

## Index

### **a**

absorption-based optical activity, of chiral mesoporous inorganic materials 150  
achiral amphiphiles CMSs templated by 128–135  
1,4-addition reaction, rhodium-catalyzed asymmetric 248–249  
aldol reactions, asymmetric copper nanoparticle-catalysed 250–251  
NAP-MgO-catalyzed 250  
 $\alpha$ -helices, chiral polypeptide mineralization of 161  
 $\alpha$ -ketoesters, asymmetric hydrogenation of, Pt/CNTs-catalyzed 227, 229  
3-aminopropyltriethoxysilane (APTES) 55, 267–269  
3-aminopropyltrimethoxysilane (APTMS) 124, 125, 154, 267–269, 274  
Ångström scale 179  
aromatic ketones asymmetric hydrogenation of catalyzed by Nano-CuO with BINAP 237, 238  
chiral Ir nanoparticles catalyzed 234  
chiral Ru nanoparticles catalyzed 235, 236  
KIT-6 with Xyl-P-Phos 238  
artificial amphiphiles, chiral mesoporous inorganic materials templated by 123–152

chiral mesoporous silicas (CMSs) 123  
non-siliceous materials 148  
asymmetric C–C bond-forming reactions, chiral metal nanoparticles catalyzed 239–252  
copper nanoparticle-catalyzed asymmetric reactions 250–251  
gold nanoparticle-catalyzed asymmetric reactions 251–252  
nanocrystalline magnesium oxide-catalyzed asymmetric reactions 249–250  
palladium-catalyzed asymmetric allylic alkylation reactions 239–242  
palladium-catalyzed asymmetric cross-coupling reactions 243–245  
Rh nanoparticle-catalyzed Pauson–Khand reaction 247–248  
rhodium nanoparticle-catalyzed hydroformylation 245–247  
rhodium-catalyzed asymmetric 1,4-addition reaction 248–249  
asymmetric hydrogenation of carbonyl compounds, tartaric acid-modified Raney Ni-catalyzed 225  
of electron-deficient olefins 229–231

- asymmetric hydrogenation (*contd.*)
- of imines catalyzed by Pd on silk fibroin fiber 224
  - reactions, chiral metal nanoparticles catalyzed
  - Orito-type asymmetric hydrogenation 225–229
  - of unactivated ketones 232–236
  - asymmetric hydrosilylation 236–238
  - of aromatic ketones
  - catalyzed by Nano-CuO with BINAP 237–238
  - KIT-6 with Xyl-P-Phos 238
  - of ketones catalyzed by CuFe2O4 with BINAP 237, 238
  - of styrene, BINAP-Pd nanoparticles catalyzed 236, 237
- atomic force microscopy (AFM) 61
- $\text{Au}_{20}(\text{SR})_{16}$  nanocluster 102–103
- $\text{Au}_{28}(\text{SR})_{20}$  nanocluster
- chiral structure of 102–104
  - racemic mixture, separation of 111, 112
- $\text{Au}_{38}(\text{SR})_{24}$  nanocluster
- choral structure of 105
  - racemic mixture, separation of 110–111
- $\text{Au}_{102}(\text{SR})_{44}$  nanocluster 105–108
- $\text{Au}_{133}(\text{SR})_{52}$  nanocluster 106–109
- b**
- basicity influence, on enantiopurity control 138
- $\beta$ -sheet, chiral peptide mineralization of 159–161
- biomineralization method 159
- 1,2-bis(triethoxysilyl)ethane (BTEE) 139
- bisphenol A (BPA) 193
- block copolymers (BCPs) 60
- bottom-up fabrication method, for
- plasmonic chiral nanomaterials 53–68
  - dynamic shadowing growth 66–68
  - stimuli-response method 64–66
  - template-based method 53–63
- Bouligand structure 162, 163
- Bragg's reflection law 163
- c**
- Cahn–Ingold–Prelog priority (CIP) rule 197, 199
- cationic cetyl trimethylammonium bromide (CTAB) 53
- cetyltrimethylammonium bromide (CTAB) 128, 131, 135, 144, 156
- chiral amphiphiles, CMSs templated by 124
- chiral detection, plasmonic chiral nanomaterials 77–78
- chiral dimers 188–193
- g* factor, compared 192
  - preparation of 188–190
  - properties of 188–190
  - sensing 190–193
- chiral diphosphine ligands 246
- chiral diphosphite ligands 241, 242
- chiral DNA-silica films (CDSF) 157–158
- chiral gyroid network 60–61
- chiral helical nanoparticle assemblies 202
- chiral memory effect 87
- chiral mesoporous cellulose-silica freestanding film 164
- chiral mesoporous chitin-silica freestanding film 164
- chiral mesoporous inorganic materials 121, 166
- templated by artificial amphiphiles 123–152
  - chiral mesoporous silicas (CMSs) 123
  - electron transition-based optical activity 148–152
  - non-siliceous materials 148
- templated by DNA 152
- chiral DNA-silica films (CDSF) 157–158
  - one-dimensional multi-helical silica fibers 153–154
  - three-dimensional DNA-silica chiral impeller 154–157

