

## Index

- a**
- absorbance spectrum 67, 70
    - diffraction 70
  - adhesion 114
  - absorption/scattering spectrum, *see* biological windows
  - adsorption techniques, gas adsorption 243
  - air-solvent interface 69
  - alkane 88
  - alkanethiol-capped gold cluster 246
  - alkanethiol molecules, lattice of 88
  - alkoxysilanes 77
  - alkyl chain ligands 177
  - alloy
    - Au/Ag 95
    - nanomaterials, surface segregation 16
  - alumina membrane 62
  - amorphous array 87
  - amorphous silica, calcination 60
  - amphiphilic molecules 211, 221
    - lipids 211
  - anisotropy 20, 151
  - antibodies, disadvantage 165
  - antidote, calcium glutamate 56
  - antiferromagnetic materials 180. *see also* iron oxide
    - antiferromagnetism 180
  - apical polar facets 156
  - apolar solvents 175
  - atomic force microscope (AFM) 201
  - atomistic crystal growth models 14
  - Au-Ni-CNT microrods, scanning electron microscope (SEM) image 219
- b**
- baffling process 203
  - band 146
    - conduction 146, 148
    - valence 146
  - bandgap 146, 160
  - barcoding 218
  - bidentate ligand 176
  - binary atomic lattices 187
    - CaF<sub>2</sub> structure 187
    - NaCl structure 187
  - binary ordered arrays, formation 88
  - binary superlattice 187
  - binding energy 161
  - Bingel's reaction 201
  - bioconjugation technique 213, 226
  - biological tissues, absorption/scattering spectrum 107
  - biological windows 105
    - importance 105
  - biomimetics 26
  - bionano 40, 189
    - interface 37–45
      - cancer cells 37
    - magnetothermal 41
    - photothermal treatment 41
    - schematic presentation 40, 41
  - biosensors 75, 77
  - biotin, targeting vectors 227
  - Bi<sub>2</sub>S<sub>3</sub> nanorods, pseudo-liquid-crystalline arrangement of 19
  - block copolymers 208, 210, 211
  - blood stream, drug's concentration 75
  - body-centered cubic (bcc) phase 209
  - Bohr radius 149
  - Boltzmann constant 148
  - bottom-up techniques 118
  - Bragg's law 68, 71
    - refractive index 71
  - bridging group 175
  - brute-force method 152
  - bulk materials, periodic table of 22
  - bundling 202

## c

- cadmium selenide (CdSe) 6, 104, 141, 144, 145, 151, 155, 158, 163, 166, 167
  - bionano 163, 166
  - defects 160, 163
  - nanocrystals 146, 151, 152, 157, 159, 160, 163, 164, 167
    - bionano applications 167
    - bionano aspects 163
    - doping of 160
    - synthesis 151
  - nanofood 167
  - nanowire 104, 156, 246
    - growth of 156
    - properties of 145
    - self-assembly 157, 158
  - semiconductor 146
  - shape 151, 155
  - size 145
  - surface 142
    - core 144, 145
- cancer cells 37, 43
- cancer therapy 43
- capillary bond 131
- capillary forces 69, 116, 128
- capsules 184, 187
- carbon 197
  - allotrope, graphite 206
  - bionano 211–213
  - block copolymers, self-assembly 209
  - introduction 197, 198
  - self-assembly 207–211
  - shape 205–207
  - size 203–205
  - surface 198–203
- carbon nanotubes (CNTs) 198, 218, 206, 220, 222, 230, 246
  - functionalization routes 199
  - multiwalled 198
  - production 218
  - single-walled 198, 218, 246
- Cassie–Baxter state 132, 135
- centrifugation 59
- cetyltrimethylammonium bromide (CTAB) 228, 229
  - use 229
- chalcogen 141, 185
  - aspect 141
  - sulfur/selenium 185
- chalcogenides 141, 142
  - analogs 141
- chelates 189
  - functions 189
  - gadolinium organometallic complexes 189
- chemical force microscopy 201
- chemical lithography 246
- chemical probe 97
- chemical reduction process 94
- chemical vapor deposition (CVD) 74, 118, 219
- chemotherapeutic drugs 230
  - camptothecin 230
  - paclitaxel 230
- cleavage 201
- clusters of beads 87
- co-assembling systems 31
- coercive field 182
- colloidal chemistry 142
- colloidal iron oxide, advantage of 191
- colloidal nanomaterial 163
- colloid synthesis strategy 94
- colorimetry 97
- combinatorial chemistry 124
- composite 121
- compression phenomenon 119
- computed tomography 42, 163, 226
- computer simulations 74
- contact angle 131
- contrast agent 164, 189, 213, 225. *see also* delivery vehicle
- core-corona nanomaterial, phase-separation 16
- core-shell architectures 142, 145
- cost-efficient lithography methodology, *see* soft-lithography techniques
- coulombic force 228
- coulombic interactions 90, 159, 228
- coupling concept 100
- covalent bonds 159, 178
  - formation of 159
- critical micelle concentration (CMC) 65, 208
- critical supersaturation 152
- crosslinking 115
- crystalline core forces 143
- crystalline defects 71
- crystalline grains 72
- crystallographic plane 95
- crystals 34
  - doping 35
  - facets 153
  - grain boundaries 35
  - made of 34
  - point defects 35
- cubic lattice, twinning defects 104
- cubeoctahedron 102
- Curie temperature 179, 183
- curiosity-driven approach 217

