

Index

- absorption coefficient 136
- absorption of EM radiation 135–40
 - effect of electric fields 143
- acceptor atoms 90
- acids 170
- acoustic impedences 381
- acoustic sensors 380–1
- action potentials of neurons 481
- active addressing 302–3
- activity coefficient 367
- activity of ionic species 367
- actuators 360
 - polymer actuators 392–5
- addition polymerization 57
- addressing, passive and active 302–3
- adenosine triphosphate (ATP) 467–8
- adenosine diphosphate (ADP) 467–8
- admittance, electrical 123
- admittance spectroscopy 125
- adsorption 56
- aerogels 257
- alcohols 173–5
- aldehydes 175
- aliphatic compounds 179
- alkanoic acids 176
- alkoxides 175
- alpha-helix 459, 460
- ambipolar FETs 438
- amides 176
- amines 175–6
- amino acids 455–8
- amorphous solids 56
- amperometric sensors 365
- amphiphilic compounds 258
- analyte 363
- AND gate 444–5
- angular frequency of waves 74
- anions 170
- anisotropic energy 206
- anisotropic substances 46
- anodization 253
- anti conformation 39
- antibiotics 477
- antibodies 458
- antibonding orbitals 31
- antiferroelectric liquid crystal (AFLC) phase 306
- antiferromagnetism 203, 204, 208
- antigens 458
- antistatic agents 351
- anti-Stokes' radiation 231
- aramid liquid crystal polymers 310
- aromatic compounds 178–80
- artificial neural networks (ANNs) 390
- atomic force microscopy (AFM) 233
- atomic magnetic dipole 201
- atomic mass unit 19
- atomic number 19
- atomic structure 19–20
 - electrons 20–4
 - orbitals 23–4
 - periodic table 24–6
- atomic weight 19
- attenuated total reflection (ATR) 228, 385
- Auger electron spectroscopy (AES) 232
- Avogadro's number 20, 170
- axial ratio 296
- axons 480
- back lighting 302
- bacteriorhodopsin (BR) 487–8
 - data storage 490–1
 - holographic memory 491–2
 - information processing 492
 - photochromism 488–90
 - photocycle 488
- ballistic transport 67
- bandwidth 362
- based-centred unit cells 50

- bases (alkalis) 170
- bases (of nucleotides) 468–6
- bathochromic shift 137
- batteries 351–4
- Beer–Lambert law 136–7
- Beer’s law 135–6
- bimorphs 394
- bioelectronics 455
 - DNA electronics 487
 - molecular motors
 - artificial motors 501–2
 - Nature’s motors 498–500
- biological cells 468–9
- biological comparisons with
 - molecular-scale electronics 12–13
- biological membranes 474–5
 - transport across membranes
 - electrons 479–80
 - molecular and ionic 475–9
- biological molecules 455
 - amino acids and peptides 455–8
 - carbohydrates 461–2
 - enzymes 459–61
 - lipids 462–4
 - nucleotides 465
 - ATP and ADP 467–8
 - bases 468–6
 - DNA 466–7
 - RNA 467
 - proteins 458–9
- biosensors 482–3
 - see also* sensors
 - bioaffinity sensors 484–5
 - amperometric glucose sensors 486
 - optical biosensors 486–7
 - biocatalytic sensors 483
- bipolarons 110–11
- birefringence 297–9
 - birefringent media 133
- blastocysts 469
- Bloch walls 206
- body-centred unit cells 50
- Bohr atomic model 20
- Boltzmann’s constant 67
- bonding orbitals 31
- bottom-up nanotechnology 1
- Bragg’s law 218
- Bravais lattices 50
- Brewster angle 151–2
- Brillouin zones 82–3
- buckminsterfullerenes (‘buckyballs’) 188–9
- calorimetric gas sensors 364
- candelas 335
- carbohydrates 461–2
- carbon nanotubes 191–4
- carbonyl group 175
- carboxylate esters 177
- carboxylates 176
- carboxylic acids 175, 176
- Casimir force 405
- cations 170
- cause and effect 202
- cellular automata 447
- centre of inversion 134
- charge carrier mobility 69–70
- charge-flow transistors 375
- charge-transfer complexes 103–6, 185–8
- chemical bonding 26, 35
 - covalent bonds 29–32
 - hydrogen bonds 34–5
 - ionic bonds 27–8
 - metallic bonds 32–3
 - organic compounds
 - double and triple bonds 42–5
 - hybrid orbitals 35–7
 - isomers 37–42
 - principles 26–7
 - van de Waals bonds 33
- chemical force microscopy (CFM) 236
- chemical self-assembly 268–9
- chemical sensors *see* sensors
- chemical vapour deposition (CVD)
 - techniques 251–2
- chemiresistors 369
- chemisorption 56
- chiral phase 290–2
- chirality 40
- chiroptical switches 432
- chlorophyll 493–4, 496
- chloroplasts 469
- cholesterol 463
- chromaticity diagrams 334
- chromoionophores 383
- chromosomes 469
- circularly polarized radiation 129
- cis*-isomerism 40, 43
- cladding 155
- codons of DNA 470
- coercive fields 199, 206
- cofactors of enzymes 461
- coherent radiation 147
- cohesive energy 27