- templated by peptides 158–161  
 $\alpha$ -helices, chiral polypeptide mineralization of 161  
 $\beta$ -sheet, chiral peptide mineralization of 159–161  
 templated by polysaccharides 162–164  
 chiral mesoporous cellulose-silica freestanding film 164  
 chiral mesoporous chitin-silica freestanding film 164  
 chiral mesoporous organosilicas (CMOS) 139  
 chiral mesoporous silicas (CMSs) 17, 123  
 hierarchical chirality of 146  
 imprinting 144–146  
 synthesis and formation mechanism 135  
 CMSs templated by chiral gelators and amphiphiles 124  
 templated by achiral amphiphiles 128–135  
 synthetic control  
 enantiopurity control 135–139  
 helicity control 139–141  
 structure and morphology, control of 141–144  
 chiral metal nanoparticles  
 asymmetric C–C bond-forming reactions catalyzed by 239–252  
 asymmetric hydrogenation reactions catalyzed by electron-deficient olefins 229–231  
 Orito-type asymmetric hydrogenation 225–229  
 unactivated ketones 232–236  
 chiral modifiers 228  
 chiral noble metal clusters 3–5  
 with optical activity, construction of 4–5  
 origin of 3–4  
 chiral noble metal nanostructures, optical applications of 20–22  
 chiral Pd nanoparticles, synthesis of 240
- chiral plasmonic assembly  
 DNA induced 14–17  
 inorganic channel induced 17–20  
 with optical activity, construction of 12–20  
 soft template induced 12–14  
 nanoparticles 5–20  
 with optical activity, construction of 10–12  
 origin of 6–10  
 oligomers 205–206  
 chiral polarizer 79  
 chiral polybissilsesquioxanes 259, 277  
 applications of 276  
 optical activity characterization 272–276  
 preparation of 260–271  
 external templating approach 262–271  
 self-templating approach 261  
 TEM characterization 272  
 X-ray diffraction characterization 271–272  
 chiral pyramid fabrication 197–201  
 chiral semiconductor nanocrystals, optical activity of 97  
 chiral structure, classes of 122  
 chirality 1, 2, 29, 47  
 defined 51  
 in gold nanoclusters 99, 115  
 induced *see* induced chirality structure 215  
 chiroplasmonic activities, origin of 206–215  
 gold nanorods assemblies 212–215  
 plasmonic chirogenesis in gold nanoparticles assemblies 206–210  
 chirooptically active excitonic nanocrystals 86–90  
 circular birefringence 150  
 circular dichroism (CD) 29, 33, 85  
 diffused reflection 146, 150, 151, 161  
 of mirror systems 34

