

Index

a

abundant thin-layer photocatalysts 35
 active crystal surface 30–31
 active sites 13, 25, 27–28, 36–38, 41, 44, 45, 47, 48, 52, 69, 73, 78, 79, 83, 86, 90, 96, 111, 125, 134, 140, 144, 155, 158, 160, 164, 169, 170, 185, 187, 188, 190, 204, 205, 216, 217, 227, 238, 249, 252, 253, 255–259, 271, 274–278, 282, 286–289, 292, 293, 299, 305, 307, 308, 310, 314, 315, 318, 321, 323, 324
 advanced oxidation processes (AOP) 143, 205
 AgBr/BiOBr heterojunctions 104
 AgI/(Na,F)-CN Z-type heterojunction 49
 air pollution control 15, 17, 103
 air purification 35, 189, 209, 210
 all solid-state (ASS) 234, 279
 anion exchange method 201
 anion replacement 202, 203
 apparent quantum efficiency (AQE) 186, 279
 apparent quantum yield (AQY) 193, 284
 artificial photosynthesis 2, 188, 280, 318
 assembled $\text{Bi}_2\text{Sn}_2\text{O}_7$ nanoparticles (BSO) 94
 atomic doping 36
 atomic layer deposition (ALD) 29, 231, 251
 atomic layer-thick $\text{Bi}_{24}\text{O}_{31}\text{Br}_{10}$ (V_{BiO} -BOB) materials 97

b

B homogeneously doped BiOCl nanosheets 76
 g- C_3N_4 composites 37
 benzothiadiazole (BT) 189
 benzotrithiophene (BTT) 186
 $\text{Bi}_{24}\text{O}_{31}\text{Br}_{10}(\text{OH})\delta$ photocatalyst 109
 $\text{Bi}_2\text{Sn}_2\text{O}_7/\text{BiOBr}$ (BSOB) S-type heterojunction photocatalysts 47
 $\text{Bi}_2\text{WO}_6/\text{graphene}$ hydrogel (BWO/GH) 142
 $\text{Bi}_4\text{O}_5\text{Br}_2$ nanospheres 83
 Bi-based metal-organic frameworks (MOFs) 84
 $\text{Bi}_2\text{WO}_6/\alpha\text{-Bi}_2\text{O}_3$ composites 141
 Bi_2XO_6
 energy level diagram 141
 environmental pollution
 photocatalyst coupled with 140–143
 mechanism of 143–145
 preparation method 134
 solvothelmal synthesis
 synthesis reaction general steps 135–136
 additives and surfactants 136–139
 advantages and differences 137
 particle size and morphology 136
 structural characteristics of 134
 BiOCl mesoporous single crystal nanosheets (BiOCl MSCN) 109
 BiOCl/ Bi_2WO_6 (BOC/BWO) catalysts 92
 bismuth 133

