

## Index

### Symbols

*Bougainvillea spectabilis* 72–73  
*Mangifera indica* 65  
 $\beta$ -cyclodextrin ( $\beta$ -CD) 382  
 $\pi$ - $\pi$  stacking interaction 295, 379  
 1-(3-aminopropyl)imidazole (API) 385  
 1, 3-dipolar cycloaddition reaction 295  
 1-pyrenebutanoic acid succinimidyl ester (PASE) 185  
 2-aminoethyl methacrylate (AMA) 384  
 3,3-dithiodipropionic acid (DTPA) 381  
 3-aminophenyl boronic acid (3-APBA) 386  
 3D graphene oxide hydrogel membranes (GOHMs) 11  
 3-mercaptopropyl trimethoxysilane (MPTMS) 182  
 4-nitrophenol (4-NP) 65–67  
 9-vinylanthracene (VA) 378

### a

acetaminophen (AC) detection 62, 64–66  
 activated carbon 318  
 adenoid cystic carcinoma cell line (ACC-2) 387  
 adipic dihydrazide (ADH) 383  
 adsorbing agents 94–111  
 adsorption  
   through biological methods 114  
   through physical and chemical methods 93, 112–114

  using deep eutectic solvents (DESs) 114  
 air pollution remediation, FCNMs 400–401  
 allotropes 199  
 ammonia sensors 251–253  
   carbon nanotubes (CNTs) 253–256  
   functionalized carbon nanotubes for 258–259  
   single-walled carbon nanotubes (SWCNTs) 254–256  
 ammonium biosensor 258  
 antimicrobial effect 337, 429  
 Areca nut 69, 71–72  
 armchair arrangement 285, 286  
 artificial photosynthesis 403  
 ascorbic acid (AA) 65  
 atom transfer radical polymerization (ATRP) technique 384  
 attapulgite (ATT) nanofibers/GO 10

### b

bacterial nanocellulose (BNC),  
   synthesis of 354  
 Ball mill 292  
 bamboo fungi 67, 69–70  
 Bare GCE (BGCE) electrodes 71  
 BCNTPE  
   EIS characterization for 137, 139  
   FE-SEM characterization of 137, 138  
   preparation 136  
 BCNTPE with GA,  
   electropolymerization of 136

- Berthelot's indophenol reaction 252
- bio carbon nanomaterials 361  
 characterization technique 361–362
- bio-carbon nanomaterials 351
- biochar 356  
 application of 357
- biodiesel 408
- biofuels, FCNMs 408–409
- biomass  
 derived modified working electrodes 68  
 derived porous carbons 56  
 electrochemical sensing 61–62  
 structure and properties 58, 60–61  
 thermochemical decomposition of 56
- biopolymers 357  
 as bioplastics 358  
 'green' synthesis of  
 nanoparticles 357–358  
 in waste water treatments 358
- bioremediators 354
- biosensors 429
- bisphenol-A (BPA) detection 67, 69–70
- bovine serum albumin (BSA) 384
- branched polyethyleneimine (BPEI) 10, 397
- Brunauer-Emmett-Teller (BET) method 58
- bulk heterojunction (BHJ) 405
- butein detection 75–78, 86
- C**
- camptothecin (CPT) 381
- cancer cell treatment, by hyperthermia 428
- carbon-based adsorbents 317–320  
 carbon nanomaterials (CNM) 318–319  
 carbon nanotube (CNT) 319–320  
 graphene 319
- carbon-based membranes 332
- carbon based nanomaterials  
 (CNMs) 92–93, 113
- carbon dioxide (CO<sub>2</sub>) conversion  
 process 402
- carbon dots, in drug delivery 384–387
- carbon fiber paper (CFP) 74
- carbon monoxide 400
- carbon nanocapsules (CNCs) 404
- carbon nanocones 176  
 as environmental sensors 189–190
- carbon nanofibers (CNFs) 401
- carbon nanohorns (CNHs) 286
- carbon nanomaterials (CNM) 149–150,  
 173–174, 197, 199, 201, 349, 375–376
- carbon-based adsorbents 318–319
- carbon nanotube 149, 199
- classification 200
- covalent functionalization 201–202,  
 206–208
- in drug delivery 375–388
- fullerene 149, 199
- functionalization for 176, 200–202
- gas sensors 214
- graphene 200, 201
- graphene derivatives 149, 151
- humidity sensors 215
- light emitting devices (LEDs) 215–216
- metal absorption 216–217
- non-covalent functionalization 208–213
- solar cell 213–214
- synthesis 174
- water purification 217
- carbon nanoparticles 348–349
- carbon nanospheres (CNSs) 58, 69
- carbon nanotubes (CNTs) 149  
 adsorption mechanisms of 93  
 advantages of 287  
 ammonia sensors 253–254  
 antioxidants 429  
 bioactive agents 424  
 as biological sensor 179–180  
 carbon-based adsorbents 319, 329  
 composites and functionalised  
 nanomaterials 135  
 covalent functionalization 293–295,  
 425–426  
 disadvantages of 287  
 as environmental sensor 177–178  
 as filler 180–181  
 based magnetic nanocomposites 228  
 biomedical applications 424  
 carbon nanomaterials (CNMs) 174, 199  
 diagnostics 429–430  
 in drug delivery 375, 379