**d**

damped oscillators 90  
damping mechanism 90  
dangling bonds 12, 16, 17, 102  
– surface density 13  
daunorubicin 78  
defects 35, 88, 100, 160  
– 2D 100  
– 3D 121  
– influence 89  
defocusing stage 153  
delivery vehicle 165, 167  
diamond 203  
diapason's oscillations 90  
dichloromethane-water interface 220  
dielectric constant 93  
diffraction techniques 238, 239  
– neutron diffraction 238  
– small-angle X-ray scattering (SAXS) 239  
– small-angle XRD (SAXRD) 238  
– X-ray diffraction (XRD) 238  
diffusion 88, 122, 143, 185  
– definition 88  
– length 94  
dipole 90, 100  
DNA, molecular-recognition capabilities 97  
dopants 161  
– concentration 161  
– random distribution 161  
dope nanomaterials 35  
doping process 35, 160  
drinking water, arsenic contamination of 65  
drug delivery 42, 75, 164, 225  
– advantage 42  
– agents 211  
– huge doses 42  
– systems 133  
drug delivery vehicles 133  
drug therapy 164  
dynamic equilibrium 52

**e**

e-beam 64  
electrical conductor 90  
electrical techniques 244  
– electrical measurements 244  
– zeta potential 244  
electrodeposition 218  
electromagnetic radiation 68  
electromagnetic wave 68, 90  
electron 89, 149  
– cloud, *see* plasmon  
– conduction 36

– dynamics 149  
– physical model 89  
– gas model, *see* electron sea model  
electronic bandgap 148  
electron sea model 90  
electrostatic repulsion 59  
emission, polarized 151  
end functionalization 201  
energy-consuming phenomenon 90  
enhanced permeation and retention (EPR)  
– effect 167  
enthalpy 133  
entropy 133, 210  
epitaxy 143  
equilibrium 128  
– definition 128  
– self-assembly 128  
etching process 118, 122  
evolution 30  
exciton 21, 22, 149,  
– Bohr radius 21, 149

**f**

face-centered cubic (fcc) lattice structure 74, 97  
Faraday's synthesis 94  
fatty acid 145  
 $\text{Fe}_2\text{O}_3$ , *see* hematite  
 $\text{Fe}_3\text{O}_4$  175  
ferrimagnetism 180  
ferrofluids 183, 184  
ferromagnetic materials  
– ferromagnetism 21, 179  
– hysteresis behavior of 182  
fillers 121  
flow-focusing device 125  
fluid-based chemical processes 124  
fluorescein isothiocyanate (FITC)-aminopropyltriethoxysilane (APTES) 229, 231  
– conjugation 231  
fluorescence 229  
fluorinated gold segments, switching wettability 224  
focusing stage 153  
folic acid, targeting vector 231  
free electron model 89  
frequency-wavelength conversion 92  
fullerenes 205  
funding 217