- circular dichroism (CD) (*contd.*)  
 plasmonic 146  
   chiral nanomaterials 68–74  
 plasmon-induced 196  
   spectrum 2, 3  
 circular polarized lights (CPLs) 2  
 circularly polarized emission (CPL)  
   85  
 conductor-like polarized continuum  
   model (CPCM) 275  
 copper nanoparticle-catalyzed  
   asymmetric reactions 250–251  
 core-satellites assemblies 202–205  
 co-structure directing agents (CSDAs)  
   124  
 crossed finger model *see* twist rod model  
 cysteine 85
- d**
- density functional theory (DFT) 87  
 diarylpropenoic acids  
   asymmetric hydrogenation of, over  
     cinchonidine-modified Pd  
     catalyst 229  
   asymmetric hydrogenation of, over  
     cinchonidine-modified  
     Pd/Al<sub>2</sub>O<sub>3</sub> 230  
 diffused reflection circular dichroism  
   (DRCD) 146, 150, 151, 161  
 1,2-dimyristoyl-sn-glycero-3-  
   phosphatidylcholine (DMPC) 63  
 discrete dipole approximation (DDA)  
   33, 34, 70  
 dithiothreitol (DTT) 185, 194  
 DNA-based chiral nanostructures 179,  
   217  
   Au NP chiral chains 193–194  
   Au NR chiral ladder 194–197  
   chiral dimers 188–193  
   chiral helical nanoparticle assemblies  
     202  
   chiral plasmonic oligomers  
     205–206  
   chiroplasmonic activities, origin of  
     206–215
- gold nanorods assemblies,  
   chirogenesis in 212–215  
 plasmonic chirogenesis in gold  
   nanoparticles assemblies  
     206–210  
 core-satellites assemblies 202–205  
 detection based on pyramid  
   nanostructures 201–202  
 individual chiral nanoparticles  
   185–188  
 preparation of 180–185  
   nanoassembly by PCR 183–185  
   nanoparticle-DNA conjugates  
     180–182  
   nanoparticles, chiral assembly of  
     182–185  
 tetrahedron nanoarchitectures  
   197–202  
 DNA, chiral mesoporous inorganic  
   materials templated by 152  
 chiral DNA-silica films (CDSF)  
   157–158  
 one-dimensional multi-helical silica  
   fibers 153–154  
 three-dimensional DNA-silica chiral  
   impeller 154  
 DNA induced-chiral plasmonic  
   assembly 14, 17  
 DNA origami 15, 16  
 DNA template 56, 57  
   matching 182, 183  
 dynamic shadowing growth (DSG)  
   66–68
- e**
- electromagnetic interaction 36  
 electron-deficient olefins, asymmetric  
   hydrogenation of 229–231  
 electron transition-based optical activity  
   (ETOA) 145, 146  
   of chiral mesoporous inorganic  
     materials 148–152  
 enantiomeric excess 93–95, 97  
 enantiomers 179  
 enantiopurity control, chiral  
   mesoporous silicas (CMSs)  
     135–139

enantioselective catalysis 223  
 ethyl pyruvate, asymmetric hydrogenation of 227  
 external stimuli (molecules/salts) 64–65  
 external templating approach, for chiral polybissilsesquioxanes preparation 262–271  
 chiral anionic LMWAs 267–271  
 chiral cationic LMWAs 263–267

**f**

Fe<sub>3</sub>O<sub>4</sub>/Pd nanoparticles 244  
 field-emission scanning electron microscopy (FESEM)  
 chiral polybissilsesquioxanes 264, 266, 267, 269, 274  
 finite-difference time-domain (FDTD) method 33  
 fluorescence detected circular dichroism (FDCD) 90  
 Fourier transform infrared (FT-IR) spectroscopy 77  
 Frequency Domain Finite Integral (FDI) method 210

**g**

gelator template 61–63  
 glancing angle deposition (GLAD) *see* dynamic shadowing growth (DSG)  
 gold nanoclusters  
     chirality in 99, 115  
     induced by carbon center in thiolate ligand 111–114  
     origin of 100–101  
     phospine-protected 114–115  
 racemic mixture, separation of Au<sub>28</sub>(SR)<sub>20</sub> 111, 112  
 Au<sub>38</sub>(SR)<sub>24</sub> 110–111  
 X-ray structure of 101–110  
     Au<sub>20</sub>(SR)<sub>16</sub> 102–103  
     Au<sub>28</sub>(SR)<sub>20</sub> 102–104  
     Au<sub>38</sub>(SR)<sub>24</sub> 105  
     Au<sub>102</sub>(SR)<sub>44</sub> 105–108  
     Au<sub>133</sub>(SR)<sub>52</sub> 106–109

gold nanoparticle-catalyzed asymmetric reactions 251–252  
 gold nanoparticles (Au NPs)  
 assemblies, plasmonic chirogenesis in 206–210  
 chiral chains 193–194  
 gold nanorods (Au NR)  
 assemblies, chirogenesis in 212–215  
 chiral ladder 194–197

**h**

handedness inversion mechanism 155–157  
 Hausdorff chirality 3  
 helicity control, chiral mesoporous silicas (CMSs) 139–141  
 Henry reactions, asymmetric, NAP-MgO-catalyzed 249  
 heteroaromatic methyl ketones, asymmetric hydrogenation of, chiral Ir nanoparticles catalyzed 234  
 hierarchical chirality, of chiral mesoporous silicas 146  
 high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM) 12  
 high-performance liquid chromatography (HPLC) 3  
 high-resolution transmission electron microscopy (HR-TEM) 10  
 highest occupied molecular orbital (HOMO) 30, 273  
 homogeneous catalysts *vs.* immobilized catalysts 224  
 hybrid nanostructures  
     induced chirality in  
     made of chiral molecules and metal nanoparticles 39–42  
     made of chiral molecules and QD 37–39  
     made of chiral QD and metal nanoparticles 43–47  
 hydroformylation, rhodium nanoparticle-catalyzed 245–247