- functionalization of 257–258, 333  
 functionalized carbon nanotubes  
   (FCNTs) 285  
 imperfection functionalizations 425  
 infectious diseases treatment 428–429  
 in green nanocomposites design 179  
 membrane based filtration of  
   contaminants 115, 132  
 need of functionalization of 293  
 non-covalent functionalization 295–296,  
   425–427  
 in pharmaceutical field 426–427  
 polyethersulfone-PES 333  
 remove heavy metals 336  
 solid phase extraction (SPE) of drugs and  
   biochemical's 430–431  
 synthetic methodologies of 288–289  
 synthesis methods 255, 350  
 toxicity contemplation of 431–432  
 tumor treatment 428  
 in wastewater treatment 178–179  
 carboxylation 294  
 carboxymethyl cellulose (CMC) 379, 380  
 cardiovascular toxicity 158  
 casein micelles 360  
 catalytic chemical vapor deposition (CCVD)  
   method 254, 289–290  
 catalytic wet peroxide oxidation  
   (CWPO) 236  
 Catechin (CA) 72  
 catechin sensing 72–73  
 CCK-8 assay 378  
 cellular toxicity 151, 155  
 cellular toxicity, CNTs 432  
 cellulose acetate (CA)/graphene oxide (GO)  
   nanocomposites 9  
 cellulose nanocrystals (CNCs),  
   synthesis of 353  
 cellulose nanofibrils (CNFs),  
   synthesis of 353  
 cetuximab (CET) 383  
 charged congo red (CR) 6  
 chemical oxygen demand (COD) 43  
 chemotherapy 428  
 Cherenkov radiation 276–277  
 chiral arrangement 285  
 chitosan and graphene oxide embedded with  
   iron oxide nanoparticles  
   (CSGOIO) 41  
 chitosan (CS) functionalized SWCNT 377  
 chlorine resistance 19  
 chlorofluorocarbons 400  
 cholesterol oxidase biosensor (COx) 186  
 chronic inflammation 75  
 ciprofloxacin (CIP) 43, 237  
 citric acid 386  
 CNT-based composite adsorbents 114–115  
 CNTs purification techniques  
   annealing 292  
   chemical oxidation 291  
   chromatography 292  
   cutting 292  
   magnetic purification 292  
   microwave treatment 291  
   Piranha treatment 291  
   ultrasonication 292  
   vacuum oven treatment 291  
 CO<sub>2</sub> reduction reaction (CO<sub>2</sub>RR) 402  
 co-doped bio-carbon  
   application 356  
   nitrogen and sulphur 356  
 coiled-coil peptides 360  
 copper functionalized-CNDs 397  
 co-precipitation method 230  
 covalent functionalization 201, 206, 293  
   of CNTs 425–426  
   end-effect 293–294  
   side-wall 294–295  
 covalent organic frameworks (COFs) 15  
 covalent triazine framework (CTF) 15  
 crosslinking approach 17  
 cyclic voltammetry (CV) 62, 72  
 cyclic voltammograms 71  
 cyclovoltametry (CV) 180  
 cytotoxicity 151, 155
- d**
- de-carboxylated cellulose (DCC),  
   synthesis of 354  
 deep eutectic solvents (DESS) 114

