

## Index

### **a**

abiotic  
 fauna 738  
 flora 738  
 processes 664  
 absorbance intensity 216  
*Acacia nilotica* 556  
 acetaldehyde 218  
*Acetobacter xylinum* 582, 700  
 acetone 237  
 acetylcholine esterase (AchE) 103  
   liposome bioreactor 531  
 acetylcholinesterase 558  
 acetylthiocholine 531  
 acid–base interactions 622, 623  
 acid fuchsine 136  
 acid hydrolysis 583  
 acid sites 54  
 acridine orange (AO) 136  
 acriflavine (AF) 300  
 acrylamide 331  
 2-acrylamido-2-methyl-1-  
   propanesulfonate acid 612  
 2-acrylamido-2-methyl propane sulfonic  
   acid (AMPS) 131  
 acrylic acid (AA) 94, 331  
 acrylonitrile 137  
 actinomycetes 544  
 activated carbon (AC) 99, 139, 171, 615  
 activated carbon fiber (ACF) 56, 615  
 activated sludge 354, 366  
 activation energy 619  
 active oxygen species 54  
 acylation 603

additives 770  
 adenosine triphosphate (ATP) 744  
 adhesion force 301, 727  
 adiabatic temperature 43  
 adsorbents 457, 599  
   adsorbate–adsorbent interaction 96  
   dose 133  
 adsorption 130, 135, 369, 373, 393,  
   698, 724  
   capabilities 95, 131–135, 137, 138,  
   192, 194, 199, 200, 299, 323,  
   619, 622, 696, 700, 722, 725,  
   826  
   bioinspired spherical  $\text{Fe}_3\text{O}_4$ /  
     bacterial cellulose  
     nanocomposites for 700  
 ciprofloxacin 200  
   on GS 199  
 desorption cycles 96, 131  
 efficiencies 132, 135, 136, 219, 323  
   for Cu(II) and Pb(II) toxic  
     ions 133  
 energy 24, 29, 35  
 equilibrium 131  
 isotherms 193, 200, 201  
 kinetics, of tetracycline 202  
 mechanism 136  
 and membrane separation 296  
 photodegradation effect 666  
 of pollutants 666  
 procedure 127, 416, 698  
 tetracycline on GS hydrogels 200  
 advanced oxidation processes 11, 296,  
   652

- aerogels 192, 200, 204, 584, 589, 591  
 aerosols 423, 805  
 aflatoxin B1 558  
 Ag/AgCl/WO<sub>3</sub> composite system 223  
 Ag/AgCl/WO<sub>3</sub> photocatalyst 223  
 Ag/AgCl/ZnO nanocomposite 696  
 Ag-Au bimetallic nanoparticles 301  
 Ag/Au core-shell nanoprisms 557  
 Ag-based semiconductor 223  
 AgBr/Ag<sub>3</sub>PO<sub>4</sub>/ceria  
     nanocomposites 307  
 Ag<sub>2</sub>CdI<sub>4</sub>/AgI nanocomposites 233  
 Ag<sub>2</sub>CdI<sub>4</sub> nanoparticles 233  
 Ag/CNT composites 621  
 Ag-decorated Fe<sub>3</sub>O<sub>4</sub>/TiO<sub>2</sub>-coated  
     cenosphere 253  
 Ag film nanoneedle array 492  
 agglomeration 195, 197, 198, 333, 663,  
     739, 740, 764  
     nanoparticles 400  
     processes 232  
 aggregation 233, 827  
     structure 495  
 aging 167  
 Ag ions 230  
 Ag-modified BiVO<sub>4</sub> composite 307  
 Ag<sub>2</sub>MoO<sub>4</sub> and Ag-Ag<sub>2</sub>MoO<sub>4</sub>,  
     characterization 494  
 Ag nanoclusters (AgNCs) 557  
 Ag nanoparticles 218, 230, 252, 253  
     degradation efficiency 559  
     mechanism of formation 521  
 Ag<sub>3</sub>PO<sub>4</sub>-based photocatalysts 254  
 agriculture 127, 761  
 Ag/TiO<sub>2</sub> nanotube plates, coated with  
     RGO as photocatalysts 250  
 Ag-ZnO hybrid heterostructures 247  
 Ag-ZnO hybrid photocatalysts 246  
 air gap membrane distillation 362  
 air pollutants 138  
 air pollution 42, 414  
 Al-based composites 416  
 AlB<sub>10</sub> nanoparticles 416  
 aldrin 303  
 algal blooms 294  
 alginates 535, 695  
 aliphatic polyester 668  
 alkali metals 419  
     earth metals 45  
 alkaline phosphatase 527  
 alkalinity 727  
 alkoxides 740  
 alkylation 603  
 alkyl lithium compounds 606  
 alkyl lithium reagents 603  
 allergies 664  
*Allium cepa* 180, 746  
*Allium sativum* 556  
 Al<sub>2</sub>O<sub>3</sub>NPs 79  
 Al<sub>2</sub>O<sub>3</sub> substrates 533  
 γ-Al<sub>2</sub>O<sub>3</sub>-supported catalyst 59  
 alumina 48  
     based ceramic membranes 724  
     clays 661  
     coated magnetite nanoparticles  
         (Fe<sub>3</sub>O<sub>4</sub>/Al<sub>2</sub>O<sub>3</sub>) 96  
     NP-immobilized-DNPH (2,4-  
         dinitrophenylhydrazine) 95  
     template 492  
 aluminum 661  
     based materials 227  
     doped materials 225  
 American Society for Testing and  
     Materials (ASTM) 655  
 amidation reaction 603  
 amines 139  
 aminesilanes 591  
 4-aminoantipyrine (4-AAP) 107  
 aminomethyl phosphonic acid 335  
 p-aminophenol (*p*-AP) 301  
 3-aminopropylethoxysilane 623  
 3-aminopropylmethyl-  
     diethoxysilane 623  
 3-aminopropyltriethoxysilane 94, 623  
 3-aminopropyltrimethoxysilane 607  
 aminosilanes 591  
 ammonia (NH<sub>3</sub>) 54, 139, 367, 446,  
     532, 621, 622  
     adsorption capacity 622  
 ammonia bisulfate (ABS) 54  
 ammonium hydroxide 332  
 ammonium pyrrolidine  
     dithiocarbamate 141  
 ammonium sulfate 372  
*Amomum subulatum* 554  
 amorphous boron 416  
 amorphous microporous MnO<sub>2</sub>  
     nanosheets 303

- amperometric acetylcholinesterase (AChE) 530
- amphotericin B lipid complex (ABLc) 783
- Anacardium occidentale* 553
- analytical applications
- methods, enable monitoring of hazardous substances 581
  - separation and removal, inorganic species and organic molecules 85
- analytical nanoscience and nanotechnology (AN&N) 581
- anatase–rutile transformation 243
- anatase to rutile transition 240
- anion–cation interaction 136
- anionic dyes 136
- removal of 585
- anion membrane 364
- anisotropy 231
- anode materials 297
- anodic stripping linear sweep voltammetry (ASLSV) 91
- anodic stripping voltammetric (ASV) 92
- anodized iron 661
- anthracene 556
- anthraquinone (AQ) 93
- anthropogenic activities 141
- antibacterial coatings 790
- antibiotics 300
- antifullerene IgG monoclonal antibody 605
- antimicrobial nanotechnology 778
- antimicrobial packaging 781
- antioxidant activity 220
- antioxidant properties 737
- apoptosis 554
- apparent quantum efficiency (AQE) 258
- aquifers 294
- Arabidopsis thaliana* 154
- arc-discharge 417, 764, 765
- archaeabacteria 583
- aromatic compound, ionizable 620
- aromatic hydrocarbons 666
- aromatic organic molecules 138
- array structure 491
- arsenate ions 401
- arsenic 302, 401, 402, 524, 686
- immobilization 302
  - removal, pilot-scale system 404
  - species As(III) and As(V) 134
- artificial photosynthesis 774, 775
- artificial seawater 728
- asbestos 742
- ascorbic acid 96, 194
- ascorbyl palmitate 791
- aseptic application 392
- Aspergillus fumigatus* 810
- assembled nanostructures, SEM images 496
- ASTM D6866 standard testing method 655
- atomic arrangement 27
- atomic force microscopy (AFM) 133, 301, 396, 495, 550
- atrazine 401
- Au-doped PdO NPs, photocatalysis process 219
- Au/GO/ZnO composite
- nanostructures 248
- Au/GO/ZnO hybrid photocatalyst 246
- Au/GO/ZnO nanostructures
- composite 246
- Au/graphene quantum dots/ferroferric oxide composite 300
- Au nanoparticles 42, 222, 301, 560
- AuNP–antibody conjugates 558
  - AuNP–CaCO<sub>3</sub> hybrid material 558
  - AuNPs, as chemical sensor 524
  - AuNPs, by fungus *Trichothecium* sp. 809
  - biofunctionalized AuNPs 549
  - incorporated enzymes 781
  - metallic 544
  - TEM images of 80
- Au@Pd core–shell with different shapes
- TEM-EDS analysis and schematic diagram of 487
- Au-Pd/rGO composite 300
- Au/TiO<sub>2</sub> photocatalyst 249
- Au–TiO<sub>2</sub>/SiO<sub>2</sub> nanocomposite 222
- Au/ZnO hollow-sphere monolayer thin films, and photocatalytic properties 247