- Cole–Cole diagram 125
- collagen 458
- compensated materials 91
- complimentary MOS (CMOS)
 - transistors 328
- computing architectures 447–9
- condensation polymerization 57
- conduction, intrinsic and extrinsic 88–9
 - disordered semiconductors 94
 - Fermi level position 92–3
 - low-dimensional solids 95–6
 - n-type doping 89–90
 - p-type doping 90–1
 - quantum wells 93
 - traps and recombination centres 92
- conduction band 85, 87
- conductive coatings 351
- conductive polymers 180–5
- conductivity, high-frequency 121
 - complex permittivity 121–5
 - impedance spectroscopy 125–7
- conductivity, low-frequency 112–13
 - electronic versus ionic conductivity 113–14
 - quantum mechanical tunnelling 114–16
 - Schottky and Poole–Frenkel effects 120–1
 - space-charge injection 118–19
 - variable range hopping 116–17
- conductors 85–6
- configurational isomers 40–2
- confocal microscopy 214
- conformation of proteins 459
- conformational isomers 38–9
- conjugated chains 99
- conservation of energy 76
- contact potential 315
- continuous random network (CRN) 56
- Cooper pairs 112
- coordination number 27
- copolymers 57
- Coulomb blockade 427–8
- Coulomb staircase 429
- Coulombic repulsion 19
- covalent bonds 29–32
- critical angle of incidence 151
- critical micelle concentration 294
- crossed polarizers 298
- crystal lattices 48–9
- crystal planes 52
 - defects 52
 - line defects 53–4
 - plane defects 54–5
 - point defects 52–3
 - surface defects 55–6
- crystal systems 49–50
 - Miller indices 50–1
- crystallographic axes 48
- cubic crystals 49
- Curie law 205
- Curie temperature 197, 205
- Curie–Wiess law 207–8
- current density 66
- cyanide group 178
- cytochromes 479
- cytoplasm 469
- cytoskeleton 469
- dangling bonds 56
- Davydov splitting 140
- de Broglie relationship 75
- Debye equations 125
- degenerate energy states 109
- degree of polymerization 59
- Del vector operator 398
- dendrites 480
- density of states function 72
- deoxyribonucleic acid (DNA) 465, 466–7
- depletion 320
- depletion region 315
- deposition ratio 263
- Dexter transfer 147–8
- dextrarotatory isomers 41
- diagonalizing a matrix 132
- diamagnetism 203, 204, 205
- dielectric constant 122
- dielectric elastomers 395
- dielectric sensors 376–80
- dielectrophoresis 397–8
- differential capacitance 320
- diffraction limited optics 215
- diffusion 63–4
- dimers 137
- diodes, organic 313
 - Schottky diode 313–18
- dipeptides 456
- dipolar polarization 122
- dipole moment 131
- dip-pen nanolithography (DPN) 280–2
- director of liquid crystals 288
- disclinations 307
- discotic phase 292–3
- dislocations 53–4
- disordered semiconductors 94

- dispersion curves 158
- dispersion energy 140
- displacement current 113
- donor atoms 89
- doping 107–8
 - n-type 89–90
 - p-type 90–1
- double bonds 42–5
- drain electrodes 321
- drift velocity 67
- dye-sensitized solar cells 348–50
- dynamic random access (DRAM) 417
- dynamic range 363