defluoridation 317  
 deionized water 8  
 dendrimers 360  
 dense membrane 2  
 density functional theory (DFT) 182  
 dermal or skin toxicity 157–158  
 desalination 4, 333–335  
 diclofenac (DCF) 43  
 Diels-Alder cyclo-addition 295  
 diethylenetriaminepentaacetic acid  
     modified magnetic graphene  
     oxide 35  
 differential pulse voltammetry (DPV) 65,  
     72, 140, 142  
 dipeptides 359  
 diquat dibromide (DQ) 237  
 disinfecting agents 121  
 disinfection by-products (DBPs) 121  
 docetaxel (DTX) 377–378  
 double-walled carbon nanotubes  
     (DWCNTs) 175, 253, 286, 376  
 double walled or multi-walled  
     (MWCNT) 175  
 down-conversion method 216  
 doxorubicin (DOX) 300  
 drug delivery  
     carbon dots in 384–387  
     carbon nanomaterials in 375–388  
     carbon nanotubes (CNTs) in 375–378  
     graphene oxide in 379–384  
     nanodiamonds in 387–388  
 drug delivery system (DDS) 378  
 drug targeting  
     brain 302  
     cancer 301–302  
     lymphatic 302–303  
     tuberculosis 303, 312  
 DTPA/MGO 38  
 dye-sensitized solar cells (DSSCs) 404  
 dyes treatment 5

## e

EHT/GO 6  
 electric arc discharge (EAD) method 289  
 electrocatalysts 402–403

electrocatalytic activity 180  
 electrochemical sensors 54–55  
 electrode materials 54, 56  
 electrolysis method 289  
 electron transport layer (ETL) 404  
 electrospinning nanofibers 336  
 energy dispersive X-ray spectroscopy  
     (EDX) 62  
 energy storage, FCNMs 403  
 enzyme AlaDH 253  
 esterification-amidation reactions 294  
 ethylenediamine 386  
 ethylenediaminetetraacetic acid  
     (EDTA) 184

## f

f-CNTs 213  
 Fe<sub>3</sub>O<sub>4</sub>/reduced graphene oxide 42  
 ferromagnetic catalytic impurities 292  
 FET (Field effect transistor) sensors 185  
 fluoride  
     adsorbents classification 317–318  
     carbon-based adsorbents 317  
     in environment 316  
     geochemistry of 314  
     in groundwater 315  
     hazardous effect of 317  
     health effects of 316  
     removal technologies 316–317  
     solubility & temperature 316  
 forward osmosis (FO) based water  
     treatment 8  
 freeze-dried okra 62  
 Freundlich model 45, 46  
 fuel cell, FCNMs 407–408  
 fullerene(s) 149, 188  
     in agriculture 189  
     as biological sensor 188–189  
     carbon nanomaterials (CNMs) 199  
     as environmental Sensor 188  
     magnetic nanocomposites 229  
     synthesis of 349  
     in wastewater treatment 188  
 functionalized carbon  
     nanomaterials (FCNMs)

- air pollution remediation 400–401
  - antibiotics removal 400
  - applications 409–410
  - biofuels 408–409
  - electrocatalysts 402–403
  - energy storage 403
  - environment friendly and greener
    - ways 396–398
  - fuel cell 407–408
  - functionalization 395
  - gas sensors 214
  - green and sustainable environment 398
  - humidity sensors 215
  - hydrogen storage 406–407
  - light emitting devices (LEDs) 215–216
  - metal absorption 216–217
  - nanofertilizers 409
  - nuclear waste management 401–402
  - photocatalysts 402–403
  - solar cells 213–214, 403–405
  - supercapacitors 405–406
  - water purification 217
  - wastewater remediation 398–400
  - functionalized carbon nanotubes (FCNTs)
    - advantages of 296
    - biocompatibility and toxicity
      - considerations 303
    - carbon nanotubes 285
    - drug delivery 296–298
    - drug loading 298–305
    - drug targeting 301–305
    - MWCNTs 286–287
    - SWCNTs 285
  - functionalized graphene oxide (fSGO) 182
  - functionalized multiwalled carbon nanotubes (FMWCNTs) 398
- g**
- galactosylated chitosan/graphene oxide/  
doxorubicin (GC-GO-DOX) 381
  - gallotannin 397
  - gas sensors 214
  - glassy carbon electrode (GCE) 62, 64
  - GO–chitosan (GO–CS) composite
    - hydrogels 184
  - GO framework (GOF) 10
  - gold nanoparticles (AuNPs) 302
  - GO/MXene 21
  - GO nanosheets, carboxylation of 8
  - GO-polyaniline (GO-PANI) 114
  - GO/prodrug nanohybrids (GOPN) 379
  - GPAC 72
  - graphene 181, 285, 333
    - adsorption mechanisms of 93
    - as biological sensors 185–186
    - characteristics and properties 2–4
    - as environmental sensors 182–183
    - carbon-based adsorbents 319, 329
    - carbon nanomaterials 175–176
    - carbon nanomaterials (CNMs) 200, 203
    - fabrication of 4, 23
    - in wastewater treatment 183–185
    - magnetic nanocomposites 228
    - membrane based filtration of
      - contaminants 115, 132
    - production of 175
    - removing organic pollutants 186–188
    - synthesis of 350–351
  - graphene acidic (GA) membrane 8
  - graphene-based composite
    - adsorbents 114–115
  - graphene/CNTs, adsorption capacity 113
  - graphene derivatives 149, 151
  - graphene nanoflakes (GNFs) 405
  - graphene nanomembranes
    - for salt and dye rejection 5, 23
  - graphene nanomembranes, translation
    - of 23–24
  - graphene oxide (GO) 10, 187, 214
    - characteristics and properties 2–4
    - in drug delivery 379–384
  - graphene oxide/attapulgite (GO/APT) 7
  - graphene oxide nanomembranes
    - (GONMs) 20
  - graphene oxide nano ribbons (GONRs) 18
  - graphitic carbon nitride, based magnetic
    - nanocomposites 229
  - graphyne nanosheet 402
  - ground-level ozone 400