***i***

immobilized catalysts *vs.* homogeneous catalysts 224  
imprinting, chiral mesoporous silicas (CMSs) 144–146  
induced chirality 37  
in hybrid nanostructures  
made of chiral molecules and metal nanoparticles 39–42  
made of chiral molecules and QD 37–39  
made of chiral QD and metal nanoparticles 43–47  
inorganic channel induced-chiral plasmonic assembly 17–20  
intramolecular cyclopropanation, asymmetric 251, 252  
isophorone, asymmetric hydrogenation of  
catalyzed by DHVIN-modified Pd 230, 231  
catalyzed by Pd and proline 231

***k***

ketones  
asymmetric  $\alpha$ -arylation of, with aryl halides 244, 245  
asymmetric hydrosilylation of, catalyzed by CuFe<sub>2</sub>O<sub>4</sub> with BINAP 237, 238  
unactivated, asymmetric hydrogenation of 232–236  
Kramers–Kronig relations 33

***l***

left circularly polarized (LCP) light 29  
localized plasmon 33  
localized surface plasmon resonance (LSPR) 180, 186, 190, 215  
low-molecular-weight amphiphiles (LMWAs)  
chiral anionic 267–271  
chiral cationic 263–267  
lowest unoccupied molecular orbital (LUMO) 30, 273

***m***

magnetic properties, of plasmonic chiral nanomaterials 74–77  
metallic nanostructures 33  
metal nanoparticles (MNPs)  
catalysis 224, 225  
hybrid nanostructures with, induced chirality in 39–47  
metamaterial effect, of plasmonic chiral nanomaterials 73–74  
Michael reactions, asymmetric NAP-MgO-catalyzed  
with malonates 250  
with nitroalkenes 249  
microcystin-LR (MC-LR) 78  
microencapsulated (MC) catalysts 239  
microencapsulation 239, 240  
molecules 32–33

***n***

*N*-acylamino acid 55  
nanocrystalline cellulose (NCC) template 17, 53–54  
nanocrystalline magnesium oxide-catalyzed asymmetric reactions 249–250  
nanoparticle, chiral assembly of 182–185  
DNA template matching 182, 183  
Watson–Crick base pairing, direct hybridization of 182  
nanoparticle-DNA conjugates 180–182  
nickel boride nanoparticles, preparation of 232  
4-nitrobenzaldehyde  
asymmetric allylation of, with allyltributyltin 245  
non-siliceous materials 148  
*N*-trimethoxysilylpropyl-*N,N*,  
*N*-trimethyl ammonium chloride (TMAPS) 124–126, 132, 139, 140, 143, 153–160

***o***

ochratoxin A (OTA) 205  
olefins

- asymmetric hydroformylation of, by BINAP-Rh/SiO<sub>2</sub> 246, 247
- asymmetric hydrogenation of, over cinchonidine-modified Pd catalyst 230
- one-dimensional (1D) chiral structures 122
- one-dimensional multi-helical silica fibers 153–154
- optical activity, of chiral semiconductor nanocrystals 97
- chiral shaped nanostructures 95–96
- chiroptically active excitonic nanocrystals 86–90
- effects of chiral arrangement 92
- symmetry 92–94
- optical properties, of plasmonic chiral nanomaterials 68–74
- circular dichroism 68–74
- metamaterial effect 73–74
- optical rotation dispersion (ORD) 2, 29, 33
- Orito-type asymmetric hydrogenation 225–229
- p**
- palladium-catalyzed asymmetric cross-coupling reactions 243–245
- Pauson–Khand reaction, rhodium-catalyzed 247–248
- penicillamine 85
- peptide, chiral mesoporous inorganic materials templated by 158–161
- α-helices, chiral polypeptide mineralization of 161
- β-sheet, chiral peptide mineralization of 159–161
- peptide conjugates 59
- peptide nanotubes (PNT) 59
- peptide template 58–60
- phosphine-protected gold nanoclusters, chirality in 114–115
- plasmonic chiral nanomaterials applications of chiral detection 77–78
- chiral polarizer 79
- SERS sensor 79
- fabrication of bottom-up method 53–67 top-down method 52–53
- magnetic properties 74–77
- optical properties of 68–74
- SERS sensor 79
- plasmonic chiral nanomaterials 51, 80
- plasmonic chirogenesis, in gold nanoparticles assemblies 206–210
- plasmonic circular dichroism (PCD) 146
- plasmon-induced circular dichroism 196
- poly(vinylpyrrolidone) (PVP) 63
- poly-(fluorene-*alt*-benzothiadiazole) (PFBT) 12, 13
- poly(propionic acid) sodium salt (PPAS) 145
- polymerase chain reaction (PCR) 15, 188–191, 193–196, 212
- asymmetric 184
- nanoassembly by 183–185
- symmetric 184
- polymethylhydrosiloxane (PMHS) 237, 238
- polysaccharides, chiral mesoporous inorganic materials templated by 162–164
- cellulose-silica freestanding film 164
- chitin-silica freestanding film 164
- polyvinylpyrrolidone (PVP) 226
- propagating plasmon 33
- q**
- quantum dots (QDs) 32–33, 85–87, 89, 90, 92, 96
- hybrid nanostructures with, induced chirality in 37–47
- quantum mechanical theory 61
- r**
- refraction-based optical activity, of chiral mesoporous inorganic materials 148–150