- eclipsed conformation 38
- effective mass 87
- eigenenergies 77
- eigenfunctions 77
- Einstein relation 117, 476
- electret 197
- electric dipoles 33
- electric displacement 132
- electric field strength 66
- electric potential 66
- electrical conductivity 65
 - classical theory 65–8
 - charge carrier mobility 69–70
 - Fermi level 70–2
 - Ohm's law 68–9
- electroabsorption 143
- electroactive organic compounds 169
 - see also* organic compounds
 - magnetic materials 208–10
 - piezoelectric, pyroelectric and ferroelectric substances 197–200
- electrochemical cells 365–9
- electrochemical vapour deposition
 - techniques 252–3
- electrochromism 431
- electroless deposition 253
- electromagnetic radiation 129–30
 - interactions with organic molecules
 - absorption processes 135–40
 - electric fields and absorption 143
 - emission processes 144–7
 - energy transfer 147–9
 - linear and nonlinear optics 133–5
 - permittivity tensor 132–3
 - photonic crystals 162–4
 - subwavelength optics 165–6
 - reflection and refraction 149–50
 - ellipsometry 152
 - Fresnel equations 150–2
 - thin films 152–4
 - refractive index 130–2
 - surface plasmons 156
 - evanescent field 156–7
 - resonance 157–62
 - waveguiding 154–6
- electromagnetic waves 73–4
- electron affinity 98
- electron-beam lithography 277
- electron density profile 221–2
- electron spin resonance (ESR) 109
- electronegativity 25–6
- electronic noses 390–1
- Electronic Numerical Integrator and Computer (ENIAC) 6
- electronic paper 345
- electronic tongue 390
- electrons 19, 86–8
 - structure in atoms 20–4
 - orbitals 23–4
 - periodic table 24–6
 - velocity in silicon 10
- electro-orientation effects 398
- electro-osmotic pumping 397
- electrophoresis 397
- electropositive elements 25
- electro-rotation effects 398
- electrostatic layer-by-layer (LbL) deposition 270–4
- electrostrictive Maxwell stress 395
- ellipsometry 152, 237–8
- elliptically polarized radiation 129
- emission of EM radiation 144–7
- emulsions 63
- enantiomers 40
- energy bands in solids 72–3
- energy gaps 82
- enthalpy 47
- entropy 47
- enzymes 459–61
- epitaxial deposition 241
- epithelium 389
- equivalent weight 252
- esters 177
- ethers 177
- eukaryotic cells 469
- evanescent fields 156
 - surface plasmons 156–7
- excimers 145

- excited vibrational states 139
- excitons 140, 141–3
- exons 470
- extended X-ray absorption fine structure (EXAFS) 233
- external quantum efficiency 335
- extraordinary rays 133
- extreme ultraviolet radiation 276
- extrinsic conduction 88–9

- face-centred unit cells 50
- Faraday's constant 253
- far-field optical microscopy 215
- fats 462
- fatty acid salts 264
- Fermi level 70–2, 92–3
- Fermi level pinning 318
- Fermi wavelength 95
- Fermi–Dirac quantum statistics 71
- fermions 24
- ferrimagnetism 203, 204, 208
- ferroelectric liquid crystals 305–6
- ferroelectricity 196–7
 - organic compounds 197–200
- ferromagnetism 203, 204, 205–8
- Feynman, Richard 1–2
- Fick's first law 64
- field effect transistors 321–7
- field emission 121
- fingerprnt region of IR spectra 227
- finite-state machines 447
- first-order transitions 47
- flagellae 500
- flash evaporation 245
- flash memory 417, 421–4
- flat band conditions 319
- fluid mosaic model 474
- fluorescence 144
- foams 63
- force modulation microscopy (FMM) 236
- forisomes 500
- Förster transfer 147
- forward bias 315
- Fourier summation 221
- Fowler–Nordheim tunnelling 121
- Franck–Condon principle 139
- Fredericksz transition 299–300
- Frenkel defects 53
- Frenkel excitons 141–2
- Fresnel equations 150–2
- fuels cells 351–4

- fullerenes 188–91
- functional groups 173
 - alcohols 173–5
 - aldehydes 175
 - amides 176
 - amines 175–6
 - carboxylic acids 176
 - esters 177
 - ethers 177
 - ketones 177–8
 - nitriles 178
 - thiols 178

- Game of Life 448
- gas sensors
 - calorimetric 364
 - resistive 369–76
- gate effect 321
- gauche conformation 39
- gelation 255
- gels 63
- genetic coding 469–70
 - replication, transcription and translation 470–3
- genome 469
- giant magnetoresistance (GMR) 424
- Gibbs function 47
- glass transition temperature 62
- glasses 56
- glomeruli 389
- glycolipids 463
- grain boundaries 54
- granular cells 389
- graphene sheets 188
- gravimetric sensors 380
- gravure 282
- gray scales 303
- ground state for electrons 24
- ground-state dipole 131
- group velocity 75
- gustation 390