**h**

heavy metals  
 adsorption 231–233  
 treatment 24–26  
 HeLa cells 380  
 heparin (Hep) 383–385  
 hepatotoxicity or liver toxicity 159–160  
 HGOST nanofiltration 18  
 hierarchical carbon membrane (HCM) 21  
 HNO<sub>3</sub> washing 217  
 hole transport layer (HTL) 404  
 H<sub>2</sub>O<sub>2</sub> sensing 61–62  
 humidity sensors 215  
 hyaluronic acid (HA) 385  
 hydrogen-bond donors (HBDS) 114  
 hydrogen evolution reaction (HER) 402  
 hydrogen storage, FCNMs 406–407  
 hydrophobic effect 379  
 hydrothermal carbonization (HTC) 56–57  
 hydrothermal method 230

**i**

*in situ* polymerization 230–231  
 interference analysis 141  
 ion exchange 90  
 IT and GA 136  
 IUPAC classification 58

**k**

kelp carbon (KC) 64

**l**

lab-on-box 268  
 lab on chip (LoC)  
 agriculture applications 268–269  
 bio-medical applications 270–274  
 need 266–267  
 ocean and atmospheric  
 applications 274–278  
 renewable Energy applications 267–268  
 Langmuir Blodgett (LB) technique 183  
 Langmuir model 38, 46  
 laser ablation (LA) method 254, 288  
 layer by layer (LBL) 10

layer-by-layer self-assembly method 380  
 levofloxacin (LVF) delivery system 378  
 light emitting devices (LEDs) 215–216  
 light trapping 267  
 limit of detection (LOD) 65, 77  
 limit of quantification 77  
 linear regression equations 72  
 lipid nanoparticles 348  
 liquid crystalline molecularly imprinted  
 polymers (LC-MIP) 378  
 low pressure nanofiltration membranes  
 (LMPs) 15

**m**

magnetic  $\beta$ -cyclodextrin-graphene oxide  
 (MCG) 187  
 magnetic  $\beta$ -cyclodextrin/graphene  
 oxidenanocomposite (MCGN) 184  
 magnetic annealing-reduced graphene  
 (MARG) 233  
 magnetic carbon nanocomposites 228  
 magnetic chemically-reduced graphene  
 (MCRG) 233  
 magnetic chitosan and graphene oxide  
 composite (MCGO) 43  
 magnetic functionalized-CNMs  
 (Fe(NO<sub>3</sub>)) 398  
 magnetic graphene oxide 379  
 application of 36  
 composite nanomaterials 35–36, 40–44  
 other contaminants, removal 45–46  
 synthesis of 35–36  
 toxic metal contaminants,  
 removal 36–41  
 toxic organic contaminants,  
 removal 41–44  
 magnetic graphene oxide (MGO) 233, 382  
 magnetic multi-walled carbon nanotubes/cerium  
 dioxide (MMWCNTs-CeO<sub>2</sub>) 235  
 magnetic nanocomposites  
 carbon nanotubes 228  
 co-precipitation method 230  
 fullerene 229  
 graphene 228