- Au-ZnO hybrid nanopyramids 246  
 Au-ZnO hybrid photocatalysts 245  
 Au-ZnO NPs  
     hybrid NPs 245  
     TEM image of 246  
 average pore diameters of GS0, GS1,  
     GS4, and GS8 199  
*Azadirachta indica* 554  
 azo dyes 664  
     biodegradation of 664  
     removal of 663  
 azomethine 606
- b**
- Ba, and Ce oxides 58  
*Baccaurea ramiflora* 552  
*Bacillus botulinus* 558  
*Bacillus licheniformi* 518  
*Bacillus megaterium* D01 809  
 backpropagation 421  
 bacterial cellulose (BC) 698, 702  
     aerogel 589  
     TiO<sub>2</sub> hybrid nanofibers, biosynthesis  
         route for 704  
 bacterial nanocellulose (BNC) 582  
     sponges, preparation of 589  
 bacteriorhodopsin 726  
 Baker's yeast (*Saccharomyces cerevisiae*) 809  
 ball and powder mixture 766  
 ball milling 417  
 bandgap 216, 224, 244, 654, 774  
     energy 244, 303  
     semiconductor 244  
     Si crystals 719  
 barium nitrites 57  
 barrier protection 781  
 basic fuchsin 218  
 batch adsorption method 133  
 batch sorption experiments 193  
*BaTi<sub>1-x</sub>Cu<sub>x</sub>O<sub>3</sub>* perovskite 62  
 BC and spherical Fe<sub>3</sub>O<sub>4</sub>/BC  
     nanocomposites, digital  
         images of 699  
 bentazon 401  
 bentonite/g-C<sub>3</sub>N<sub>4</sub>/Ag<sub>3</sub>PO<sub>4</sub> 263  
 benzene 138, 372, 615  
 benzophenone-3 (2-hydroxy-4-methoxy benzo-phenone) 103  
 benzotriazole (BTA) 106  
 BET isotherms 192  
 Bi-based semiconductors 256  
 bicarbonates removal, pilot-scale system 404  
 bicontinuous phase Cr-TiO<sub>2</sub>  
     nanoparticles 241  
     phase transition studies of 241  
 bienzymatic biosensor 527  
 bifunctional abilities 827  
 bifunctional reagent 606  
 binding energy 25  
 bioactive compounds 727  
 bioadhesive properties 727  
 bioavailability 166, 727  
 biobased carboxylated NC 590  
 biobased plastic 655  
 BiOBr/NiFe<sub>2</sub>O<sub>4</sub> composite 260  
     photocatalyst 260  
 biochar surface 153–155, 165, 166  
     pH-dependent dissociation of acid/base groups 166  
     plant growth, effects of 166  
     soil fertility, effects of 155  
 biochemical oxygen demand (BOD) 664  
 BiOCl photocatalyst, SEM images of 257  
 biocompatibility 153, 154, 192, 581, 726  
 biocomposite screen-printable material 528  
 biodegradable 191, 579, 656  
     organic materials 71, 72  
     plastic 655  
     polymers 658, 668  
 biodistribution 790  
 biodiversity 3, 4  
 bioelectronics applications 726  
 biofabricated nanoparticles 558  
 bioflocculation 675  
 biofunctionalized AuNPs 549  
 bioimaging 739  
     materials 667  
 BiOI microspheres, thermal conversion of 240  
 bioinspired  
     functional nanocomposites 698  
     hybrid nanofibers 702

- magnetically responsive alginate-based nanocomposites, removal capacity 696
- mineralization methods 696
- nanocomposites 685, 687, 692, 706 decontamination via photocatalytic application 702 dispersed phase 687 environmental application of 697
- nanomaterials 827
- Pd/Fe<sub>3</sub>O<sub>4</sub>, Au/Fe<sub>3</sub>O<sub>4</sub>, and PdAu/Fe<sub>3</sub>O<sub>4</sub> nanocomposites 704
- photocatalytic nanocomposites 702
- BiOI powders, pure/heat-treated, SEM images of 241
- biological applications 727 chemicals 294 contaminants 737 materials 693 oxidation 369 oxygen demand 71, 369
- biomass 557 separation membrane bioreactor 365 technology 774
- bio-mediated nanocatalysts 557
- biomedical and medical applications 220, 667
- biomedicine 211
- biomimetic immune technology 478, 481 strategy 696
- biomineralization 518, 519
- biomolecules 549 immobilization 531 sensitized solar cell (BSSC) 726
- bionanomaterials 519 based devices, for environment 717, 726
- bionanoparticle (BNP) 517, 518 advantages of 520 fabrication using different microorganisms 520
- bionic immunization 473, 480
- bioplastics 657 from mixed sources 656
- biopolymers 654–656, 663, 671, 673 as immobilization supports 662
- matrices 726
- nanobiohybrids 726 supported photocatalysts, for pollution remediation 662
- bioprotein 726
- bioreceptors 527
- bioremediation 584, 651, 724, 778
- biosensors 103, 336, 483, 527, 531 based on gold nanorods (AuNRs) 530 for trace metal ions 525
- biosynthesized spherical Fe<sub>3</sub>O<sub>4</sub> 698, 699
- biotemplates 517
- biotic processes 664
- biotinylated ditryptophan peptide 548
- biotreatment methods 651
- BiOX-based photocatalysts 256
- biphenyls 543, 650
- bipotentiostatic chronoamperometric biosensor 528
- bis(2,2-bipyridine)-[4-(4-methyl-2,2-bipyridin-4-yl) propylamine] ruthenium(II) dihexafluorophosphate complex 591
- Bismarck Brown 664
- bismuth 307
- bismuth oxychloride (BiOCl) 256
- bismuth oxyhalide-based photocatalysts 256
- bis [*o*-(*N*-methylidenamino-2-thiol-1,3,4-thiadiazole-5-yl) phenoxy] ethane (BMTTE) 93
- bisphenol A 138, 300, 397, 398 polyester 397
- Bi<sub>12</sub>TiO<sub>20</sub>-Bi<sub>2</sub>WO<sub>6</sub> heterostructures 221
- black carbon 39
- blue baby's syndrome 543
- Bois durci 655
- Boltzmann constant 425
- Bombyx mori* 791
- borax decahydrate 419
- boric acid 419

- boron 413, 421, 686  
 agglomerated 418  
 based fuel-rich propellant 422  
 based pyrotechnic composition 414  
 boron filament resistance 418  
 combustion 419  
 containing fuel 415  
 doped diamond 297  
 fuel 414, 421  
 minerals 419  
 nanoparticles 414, 419  
 oxidation 420  
 particles 413  
   burning 418  
   combustion process 415  
 powders 415, 420  
   amorphous 414, 418  
   removal rate 701  
 boron carbide 417, 420  
 boron oxide 419, 420  
   radiation emission 418  
 boron suboxide  $B_6O$  416, 417  
 boron trichloride 417  
 borothermic decomposition 416  
 bovine serum albumin (BSA) 605  
*Brassica juncea* 744  
*Brassica oleracea* 746  
 Britton–Robinson buffer 102  
 Brønsted acid 54  
 bromomalonates 606  
 Brownian effects 424, 427, 433  
 Brownian force 425, 427, 432  
 Brownian mechanisms 434  
 Brownian motion 422–425, 427, 430,  
   431, 433, 434, 767  
   induced force 723  
 Brownian velocities 427  
 Brunauer–Emmett–Teller (BET)  
   396  
 Buckminster fullerene 140  
 burning  
   behaviors 419  
   rate 420  
 butanol 307  
 butyllithium-functionalized  
   MWCNTs 606  
 butyl nitrite  $C_5H_9NO_2$  419  
 butyraldehyde 623
- c**
- cadmium 90, 92, 555  
 adsorption 90  
 detection limit 94, 527  
 ions 91, 92, 131  
 cadmium oxide ( $CdO$ ) 454  
 cadmium toxic metal 132  
 $Ca_2Fe_2O_5$  nanofibers 228  
 calcarosol 167  
 calcination 228, 229, 518  
   temperature 243  
 calibration curve 524  
*Candida albicans* 669  
 CaO NPs 96  
 capacitance 720, 777  
 capacitive deionization 136  
 capillary action 498  
 capillary electrophoresis (CE) 106  
 capping agents 333  
 carbaryl pesticides 103  
 carbon 417  
   particles 764  
   paste electrode 90  
   quantum dots 223  
   vapor aggregates 764  
 carbonaceous  
   adsorbents 138  
   fertilizer 154  
   materials 221  
   nanomaterials 300, 324  
 carbon aerogels 777  
 carbon atom structure 718  
 carbon-based fertilizers 154  
 carbon-based nanomaterials 298, 738  
   in environmental sector  
     potential applications 717  
 carbon-based nanoparticles 718  
 carbon dioxide ( $CO_2$ ) 39, 45, 72, 603,  
   655, 668  
 adsorption 323  
 capture technology 323  
 photocatalysts 267  
   reduction 256  
 carbon dot (CD) 154, 178  
 carbon fertilizers 165  
 carbonization 612  
 carbon monoxide ( $CO$ ) 39, 56, 446, 532  
   oxidation 42  
   catalysts 41

- carbon nanoadsorbents 74  
 carbon nanocones 739  
 carbon nanofiber (CNF) 93, 223, 739  
 carbon nanofragment (CNF) 104  
     based electrochemical analysis of organic molecules 104  
 carbon nanohorn 739  
 carbon nanomaterial (CNM) 125, 128, 716, 785, 825, 826  
     and composite 298  
     for environmental devices and techniques 717  
 carbon nanoonion 154  
 carbon nanoparticle (CNP) 103  
 carbon nanorods 154  
 carbon nanotechnology 155  
 carbon nanotube (CNT) 19, 74, 128, 223, 298, 324, 393, 400, 523, 531, 591, 722, 739, 764, 807  
     adsorption 619  
     based biosensors 718  
     based film 718  
     based metal matrix composite (CNT-MMC) 692  
     based nanomaterials 825  
     bilayers 456  
     CNT–NiCo oxide composite 106  
     composites 300  
     defunctionalized 607  
     dispersion 619  
     electrode 456  
     functionalization routes 604  
     for inorganic molecule analysis 90  
     network transistor 726  
     noncovalent functionalization of 326  
     paste electrode (CNTPE) 96  
     in removal of target pollutants 616  
     sensors 129, 456  
      $\text{TiO}_2$  composites 621  
 carbonyl chromophore 673  
 carcinogens 664  
     dyes 300  
 catalytic  
     degradation 686  
     oxidation 477  
     performance over  $\text{Ce}_{1-x}\text{Zr}_x\text{VO}_4$  catalysts 54  
     processes 39  
     technologies 39  
 catechol 101  
*Catharanthus roseus* 169  
 cation– $\pi$  bonding 137  
 cation-exchange capacity (CEC) 166  
 cation-exchange membrane 364  
 cationic–anionic force 135  
 cationic dendrimers 787  
 cationic dyes 131, 136  
 cationic ions 621  
 cation membrane 364  
 cavitation 770  
 cavities 806  
 $\text{C}_3\text{-C}_{60}\text{F}_{36}$  fluorofullerene 32  
 Cd(II), Co(II), and Pb(II) ions 133  
 $\text{Cd}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$  233  
 CdO nanostructures 455  
 CdS/BCF hybrid nanofibers 702  
 CdS/BC hybrid nanofibers, pathway for preparation 703  
 CdS nanoparticles 702  
 Ce doping 54  
 Ce-Fe-O solid solutions 45  
 cell-disruption mechanism of Ag-impregnated ZnO nanoparticles 305  
 cellulose 419, 667  
     membranes 587, 661  
     nanocrystals 582, 726  
     nanofibers 582, 590  
     nanofibril 582  
     nanomaterials 579, 582  
     nanoparticles 579, 584  
     nanowhiskers 582, 583  
     polymers 667  
 cellulose acetate (CA) 402, 668  
     silica composite-based membranes 812  
 cellulose-g-oxolane-2,5-dione, preparation of 588  
 cellulose-g-oxolane nanofibers 587  
 Ce-Mn-O solid solutions 45  
 Ce-M samples 48  
 Ce-NC sample 48  
     ZSM-5 sample 48  
 Ce-NR sample 48  
 centrifugation limit 299  
 $\text{CeO}_2\text{-Ag}$  catalyst 45  
 $\text{CeO}_2$  nanoflakes 307