- H-band shift 140
- Heisenberg model of ferromagnetism 206
- Heisenberg's uncertainty principle 79–80
- helielectric phase 305
- Helmholtz function 47
- heteroatoms 179, 181
- heterogeneous crystal growth 264
- hexagonal crystals 49
- hexatic phases 290

- highest occupied molecular orbital (HOMO) 97
- historical perspective 1–2
- hole accumulation 319
- hole burning 434
- holes 86–8
- holographic memory 491–2
- homeotropic texture 299
- homogeneous crystal growth 264
- homogeneous texture 299
- hopping, variable range 116–17
- hot carriers 70
- Hückel rule 178
- Hund's rule 24
- hybrid orbitals 35–7
- hydration shell 172
- hydrogen bonds 34–5
- hydroxyl group 173
- hyperpolarizabilities 134
- hypsochromic shift 137
- hysteresis loop 199

- ideality factor 317
- image force effect 120
- impedance, electrical 123
- impedance spectroscopy 125–7
- incoherent radiation 146
- indium tin oxide (ITO) 392
- information content 11–12
- inkjet printing deposition techniques 253–5
- insulators 85–6
- integrated circuits (ICs) 6–7, 327
- integrated organic circuits 327–8
- integrated sensors 361
- interatomic forces 404–5
- interfacial polarization 122
- intermolecular conductors 106
- internal energy 47
- internal quantum efficiency 335
- intersystem crossing 144
- intramolecular conductors 106
- intrinsic conduction 88–9
- introns 470
- inverse micelles 295
- inverse opal structure 411
- inverter device 327
- ion-beam projection lithography 277
- ionic bonds 27–8
- ionic polarization 122
- ionization energy 28
- ionophores 383, 477
- ions 170, 171–2
- ion-selective electrodes 366
- ion-sensitive field effect transistors (ISFETs) 368
- isomers 37–8
 - configurational 40–2
 - conformational 38–9
- isobestic point 383
- isotopes 19
- isotropic substances 46

- Jablonski diagrams 144
- J-aggregates 141

- keratin 458
- Kerr effect 134
- ketones 177–8
- Kevlar 310–11
- kinetic theory of gases 65
- Knudsen cells 249
- Kraft temperature 294
- Krebs cycle 468
- Kretschmann configuration 159
- Kronig–Penney model 80–5

- lab-on-a-chip 395–9
- Langmuir expression 243
- Langmuir isotherm 373
- Langmuir trough 263
- Langmuir–Blodgett films 115, 148, 161
 - production technique 258–68
- Langmuir–Schaefer technique 268
- lasers 147
- lateral force microscopy (LFM) 236
- lavorotatory isomers 41
- layer-by-layer (LbL) deposition 270–4
- Lewis acids 171
- ligands 187
- light-emitting displays, organic (OLEDs) 331–4
 - device efficiency 335–6
 - efficiency improvement methods 336
 - blended and doped layer OLEDs 341–3
 - electrodes 336–7
 - microcavity structures 340–1
 - multilayer structures 337–8
 - shaped substrates 340
 - triplet emission 338–40
- limbic system 389
- line defects 53–4
- Linear Combination of Atomic Orbitals 30
- linear electro-optic effect 134
- linear optics 133

- lipids 462–4
- liquid crystals 2, 287
 - display devices 297
 - birefringence 297–9
 - Freedericksz transition 299–300
 - full-colour displays 303
 - passive and active addressing 302–3
 - super twisted nematic displays 304
 - twisted nematic displays 300–2
 - ferroelectric 305–6
 - lenses 308–9
 - other applications 309–11
 - phases 287
 - lyotropic liquid crystals 293–5
 - thermotropic liquid crystals 287–93
 - polymer-dispersed 306–8
 - polymers 295–7
- lithium ion batteries 351
- lithium ion polymer batteries 351–3
- logic circuits 443–7
- lone pair electrons 37
- Love wave 381
- low-dimensional solids 95–6
- lowest unoccupied molecular orbital (LUMO) 97
- Lowry–Brønsted theory 170
- lumens 335
- luminescence 144
- luminescent concentrator 350–1
- luminosity 336
- luminous efficiency 335
- luminous flux 335
- luminous intensity 335
- luminous power efficiency 336
- lyophilic 293
- lyophobic 293
- lyotropic liquid crystal phases 293–5

- magetization 201
- magnetic domains 206
- magnetic force microscopy (MFM) 236
- magnetic materials
 - organic magnets 208–10
 - principles 201–8
- magnetic random access memory (MRAM) 424
- magnetic susceptibility 202
- magnetolectronics 424
- main-chain polymer liquid crystals 295
- majority carriers 316
- Maxwell–Boltzmann distribution 65, 66–7
- mean free path 67

