sulfonic acid, 503
trim mask, 811
trimethylsilyldiethylamine (TMSDEA), 393, 466, 794
trimethylsilyldimethylamine (TMSDMA), 393, 794
triphenyl sulfonium hexafluoroantimonate, 278
triphenyl sulfonium trifluoromethanesulfonate, 340
triphenyl sulfonium salts, 343
triplet, T_1, 395
triplet sensitization, 407
triplet-to-singlet energy transfer, 402
truxillate, 202
truxinate, 202
T-topping, 315
tung oil, 194
tungsten (W), 367, 706, 747
tungstic acid, 103
tunnel diode, 149
turpentine, 118, 184
tusche, 452
twin-well process, 773
Tyndall phenomenon, 116

U

ultraviolet (UV) lithography, 606
— optical materials used in, 649
ultraviolet (UV) radiation, 55
ultraviolet (UV) radiation curing, 537–540
undercutting, 430
undulatory theory of light, 40, 42–44
universal gas constant, 121
uranium, 64, 133
urea, 117
uric acid, 104

V

vacuum tubes, 147
valency, electronic theory of, 129
van der Waals radii, 397
vapor pressure, lowering of, 123
vector scan mode, 749
vector scanning, 751
via and tungsten plug formation processes, 773
via-first approach, 429, 787
vias, 463, 783
vinyl addition polymerization, 368
viscosity, 185, 469
— kinematic, 470
viscous forces, 468
visible light lithography, 606
vital force, 117

W

W (tungsten), 367, 706, 747
wafer, 543
wafer testing, 773
water, 184
water marks, 696
water-based top antireflection coating materials, 423
water-immersion ArF (193-nm) lithography, 164, 692–700
waterless offset lithography, 460–461
waterless plates, 141
water-processable resists, 207, 217
wave theory of light, 40, 42–44
wavefront aberration, 708
wavefunction ψ, 132
wavelength markers, 86
wave-particle duality, 81
wax-lampblack-soap resists, 199–200
web system, 457
weight-average molecular weight, 252
wet etching, 544–545
wetting agents, 194
Wittig reaction, 350
Wolf rearrangement, 296
Wollaston doublet lens for microscopes, 50
work function, 747
work of adhesion, 468
writing rate, 749

X

xanthenes, 268
xenon (Xe), 717
x rays, 5, 63
— soft, 170
x-ray diffraction, 91
x-ray lithography, 165–166, 703
x-ray mask absorbers, 706
x-ray mask membranes, 706
x-ray masks, 166, 706–707

x-ray reflectivity, 479
x-ray reflectometry, 477
xylene, 184, 187

Y

ylide resists, 232–223
Young's equation, 467
Young's modulus, 534, 706
Young's two-slit experiment, 73

Z

Z-constant, 833
Zernike coefficient, 562
Zernike polynomials, 93, 561
zero reflectivity, phase match condition
for, 426
zero-order scalar model, 564
Ziegler-Natta catalysts, 367
zinc chloride, 234

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