- CeO<sub>2</sub>NPs 76  
 CeO<sub>2</sub>-TiO<sub>2</sub> composite 54  
 CeO<sub>2</sub> truncated nanocubes 47  
 CeO<sub>2</sub>-ZrO<sub>2</sub> (CZ) catalyst 45, 49  
 ceramics 316, 416  
     matrix nanocomposite 691  
     membranes 661  
 ceria-based catalysts 62  
 ceria NPs 76  
 ceria-zirconia-based catalyst 47  
 cerium-doped activated carbons 56  
 cerium-doped copper ferrite NPs  
     (CuFe<sub>2-x</sub>Ce<sub>x</sub>O<sub>4</sub>) 262  
 cetyltrimethylammonium salt 586  
 cetyltrimethylammonium bromide  
     (CTAB) 333, 551  
 Ce-Zr-O nanostructured catalyst 41  
 Ce<sub>0.9</sub>Zr<sub>0.1</sub>O<sub>2</sub>-NP catalyst 46  
 C<sub>60</sub>F<sub>36</sub> adsorbed molecules 35  
 C<sub>60</sub>F<sub>18</sub> fluorofullerene 27  
 C<sub>60</sub>F<sub>36</sub> fluorofullerene  
     molecules on Si(111)-7×7 surface 31  
 C<sub>60</sub>F<sub>18</sub> isomers 32  
 C<sub>60</sub>F<sub>18</sub> molecule 20–29, 31, 35  
     on Si(111)-7×7 surface  
         orientations 24  
 C<sub>60</sub>F<sub>36</sub> molecule 31–34  
 C<sub>60</sub>F<sub>42</sub> molecule 20  
 C<sub>60</sub>F<sub>44</sub> molecule 20  
 C<sub>60</sub>F<sub>48</sub> molecule 20  
 C<sub>60</sub>F<sub>36</sub> molecules 33  
 C-60 fullerenes 141  
 charcoal 134  
 charge  
     densities 27  
     exchange phenomena 481  
     membrane 355  
 cheese concentration 391  
 chelating adsorbent 133  
 chemical  
     bonding 717  
     complexation methods 374  
     composition 401  
     contaminants 543  
     enhancement 475, 476  
     exfoliation 457  
     functionalization 579  
     industry 39  
     inertness 303  
     interaction 30, 323  
     methods 544  
     modification 603, 671, 721  
     modified electrode (CME) 93  
     organic compounds 722  
     oxidation 698  
     oxygen demand (COD) 367, 650  
     pollutants 543, 544  
     precipitation 373  
     process 4  
         engineering 3  
     properties 825  
     reactions 727  
     reduction 544  
     routes/bottom-up approaches 767  
     sensing techniques 474  
     sensitivity 445  
     sensors 224, 720  
     stability 82, 155, 333, 663, 673  
     storage sites 543  
     structure, of widely used dyes and  
         absorption band maxima  
         ( $\lambda_{\text{max}}$ ) 260  
     transformation 738, 827  
     treatment 650  
     vapor deposition (CVD) 77, 128,  
         607, 662, 724, 740  
 Chemical Warfare Convention  
     (CWC) 557  
 chemiluminescence 523, 528  
 chemiosmotic cation 518  
 chemisorption 40, 132, 776  
 chemo-biosensing 473  
 chi-AgNPs as fluorophore 558  
 chiral 582  
     compounds 723  
     pharmaceuticals 723  
 chitin 663  
 chitosan (CS) 129, 135, 531, 626, 663,  
         666, 673, 779, 781  
 capped AgNPs (chit-AgNPs) 557  
 chitosan gelatin/GO monoliths  
     (CGGO) 626  
 chitosan–GO composites  
     (CSGO) 134, 627  
 chitosan–polyacrylamide  
     [Chi-PAA] 97  
 chitosan/sulphydryl-functionalized  
     GO (CS/GO-SH) 131

- chitosan-TiO<sub>2</sub> composite 666  
 epichlorohydrin 671  
 films 726  
 nanoparticles 298  
 vulnerability 666  
 chlорfenvinphos 531  
 chlorides 769  
 ions 391, 548  
 chlorinated hydrocarbons 670  
 chlorination 670  
 of lignin 670  
 chlorobenzene 615  
 chloroform sensors 108  
 chlorophenols 12, 104  
 2-chlorophenol 104  
 4-chlorophenol 307  
 chloroplasts 154, 176  
 chlorpyrifos 138  
 chromatography-based systems 445  
 chromium 93, 96, 267, 528, 553, 695  
 and chromium(VI) in water  
     samples 96  
 detection limit 94  
 in drinking 93  
 electrode 93  
 species 588  
 chromium(VI) 96  
 chromophores 728  
 C.I. Acid Red 73 665  
 C.I. Direct Blue 71 665  
 ciprofloxacin 199, 300  
 cisplatin 787  
 citric acid 229, 331  
*Citrobacter freundii* 812  
*Citrus limetta* 552  
*Citrus limon* 552  
 civilization 4  
 clean water 71  
 climate  
     change 414  
     warming 39  
 clove silver nanospheres (C-SNSs) 553  
 clustering of particles 422  
 CNM's functionalization methods 324  
     alkali activation 325  
     covalent functionalization 324  
     doping heteroatoms 325  
     grafting 325  
     sulfonation 325  
     surface oxidation 324  
     CO<sub>2</sub> adsorption 323  
     coagulation 369, 675  
     coalescence 724  
     CoAl-LDH flakes 610  
     coarsening 232  
     coating film 788  
     coating industry 788  
     cobalt-doped antimony oxide nanoparticle (CoSb<sub>2</sub>O<sub>6</sub> NP) 108  
     cobalt nanocrystals 81, 82  
     CO<sub>2</sub> capture technology 323  
     cocondensation method 333  
     codoping 243  
     CoFe<sub>2</sub>O<sub>4</sub>/CeO<sub>2</sub> nanocomposite 262  
     CoFe<sub>2</sub>O<sub>4</sub>/graphene 251  
         hybrid material 262  
     coking wastewater 372  
         treatment 372  
 cold vapor atomic absorption spectrometry (CVAAAS) 93  
 collagen protein 548  
 collisions 763, 767  
 colorimetric sensors 336, 551, 552  
 combine membrane separation technology 380  
 combustion 413, 414, 419  
     behavior 419  
     chamber 422  
     characteristics 421  
     mechanisms 418  
     models 421  
     propellant 415  
 commercialization 825, 826  
 communications 761  
 Co-Mn/TiO<sub>2</sub> catalyst 53  
 competing demands 293  
 competitive water treatment technology 12  
 complexed metal ions 94  
 complex hydrocarbon fuel 413  
 complex matrices 724  
 composite membrane materials 380  
 composition and structure analysis, GN and GS 197  
 concentric parabolic collector (CPC) 676  
 conductivity 30, 92, 534, 692, 777  
     conduction band (CB) 652

- conductometric transducer 527  
confocal scanning laser microscopy 155  
Congo red (CR) 137, 217  
contact angles, of GS0 aerogels and GS6 aerogels 196, 197  
contaminants 72, 127, 671, 686  
conventional colorimetric methods 524  
conventional Si-based photovoltaic devices 719  
cooler inert gas 763  
copper(II) detection limit 94  
copper interdigital electrode 534  
copper ions 133, 528  
coprecipitation 81, 82, 95, 232, 234  
method of synthesis 307, 534  
ferrite catalysts 234  
silver-based catalyst 233  
titanium-based catalysts 234  
zinc-based catalyst 233  
core–shell monomers 482  
core–shell nanostructure 225  
core–shell structure 244, 302  
PANI/Fe<sub>3</sub>O<sub>4</sub> nanoparticles 400  
core–shell ZnO/oxygen-doped g-C<sub>3</sub>N<sub>4</sub> nanocomposite 224, 225  
*Corynebacterium* sp. SH 09 809  
cosmetics 790  
nanocarriers 790  
cost optimization 722  
cost ratio limitation 774  
coupled semiconductors 244  
coupling agents 333, 671  
covalent bonding 300, 786  
covalent coupling 603  
covalent interaction 137  
CPE modifier, for electrochemical sensing of copper ions 93  
Cr<sup>3+</sup> doping 242  
Cr<sup>3+</sup> ions 553  
Cr<sub>2</sub>O<sub>3</sub> clusters 243  
crop/plant productivity 153, 155  
crotonic acid (CA) 94  
Cr oxide 242  
Cr-TiO<sub>2</sub> samples 242  
crude oil 39  
crystal lattice 45, 237  
crystalline cellulose 582  
crystalline solids 237  
crystallization 483  
promoting in gel media 592  
techniques 580  
crystal morphology and size distribution of MDC 369  
crystal structure 254  
sulfapyridine solvate 593  
crystal violet (CV) 131  
CS-glass system 667  
CS-SH-MWCNT nanocomposite film 92  
*Cucumis sativus* 746  
Cu<sup>2+</sup> detection 530  
CuFe/beta monolith catalyst 55  
Cu(II)–GO interactions 623  
Cu(II) ions 301  
Cu loadings 55  
culturing process 545  
Cunningham Correction Factor 425  
CuO/G hybrids 231  
CuO/graphene (CuO/G) 231  
hybrid composite 230  
CuO/graphene-oxide hybrid 230  
Cu<sub>2</sub>O nanocubes 301  
Cu<sub>2</sub>O NP-modified ZnO nanowires 533  
cupric ions 554  
cup-stacked carbon nanotube 154, 178  
current imaging tunneling spectroscopy (CITS) 32  
CuS doped with Ni ions 218  
Cu-TiO<sub>2</sub>/ZnO heterojunction nanocomposite 262  
*Cyamopsis tetragonoloba* 557  
cyanide (CN<sup>-</sup>) 557  
cyanotoxins 303  
cyclic microwave radiation 230  
cyclic voltammetry (CV) 102  
cycloaddition reactions 606  
β-cyclodextrin (β-CD) 336  
cyclohexane 615  
cysteamine (CA) 335  
cysteine 523  
cysteine-alanine-leucine-asparagine-asparagine pentapeptide 553  
cytotoxicity 191, 749, 787, 791