- measurand 360
- measurements
 - energy change 9
 - power dissipation 9
 - switching energy 9
- Meissner effect 112
- mercaptans 178
- mesophases 287
- metal–insulator–semiconductor (MIS) structures
 - 318–19
 - idealized devices 319–20
 - organic structures 320–1
- metal–insulator–semiconductor field effect transistors (MISFETs) 318–19, 421–2
 - drain current–voltage characteristics 322–3
- metallic bonds 32–3
- metallorganic CVD (MOCVD) 251–2
- metal–oxide–semiconductor transistor (MOSFET) 5–6, 8–9
- metastable states 47
- micellar structures 293
- micro-electro-mechanical systems (MEMS) 391
- microprocessors 7
- Miller indices 50–1
- mitochondria 467
- mitral cells 389
- mixed valence states 105
- mobility edges 94
- mobility gaps 94
- mode dispersion 156
- mode of waves 155
- molecular beam epitaxy (MBE) 248–9
- molecular crystals 96–8
- molecular electronics tools 213–14
 - electron reflection 223–4
 - film thickness measurement 236–8
 - imaging, direct
 - electron microscopy 216–18
 - optical microscopy 214–16
 - infrared spectroscopy 224–31
 - Raman scattering 231–2
 - neutron reflection 223
 - scanning probe microscopies 233–6
 - surface analytical techniques 232–3
 - X-ray reflection 218–21
 - electron density profile 221–2
 - in-plane measurements 223
 - Keissig fringes 222–3
- molecular magnets 208–9
- molecular materials for electronics 1, 2–5

- molecular motors
 - artificial motors 501–2
 - Nature's motors 498–500
- molecular weight 20
- polymers 57–9
- molecular-scale electronics 1, 5, 403
 - actuation 440
 - dynamically controllable surfaces 440–2
 - optical tweezers 443
 - rotaxanes 442–3
 - computing architectures 447–9
 - contemporary situation 8–12
 - device architectures 411–14
 - electronic switching and memory devices 417–18
 - flash memory 421–4
 - resistive bistable devices 418–21
 - spintronics 424–5
 - three-dimensional architectures 426
 - engineering materials 405
 - nonlinear optical materials 408–10
 - photonic crystals 410–11
 - polar materials 406–8
 - evolution of microelectronics 5–7
 - timeline 6
 - interatomic forces 404–5
 - logic circuits 443–7
 - Moore's Laws 7–8
 - nanomagnetic systems 436–7
 - nanosystems 403
 - scaling laws 403–4
 - nanotube electronics 437–40
 - optical and chemical switches 429–30
 - chemical control 435–6
 - fluorescence switching 430
 - photochromic systems 431–4
 - quantum computing 449–50
 - rectification 415–17
 - single-electron devices 427–9
- molecules 169–70
- moles 20, 169–70
- monoclinic crystals 49
- monomers 57
- monosaccharides 461
- Moore's Laws 7–8, 14–15
- Morse curves 139
- multiplicity 144
- multivariate evaluation 390
- myelin sheath 481
- NAND gate 444–5
- nanofabrication 275
 - dip-pen nanolithography 280–2
 - nanometre pattern definition 276–7
 - other methods 282
 - photolithography 275–6
 - scanning probe manipulation 278–80
 - soft lithography techniques 278
- nanometre pattern definition 276–7
- nanotubes 191–4, 437–40
- near-edge X-ray absorption fine structure (NEXAFS) 233
- Néel temperature 208
- negative differential resistance (NDR) 420
- nematic phase 288
- Nernst equation 366
- Nernst–Planck equation 475–6
- neurons 480–2
- neurotransmitters 481–2
- neutrons 19
- Newman projections 39
- nitriles 178
- nits 335
- nonbonding pairs of electrons 37
- non-degenerate ground states 110
- nonlinear optical materials 408–10
- nonlinear optics (NLO) 134
- nonpolar solvents 173
- nonvolatile memory 417
- NOR gate 444–5
- NOT gate 444–5
- n-type doping 89–90
- nuclear magnetic resonance (NMR) spectroscopy 179
- nucleosomes 467
- nucleotides 465
- ohmic contacts 318
- Ohm's law 68–9
- olfaction, biological 388–9
- olfaction, electronic 390–1
- olfactory cortex 389
- oligosaccharides 461
- on-wire lithography 278
- opals, synthetic 410
- optical microcavity 163
- optical phenomena 129
 - see also* electromagnetic radiation
- optical tweezers 443
- OR gate 444–5
- orbital magnetic moment 201