- bismuth oxybromide (BiOBr) nanosheets 25
 - bismuth oxyhalide (BiOX)
 - chemical deposition 65–66
 - composition modulation
 - bismuth-rich strategy 70–72
 - defect engineering 73
 - elemental doping 74–76
 - solid solution strategy 76–78
 - crystal structure of 59–61
 - energy conversion
 - CO₂ reduction 104–105
 - hydrogen production 104
 - N₂ fixation 105–108
 - environmental remediation
 - air pollution control 103
 - heavy metal removal 104
 - water pollution purification 103
 - heterojunction structure construction
 - facet heterojunction 95–96
 - p–n heterojunction 92–93
 - S-scheme heterojunction 94–95
 - 2D-2D faceted junctions 90–91
 - type I heterojunctions 91
 - type II heterojunction 92
 - Z-scheme heterojunction 93–94
 - high-temperature solid-phase synthesis
 - method 64–65
 - hydrothermal methods 63–64
 - mechanochemical method 67
 - microwave method 67–68
 - organic synthesis reactions 109–110
 - photodynamic therapy 108–109
 - polarization strategy 97–101
 - reactive ionic liquid (IL) method 68–69
 - single-atom engineering 96
 - solvothermal methods 63
 - statistical chart for 60
 - structural regulation strategy
 - facet-synergistic mechanisms 87–89
 - morphostructural modulation 78–87
 - surface plasmon excitation effect 101–102
 - bismuth-rich strategy 70–72
 - BiVO₄
 - modification of
 - crystallographic engineering 125
 - heterojunction composite materials 125
 - ion doping 124
 - morphology control 124–125
 - photocatalysis
 - field of 127
 - photocatalytic performances of 127–128
 - photocatalyst
 - crystal structures of 117–119, 126–127
 - electronic structures of 119–120
 - optical characteristics of 120–122
 - preparation of 122–124
 - three crystallization phases of 118
 - black BiOCl-Bi-Bi₂O₃/rGO catalysts 94
 - black phosphorus (BP) 21, 36, 99, 306
- C**
- cadmium sulfide (CdS) 166, 167, 253, 279
 - carbon-neutral fuels 303, 307–311
 - carbon quantum dots (CQDs) 299
 - C-doped TiO₂ photocatalysts 8
 - CdS nanospheres/graphene (CdS NSPs/GR) nanocomposites 50
 - charge carrier separation and transfer
 - cocatalyst loading 13
 - facet engineering 12
 - solid-solid junctions 10–12
 - charge separation 4–7, 10–13, 16, 25, 26, 38, 43, 46, 49, 73, 81, 83, 87–90, 92, 93, 97, 101, 104, 110, 125, 140, 142, 144, 158, 171, 185, 187, 193, 229, 232, 234, 235, 240, 255, 281, 282, 301, 303, 305, 306, 310, 315, 318, 322, 323
 - chemical deposition 65–66, 110
 - chemical exfoliation 162, 164

chemical vapor deposition (CVD) 65,
224, 249, 258, 265, 269

chiral mesostructured bismuth
oxybromide (BiOBr) thin films
(CMBF) 83

Co-Bi₃O₄Br catalysts 96

Coprecipitation method 123, 200

CO₂ reduction 39, 104, 172

CO₂ reduction reaction 40, 41, 172, 187,
188, 203, 209, 211–213, 281, 283,
285, 288

cocatalyst loading 13, 275

cocatalyst, mechanism of 274–275

COFs

- advantages 182
- composite photocatalysts 186
- donor–acceptor (D–A) structure 193
- mechanochemical synthesis 184
- microwave-assisted synthesis of 183
- non-metallic development of 182

compound/g-C₃N₄ heterojunction
166–167

conduction band (CB) 4, 23, 43, 47, 60,
119–121, 142, 143, 154, 189, 190,
205, 235, 247, 274, 278, 299

coprecipitation method 123, 200

covalent organic frameworks (COFs)
181

- CO₂ reduction 187–189
- H₂ production 184–187
- H₂O₂ production 192–194
- photocatalytic organic conversion
190–192
- preparation method 182–184
- pollutant removal 189–190

crystallographic engineering 125

d

defect engineering 36, 38, 41, 51, 52, 73,
164–165, 205, 248, 252

density functional theory (DFT) 27, 43,
125, 161, 165, 187, 247, 273, 274,
292, 307

density of states (DOS) 27, 70–72, 119,
276

1,4-dicyanobenzene (DCB) 183

N,N-dimethylformamide (DMF) 135,
185, 249, 268, 304

direct Z-scheme heterojunctions 94,
169, 234–236, 301–303, 306

e

electron spin resonance (ESR) 172, 191,
213, 315, 316

electronic density 204

electrophoretic deposition (EPD) 232

elemental doping 74–76, 158, 160, 161,
252

energy-dispersive X-ray spectroscopy
(EDS) 134

etching methods 48, 266–270

excitons 5, 44, 77, 83, 103, 183, 193, 286

exfoliation method 162

- chemical 164
- thermal 162–163
- ultrasound 163

f

face-to-face 2D/2D heterojunction

- CO₂ reduction into carbon-neutral fuels
307–311
- ex situ electrostatic self-assembly
305–306
- in situ hydrothermal and solvothermal
approaches 303–305
- N₂ fixation for ammonia production
318–323
- principles and characteristics 300–303
- water splitting for H₂ and O₂
production 311–318

facet engineering 2, 10, 12, 16

facet heterojunction 95–96

facet-synergistic mechanisms 87–89

facile polyvinyl pyrrolidone
(PVP)-assisted solvothermal
controlled synthesis scheme 64