**d**

Danish Environmental Protection Agency Report 6  
*Daucus carota* 746  
 decolourization 559  
 decontamination 658  
   factor 374  
 degradation 219  
   organic dyes 220  
   paint pigments 238  
 degrouping 435  
 Degussa P25 nanoparticles 703  
 dendrimer 782  
   composite membranes 301  
   nanocarrier 787  
 dendritic encapsulation 806  
 dendritic nanopolymers 723  
   composites 723  
 DeNO<sub>x</sub>/HC oxidation catalysts 49  
 dense solid fuel 413  
 densities of state (DOS) 24, 25  
 density distribution 27  
 density of state 29  
 deodorants 591  
 deoxidization 230  
 deposition-precipitation (DP) 50  
 deprotonation 165, 204  
 dermatitis 664  
 desalination rate 367  
 desethyldeisopropyltriazine 401  
 desorption efficiency 202  
 detection limits of chromium(III) 96  
 detergents 650  
 detoxification 132  
 devices optimization 377  
 dextran 725  
 3D geometry of hot spots 482  
 β-D-gluopyranose 582  
 3D graphene systems (3DGNs) 130  
 3D hot spots 498, 500  
   concept 827  
   matrix  
     noble-metal sols 500  
     structure 498  
   plasma 827  
   structures 827  
   for SERS detection 500  
 3,4-diaminophenyl-functionalized dextran 129

diazonium cation 728  
 dicarboxylated cellulose (DCC) 582  
 2,3-dicarboxylic cellulose  
   nanofibrils 582  
 dicetyl phosphate (DCP) 102  
 2,6-dichlorobenzamide 401  
 1, 2-dichlorobenzene 105, 141,  
   615, 620  
 1,1-dichloro-2,2- bis-(4'-chlorophenyl)  
   ethane 98  
 dichlorocarbene 606  
 dichloromethane 109  
 dichlorophenol 303  
 dielectrophoresis (DEP) 723  
 [2 + 1], [4 + 2] Diels–Alder  
   cycloaddition of  
   *o*-quinodimethane 606  
 diesel oxidation catalyst (DOC) 39,  
   40  
 diesel particulate 45  
 diesel particulate filter (DPF) 39, 42  
   temperature 43  
 diethylenetriamine 397, 398  
 differential pulse anodic stripping  
   voltammetry (DPASV) 94  
 differential pulse voltammetry  
   (DPV) 93  
 differential scanning calorimetric  
   (DSC) 95  
 diffusion 763  
   flame 420  
   rate 371  
 digital images  
   graphite oxide 194  
   GS0, GS1, GS4, GS6, and GS8  
   hydrogels 194  
   protein 194  
 3,4-dihydroxy-L-phenylalanine  
   (L-DOPA) 549  
 di-iso-butyl phthalate 99  
 dimer 29, 482  
 dimer-adatom-stacking-fault (DAS) 22  
 dimercaptosuccinic acid (DMSA) 95  
 dimethylbenzene 138  
 dimethyl sulfone 129  
 3,5-dinitrosalicylic acid 402  
 diphenylcarbazide (DPC) 91  
 1,5-diphenylcarbazide  
   nanocomposite 93

- dipole-like formation 27  
 dipole moment 27  
 direct electrooxidation 297  
 direct functionalization (cocondensation and *in situ*) 318  
 disinfectant, ideal 298  
 disinfection 72  
     using nanomaterials 297  
 disinfection by-product (DBP) 674  
 dispersed phase on properties of  
     composites, influence of geometry 688  
 disruptive behavior 420  
 dissolved organic carbon (DOC) 674  
 dissolved organic matter 738  
 dithiodibenzothiophene (DDA) 93  
 divalent ions 391, 403  
 DNA biosensors 526  
 DNA-CNT linking strategies 614  
 DNA-CNT sensors 129  
 DNA coupling 614  
 DNA damage 749  
 DNA guide assembly scheme 495  
 3D nanostructured graphene-  
     polypyrrole (Ppy)  
     nanocomposite 135  
 DNazyme 554  
 dodecane-1,2-diol 81  
 dodecanethiol 333  
 domestic wastes 294  
 Donnan exclusion effect 332  
 doping 216, 304, 305, 609, 612, 739, 777  
     anatase, TiO<sub>2</sub> with N, S, and C 243  
     transition metals 224  
     ZnO (M/ZnO) nanostructures 224  
 dose-dependent toxicity 155  
 doxycycline 137, 300  
 D-penicillamine-AuNPs  
     (D-PC-AuNPs) 554  
 D-penicillamine-capped copper  
     nanoparticle (DPA-CuNP) 530  
 3D plasma nanoclusters, fabrication and  
     characterization of 499  
 drag-induced particle velocities 427  
 Drexler, Eric 762  
 drinking water 543  
 drop-coating process 766  
 drug delivery 549, 782  
     system 737, 739, 784  
 3D sepiolite 613  
 3D SERS hot spots 481  
 3D SERS substrate 501  
 3D sulfonated reduced GO (3D SRGO)  
     aerogel 131  
 dyes 128, 135, 686  
     contaminated waters 686  
 degradation 256  
 sensitized solar cell (DSSC) 238,  
     726, 774, 813  
     schematic representation 814  
 dimethylformamide 532, 533  
 dynamic light scattering (DLS) 550
- e**
- eco-friendly materials 698  
 ecotoxicity 9  
 π-π EDA interaction 615  
 ED process, schematic diagram of 365  
 EDS mapping for Ag-Au/Cu<sub>2</sub>O  
     nanocomposites 302  
 electrical conductance 130, 166, 718,  
     720, 726  
     CNT-FETs 718  
 electrical energy 777  
 electrical properties 826  
 electric field-enhanced simulation of  
     silver nanocubes 490  
 electric field gradient 723  
 electric field intensity 476  
 electric/microwave heating 43  
 electrochemical 544  
     capacitors 719  
     characterizations 531  
     detection  
         carbohydrates 106  
         devices 129  
 DNA-based biosensor 526  
 electrode 475  
 impedance spectroscopy (EIS) 523  
 impedance technique 523  
 measurements 531  
 methods 297, 369  
 modification 609  
 O<sub>3</sub> sensor 532  
 reactions 776  
 reduced graphene oxide (ERGO)  
     -Au nanoparticles (AuNPs)-  
     β-cyclodextrin (β-CD) 531

- sensor (ECS) 523, 526, 528, 529, 557, 558  
 based on CuNPs 523  
 synthesis 220  
 electrocoating paints 391  
 electroconductivity 523  
 electrode 764  
     insulation 528  
     potentiometric response 93  
     sensor 529  
 electrodeposition 740  
 electrodialysis 354, 364  
 electrogenerated chemiluminescence (ECL) 107  
 electrolysis 238  
 electrolyte  
     accessibility 720  
     gate efficiency of 718  
     ions 720  
     sensor 556  
 electromagnetic enhancement 475, 476  
 electron donor–acceptor (EDA)  
     interaction 615  
 electron–hole pair recombination 263  
 electron–hole recombination rate 654  
 electron–hole separation 249  
 electronic coupling 476  
 electronic detection techniques 720  
 electronic properties 130  
 electron microscopy 155  
 electron relays, for producing electricity 719  
 electrons 244  
     transfer mediator 528  
 electrooxidation 297  
 electroplating 553  
     wastewater 353  
 electropolymerization 531  
 electroreduction 523  
 electrospark deposition 789  
 electrospinning 73, 84, 316  
 electrospun nanofibers 74, 400  
 electrostatically stabilized  
     nanocrystalline cellulose 582  
 electrostatic forces 739  
 electrostatic interaction 82, 136, 137, 300, 591, 620  
 electrostatic repulsions 398  
     force 397  
 electrothermal atomic absorption spectrometry (ETAAS) 96  
 elementary boron 414  
 emission intensities 592  
 emulsified oils 391  
 emulsion 689  
     or suspension 333  
 encapsulation 773, 785  
 endocrine disrupting compound (EDC) 294, 300  
 endosulfan 138  
 energy 774  
     consumption 367, 726  
     density 420, 720  
     efficiency 790  
     solar economy 774  
 energy-conserving water  
     purification 71  
 energy dispersive X-ray analysis (EDX) 101  
 energy-level diagrams  
     molecule adsorbed on a metal surface 477  
     for undoped and N-doped TiO<sub>2</sub> 217  
 engine emissions 422  
 engineered nanomaterial 7  
 engineering nanoparticle (ENP) 737, 738, 747  
     common methods of 739  
         chemical precipitation 739  
         chemical vapor deposition 740  
         electrodeposition 740  
         gas condensation 739  
         sol-gel techniques 740  
     toxicity  
         environmental organisms 742  
         on humans, effect of 747  
         metal nanoparticles 743  
         on plants, effect of 745  
         polymeric nanoparticles 745  
 enhanced vascular permeability and retention (EPR) 783  
 enhancement factor (EF) 474, 476  
 enthalpy change 619  
 entropy change 619  
 environmental  
     contaminants 737  
     engineering 4, 15  
         applications 11