- orbitals 20–2, 23–4
 - antibonding 31
 - covalent bonds 29–32
 - double and triple bonds 42–5
 - hybridized 35–7
- order of reflection 219
- order parameter 289
- orders of diffraction 161
- ordinary rays 133
- organelles 469
- organic compounds
 - see also* electroactive organic compounds
 - band structure 96
 - charge-transfer complexes 103–6
 - molecular crystals 96–8
 - Peierls distortion 99–103
 - polymers 98–9
 - doping 107–8
 - double and triple bonds 42–5
 - hybrid orbitals 35–7
 - interactions with EM radiation
 - absorption processes 135–40
 - aggregate formation 140–1
 - electric fields and absorption 143
 - emission processes 144–7
 - energy transfer 147–9
 - excitons 141–3
 - isomers 37–42
- organic diodes *see* diodes, organic
- organic semiconductor solar cells 346–8
- orientational polarization 122
- orthorhombic crystals 49
- Otto arrangement 160
- oxygen acids 177

- panchromatic photoconductive
 - response 355
- paraelectric phase 197
- paramagnetism 203, 204, 205
- parametric sensors 360
- partition coefficient 376–7
- passive addressing 302–3
- Pauli Exclusion Principle 24
- Pauli model of paramagnetism 205
- Pauling scale of electronegativity 25
- Peierls distortion 99–103
- pellistors 364
- peptides 455–8
- periodic table 24–6
- permeability, relative 132
- permeability of free space 202

- permittivity 121
- permittivity of free space 123
- permittivity tensor 132–3
- phase changes 27, 47
- phase contrast microscopy 214
- phase problem 221
- phase velocity 73, 219
- phenol 174
- phonons 112
- phospholipids 463
- phosphorescence 145
- photobiology
 - bacteriorhodopsin 487–8
 - data storage 490–1
 - holographic memory 491–2
 - information processing 492
 - photochromism 488–90
 - photocycle 488
- photolithography 275–6
- photoluminescence 144
- photometric LEDs 335
- photonic crystals 162–4
- photons 74–5
- photoptic response 335
- photosynthesis 461, 493–4
 - artificial systems 497–8
 - electron transfer 496
 - reaction centres and antennae 494–5
- physical vapour deposition techniques
 - molecular beam epitaxy (MBE) 248–9
 - sputtering 249–51
 - thermal evaporation 243–8
- pi bonds 42–4
- piezoelectric coefficients 195
- piezoelectricity 194–6
 - organic compounds 197–200
- pinch-off 323
- planar texture 299
- planar waveguide 155
- Planck's constant 75
- plane defects 54–5
- plane polarized radiation 73, 129
- plasma frequency 157
- plasma-enhanced CVD (PECVD) 251
- plasmons, surface 156
 - evanescent field 156–7
 - resonance 157–62
- plastic crystal 287
- plastic electronics 313
 - field effect transistors 321–7
 - integrated organic circuits 327–8