Fe-doped BiOCl 74

Fermi energy levels (EF) 10, 12, 93, 245,
274, 276

Fermi level 11, 28, 102, 119, 120, 129, 165, 203, 232, 235, 272, 273, 279, 281, 300, 301, 303, 307, 311, 315
 field emission scanning electron microscopy (FESEM) 308
 fluoride salt etching 268
 Fourier transform infrared spectroscopy (FTIR) 134, 203, 257, 284
 functionalized MXenes 288–289

g

Gibbs free energy 3, 4, 41, 107, 108, 255, 258, 277, 314, 321
 graphene
 correlation property 221–222
 photocatalysis application
 CO₂ reduction 238
 hydrogen generation 239
 photocatalytic disinfection 240–241
 pollutant degradation 239–240
 photocatalyst heterojunction
 Schottky junctions 232
 type II heterojunctions 232–234
 Van der Waals heterostructures 236–237
 Z-type heterojunctions 234–236
 preparation method
 chemical vapor deposition 224
 Hummers method 224–227
 liquid phase stripping method 223–224
 micromechanical exfoliation method 223
 semiconductor photocatalysts
 atomic layer deposition 231
 hydrothermal/solvothermal method 229–231
 in situ growth strategy 227
 solution mixing method 227–229
 graphene-based composite photocatalysts 50
 graphene oxide 21, 26, 40, 90, 130, 169, 211, 222–229, 231, 234, 238, 239, 299
 graphene quantum dots (GQDs) 299

graphite
 mechanical grinding 223
 and stripping process 223
 graphitic carbon nitride (g-C₃N₄) 21, 52, 280
 defect engineering 164–165
 elemental doping
 metallic elements 161
 nonmetallic elements 160–161
 exfoliation method
 chemical 164
 thermal 162–163
 ultrasound 163
 preparation method 155–157
 heterojunction construction
 compound/g-C₃N₄ heterojunction 166–167
 metal oxide/g-C₃N₄ heterojunction 168
 metal sulfide/g-C₃N₄ heterojunction 167
 MOF/g-C₃N₄ heterojunction 167–168
 Z-scheme heterojunction 168–169
 modification method for 157–158
 morphological control
 hard template method 158–159
 soft template method 159–160
 template-free method 160
 photocatalysis applications
 degrading pollutants 170–171
 inactivation of bacteria 172
 photocatalytic reduction of CO₂ 171–172
 photohydrolysis of water 171
 surface-loading cocatalyst 170
 graphitic phase carbon nitride (g-C₃N₄) 40, 51, 53
 green hydrogen 36, 209, 303

h

H₂O₂ production 51–53, 192–194
 Haber-Bosch process 44, 105, 289, 318
 hard template method 158–159
 heavy metal removal 104, 206