**g**

gadolinium organometallic complexes 189  
galvanic replacement reaction 94

- gas adsorption isotherm 66, 67
  - gas-liquid reactions 127
  - Gedanken experiment 87
  - geometry-property-function relations 26
  - Gibbs free energy 135
  - glasses 51
  - gold 85, 86, 87, 88, 90, 91, 98, 106, 107, 156, 218
    - affinity 85
    - arrays of molecules 88
    - bionano 104, 106
    - defects 100, 156
    - fcc lattice symmetry 100
    - galvanic replacement process 95
    - lattice, orientation 88
    - nanocrystals 92, 93, 94, 98, 104, 177, 192, 227, 228
      - based detection scheme 99
      - colloidal dispersions 92
      - synthesis 93
    - nanofood 107
    - nanoparticles 22, 43
    - nanorods 4, 105
      - absorbance spectrum 105
      - effect on malignant HSC/HOC cancer cells 105
      - molecule detection 4
    - nanostructures, plasmon resonance 91
    - particle 90
    - self-assembly 97, 98
    - shape 94
    - size 89, 91
    - surface 85, 86, 87, 114
      - reaction 86
      - uniformity 87
  - grain boundary(ies) 35, 71, 89, 143
    - induced slips 205
    - types 88
  - graphene 206, 207
    - advantage 206
    - nanoelectronic materials 206
  - graphite 198, 207
    - oxide sheets 207
- h**
- halogenation reaction 200
  - head groups 175, 176
  - heat conduction 36
  - hematite 173
  - heterogeneous nucleation scheme 143
  - hexagonal close-packing (hcp) 87
  - hexagonal wurtzite structure 155
  - hexane 175
  - hierarchical system 31
  - highly toxic chemicals 47
  - high-resolution transmission electron microscopy (HRTEM) 103
  - high-temperature lubricants 141
  - hollow nanocrystal 14
    - surface effects 14, 15
  - hot injection method 152, 153, 155, 157
  - human foreskin fibroblast (HFF) cell
    - line 231
  - hybrid microrods 220
  - hydration layer 54
  - hydrogen-bonding interactions 54, 99, 133
  - hydrolysis reactions 59, 142, 230
  - hydrophilic force 129
  - hydrophobic force 129
  - hydrophobic polymers, surface energy 114
  - hydrophobic substance 222
  - hydrophobicity 16
  - hyperthermia phenomenon 104
  - hypothesis 23
  - hysteresis 182
- i**
- imaging techniques 39, 42
    - resolution of 39
    - sensitivity of 42
  - infiltrate templates 64
  - infiltration complications 63
  - inkjet printer 124
  - interface 210
  - International Union of Pure and Applied Chemistry (IUPAC) 67, 113
  - inverse opal 71
  - inverse silicon opals 246
  - inverted micelle-like aggregate, diagram 221
  - ion-adsorption reactions 145
  - ionic crystal 31
  - ionic strength 159
  - iron oxide 7, 173
    - bionano 190
      - applications 189
    - introduction 173
    - nanocrystals 180, 191, 229
      - advantages of 191
      - synthesis of 180
    - self-assembly 187–189
    - shape 184–187
    - size 179
      - hysteresis curve 181
      - superparamagnetism 181
    - surface 174
      - ligand exchange equilibrium 174
  - isothiocyanate appendicle 229
  - isotropic 20