- plastic electronics (*continued*)
 - RF identification (RFID) tags 328–31
 - metal–insulator–semiconductor (MIS)
 - structures 318–19
 - idealized devices 319–20
 - organic structures 320–1
 - organic diodes 313
 - ohmic contacts 318
 - Schottky diode 313–18
 - organic light-emitting displays (OLEDs)
 - 331–4
 - device efficiency 335–6
 - efficiency improvement methods 336–43
 - electronic paper 345
 - full-colour displays 343–5
 - other applications
 - batteries and fuel cells 351–4
 - conductive coatings 351
 - xerography 354–6
 - photovoltaic cells 345–6
 - dye-sensitized solar cells 348–50
 - luminescent concentrator 350–1
 - organic semiconductor solar cells 346–8
- pleated sheets 459, 460
- Pockels' effect 134, 408–9
- point defects 52–3
- point lattice 48
- Poiseuille flow 396
- polar aprotic solvents 173
- polar protic solvents 173
- polarizability 134
- polarization 33, 133
- polarons 110–11
- poling 62
- polyacetylene 2
- polyelectrolytes (PEs) 270
- polyethers 177
- poly(3,4-ethylenedioxythiophene) (PEDOT)
 - 183–5, 418
- polymer actuators 392–5
- polymer-dispersed liquid crystals 306–8
- polymeric semiconductors 3–4
- polymers 2, 57
 - band structure 98–9
 - conductive *see* conductive polymers
 - crystallinity 60–3
 - molecular weight 57–9
 - structure 59–60
- polypeptides 457
- polysaccharides 461
- Poole–Frenkel effect 121
- population inversion 147
- porphyrins 497–8
- postsynaptic cells 481
- potentiometric sensors 365
- potentiostatic feedback 365
- p-polarized radiation 129
- presynaptic cells 481
- principal axes of a matrix 132
- principal component analysis 390
- prokaryotic cells 469
- propagation constant 74
- proteins 458–9
 - protein folding 459
- protons 19, 170
- p-type doping 90–1
- pumped energy 147
- pyroelectric coefficient 196
- pyroelectricity 196–7
 - organic compounds 197–200
- Q bands 382–3
- quadratic electro-optic effect 134
- quantum bits 449
- quantum computing 449–50
- quantum dots 95
- quantum mechanical tunnelling 80, 114–16
- quantum mechanics 20, 73
 - electromagnetic waves 73–4
 - electron wavefunction 75–6
 - Heisenberg's uncertainty principle 79–80
 - photons as particles 74–5
 - Schrödinger wave equation 76–9
- quantum numbers for electrons 20–2
- quantum wells 93, 93
- qubits 449
- quinoid structure 182–3
- radicals 100
- radiofrequency identification (RFID) tags 328–31
- radiometric LEDs 335
- Raleigh wave 381
- Raman scattering 231
- Raman spectroscopy 231–2
- random walk 404
- Rayleigh scattering 231
- reaction centres 494–5
- recombination centres 92
- recovery time 361
- redox reactions 107
- reduced wavevector representation 83
- reflectance 151

- reflection 149–50
 - Fresnel equations 150–2
- reflection absorption infrared spectroscopy (RAIRS) 228
- reflection coefficient 150
- refraction 149–50
- refractive index 130–2
- relative permeability 132
- relative permittivity 121
- reliability 361
- remnant magnetization 206
- remnant polarization 199
- replication of genetic codes 470–3
- residual polarization 199
- resistance, electrical 68
- resistive gas sensors 369–76
- resolution 363
- resonance hybrids 44–5
- response time 361
- reversed bias 315
- reversibility 361
- Reynolds number 396
- rhombohedral crystals 49
- ribonucleic acid (RNA) 465, 467
- ribosomes 467
- rotaxanes 442–3

- saponification 463
- Sauerbrey equation 380
- scaling laws 403–4
- scanning capacitance microscopy (SCM) 236
- scanning electron microscopy (SEM) 216
- scanning near-field optical microscopy (SNOM) 214–16
- scanning probe manipulation 278–80
- scanning tunnelling microscope (STM) 233
- Schottky barrier 120, 313–14
- Schottky barrier height 315
- Schottky defects 53
- Schottky diode 313–18
- Schottky effect 120–1
- Schottky emission 120
- Schrödinger wave equation 76–9
- secondary-ion mass spectrometry (SIMS) 232–3
- second-harmonic generation 134
- second-rank tensors 132
- selectivity 361
- self-assembly techniques 268–9
- semiconductors 85–6
 - disordered 94
 - doping 107–8
 - polymeric 3–4
 - quantum wells 93
- semi-metals 193
- sensitivity 361
- sensors 4, 359
 - see also* biosensors
 - chemical sensors 363–4
 - acoustic devices 380–1
 - calorimetric gas sensors 364
 - dielectric sensors 376–80
 - electrochemical cells 365–9
 - optical sensors 382–8
 - resistive gas sensors 369–76
 - definition of terms 361–3
 - electronic noses 390–1
 - physical sensors and actuators 391
 - lab-on-a-chip 395–9
 - polymer actuators 392–5
 - touch sensors 391–2
 - sensing systems 360–1
 - smart textiles and clothing 399
- seven-segment arrays 302
- sheet resistance 69
- shells 20
- side-chain polymer liquid crystals 295
- sigma bonds 31
- signal-to-noise ratio 361
- single-electron devices 427–9
- single-electron transistors (SETs) 429
- singlet states 139
- single-wall nanotubes (SWNTs) 192–3, 437–8
- skeletonization 267
- smart sensors 361
- smart textiles 399
- smectic phase 290
- Snell's law 132, 150, 151
- soft lithography techniques 278
- solar cells
 - dye-sensitized 348–50
 - organic semiconductor 346–8
- sol-gel deposition techniques 255–7
- solitons 109–10
 - soliton switch 446
- solvatochromism 137
- solvents 173, 174
- soma 480
- Soret band 382
- source electrodes 321
- space-charge injection 118–19
- space lattice 48