- heterogeneous structure construction
method 129–130
- heterojunction construction
compound/g-C₃N₄ heterojunction 166–167
metal oxide/g-C₃N₄ heterojunction 168
metal sulfide/g-C₃N₄ heterojunction 167
MOF/g-C₃N₄ heterojunction 167–168
Z-scheme heterojunction 168–169
- hexagonal boron nitride (hBN) 49, 237
- hexavalent chromium 103, 189, 208
- high-temperature solid-phase synthesis
method 64–65, 110
- high-temperature solid-state reaction
method 122
- homogeneous 2D Moire superlattice
(MSL) BiOCl semiconductor 83
- Honda–Fujishima effect 4
- Hummers method 224–227, 231
- hydrofluoric acid etching method 266–268
- hydrogen evolution reaction (HER) 10, 12, 187, 214, 247, 255
- hydrogen generation 36–39, 183, 186, 238, 239
- hydrogen, graphene 239
- hydrogen production 2, 15, 16, 36–38, 104, 153, 157, 167, 169, 182, 183, 185–187, 209, 211, 213, 237, 239, 245, 247, 249, 277–279
- hydrothermal method 30, 37, 50, 53, 63, 70, 88, 89, 95, 123–129, 134, 142, 163, 229, 230, 239, 252, 269, 285, 290, 291
- hydrothermal/solvothermal method 28–29, 201, 227, 229–231
- hydrothermal synthesis 31, 63, 126, 134, 137, 138, 303
- i**
- indirect Z-scheme heterojunctions 169, 234–235
- indium tin oxide (ITO) 232
- internal electric field (IEF) 5, 10–12, 25, 26, 31, 70, 97, 105, 125, 300, 301
- internal friction heat 67
- intramolecular charge transfer (ICT) 188
- ion doping 7, 124, 128, 129
- ionothermal synthesis method 182, 183
- k**
- Kelvin probe force microscopy (KPFM) 311
- Knoevenagel condensation 185
- l**
- layered bismuth-based photocatalysts
BiOX 59–111
BiXO₄ 117–130
Bi₂XO₆ 133–145
- layered double hydroxides (LDHs) 287–288
- anion characteristics 203
- energy application
characteristics 209–211
CO₂ reduction reaction 211–213
water splitting 213–217
- environment application
air purification 209
characteristics 205–206
water purification 206–208
- history 197
- infrastructure preparation
anion exchange 201
coprecipitation 200
hydrothermal/solvothermal 201
roasting-reduction 201
self-assembly 202
sol-gel 201
- photocatalysis functionalization
defect engineering 205
guest modification 202–203
host modification 203–204
hybridization 204
morphology adjustment 204
surface modification 205
2D exfoliation strategies 204

- layered double hydroxides (LDHs)
(*contd.*)
- properties
 - host layer controllability 199
 - intercalated ions fungibility 199
 - multi-dimensional growth direction and delamination 200
 - topological transformation 199
 - structures 197–199
 - 2D monolayer/single-layer 204
- layered photocatalysts
- CO₂ reduction 39–43
 - H₂O₂ production 51–53
 - hydrogen generation 36–39
 - N₂ fixation 44–47
 - organic synthesis 50–51
 - removal of pollutions 47–50
- layered transition metal dihalides (LTMD) 271
- layer structured catalysts 21–22
- active crystal surface 30–31
 - function of
 - active site, increasing 27–28
 - strong built-in electric field 25–26
 - hydrothermal/solvothermal method 28–29
 - morphology control 31
 - nitrogen fixation 24
 - photocatalytic CO₂ reduction
 - technology 23
 - photocatalytic degradation of pollutants 24
 - photocatalytic production of H₂O₂ 23
 - photocatalytic water decomposition to produce hydrogen 23
 - semiconductor composite 31–32
 - sol-gel process 29–30
 - solid-phase synthesis method 29
 - template method 29
 - ultra-thin layered materials 30
- light absorption 4, 6–8, 10, 16, 27, 28, 31, 32, 38, 40, 47, 49, 51, 52, 78, 83, 102, 117, 120, 124, 129, 134, 140, 142–144, 157, 159–161, 164, 169, 172, 183–185, 187, 189, 193, 240, 257, 273, 285, 289, 308, 310, 316, 324
- liquid exfoliation method 164, 249, 250
- liquid phase stripping method 25, 222–224
- localized surface plasmon resonance (LSPR) 8, 101
- lowest unoccupied molecular orbital (LUMO) 92, 168, 199
- m**
- MAX, element composition diagram 264
- mechanical cutting 249
- mechanochemical grinding method 182
- mechanochemical method 67
- metal element doping 129
- metal/nonmetal doping 7–8
- metal oxide/g-C₃N₄ heterojunction 168
- metal sulfide/g-C₃N₄ heterojunction 167
- methylene blue (MB) 47, 125, 127–130, 134, 142, 157, 240, 290, 292
- micromechanical exfoliation method 221, 223
- microwave-assisted heating method 123
- microwave-assisted synthesis 183
- microwave irradiation method 161, 182
- microwave method 67–68
- microwave synthesis method 67, 127
- MOF/g-C₃N₄ heterojunction 167–168
- molecular beam epitaxy (MBE) 251
- monoclinic BiVO₄ (m-BiVO₄) 117, 118, 125
- Mo₂CTx 267, 268
- MoS₂/CdS composites 38
- MoS₂/graphene composites 253
- MXene
- active site 276–277
 - adsorbents 276
 - advantages 274
 - cocatalyst in photocatalysis 274–275
 - CO₂ reduction 279–280
 - electrical properties 272–273
 - electronic properties 273
 - electronic storage 275–276
 - element composition diagram 264