- graphitic carbon nitride 229
  - heavy metals adsorption 231–233
  - hydrothermal method 230
  - in situ* polymerization 230–231
  - melt blending 229
  - nanodiamond 229
  - organic dye adsorption 234–236
  - other organic pollutants 236–237
  - sol-gel method 231
  - mango leaves 65, 67
  - melt blending 229
  - metal absorption 216–217
  - metal nanoparticles 348
  - metal-organic framework (MOF-5) 380
  - metal phenolic networks (MPNs) 17
  - methotrexate (MTX) 382
  - methyl acrylate (MA) 383
  - methylene blue (MB) 41
  - microbial fuel cell (MFC) 407
  - microorganisms removal 336–340
  - microwave radiations 397
  - milk protein 360
  - MOF-GO-CS 13
  - molecular straws 216
  - mPES 17
  - MPNs. See metal phenolic networks (MPNs)
  - MTT assay 380–381
  - multifunctional thin film nanocomposites (MTFN) 15
  - mutli-walled or multilayer carbon nanotubes (MWCNTs) 93, 112, 175, 199, 253, 332, 336, 376, 378, 424, 425
    - filter 337
    - functionalized carbon nanotubes (FCNTs) 286–287
- n**
- Nafion (binding agent) 62
  - nanobiosensor 269–270
  - nanobuds 286
  - nanocellulose (NC) 352–353
    - in biomedicine 355–356
    - as solar cells 355
    - as stabilizing agent 355
    - synthesis of 352–353
  - nanocomposites 358–359
  - nano-cytotoxicity, assessment of 155
    - cardiovascular toxicity 158
    - dermal or skin toxicity 157–158
    - hepatotoxicity or liver toxicity 159–160
    - ocular toxicity 160
    - reproductive and developmental toxicity 158–159
    - respiratory or pulmonary toxicity 155, 157
  - nanodiamond
    - magnetic nanocomposites 229
    - in drug delivery 387–388
  - nanofertilizers, FCNMs 409
  - nano graphene oxide particles (NGO) 14
  - nanomaterials 90–91, 148, 331, 337–338
    - functionalization of 351–352
  - nanoparticles, surface properties of 148
  - nanotechnology 424
  - nanotorus 286
  - nanotoxicology 151
  - nanowires 177
  - Nessler's reagent 252
  - n-hydroxysuccinimide (NHS) 294
  - nitrite ion detection 69, 71
  - nitrogen-based oxides (NO<sub>x</sub>) 400
  - nitrogen co-doped bio-carbon 356
  - nitrogen reduction process 402
  - nitrogen reduction reaction (NRR) 402
  - nitrophenol detection 65, 67
  - non-covalent functionalization 208, 210, 257, 295
    - $\pi$ - $\pi$  stacking interaction 295–296
    - of CNTs 425, 427
    - PEGylation 296
  - NPEY 185
  - nuclear waste management 401
- o**
- octadecylamine 207
  - ocular toxicity 160
  - ofloxacin (OFL) 178
  - oil palm leaves (OPL) 75, 86