- spacers 295
- spatial filtering 214
- spin-coating 242–3
- spin-forbidden transition 144
- spin magnetic moment 201
- spin-momentum transfer effect 424
- spin valve 424
- spintronics 424–5
- spontaneous emission 147
- sputtering 249–51
- stability 361
- stacking faults 55
- staggered conformation 38
- Stark effect 143
- states of matter 45–6
 - crystal lattices 48–9
 - crystal systems 49–50
 - Miller indices 50–1
 - phase changes 47
- static random access (SRAM) 417
- stem cells 469
- steradians 335
- stereoisomerism 40–1
- steric hindrance 296
- steroids 464
- stimulated emission 147
- stoichiometric composition 91
- Stokes radiation 231
- Stokes shift 145
- stop gap 165
- strong force 19
- structure factor 221
- subshells 20
- substrates of enzymes 459
- subthreshold conduction 324
- super twisted nematic displays 304
- superconductivity 4, 112
- supercritical drying 256–7
- surface acoustic wave (SAW) 381
- surface defects 55–6
- surface plasmon polaritons (SPPs) 157
- surface plasmon resonance (SPR) 157–62, 385–8
- surface plasmons 156
 - evanescent field 156–7
- surface selection rule 229
- surface states 318
- surface-enhanced Raman spectroscopy 232
- surfactants 293
- susceptibility tensor 134
- synapses 481
- synthetic opals 410
- tautomers 435
- tensile strength 194
- terpenes 464
- tetragonal crystals 49
- thermal velocity of electrons 66
- thermistors 360
- thermochromism 431
- thermodynamic equilibrium 47
- thermoelectric power 182
- thermotropic liquid crystal phases 287
 - chiral phase 290–2
 - discotic phase 292–3
 - nematic phase 288
 - smectic phase 290
- thin film processing 241
 - deposition methods, established
 - chemical vapour deposition (CVD) 251–2
 - electrochemical methods 252–3
 - inkjet printing 253–5
 - other techniques 258
 - physical vapour deposition 243–51
 - sol–gel processing 255–7
 - spin-coating 242–3
 - molecular architectures 258
 - chemical self-assembly 268–9
 - electrostatic layer-by-layer (LbL) deposition 270–4
 - Langmuir–Blodgett technique 258–68
 - nanofabrication 275
 - dip-pen nanolithography 280–2
 - nanometre pattern definition 276–7
 - other methods 282
 - photolithography 275–6
 - scanning probe manipulation 278–80
 - soft lithography techniques 278
- thin films 152–4
- thioacetals 178
- thioesters 178
- thioethers 178
- thiols 178
- third rank tensors 195
- third-harmonic generation 134
- three-dimensional architectures 426
- thylakoids 496
- time constant 404
- top-down nanotechnology 1
- total internal reflection 151
- touch sensors 391–2

- trans*-isomerism 40, 43
- transconductance 323
- transcription of genetic codes 470–3
- transducers 360
- transfer integral 101
- transfer ratio 263
- transition dipole moment 138
- translation of genetic codes 470–3
- transmission coefficient 150, 153
- transmission electron microscopy (TEM) 216
- transmittance 151
- transverse-magnetic (TM) radiation 129
- trap-filled limit 118
- traps (in semiconductors) 92
- travelling-wave dielectrophoresis 399
- triacylycerols 462
- triboelectric effect 351
- triclinic crystals 49
- triglycerides 462
- trimers 137
- triple bonds 42–5
- triplet states 144–5
- truth tables 444–5
- tunnelling, quantum mechanical 80, 114–16
- twisted nematic displays 300–2
- twisted nematic displays, super 304

- unit cells of crystals 50
- universal gas constant 170
- universal law for dielectrics 124

- vacuum level 314
- valence band 87

- valence electrons 24
- valency 25
- van de Waals bonds 27, 33
- vesicles 464
- virtual states 231
- volatile memory 417
- von Klitzing constant 95
- von Neumann architecture 447

- Wannier–Mott excitons 141–2
- wave vector 74
- wavefunction 22–3, 75–6
 - bonding electrons 32
- waveguiding 154–6
- wave-mechanical model of
 - atoms 20
- wavenumber 226
- Wilhemmy plate 261
- work functions 313–14

- xerogel 255
- xerography 354–6
- X-ray absorption near-edge structure (XANES) 233
- X-ray lithography 277
- X-ray photoelectron spectroscopy (XPS) 232–3
- X-type deposition 262

- Young’s modulus 194

- Z-type deposition 262
- zwitterions 456