**k**

Kirkendall effect 185, 186

**l**

La Mer model 151

Laplace law 16

lattice mismatch 143

layer-by-layer deposition (LbL), potential 157

leaving group, fluorine 200

ligand 89, 145, 153, 156, 175

– capped iron oxide nanocrystal 173

– capping 94

– definition 89

– exchange 157

– strategy, role 89

– techniques 157, 227

– ligand interaction 177, 178

– role 153

– structure of 175

light-emitting diode (LED) materials 150

line defects 35

liposomes 211

liquid crystal 20

lithographic techniques 64

lotus leaf 132

luminescent nanocrystals 37

– proteins/cells, tracking 37

**m**

macroscopic length scale 23

macroscopic/nanosopic materials 26

macroscopic process 23

magnetic fields 43, 179

magnetic resonance imaging (MRI) 99, 163, 189, 226

– contrast agents 189

magnetic techniques, magnetometry 242

magnetism 179

magnetite, *see* Fe<sub>3</sub>O<sub>4</sub>

magnetohyperthermia 192

– cancer therapy 246

magnetothermal 41

malignant cells 105

malignant tissue, nanoscopic probes 43

maroon rhombus 76, 77

meniscus 129, 187

mesopores 227

– definition of 67

mesoporous materials 18

– periodicity 68

mesoporous silica colloids 231

– TEM micrographs 231

mesoporous silica formation 229, 230

mesoscale 220

metallic nanorods, SEM micrograph 103

metallic nanostructures 39

metals, plastic deformation of 35

metastable, diamond 52

micelles 65, 208, 211, 220

microchannels 46

microcontact printing process 115

microembossing approach 116

microfluidics 16, 123

– chip 46

– polydimethylsiloxane lab-on-a-chip 246

– technology 124

microlithography 118, 123

micromolding approach 116

microscopy techniques 235

– atomic force microscopy (AFM) 237

– confocal microscopy 237

– energy dispersive X-ray spectroscopy (EDX) 236

– high-resolution transmission electron microscopy (HRTEM) 236

– optical microscopy 237, 238

– profilometry 237

– scanning electron microscopy (SEM) 236

– scanning tunneling microscopy (STM) 237

– scanning transmission electron microscopy (STEM) 236

– selected area electron diffraction (SAED) 236

– transmission electron microscopy (TEM) 235

Mie theory 93

Miller indices 95, 100, 122

Moire patterns 122

molecular imaging techniques 39

molecular nanocomplexes 5

molecular weight 114

monetary system, core 85

monodispersity 151

monomers 114

Morpho butterflies 69

multifunctional microrods, fabrication 219

multifunctional probe system 226

– mind-map 226

multiple-exciton generation 150

**n**

nanocapsule(s) 18, 37

nanochannel membrane 62

nanochemistry 1, 192, 217, 235, 246. *see also* nanoscience

- approximations 12
- bioanalytical approaches 39
- bio-nano interface 37
- diagnostics techniques 235–244
- introduction 217, 218
- challenges in 245–248
  - humanity 246
- colloids 56
- concepts of 6
- definition 4, 5, 11
- educational philosophy 11
- enablers 248
- interfaces 12
- introduction 1–4
- iron oxide 7
- magnetic resonance imaging (MRI) 7
- molecular imaging 39
- nanoscale building blocks 245
- principles 8
- problem 11
- shape 23–26
  - diagram of 24
  - size-invariant effect 25
  - size relationship 24
- size
  - dependent effects 24
  - size-independent effects 24
  - size, relations of 19–22
- subtle effects 24
- teaching, challenge of 11
- nanochemists, drug delivery 77
- nanocrystal(s) 19, 99, 178, 187
  - assembly 25
    - anisotropic 25
    - properties of 25
    - size-invariant behavior 25
- binary lattices, TEM images 33
- co-assemble mixtures of 32
- *in vivo* 176
- iron oxide 246
- scanning electron microscope images
  - of 19
- self-assembly of 187
- size function of 13
- superlattices 177
- nanodiamond nanorod, compressibility 204
- nanofabrication techniques 29
- nanoferroelectrics 16
- nanofluidics 63
- nanolithography 123
- nanomaterials 1, 36
  - analytical purposes 38
  - building blocks 32
    - coating 17
    - molecule detection 39
    - non-interacting 32
    - safety 45–47
      - standardization 45
    - shape 26
    - size 37
    - standardization of 46
    - stoichiometry 36
    - toxicity 1
    - van Gogh’s 22
- nanomedicine 44
- nanometer 20
  - scale 12
- nanoparticles, seeds 59
- nanophotonic crystal circuits 29
  - fault-tolerant computers 29
- nanorainbow multilayer 159
- nanorods 23, 221, 222
  - diagram 222
  - self-assembly 221
- nanoscale 5
  - BaTiO<sub>3</sub> 16
  - building blocks 25
  - bulk tetragonal ferroelectric perovskite 16
  - channels 63, 77
    - fluids behaviour 63
  - diffusion-controlled reaction 17
  - sensing/catalysis 17
- nanoscience 2, 246. *see also* nanochemistry
  - challenges 247
    - catalysis 247
    - chemical detection 248
    - diagnostics 247
    - disease treatment 247
    - environmental remediation 248
    - nanocomposites 248
    - nanolocomotion 248
    - nanotoxicology 248
    - quantum information materials 248
    - safe gas storage materials 248
    - separation technologies 248
    - solar cells 247
  - global warming 3
  - patient, treatment costs 44
- nanoscopic gold 39
  - color changes 39
  - particles, size/shape-controlled 43
- nanoscopic heaters 43
- nanoscopic materials 17
- nanoscopic probes 43
- nanoskiving 122, 123
- nanosolids 18
- nanostucture(s) 32, 35, 104