hole receiver 276
 hydrogen production from water
 decomposition 278–279
 LDHs 287–288
 mechanical properties 273–274
 metal oxide 282–285
 metal salt 285–286
 nitride 280–282
 photocatalysis field 293–294
 photocatalyst activity 275–278
 photocatalytic degradation of organic
 pollutants 290–293
 photocatalytic nitrogen fixation
 289–290
 physicochemical properties 271
 preparation of 265
 stability 271–272
 structure of 263–265
 surface chemical properties 272
 synthesis method 269
 two-dimensional (2D)-layered
 inorganic compounds 263
 MXene quantum dots (MQDs) 285, 292

n

near free electron (NFE) 272
 nitrogen fixation 24, 36, 44–47, 105, 108,
 289–291, 300, 303, 318–324
 N-methylpyrrolidone (NMP) 249
 N–N heterojunction 232, 233
 nonmetallic element doping 27, 160–161
 nonmetallic layered photocatalysts 21,
 40
 normal hydrogen electrode (NHE) 240,
 321

o

one-dimensional $\text{Bi}_4\text{O}_5\text{I}_2$ hollow
 nanotubes ($\text{Bi}_4\text{O}_5\text{I}_2$ HNT) 64
 1D BiOX 79–81
 optimizing preparation methods 128
 organic synthesis 4, 50–51, 109–110,
 190, 221, 223
 oxalyl dihydrazide (ODH) 165
 oxygen vacancy engineering 48

p

P–N heterojunction 92, 232–234
 CdIn_2S 43
 persistent organic pollutants (POPs)
 103, 143, 290, 292
 photocatalysis 153
 applications 14–16
 charge carrier separation and transfer
 10
 definition 2–6
 fundamental principles of 2–6
 light absorption 6–7
 metal/nonmetal doping 7–8
 plasmonic photocatalysts 8–9
 photocatalysis graphene
 CO_2 reduction 238
 hydrogen generation 239
 photocatalytic disinfection 240–241
 pollutant degradation 239–240
 photocatalyst heterojunction, graphene
 Schottky junctions 232
 type II heterojunctions 232–234
 van der Waals heterostructures
 236–237
 Z-type heterojunctions 234–236
 photocatalytic CO_2 conversion 255–257,
 305, 307
 photocatalytic CO_2 reduction 9, 23,
 40–43, 107, 187, 188, 203, 238, 248,
 278, 280, 281, 283–286, 288,
 307–312
 photocatalytic degradation
 of organic pollutants 290–295
 of pollutants 24, 257
 photocatalytic disinfection 238, 240–241
 photocatalytic nitrogen fixation 24,
 44–47, 108, 289–291
 photocatalytic organic synthesis 50, 190
 photocatalytic production of H_2O_2 23
 photocatalytic reactions 3, 5, 6, 10, 31,
 41, 48, 49, 61, 69, 86, 87, 102, 111,
 125, 129, 144, 164, 170, 201–205,
 212, 245, 253, 271, 274, 277, 293,
 294, 299–301, 309, 312, 315, 319,
 320