- environmental (*continued*)  
 science 11, 16  
 health, and safety (EHS) 731  
 pollutants 474  
 laboratory analysis and  
 detection 473  
 pollution 128, 257, 721  
 and SERS detection 478  
 problem 685  
 protection 15  
 remediation 721  
 potential methods for 295  
 reservoirs 721  
 safety 300  
 samples 581  
 stability 534  
 sustainability 4, 8, 15  
 techniques, functionalized  
 nanomaterials for 721
- Environmental Protection Agency  
 (EPA) 686
- environmental science 581, 721  
 communities 826
- environment today, status 7
- enzyme-linked immune sorbent assay  
 (ELISA) 473
- enzyme-TiO<sub>2</sub>/rGO nanocomposite for  
 removal of 4-nitrophenol,  
 synthesis route of 697
- epichlorohydrin 673, 674
- epoxidized natural rubber (ENR)  
 667
- epoxy-resins 673
- Escherichia coli* 300, 480, 527, 558,  
 588, 779, 808
- Es-PPy gas sensor 534
- ethanol 232, 457
- ethyl alcohol 237
- ethyl cellulose (EC) 784
- N*-ethyl-*N*-(3-dimethyl-aminopropyl)  
 carbodiimide hydrochloride  
 (EDC) 603
- ethylenediamine 585
- ethylenediaminetetra acetic acid  
 (EDTA) 103
- Euphorbia nivulia* 559
- European Commission Report 6
- Europium 335
- eutrophication 135, 664
- eutrophication 135, 664
- exfoliated graphite nanoplatelet  
 (xGnP)-chitosan cross-linked  
 composite 531
- exhaust-gas 43
- exhaust system 423
- exopolysaccharides 517
- external energy 293
- extractive membrane bioreactor 365
- f**
- fabricated bioinspired magnetic  
 nanocomposite 696
- fabricated polyacrylonitrile/CNT/  
 TiO<sub>2</sub>-NH<sub>2</sub> composite  
 nanofibers 300
- fabrication  
 of Al<sub>2</sub>O<sub>3</sub>/SiC nanocomposite, polymer  
 precursor route for 693
- of Au/Pt/Au core/shell  
 nanoraspberries,  
 morphological and structural  
 changes 484
- technique, of In<sub>2</sub>O<sub>3</sub> and its variation  
 on 451
- Faradic current 526
- feed concentration 363
- feed flux 364
- Fe(III) complexing ligand 2-(5-bromo-2-  
 pyridylazo)-5-  
 diethylaminophenol 529
- FeMgAl LDO flakes 613
- fenthion 558
- Fe<sub>2</sub>O<sub>3</sub>-Ba<sub>0.99</sub>Ce<sub>0.01</sub>TiO<sub>3</sub> sensor 534
- Fe<sub>3</sub>O<sub>4</sub>-based photocatalysts 252
- Fe<sub>3</sub>O<sub>4</sub>/BiOCl nanocomposite 252
- Fe<sub>2</sub>O<sub>3</sub>/Bi<sub>2</sub>S<sub>3</sub> nanorods 260
- Fe<sub>3</sub>O<sub>4</sub>-coated cenospheres deposited  
 with a film of TiO<sub>2</sub>  
 nanoparticles 253
- Fe<sub>3</sub>O<sub>4</sub>/γ-Fe<sub>2</sub>O<sub>3</sub> sensor 533
- Fe<sub>3</sub>O<sub>4</sub>-mixed oxide 81
- Fe<sub>3</sub>O<sub>4</sub> MNPs 94
- Fe<sub>3</sub>O<sub>4</sub> nanoparticles 698  
 binding of PPA on 334
- Fe<sup>3+</sup>/Al<sup>3+</sup> doping 243
- Fe<sub>3</sub>O<sub>4</sub>-supported noble metal  
 nanocomposites 703
- Fe oxidation 302

- Fe<sub>3</sub>O<sub>4</sub>/ZnO/NiWO<sub>4</sub>**  
nanocomposite 254
- Fermi energy ( $E_F$ ) 24, 25
- ferricyanide 528
- ferrite alloys 454
- ferrite materials 234
- ferrite synthesis 228
- ferritin 778
- ferrosol 167
- ferrous hydroxide suspension 81
- fertility 153
- fertilizers 127, 543
- Feynman, Richard 714, 762
- FGO/EP polymer nanocomposites 609
- fiberglass 661
- fibers diameter 722
- fibrous nanostructure 722
- field-effect transistor (FET) 129, 224, 718, 720
- field emission scanning electron microscopy (FE-SEM) 108, 526, 534
- images, of L.S. of root 177
- micrographs, of native bacterial cellulose 700
- field emitters 224
- filtration  
applications 722  
efficiency 43  
spectrum 392
- fireproofing 815
- flame atomic absorption spectrometric (FAAS) 90
- flocculation 354, 369, 724
- flotation 675
- flow conditions 430
- flower-like hierarchical BiOCl photocatalyst 257
- flow oscillations 428
- fluorescein isothiocyanate (FITC) 169
- fluorescence quenching 96, 528, 530
- fluorescence spectroscopy 523
- fluorescent metals 335
- fluorescent silica nanoparticle (FSNP) 745
- fluoride 132  
adsorption capacity 135  
ions 135
- fluorinated anatase TiO<sub>2</sub> 222
- fluorine removal, pilot-scale system 404
- fluorofullerene 19, 23, 31  
molecule 19, 23, 25, 26, 35
- fluorophore 558, 580  
entities 591
- fluorosis 543
- 5-fluorouracil 784
- Fokker–Planck equation 423
- food additives 560, 579
- food packaging 220, 780, 781
- food processing 780
- food safety 737
- formaldehyde 623, 650
- forward osmosis 359, 360
- fossil fuel 655
- foulants, and control capacities 406
- fouling 400, 404  
mechanism of 404  
resistance 393, 403
- Fourier transform infrared spectroscopy (FTIR) 94, 523, 550  
analysis of aerogel, before and after adsorption 204  
analysis of GS0 and GS6 205
- Francois gulliot* 555
- free energy 20, 239
- free-radicals 660
- free-standing biotemplate mesoporous hybrid film, fabrication of 585
- Freundlich and Langmuir models 133
- Freundlich equation, for 3D RGO hydrogel 132
- Freundlich isotherm 201  
model 131
- Freundlich model 131, 193, 194, 201
- F-R sample catalysts 50
- fuchsine 136
- fuel additives 414
- fuel ignition 413
- fullerene C60 19, 140, 154, 178, 299, 610, 718, 719, 738, 739, 790
- fullerene-like carbon nanoparticles 777
- functionalization of 140
- insoluble 180
- transforms 140
- fullerol 178

- functionalization  
of CNTs 605  
methods 321, 336, 608
- functionalized CNMs, applications  
of 327
- adsorbents, for removal of heavy  
metals and organics 329
- catalysts support 328
- membrane-based separation 331
- removal of metal ions, and organic  
contaminants 327
- sensing and monitoring 328
- functionalized grapheme sheet  
(FGS) 609
- functionalized graphene (G)  
nanomaterials, adsorption  
capacity 624
- functionalized graphene oxide  
(FGO) 609
- functionalized LDHs, preparation  
of 610
- functionalized nanomaterials 599, 721,  
826
- application in pollution  
abatement 613
- carbon nanotubes 613
- graphene 621
- in environmental remediation 600
- in pollution abatement, future  
perspective 629
- preparation of 602
- carbon nanotubes 602
- graphene and graphene oxide 607
- LDHs 609
- utilization of 600
- functionalized silica-based  
nanomaterial, applications  
of 322
- Fusarium solani* 307
- fusion 767
- peptide 551
- g**
- gallic acid 553
- gas chromatography (GC) 662
- gas condensation process 739
- gas diffusion 458
- gaseous pollutants, sources, and effect  
on environment 447
- gas generator 414
- gas-phase effluents 649
- gas sensing mechanism 458
- g-C<sub>3</sub>N<sub>4</sub>-based composites 256
- g-C<sub>3</sub>N<sub>4</sub>-based nanocomposites 259
- g-C<sub>3</sub>N<sub>4</sub> catalyst 255
- g-C<sub>3</sub>N<sub>4</sub>/Fe<sub>3</sub>O<sub>4</sub>/Ag/Ag<sub>2</sub>SO<sub>3</sub> plasmonic  
photocatalyst 263
- g-C<sub>3</sub>N<sub>4</sub>/Fe<sub>3</sub>O<sub>4</sub>/AgI/Ag<sub>2</sub>CrO<sub>4</sub>  
nanocomposite 263
- g-C<sub>3</sub>N<sub>4</sub>/Fe<sub>3</sub>O<sub>4</sub>/Ag<sub>3</sub>PO<sub>4</sub>/Co<sub>3</sub>O<sub>4</sub>  
nanocomposite 263
- Gd ions 218
- gelation 191
- gelling agent 229
- gels based, on NC 589
- gel-sol transition 554
- generalized gradient approximation  
(GGA) 22
- generation of electricity 737
- genotoxicity of MWCNTs 180
- Geobacter sulfurreducens* 809
- German Environment Agency  
Report 6
- German Federal Government report 7
- Gibbs energy change 619
- Gibbs free energy 238, 268
- glass transition 671
- glassy carbon electrode (GCE) 92, 455
- global energy consumption 719
- global warming 423
- global water crisis 10
- Gluconacetobacter xylinum* 698
- glucose 548
- glucose oxidase (GOx) 528
- glutathione (GSH) 554
- glycerol, dosage 232
- glycerol selective oxidation 249
- glycopyranosides 548
- GN/magnetite (Fe<sub>3</sub>O<sub>4</sub>) composite 137
- GNs/δ-MnO<sub>2</sub> composite  
(GNs/MnO<sub>2</sub>) 134
- GO-Al<sub>13</sub> composite 132
- GO/aluminum-zirconium polycation  
composites 622
- GO/chitosan materials 626
- GO cross-linked with ferric hydroxide  
(GO-Fe) 134
- GO/Cu-MOF composites 623