- assemblies, size-dependent properties 32
- defects in 35
- development of 46
- dry powders of 47
- health, impact of 46
- Karlsruhe Institute of Technology 173
- safety procedures 47
- surface, ligands 173
- template 61
- therapeutic agent 42
- nanotechnology 1, 61
- enabled devices 29
- fabrication techniques 61
- in academic curriculum 2
- introduction 1–4
- materials, miniaturization of 12
- Richard Feynman 45
- nanotubes 18
- architectures 63
- cross-section of 14
- mesoporous materials 18
- nanowires 47
- asbestos 47
- sensors 39
- National Institutes of Health (NIH) 38
- native oxide 115
- near-infrared (NIR) region 105
- laser light 107
- nitrenes 200
- nucleophilic cyclopropanation 201
  
- o**
- octahedron 102, 103
- oleic acid-stabilized iron oxide nanocrystals, diagram 229
- oligonucleotides 97
- opals 68
- optical coherence tomography (OCT) 164
- orbitals 32, 179
- organometallic 189, 228
- oriented attachment mechanism 156
- oscillations frequency 90
- oscillator 90
- damped oscillator 90
- strength 150
- osmosis process 135
- osmotic pressure 135
- oxidation state 141
- oxygen-based functional groups 207
  
- p**
- pancreatic cancer cell line, PANC-1 231
- paraelectric 16
- particle-particle interaction 178
- particle-solvent interaction 175, 176
- passivation layer 19
- PbS nanocrystals, superlattice 19
- perfluorodecalin (PFD) 129
- water interface 129
- perfluorodecanethiol, structure 223
- periodic mesoporous silicas (PMSs) 65, 66, 76
- aminosilane 76
- drug molecules 77
- self-assembled 77
- periodic structures 70
- periodic unit cell 86
- periodicity, definition 177
- phase segregation phenomenon 121
- phase separation 208
- phonons 36
- photocatalysts, efficiency of 71
- photolithography 118
- photoresist 124
- photonic crystals 69, 70
- defect state 75
- light diffusion, speed of 71
- optical performance 71
- states 71
- stopgap 70
- wavelength 70
- photons 70, 148
- photothermal treatment 40, 41, 43, 104
- density 71
- $\pi$ -orbitals 202
- $\pi$ -delocalization 202
- pitting process 95
- planar defects 35
- Planck's constant 104, 148
- plasma 52
- plasmon(s) 24, 90, 99
- coupling 99
- resonance 93, 103, 104
- frequency 90, 92, 95, 100, 104
- shifts 97
- plastic deformation 35
- point defects 35
- poly (ethylene oxide) 133, 137, 175
- chains 136
- monolayer 133, 135
- protein resistance 133
- surface density 137
- poly[lactic-co-(glycolic acid)] (PLGA) 226, 227
- polycrystalline 187, 203
- polydimethylsiloxane (PDMS) 7, 113, 114, 119, 123, 127, 130, 132, 134, 136, 137, 175
- adhesive properties 114
- applications 114