- photocatalytic water decomposition 23,
 35, 278, 279
 photocatalytic water splitting 2, 15, 169,
 184–186, 209, 211, 214–216,
 253–255, 314, 315, 318, 319
 photodynamic therapy 108–109
 photoluminescence (PL) 281, 310
 photolytic water splitting 213
 photon energy 2, 120–122, 170, 299, 309,
 324
 photosynthesis, description 2
 plasmonic photocatalysts 8–9
 polarization strategy 97–101, 110
 pollutant degradation 4, 6, 36, 47, 48,
 143, 145, 169, 182, 217, 238–240,
 245, 249, 275
 pollutions, removal of 47–50
 polyvinyl alcohol (PVA) 274
 post-treatment techniques 137
 Pt quantum dots (PtQDs) 284
 Pt-modified Sb_2WO_6 ultrathin
 nanosheet-assembled
 microspheres 51
- q**
- quantum dots (QDs) 25, 27, 43, 78, 79,
 167, 229, 232, 256, 284, 285, 292,
 293, 299
- r**
- reactive ionic liquid (IL) method 68–69
 reactive oxygen species (ROS) 6, 108,
 143, 165, 189, 240, 272
 reversible reactions 182
 rhodamine B (RhB) 47, 48, 50, 128, 129,
 133, 134, 145, 159, 232, 257,
 290–292
 roasting reduction methods 201
 room temperature synthesis method 183
- S**
- S-scheme heterojunction 90, 94–95,
 301–303
 S-type $\text{Bi}_2\text{WO}_6/\alpha\text{-Bi}_2\text{O}_3$ heterojunctions
 141
 scanning electron microscopy (SEM)
 134, 308
 Schottky heterojunction 43, 232, 233,
 274, 304, 314, 322
 Schottky junction 101, 231, 281, 285,
 291, 301, 302, 310, 323
 self-assembly method 130, 202, 227
 semiconductor composite 31–32, 229
 semiconductor graphene 228–230, 235
 semiconductor photocatalysts, graphene
 atomic layer deposition 231
 hydrothermal/solvothermal method
 229–231
 in situ growth strategy 227
 solution mixing method 227–229
 single-atom engineering 96, 110
 SnO_2 /graphene nanocomposites 231
 soft template method 159–160
 sol–gel method 29–30, 123–124, 201
 solar fuels 2, 15, 17, 111, 232, 305, 324
 solar photocatalytic hydrogen evolution
 36
 solid solution strategy 76–78
 solid-phase synthesis method 29, 64–65,
 110
 solid–solid junctions 10–12
 solid-state reaction method
 process overview 138–139
 structure and properties 139
 solid-state synthesis 138
 solution mixing method 227–229
 solvent-thermal method 63–64, 182,
 183, 190
 solvothermal method 28–29, 31, 63, 69,
 77, 83, 126, 128, 201, 227, 229–231,
 293
 solvothermal synthesis
 additives and surfactants 136
 advantages and differences 137
 particle size and morphology 136
 synthesis reaction general steps
 135–136
 space-limited domain chemical vapor
 deposition (SCCVD) method 65