- GO diffraction 696  
 GO dispersion 194  
 GO films 131  
 GO foam, 3D binary images of 299  
 GO/GN nanocomposites 621  
 G4-OH(Pt<sub>40</sub>)/G4-OH(Pt<sub>60</sub>)/G4-OH-(Pd<sub>40</sub>), HRTEM images 83  
 gold cube nanoparticles 491  
 gold nanoclusters, high coordination number of 498  
 gold nanorods 135, 136  
 gold octahedron 491  
 nanoparticles 491  
 gold substrate 488  
 GO membranes 131  
 GO (RGO)-metal/metal oxide composites 627  
 GO/MnO<sub>2</sub> composites 622  
 GO nanosheets (GOS) 133, 230, 623  
 GO oxidation 622  
 GO/polyoxometalate nanocomposites 622  
 Gore-Tex® 523  
 GO-TiO<sub>2</sub> hybrid 134  
 GO/torlon composite membrane 132  
 grafting 320  
 polymers 333  
 grain morphology 239  
 grain-size distribution 414  
 granular activated carbon (GAC) 56  
 grapheme 128  
 graphene 19, 130, 135, 191, 195, 211, 298, 610, 739  
 based LaNiO<sub>3</sub> composite films 609  
 deposits 196  
 for improving sensing properties 459  
 materials 192  
 c-MWCNT composites 628  
 nanocomposites 300  
 based electrochemical analysis of organic compounds 104  
 nanoplanar 457  
 nanosheet 599  
 sensors 458  
 sheets 130, 196, 457, 718  
 synthesis method 457  
 graphene device transient gas-sensing characteristics of 458  
 graphene oxide (GO) 130, 132, 135, 136, 139, 196, 230, 299, 458, 529, 607, 610  
 Al<sub>13</sub> (GO-Al<sub>13</sub>) 132  
 coated adsorbent 131  
 composite 131  
 electrode 456  
 β-FeOOH composite 133  
 protonated C<sub>3</sub>N<sub>4</sub> composite 300  
 RGO-Fe<sub>3</sub>O<sub>4</sub> nanoparticles 137  
 titanate (RGO-Ti) hybrids 136  
 graphene-polypyrrole (Ppy) nanocomposite 629  
 graphene quantum dot (GQD) 221  
 graphene-soy protein (GS) aerogels 192  
 preparation of 192  
 graphite 420  
 oxide 192, 607  
 graphitic C<sub>3</sub>N<sub>4</sub> (g-C<sub>3</sub>N<sub>4</sub>) 255  
 graphitic oxide (GO/Cu-MOF) composites 140  
 graphitization 154  
 gravimetric energy densities 413  
 greases 650  
 green colorimetric sensor 554  
 greenhouse gas emissions 39, 828  
 green methods 544  
 green nanomaterial 583  
 green nanotechnology 552, 731, 805, 811, 828  
 applications 811  
 construction industry 815  
 metal nanoparticles 812  
 nanoclays 813  
 nanoenhanced green applications 815  
 nanofibers 811  
 nanomaterials, for water treatment 811  
 nanomembranes 812  
 principles and applications 806  
 prospects of 815  
 for renewable energy 813  
 dye-sensitized solar cells 813  
 fuel cell 814  
 hydrogen gas 814

- green nanotechnology (*continued*)  
     quantum dots 813  
     risk assessment 815  
 green polymers 658, 828  
 green purification technologies 590  
 green synthesis 548, 555, 826  
     methods 544  
     nanoparticles 556  
         future perspectives 559  
 grid electricity 719  
 Griess reaction 728  
 Griess reagent 728  
 Grignard reagents 606  
 groundwater 401  
     contamination 294  
     pollution 294, 555  
     remediation 11  
     resources 353  
 groups' drag-induced motion 435  
 growth of nanoparticles, *in situ* 333  
 growth-stimulating effects 154  
 Grätzel cell 774  
 GS0 and GS6, surface morphologies  
     of 192  
 GS preparation process 195
- h**
- HAADF-STEM, TEM image of 246  
 halloysite nanotubes 400  
 haloacetic acids 403  
 haloacetonitriles 403  
 halogenated aromatic  
     hydrocarbons 650  
 hardening agent 655  
 hazardous chemicals 154, 808  
 hazardous nanoparticles 585  
 hazardous substances 581  
 Hb/PCNA/MWCNT electrode 556  
 health hazards 558  
 heat loss 363  
 heavy metal 129–132, 650, 686  
     adsorption 300  
     ions 96, 128, 130, 133, 527, 528, 543,  
         555, 586, 700, 737, 826  
     adsorption of 322  
     photocatalyst for reduction of 267  
     pollutants 354  
 hemolysis 664  
 herbaceous metals 528  
     herbicides 589, 670, 686  
 heterogeneous catalysts 222  
 heterogeneous chemistry 414  
 heterogeneous magnetic  
     photocatalyst 250  
 heterogeneous photocatalysis 229, 259,  
     267, 652  
     adsorbents 667  
 heterogeneous photosystem 659  
 heterogeneous process 414  
 heterogeneous structure  
      $M_xBi_{2-x}Ti_2O_7$  218  
 heterostructured  $Fe_2O_3/Bi_2S_3$   
     nanorods 261  
 hetrostructure photocatalysis 215, 221  
 hexachlorocyclotriphosphazene  
     (HCTP) 609  
 hexadecyltrimethylammonium bromide  
     (CTAB) 768  
 hexadecyl trimethyl ammonium  
     chloride (HDTMA) modified  
     nanoclay 85  
 hexagonal mesoporous silica  
     (HMS) 324  
 hexagonal M-Zn-O nanorods 224  
 hexavalent chromium Cr(VI) 267  
 H<sub>2</sub> generation 257  
 Hg<sup>2+</sup>/Pb<sup>2+</sup>/Co<sup>3+</sup>/Zn<sup>2+</sup> metal ions 133,  
     552, 553, 555  
 high-density surface carboxylic  
     functionalization 154  
 high-energy ball milling 765  
 high energy irradiation 544  
 high-performance liquid  
     chromatography  
     (HPLC) 723, 724  
 high-salinity wastewater 367  
 histidine 548  
 HOBO products 414  
 HODRA-CORE membrane 402  
 homogeneous spherical NPs 81  
 HOMO–LUMO gap 27, 31, 33,  
     35  
 hot spot 482  
 human civilization 3, 13  
 human health 738, 827  
     care 473  
 humanity 127  
 human red blood cell 787

- human scientific endeavor 9, 13  
 human stem cells 481  
 humic acid (HAA) 137, 397, 676  
 humidity 445, 591  
 hybridization 300, 458
  - chain reaction (HCR) 529
  - erogels 136
  - membrane separation process 366
  - nanocomposite 703
  - nanomaterials 738, 739
  - nanostructures 258
  - of silica nanoparticles/poly(vinylidene fluoride) membranes 398
 hydrazine 106  
 hydrocarbons (HC) 39, 42, 413, 417, 543  
 hydrogels 192, 195, 196, 589, 591  
 hydrogen ( $H_2$ ) 719, 768
  - adsorption capacities 776
  - clean fuel 814
  - conversion 776
  - economy 775
  - generation 220, 249, 301
  - production 249, 775
  - sensing 534
  - separation 724
  - storage 776
 hydrogen bond 82, 129, 167, 199
  - interaction 137
 hydrogen peroxide ( $H_2O_2$ ) 225, 297, 301, 529, 652, 791  
 hydrogen sulfide ( $H_2S$ ) 140, 623  
 hydrophilicity 191, 192, 303, 582
  - protein 196
 hydrophobic 671
  - aerogels 589
  - interaction 137, 140, 739
  - membrane 533
  - polymer membrane 365
 hydroquinone 101  
 hydrothermal-electrochemical 221  
 hydrothermal impregnation
  - method 223
 hydrothermal methods 221, 222, 238, 518  
 hydrothermal-microwave method 221  
 hydrothermal-sol-gel 221  
 hydrothermal stability, of  $Cu_3Fe_3$ /beta 55  
 hydrothermal treatment 223, 225  
 hydrothermal-ultrasonic method 221  
 hydroxyapatite 701  
*N*-(2-hydroxybenzyl)-valine 555  
 hydroxyl ( $^{\bullet}OH$ ) radicals 303  
 hyper branched chitosan
  - nanoparticle 535
 hysteresis loops 253
- i*
- icosahedral symmetry 140  
 igniter formulations 416  
 ignition 419, 420
  - mixtures 415
 imaging capabilities 477  
 immobilization 249, 297
  - aspect 667
  - on MT-MWCNT composite 525
  - necessity for 658
  - photocatalyst, approaches used for 661
  - photocatalysts on supports 658
  - PM ALP nanobiocatalyst 527
  - support, features of 660
  - suspended phtotocatalyst reactor systems 659
  - TiO<sub>2</sub> 661
 immunochromatographic strip
  - testing 558
 incineration 651  
 indium(III)-tin(IV)-mixed oxide 81  
 indium oxide 533  
 industrial effluents 651  
 industrialization 127, 649, 686  
 industrial wastewater 353
  - membrane process 354
 inert gas 763  
 inert gas evaporation-condensation (IGC) 763
  - method, processing chamber of 764
 infrared spectroscopy 475  
 innovation 825, 828
  - membrane preparation technology 380
 inorganic
  - anions 135, 557
  - functionalization 327
  - industrial wastewater 367