- bionano 132, 136
  - channels, shape 125
  - defects 131, 134
  - hexagonal disks 129
  - hydrophilicity 132
  - microfluidic device 127
  - nanofood 137
  - oligomers 121
  - plasticity 123
  - polymeric nature 119
  - properties 114
  - self-assembly 128, 130
  - shape 123, 127
  - size 118, 120
  - solvent-induced swelling 119
  - stamp, preparation 115, 116
  - surface 114
    - wettability 131
  - polydispersity 57, 58
  - polymerization 125
    - initiators 125
    - UV irradiation 125
  - polymer(s) 113, 203, 208
    - based drug delivery systems 226
    - definition 113
    - networks, swelling 121
    - pre-polymer 115
    - viscoelastic behavior 203
  - polystyrene microspheres 73
  - polytypism 155
  - positron emission tomography (PET) 164
  - precipitation 57
  - protein
    - folding 208
    - resistant surfaces 133
  - proteomics 38
  - purification process 202
  - pyrene-containing derivatives 202
- q**
- quantum confinement 150
  - quantum dots 137, 142, 150, 151
- r**
- radio-frequency identification (RFID) tags 150
  - Raman intensity 39
  - Raman signals 39
  - Raman spectrum 39
  - rapid prototyping process 124, 125
    - advantage 125
  - reactive spreading method 122
  - reduction process 122
    - by compression method 122
    - oxidation potentials 94
  - reflectance spectra 73, 74
  - remanent magnetization 182
  - residence time 160, 161
  - resonance frequency 90, 100
  - resonance phenomenon 92
  - reticuloendothelial system (RES) 191
  - Richard Feynman 45
  - ring-opening polymerization 123
  - rust, *see* iron oxide
- s**
- self-assembled mono-layers (SAM) 88, 89, 115, 116, 157, 177, 178, 222, 223
    - archetypical structure 88
    - grain boundary 88
    - lattice 89
    - protected gold surface 89, 178
    - vs. grafted molecules 88
  - scaffold 44
  - scanning electron microscopy (SEM) 95, 122, 188, 218
    - micrographs 122
  - scanning transmission electron microscope (STEM) 65
  - schizophrenic molecules 65
  - screening processes 124
  - seeding 59
  - segregation 178
  - self-assembly 26–34, 178
    - boundary-condition 32
    - brute-force method 29
    - building blocks 27, 31
    - co-assembly 28
    - disadvantage 29
    - dynamic self-assembly 28
    - gravitational forces 34
    - hierarchical self-assembly 28
    - ionic crystal 32
    - nanoscale phenomenon 34
    - static self-assembly 27
    - templating strategy 30
  - semiconductor(s) 145, 148, 161
    - absorbance spectrum 148
    - nanocrystals, *see* quantum dots
  - separation methods 202, 243
    - gas chromatography 243
    - size-exclusion chromatography 202
    - ultra-centrifugation 202
  - silanization 115
  - silanols 52, 60, 132
    - chemical reaction 53
    - chlorides/alkoxides 55
    - roles of 53

- silica, surface of 52
- surface reactivity 55
- silica 51. *see also* silicon
- bionano 75–78
  - diagram of 76
  - drug delivery 75
- chemical vapor deposition 74
- colloids 57
  - ethanolic dispersion of 69
  - nucleation 57
  - particle size, control of 57
  - self-assembly 59
  - SEM micrographs of 58
  - size distribution 58
  - Stöber process 57
- condensation, surface charged speed 58
- defects 71–75
  - crystalline defects 71
  - crystalline grains 72
  - DNA 78
  - extrinsic defects 72
  - grain boundaries 72
  - intrinsic defects 72
  - opal, diagram of 73
  - stacking fault 74
- glass 51
- hydrofluoric acid 56
- hydrophobic/hydrophilic silica 55
- introduction 51
- ionic strength 59
- nanoparticles 54
- nanowires 62, 63
  - morphology 62
- self-assembly 64–71
  - adsorption-desorption curves 66, 67
  - calcination 68
  - capillary forces 69
  - colloids 69
  - diagram of 66
  - *e*-beam 64
  - lithographic techniques 64
  - meniscus 69
  - micelles 65
  - opals 68
  - photonic-crystal properties 69
  - photonic states 70
  - silicon oxide film 64
  - sol-gel reaction 65
  - spin-coating 64
- shape 61–64
  - diagram of 62
  - templating method 61
- size 56–61
  - colloidal stability 56
  - sol-gel chemistry 56
- surface 52–56, 88
  - diagram representation 53
  - hydrophilic 54
  - silanols 52
- surface charge, contact angle 54
- tetrahedral 51
- with fluorine 56
- silicon 56
- silicon surface 115
- silver
  - cutlery, tarnishing of 17
  - sulfide, dark film of 17
- single/double inversion 64
- sintering process 61
- Si–O bonds 53
- six states of nanochemistry 6
- size effects 22
- small-angle X-ray scattering (SAXS) 67
- soft-lithography techniques 114, 115, 116, 118, 120, 123
  - patterns, feature-size limitations 119
  - principles 116
  - scale-reduction techniques 120
- sol-gel chemistry 57, 58, 227
- sol-gel precursor 228, 229
- tetraethylorthosilicate (TEOS) 228
- solar cells 246
- solid solution 161
- solid-state synthesis 13
- spectroscopic techniques 239–242
  - electron paramagnetic resonance (EPR) 240
  - ellipsometry 242
  - extended X-ray absorption fine structure (EXAFS) 239
  - Fourier-transform infrared spectroscopy (FTIR) 242
  - inductively coupled plasma atomic emission spectroscopy (ICP-AES) 241
  - mass spectrometry (MS) 239
  - Mössbauer spectroscopy 241
  - nuclear magnetic resonance (NMR) 240
  - probes 146
  - RAMAN spectroscopy 241
  - Rutherford back-scattering spectroscopy (RBS) 240
  - secondary-ion mass spectroscopy (SIMS) 240
  - surface-enhanced Raman spectroscopy (SERS) 242
  - ultraviolet visible spectroscopy (UV-VIS) 241
  - X-ray photoelectron spectroscopy (XPS) 239