- rhodium-catalyzed  
asymmetric 1,4-addition reaction 248
- Pauson–Khand reaction 247–248
- rhodium nanoparticle-catalyzed  
hydroformylation 245–247
- right circularly polarized (RCP) light 29
- S**
- scattering/reflection-based optical activity, of chiral mesoporous inorganic materials 150
- self-templating approach, for chiral polybissilsesquioxanes preparation 261
- shape/aspect ratio 34–35
- silicon film template 54–56
- sodium carbonate (SCA) 212
- sodium citrate (SCI) 212
- soft template induced-chiral plasmonic assembly 12, 14
- sol-gel method 124
- stimuli-response fabrication method, for plasmonic chiral nanomaterials 64–66
- external stimuli (molecules/salts) 64–65
- temperature-triggered assembly 65–66
- structure chirality 215
- styrene  
asymmetric hydrosilylation of, BINAP-Pd nanoparticles catalyzed 236–237
- Rh nanoparticles catalyzed,  
asymmetric hydroformylation of 247
- supramolecular template 63
- surface enhanced Raman scattering (SERS) sensor 79
- surface plasmon resonance (SPR) 5, 179
- Suzuki–Miyaura coupling reactions 243, 244
- synchrotron-based small-angle X-ray scattering (S-SAXS) 199, 200
- synchrotron radiation system 3
- t**
- temperature influence, on enantiopurity control 135–138
- temperature-triggered assembly 65–66
- template matching, DNA 182, 183
- template-based fabrication method, for plasmonic chiral nanomaterials 53–63
- chiral gyroid network 60–61
- DNA template 56–57
- gelator template 61–63
- nanocrystalline cellulose template 53–54
- peptide template 58–60
- silicon film template 54–56
- supramolecular template 63
- 4-*tert*-butylbenzenethiolate (TBBT) 102, 106
- tetraethoxysilane (TEOS) 124, 132, 141, 143, 153, 160, 164
- tetrahedron nanoarchitectures 197–202
- tetramethoxysilane (TMOS) 124, 164
- tetr phenylporphine tetrasulfonic acid (TPPS) 145
- tetra(4-sulfonatophenyl)phrphyrin (TPPS) 132
- thiolate ligand, carbon center-induced chirality in 111–114
- three-dimensional (3D) chiral structures 122
- three-dimensional DNA-silica chiral impeller 154–157
- handedness inversion mechanism 155–157
- water-independent optical activity of 157
- time-dependent density functional theory (TD-DFT) 4, 273, 275
- top-down fabrication method, for plasmonic chiral nanomaterials 52–53
- transmission electron microscopy (TEM) 264, 266, 272

tris(2-(diphenylphosphino)ethyl)  
phosphine) 114  
twist rod model 34–37  
two-dimensional (2D) chiral structures  
122

**u**

unactivated ketones, asymmetric  
hydrogenation of 232–236  
unsaturated ketones

asymmetric hydrogenation of, chiral  
Ir nanoparticles catalyzed 234

**v**

vibrational circular dichroism (VCD)  
2

**w**

Watson–Crick base pairing, direct  
hybridization of 182