- inorganic (*continued*)  
 materials 371  
 membranes 371  
 mercury 551  
 molecule analysis  
     application of NPs for 93  
     multiwalled carbon nanotubes  
         for 90  
 nanoparticles 828  
 pollutants 543, 697  
 solar cells 719  
 toxicants 543  
 wastewater 353, 367
- In<sub>4</sub>Sn<sub>3</sub>O<sub>12</sub> NPs and In<sub>4</sub>Sn<sub>3</sub>O<sub>12</sub>–TeO<sub>2</sub>  
 composite nanoparticles 534
- In<sub>4</sub>Sn<sub>3</sub>O<sub>12</sub>–TeO<sub>2</sub> composite-  
 nanoparticle sensor  
 selectivity 535
- In<sub>4</sub>Sn<sub>3</sub>O<sub>12</sub>–TeO<sub>2</sub> interface 535
- In<sub>4</sub>Sn<sub>3</sub>O<sub>12</sub>–TeO<sub>2</sub> nanocomposite  
 sensor 535
- insoluble nanocarbons 180
- integral environmental pollutants  
 concept 294
- π–π interactions 137, 138, 299, 300
- interfacial polymerization 398
- interfacial tension 767
- interinterception 358
- internal combustion engine 435
- International Atomic Energy  
 Agency 373
- International Union of Pure and  
 Applied Chemistry (IUPAC),  
 terminology for  
 biopolymers 656
- interparticle distance 430
- intrafiber porosity 722
- intraparticle diffusion model 129, 203
- intraparticle diffusion rate constant 194
- invasive fungal disease (IFD) 783
- ion exchange (IE) 373, 675, 687  
     mechanism 135  
     resins 651
- ionic conductivity 673
- ionic diffusion 391
- ionic liquid (IL) 92  
     photochemical synthesis 220  
     reduced graphene oxide  
         (IL-rGO) 529
- ionic strength 81, 133, 135, 138
- ion-imprinted polymers 723
- ionization 727
- Iresine herbstii* 559
- iron-based nanomaterials 722
- iron-based oxides 303
- iron–boron coating 416
- iron oxide (Fe<sub>3</sub>O<sub>4</sub>) 454, 619  
     magnetic NMs 813  
     nanoparticles 399
- irradiation 216, 651  
     absorption, enhancement of 216
- isocontours 26
- isopropanol 532, 533
- isoproturon 401
- isotherms, of GS0 198
- isovaleric acid 129
- IUPAC classification 720
- I–V technique 108
- k**
- kinetic curves 203
- kinetic energy 763
- kinetic parameters  
     intraparticle diffusion model on GS0  
         and GS6 203  
     of pseudo-first- and second-order  
         adsorption kinetic  
         models 203
- kinetics analyses, of pseudo-first-order  
 model 203
- Knudsen diffusion 362, 363
- l**
- lab-on-a-chip systems 727
- Lactobacillus* sp. A09 809
- lactose production 391
- Lactuca sativa* 746
- LaMnO<sub>3</sub>–graphene composites 609
- Langmuir adsorption capacity 619
- Langmuir and Freundlich models 100  
     of antibiotics on GS6, parameters  
         derived from 201
- pseudo-first-order model 129
- Langmuir–Hinshelwood model 667  
     dual-site mechanism 41
- Langmuir isotherm 137, 193, 194, 201  
     equation 96  
     model 135

- Langmuir model 194, 201, 203  
 Langmuir–Schaefer technique 533  
 $\text{LaNiO}_3$  nanoparticles 609  
 lanthanide doping 234  
     hybrid films 584  
 lanthanum oxide ( $\text{Ln}_2\text{O}_3$ ) 450  
 large unilamellar vesicle (LUV) 807  
 laser ablation 544, 766  
     experiments 767  
 laser-induced ablation 79  
 laser vaporization 81  
 lauryl sulfate (LS) 523, 524  
 layer-by-layer (LBL) 132  
     self-assembly method 610  
 layered double hydroxide (LDH) 233, 627  
     CNT nanocomposites 610  
     crystallites 611  
     dispersion 610  
     flakes 611  
     GO nanocomposites 611  
     graphene composites 611  
 layered double oxide (LDO) 610  
     MWCNT nanocomposites 612  
     SWCNT nanocomposites 612  
 lead 587  
     pollution 553  
 lead ( $\text{Pb}^{2+}$ ) ions 92, 526  
 lean  $\text{NO}_x$  trap (LNT) 40  
     catalyst 57, 58, 60, 62  
 LeAqp2 gene 171  
*Lemna gibba* 743  
 lethal effects 686  
 Lewis acid 54  
     sites 53  
 LiAl LDH films 611  
 Li-doped  $\text{PbTiO}_3$  perovskite 222  
 light-emitting diode (LED) 807  
 light-off temperature of HC, CO, NO,  
     and  $\text{NO}_2$  50  
 lignosulfonate-modified graphene  
     hydrogel (LS-GH) 132  
 $\text{LiI}\cdot 2\text{H}_2\text{O}$  233  
 Li-ion-based batteries 776  
 Linear alkylbenzene sulfonate 304  
 lipid-based amphiphatic  
     membranes 545  
 lipid bilayers, multilamellar  
     vesicles 807  
 lipid-drug conjugate 784  
 liposomal amphotericin B 783  
 liposomes 783, 790, 806  
 liquid entry pressure (LEP) 363  
 liquid–liquid extraction 670  
 liquid–liquid interfaces 475  
 liquid-phase deposition (LPD) 106  
 liquid phase effluents 649  
 liquid-phase exfoliation 135  
 lithium 419  
     ion batteries 19  
 lithography 544, 805  
 $\text{Ln}^{3+}\text{--TiO}_2$  catalysts 234  
 local density of state (LDOS) 32  
 localized surface plasmon resonance  
     (LSPR) 335, 523  
     excited by spherical particles 476  
 lowest limit of detection (LOD) 551  
 lowest unoccupied molecular orbital  
     (LUMO) 140  
 low-surface energy materials 724  
*Lycopersicon esculentum* 558  
 lyophilization 299
- m**
- macromolecules 391  
     proteins 195  
 macroscopic quantum tunneling  
     effect 721  
 maghemite NPs ( $\text{Fe}_2\text{O}_3$ ) applications,  
     for analysis of inorganic  
     molecules 95  
 magnesium 417, 420  
 magnetically responsive bioinspired  
     nanocomposite 694  
 magnetically separable  $\text{MnFe}_2\text{O}_4$ /  
     graphene  
     heteroarchitectures 251  
 magnetic BiOX-based  
     photocatalysts 256  
 magnetic chitosan 137  
 magnetic Co $\text{Fe}_2\text{O}_4$ -functionalized  
     graphene sheet (Co $\text{Fe}_2\text{O}_4$ –  
     GNs) nanocomposites 628  
 magnetic composites 722  
 magnetic core–shell nanoparticles 481  
 magnetic elements 725  
 magnetic  $\text{Fe}_3\text{O}_4$ /graphene composite  
     (FGC) 137

- magnetic  $\text{Fe}_3\text{O}_4/\text{ZnO}/\text{NiWO}_4$   
nanocomposites 253
- magnetic graphene  
nanocomposite 135
- magnetic hybrid photocatalysts 250  
binary heterostructures 250  
ternary heterostructures 252
- magnetic nanoadsorbents 725
- magnetic nanomaterials 480, 694  
for environment 724
- magnetic nanoparticles 79, 81, 454,  
480, 725, 779, 785, 813  
applications, for analysis of inorganic  
molecules 97
- magnetic nanostructured  
materials 481
- magnetic Ni nanoparticles 138
- magnetic photocatalysts 254  
magnetic photocatalyst  $\text{Fe}_3\text{O}_4/\text{BiOCl}$   
nanocomposite 252
- magnetic poly(vinylpyridine)-coated  
carbon nanotubes 630
- magnetic recovery stages 725
- magnetic separation 299
- magnetic sputtering 77
- magnetite 695  
 $\text{Fe}_3\text{O}_4/\text{GO}$  composite (M/GO) 134  
 $\text{Fe}_3\text{O}_4/\text{reduced graphene oxide}$   
nanocomposites 137
- magnetite–GO (M–RGO)  
hybrids 627
- magnetite-graphene hybrids  
(M-RGO) 134
- magnetite-graphene-LDH composite  
material (MGL) 134
- nanocubes 694
- nanoparticles 95, 699  
NPs ( $\text{Fe}_3\text{O}_4$ ) applications, for analysis  
of inorganic molecules 94
- magneto-responsive composites 667
- magnetosome 694
- magnetostatic spin wave (MSW) 533
- magnetotactic bacteria 694, 695
- magnonic sensor arrays based on  
MNPs 533
- maintenance cost 392
- maize tassel-multiwalled carbon  
nanotube  
(MT-MWCNT) 525
- malachite green (MG) 135, 300, 628
- malathione 138, 532, 558
- maleic anhydride (MA) 131
- malodor nuisance 445
- malonate 523
- manganese 728
- manganese ion ( $\text{Mn}^{2+}$ ) 530
- manufacturing routes, cost-effective and  
highly efficient 826
- mass transfer 362, 371
- material efficiency 826
- material selection, for sensor  
applications 448
- mathematical model 424
- maximum adsorption capacities  
ciprofloxacin 202  
tetracycline 202
- maximum adsorption efficiency 135
- M/Ba/Al catalysts 61
- MB over BiOBr/NiFe<sub>2</sub>O<sub>4</sub> composite,  
photocatalytic degradation  
mechanism 261
- 4-MBT molecules 489
- MCM-41 nanoparticles, incorporation  
of 399
- MCM-41-silica nanoparticles 399
- MD different configurations 361
- MD permeate flux, influence of different  
factors on 364
- MD process  
for high salty wastewater 368  
schematic diagram of 361
- mechanical grinding 417
- Meisenheimer complex 556
- melt compounding 333
- melting point 221
- membrane 391  
aeration bioreactor 365  
assisted radioactive wastewater 374  
based separation technology, relevant  
application framework of 379
- bioreactor 365
- characteristic 355
- cleaning 378
- commercial, and specifications 394
- device 381
- distillation 14, 354, 360, 373  
advantages of 14, 361
- filtration, history of 392