- spherical nanocrystal 12
  - surface-to-volume ratio 12, 13
  - spin 179
  - spinel 185
  - spintronic devices 161
  - stacking faults 35
  - static dipole interactions 156
  - stealth lipids 213
  - stealth liposomes 42
  - stealth surfaces 133
  - stem cells 44
  - stereochemistry 78
  - Stöber synthesis 57, 58, 60, 227
    - colloidal dispersion 60
  - stoichiometry 35, 185
    - definition 35
  - stopgap 70
    - transmission dip, refractive index 75
  - structural mismatch 143
  - successive ion layer adsorption and reaction (SILAR) methodology 143, 145
  - superhydrophilicity 131
  - superhydrophobicity 132, 134
    - origin 134
  - superlattice 187
  - superparamagnetism 22, 183
  - supersaturation 152
  - surface atoms, approximate percentage of 13
  - surface charge 19, 52
  - surface energy 13, 102, 114, 129, 131
    - definition of 13
    - induced compression 205
  - surface-enhanced Raman spectroscopy (SERS), signals emanating 39
  - surface functionalization 15, 55, 77, 198, 202
    - adsorption 17
    - defect 15
    - grafting 16, 17
    - passivation 15, 17
    - pathways 198
    - plasmon resonance 192
    - pressure 16
    - reaction, substrates 13
    - reconstruction, definition 14, 15
    - segregation 16
    - tension 131
  - surface-to-volume ratio 102
  - surfactants 77, 202
  - symmetry 104
  - synchrotron facilities 68
- t**
- targeting schemes 165
    - active targeting 165
    - passive targeting 165
  - targeting vector 165, 167
    - binding nanostructure 165
    - choice of 165
  - target-oriented approach 217
  - teflon®-coated pan 16
  - template 104, 115, 157, 210
  - tetraethoxysilane (TEOS) 57
    - hydrolyzed/non-hydrolyzed 59
  - tetrahedron 101, 103
    - vs octahedron 101
  - thermal energy 148
  - thermal techniques 243
    - differential scanning calorimetry (DSC) 243
    - thermogravimetric analysis (TGA) 243
  - thermodynamics
    - conditions 185
    - equilibrium 36
  - thermoelectrics 35, 38
  - three-digit system 100
  - tissue engineering 43
  - toluene 175
  - top/bottom polystyrene opal template 74
  - top-down fabrication techniques 29, 118
  - toxicity 46, 164
  - toxic molecules 47
  - transmission electron microscopy (TEM)
    - 95, 186, 218, 202
    - micrographs 95, 186
  - trial-and-error protocols 125
  - trivial reactions 94
  - tumor cell lines, cell survival graph 232
  - twinning rules 103
- u**
- unit cell 95, 102
  - UV light 125
- v**
- valence band 146, 160
    - definition 146
  - valence electron 148
  - van der Waals interaction 19, 88, 89, 141
    - definition 87
  - V-grooves 122
  - viscosity 183
  - voids 186
- w**
- water exchange rate 190
  - water-resistant material, ZnS 142
  - water-silica interaction 54
  - Weiss domains 21, 179, 180, 182, 192
    - boundaries 183

- ferromagnetism 21
- Wentzel state 132
- wettability 54, 119, 131, 223
- wurtzite 156, 161
  - CdSe nanorod 156
  - lattice planes 161

**x**

- X-ray diffraction analysis 205

**z**

- zinc blende 156, 161
  - structure 155