- Okra 61–62  
 one-pot solvothermal method 380  
 onion peel 73–76  
 organic dye adsorption 234–236  
 organic dye pollutants 399  
 organic pollutants 236–237  
 organic solar cells (OSCs) 404  
 oxidized large-inner diameter  
   multi-walled carbon nanotubes  
   (O-LID-MWCNTs) 378  
 oxidized multi-walled carbon nanotube  
   (OMWCNT) 237  
 oxygen evolution reaction (OER) 402
- P**  
 PANI/MWCNTs 177  
 paracetamol 64  
 PEGylation 296  
 peptide amphiphiles 359  
 peptide nanoparticles 359  
 peptide nanotubes 360–361  
 peptide–nucleic acid complexes 360  
 peptide protamine sulfate (PRM) 380  
 PGAMCNTPE  
   and bare CNTPE, CV behavior of IT  
   at 137, 139  
   ELS characterization for 137, 139  
   FE-SEM characterization of 137–138  
 phosphate buffer solution (PBS) 74  
 photocatalysts 402–403  
 pH, selection of 137, 140  
 pH-sensitive carbon dots (pSCDs) 385–386  
 piperazine (PIP) 17  
 planar heterogeneous graphene oxide  
   membranes (PHGOM) 17  
 poly(allylamine) hydrochloride (PAH) 35  
 polyampholytic alternating polymers  
   (PMT) 376–377  
 polyampholytic PMT polymers 377  
 polyaniline (PANI) coated MWCNTs 255  
 polycaprolactone (PCL) 379  
 polycarbonate plant wastewater (PCW) 236  
 poly dimethyl diallyl ammonium chloride  
   (PDMAAC) 38  
 polydopamine and magnetic graphene oxide  
   nanocomposite (M-GO-PDA) 43  
 polydopamine (PDA) 9  
 polyelectrolyte (PE) 5  
 polyethersulfone (PES) 24  
 polyethylene glycol (PEG)-functionalized  
   MWNTs 378  
 poly(ethyleneimine) (PEI) 6, 381  
 poly(ethyleneimine) (PEI)-poly(L-lysine)-  
   poly(L-glutamic acid) 381  
 poly(lactic acid)-co-methoxy polyethylene glycol  
   copolymeric (PLA-co-mPEG) 378  
 polymeric nanoparticles 348  
 polypyrrole (PPy) 182  
 poly(vinylidene difluoride) (PVDF) 13,  
   121, 335  
 porous membrane 2  
 precise chemical composition 207  
 progesterone sensing 73, 76  
 programmable metamaterials 267–268,  
   277–278  
 proton exchange membrane fuel cell  
   (PEMFC) 407  
 pSCDs. See pH-sensitive carbon  
   dots (pSCDs)  
 pyrolysis 58–59
- R**  
 Raman spectroscopy 58  
 Randle Sevick's equation 65  
 reactive oxygen species (ROS) 152, 154  
 reagent thionyl chloride 207  
 reduced graphene oxide (RGO) 23, 151,  
   176, 182  
 reduced graphene oxide-gold nanoparticle  
   (rGO-AuNP) 8  
 reproducible and stable sensor 141  
 reproductive and developmental  
   toxicity 158–159  
 respiratory or pulmonary toxicity 155, 157  
 reverse Cherenkov radiation 277, 278  
 reverse osmosis 333  
 reverse osmosis (RO) desalination 7  
 rhodamine B (RhB) 41, 43

**S**

- scanning transmission electron microscopy (STEM) 62
- sea weed 62, 66
- semiconductor nanoparticles 348
- single-walled carbon nanotubes (SWCNTs) 93, 174–175, 199, 253, 332, 337, 376–377, 424, 425
  - ammonia sensors 254, 256
  - functionalized carbon nanotubes (FCNTs) 285
- solar cells 213–214, 355
  - FCNMs 403–405
- sol-gel method 231
- solvent-free microwave assisted methodology 397
- sonochemical synthetic process 397
- sonochemistry 398
- sononano chemistry 397
- sp<sup>2</sup> hybridization 93, 332
- sulfadiazine (SDZ) sonocatalytic degradation 43
- sulfur-based oxides (SOx) 400
- sulphur co-doped bio-carbon 356
- supercapacitors, FCNMs 405–406

**t**

- thin film nanocomposite (TFN) 7
- thioglycolic acid (TGA) 184
- toxic metal contaminants, removal 36–41
- toxic organic contaminants, removal 41–45
- triple walled carbon nanotubes (TWCNTs) 286
- truncated icosahedron 149

**U**

- ultrasound irradiation 397
- ultra-thin GO films 17
- ultraviolet (UV) photolysis 90

**V**

- vapour grown nanofibers 401
- vibrating sample magnetometric (VSM) 379
- volatile organic compounds 400
- voltage sweep rate effect 139–141

**W**

- wastewater 88, 132
  - pollutants/contaminants 88
- wastewater remediation, FCNMs 398–400
- wastewater treatment 89–90
  - commercial use of CNMs in 122
- water contamination 33
- water pollutants treatment 33
- water purification 217
- water sample analysis 141–142
- water splitting 402
- working electrode material 65, 69, 72
- working electrode sensing 71

**X**

- X-ray diffraction (XRD) 58
- X-ray photoelectron spectroscopy (XPS) 62

**Z**

- ZAKC 64
- zigzag arrangement 285–286
- zinc ions 336
- zinc oxide 258
- zwitterion (Z-CNTs) 333