- spatially resolved surface photovoltage (SRSPV) technique 13
- SrTiO₃ photocatalysts 13
- SrTiO₃ nanocrystals 38
- sulfamethoxazole (SMZ) 165
- surface plasmon excitations (SPP) 101–102, 251
- surface plasmonic resonance (SPR) effect 316
- surface plasmon resonance (SPR) 8, 101, 172, 284
- t**
- template-assisted synthesis 136–137
- template-free method 160
- template method 29, 86, 159
- tetrabutylammonium ion (TBA⁺) 268
- tetracycline hydrochloride (TC-HCl) 103, 165, 290, 292
- tetragonal-phase BiOBr nanosheets 89
- tetramethylammonium hydroxide (TMAOH) 270
- tetramethylammonium ion (TMA⁺) 268
- 3D BiOX 83–87
- thermal exfoliation method 162, 163
- thermodynamically reversible reactions 182
- Ti₃C₂ MXene 280
- transient fluorescence-emission 281
- transient photocurrent response (TPR) 281
- transition metal dichalcogenides (TMDs) 299
- cocatalysts 252–253, 258, 259
- composition 246–247
- mechanical cutting 249
- 1T-phase 259
- photocatalytic mechanism of 247–249
- photocatalytic water splitting 253–255
- single-layer production 258
- synthesis methods 249–252
- transmission electron microscopy (TEM) 134, 225, 284, 304
- triethanolamine (TEOA) 43, 171, 186, 288, 315, 316
- 2D-based heterojunctions, construction modes 300
- 2D BiOX 81–83
- 2D Co₃O₄/polypyrazole reduced graphene oxide (K₇HNB₆O₁₉) layered photocatalytic material 26
- 2D bismuth-formed 2D–2D composite materials 43
- two-dimensional oxygen vacancy-modified bismuth molybdate nanosheet (BMOV_s) 43
- 2D/2D Bi-heterojunctions
- photocatalytic CO₂ reduction 312–313
- water splitting 319–320
- 2D-2D faceted junctions 90–91
- 2D/2D face-to-face heterojunction
- ex situ electrostatic self-assembly 305–306
- in situ hydrothermal and solvothermal processes 303–305
- 2D/2D heterojunctions 212, 285, 299–324
- 2D/2D heterostructures
- CO₂ reduction, carbon-neutral fuels 307–311
- N₂ fixation, ammonia production 318–323
- water splitting for H₂ and O₂ production 311–318
- 2D/2D OV_s-BiOX/RGO composites 90
- two-dimensional semiconductors 35
- two-dimensional transition metal sulfides (2D TMDs)
- cocatalysts design 252–253
- composition 246–247
- photocatalytic CO₂ conversion 255–257
- photocatalytic degradation of pollutants 257
- photocatalytic mechanism of 247–249
- photocatalytic water splitting 253–255
- synthesis methods 249–252
- type I heterojunction 91, 92, 234, 300–302

type II heterojunction 92, 232
 N–N heterojunction 233
 P–N heterojunction 233–234

U

ultrasonic method 126–128
 ultrathin 2D hydrotalcite nanosheets 44
 ultrathin layered materials 30, 43

V

valence band (VB) 4, 37, 43, 47, 60, 76,
 92, 117, 119, 121, 124, 133, 142,
 143, 154, 190, 205, 248, 273, 274,
 276, 299
 van der Waals bonds 265
 van der Waals forces 21, 24, 63, 64, 154,
 162, 163, 199, 305
 van der Waals heterostructures 236–237
 van der Waals interactions 246, 249
 VDWG–Bi–VO₂–Bi aggregates 82
 versatile techniques 303

W

water pollution purification 103
 water purification 17, 104, 206–208

water splitting 213

H₂ and O₂ production 311–318
 2D/2D Bi-heterojunctions 319–320
 work functions (W) 10, 12, 26, 94, 96, 98,
 165, 166, 170, 232, 233, 245, 272,
 276, 307

X

X-ray diffraction (XRD) 134, 190
 X-ray photoelectron spectroscopy (XPS)
 161, 165, 309

Z

0D BiOX 78–79
 0D/2D CuO/BiOCl p–n heterostructure
 93
 Z-scheme Bi₂MoO₆/Bi₁₂SiO₂₀ (MS)
 heterojunction 144
 Z-scheme heterojunction 11, 12, 93–94,
 168–169, 216, 234–236, 302, 305,
 315, 316, 318
 Z-scheme structural heterojunctions 169
 Z-type heterojunctions
 direct Z-scheme 235–236
 indirect Z-scheme 234–235