- flux 366  
 materials 355, 366  
 and membrane processes 316  
 modification 377  
 modules 356, 366  
 advantages, disadvantages, and applications of 357  
 operated, using pressure as main parameter 395  
 porosity 362  
 principle of 354  
 processes 356, 371, 374, 395  
 properties 371  
 research 354  
 separation 354  
 interception mechanism of 358  
 processes 14  
 technology 316, 826  
 thickness 363
- membrane distillation crystallization (MDC) 368  
 process for high salty wastewater 368
- membrane fouling 367, 375  
 control 377  
 mechanism of modes 376  
 types of 405  
 inorganic fouling 405  
 microbial fouling 405  
 organic fouling 405  
 particulate fouling 405  
 prevention of fouling 406
- membrane-integrated system  
 to remove As (III) and As (V) from groundwaters 401
- membrane separation technologies  
 interception size distribution, 357
- MeNPs–semiconductor hybrid heterostructures 245
- MeNPs–ZnO ( $\text{TiO}_2$ ) heterostructures 245
- Mentha piperita* 810
- mercury (Hg) 131, 132, 528, 551  
 mercury (II) ion 92, 528, 529, 552  
 chemical accumulation of 92  
 electrochemical determination of 92  
 ( $\text{Hg}^{2+}$ ) contamination 526
- mercury-specific oligonucleotide (MSO) 526
- MeS-based composites 268
- mesoporosity 461, 720
- mesoporous carbon (MC) 103, 324
- mesoporous metal oxides 775
- mesoporous silicas 323  
 nanoparticle 786, 791
- mesoporous  $\text{TiO}_2$  527
- mesoporous ZnO nanofiber 811
- metal alkoxides ( $\text{Si(OR)}_4$ ) 740, 769
- metal and metal compound, functionalization and applications 332
- metal-based nanoparticles  
 for electrochemical analysis of organic molecules 105  
 for spectroscopy analysis of organic molecules 108
- metal-ceramic matrix nanocomposite (MMNC) 692
- metal detection, colorimetric sensor for 523
- metal-exchanged zeolite SCR catalysts (CuZ and FeZ) 54
- metal ions 95, 221, 229, 302, 336, 518, 523, 524, 528, 545, 546, 548, 552, 555, 698  
 biochemical reduction 546  
 concentration 94  
 main mechanisms for sorption of 586  
 removal, experimental procedure 587  
 selectivity 552  
 sensors 551
- metal–metal nanoparticle (Fe-Ti) 74
- metal nanoparticle (MNP) 79, 301, 545, 580, 591, 723, 768, 791  
 encapsulated 83
- metal organic framework (MOF) 105, 139, 140, 307, 622
- metal oxide 135, 221, 303, 323, 391, 448, 666, 721, 725, 738, 739, 768  
 applications, for analysis of inorganic molecules 96
- bionanomaterials 522  
 ions 518

- metal oxide (*continued*)  
 loaded graphene hybrid  
     architecture 458  
 modified composites 622  
 nanomaterials 461  
 nanoparticles 74, 303, 305, 393, 781,  
     791  
 metals 211  
     based nanomaterials 738  
     bionanomaterials 520  
     classical approaches 544  
     containing phosphate 307  
     matrix 691  
     nanocrystals 483  
     nanoparticles 580, 591  
     nanostructures 482, 483  
     nuclei 767  
     particles 546  
     salts 136  
 metals and metal compounds,  
     functionalized, applications  
     of 334  
 adsorption 334  
 photocatalysis 335  
 sensing and monitoring 335  
 metal toxicity mechanism 748  
     microbial cells 748  
         genotoxicity 749  
         membrane damage 749  
         nutrient uptake interference 749  
         production of ROS and antioxidant  
             depletion 749  
             protein dysfunction 748  
     other cells 749  
 metering pump 381  
 methemoglobinemia 153, 543, 556,  
     664  
 methidathione 558  
 L-methionine 301  
 3-(4-methoxybenzylideneamino)-2-  
     thioxothiazolidin-4-one 90  
 4-methylbenzenethiol 489  
 methyl blue 222  
 2-methyl-4, 6-dinitrophenol 402  
 methylene blue 128, 129, 135, 136,  
     223, 259, 306, 323, 526, 559,  
     628, 668, 669  
 methylene violet 136  
 methylmercury 551  
 methyl orange 218, 262, 619, 666, 702  
     degradation of 245, 703  
 methyl parathion 558  
 methyl violet 136, 628  
 Me-TiO<sub>2</sub> hybrid photocatalysts 249  
 MgAl LDH/mesoporous carbon  
     nanocomposites 612  
 MgAl LDO/mesoporous carbon  
     nanocomposites 612  
 Mg-Al mixed oxide-supported  
     catalysts 59  
 Mg/Al ratio 59  
 Mg<sup>2+</sup> ions 619  
 MgO nanoparticles 747  
 micelles 518, 767  
 Michaelis–Menten behavior 527  
 Michalis–Menten constant 531  
 microbial 391  
     biomass 651  
     communities 165  
     degradation 698  
     methods 810  
 microcrystalline cellulose (MCC) 583  
     defibrillation procedures of 583  
 microcystin 100  
 microelectromechanical system 336  
 microemulsion 767, 768  
     method 768  
     system 768  
     technique 85  
 microfiltration 354, 358, 373, 391, 392  
 microfluidic devices 727  
 microfluidic pH analysis 727  
 microorganisms 366, 548, 808  
 micropollutants 372  
 microporous carbons 324  
 microporous ceramic filters 44  
 microporous membranes 355, 365  
 microwave-assisted hydrothermal  
     process 223  
 microwave-assisted polyol method 333  
 microwave-assisted thermal  
     decomposition (MATD)  
     device 231  
 microwave irradiation (MWI) 230, 701  
 microwave method 229, 230  
     graphene-based materials 229  
     titanium-based materials 231  
     zinc-based materials 231

- Milli-Q 728  
mineralization 223, 303, 666  
MINTEQ modeling program 619  
mixed oxide NPs 81  
Mn<sup>2+</sup> detection 530  
Mn<sup>2+</sup> ions 553, 555  
MnO<sub>2</sub>-immobilized SiO<sub>2</sub>  
  nanofibrous 306  
Mn oxides 55  
MNP-based adsorption technology 725  
modified Hummers' method 192  
moisture content 194, 790  
  of hydrogels 196  
molar ratio of Ag<sup>+</sup>/Cd<sup>+2</sup> 233  
molecular beam epitaxy 77  
molecular detection 474  
molecular diffusion equation 362  
molecular dynamics (MD) 620  
molecular size 371  
molecule–substrate interaction 35  
monoliths 661  
mononitrogen oxides 446  
monosaccharide ( $\beta$ -D-glucose) 548  
monovalent ions 393  
montmorillonite 613  
*Morinda tinctorial* 559  
multidrug-resistant 737  
multifunctional materials 293  
multifunctional reactants 551  
multijunction solar cells 719  
multiple-networked nanoparticle  
  sensor 535  
multistage reverse osmosis 373  
multivalent cations 827  
multivalent ions 392  
multiwalled carbon nanotube  
  (MWCNT) 56, 74, 138, 154,  
  169, 300, 523, 531, 599, 603,  
  619, 720, 764, 807  
coupled to SPE, for organic molecule  
  analysis by  
  gas chromatography 100  
  liquid chromatography 98  
G hybrid aerogel 628  
for inorganic molecule analysis  
  coupled with SPE methodology,  
  spectroscopic applications  
  of 90  
electrochemical applications 91  
supplied with watering, effect on  
  phenotype of tomato  
  plants 173  
TiO<sub>2</sub> heterojunction  
  photocatalysts 232  
mutation 553
- n**
- NaCl desorption 92  
NADH-quinone oxidoreductase 749  
N<sub>2</sub> adsorption 198  
  desorption isotherms of GS0, GS1,  
  GS4, and GS8 198  
Na ions 216  
Na-montmorillonite 94  
Na-montmorillonite nanoparticles  
  (nano-SW<sub>y</sub>-2) 93  
nanoadsorbents 74  
  carbon nanoadsorbents 74  
  metal nanoadsorbent 75  
nanoadsorption 316  
nanobarcodes 781  
nanobiocomposites 726  
nanobioelectronics 726  
nanobiohybrid materials 726  
nanocapsules 780  
nanocarbons 154, 155  
  in agricultural plants 153  
  interactions 154  
  on plant growth 169  
  negative effects of 179  
  positive effects of 156, 169  
  toxic effects of 162  
  in plants and soil 170  
nanocatalysts 40, 297  
nanocellulose (NC) 579, 582, 827  
  based sorptive microextraction,  
  formats of 584  
contaminated waters 584  
direct air capture/gas  
  permeation 590  
industrial effluents 584  
biodegradability of 583  
filter for H<sub>2</sub> gas permeation 590  
nanocellulosic platforms 580  
as sensor  
  of contaminants 591  
nanocellulosic 591

- nanochain light scattering  
     properties 488  
 nanoclays 74, 84, 781  
 nanoclusters 806  
 nanocoatings 789  
     advantages of 790  
 nanocomposites 306, 393, 685, 687,  
     702  
     based on reinforcing agents,  
         classification of 688  
     dosage 701  
     fabrication, bioinspired synthesis  
         route for 693  
     of metal oxyhalides 307  
 nanocontaminants 580  
 nanocrystal decoration 458  
 nanocrystalline cellulose 582  
 nanocrystalline LaFeO<sub>3</sub> 258  
 nanocrystalline semiconductors 244  
 nanocrystalline solid solutions 45  
 nanocrystallinity 239  
 nanocrystals 82, 583, 806  
     solar cells 775  
 nanocuboid WO<sub>3</sub> 306  
 nanodevices 825  
 nanodiamonds 299, 739  
 nanodimensions 689  
 nanodisinfectants 298  
 nanodumbbell  
     AFM map for Raman studies 487  
     structure formed by different silver  
         shell thickness, ultraviolet  
         spectra 487  
 nanoelectronic devices 726  
 nanoengineering 713  
 nanostructural materials 581  
 nanofabrication 686  
 nanofibers 74, 83, 228, 299, 316, 776  
     application, for analysis of inorganic  
         molecules 97  
     based membranes 722  
 nanofibres 781  
 nanofibrillar cellulose 582  
 nanofibrils 582, 591  
 nanofibrous media 722  
 nanofibrous membranes 811  
 nanofillers 689  
 nanofiltration (NF) 316, 332, 354, 358,  
     373, 391–393  
     for coking wastewater  
         treatment 372  
     coupled to low-pressure ultraviolet  
         photolysis 403  
     flux rate 370  
     membranes 74, 391, 393, 722  
         characterization of 396  
         fabrication and modification  
             of 396  
     for radioactive wastewater  
         treatment 374  
     RO membranes 401  
     separation mechanisms in 395  
     treatment process 374  
 nanoflakes 222  
 nanoflowers 224  
 nanofullerene 141  
 nanogap 482  
 nano-lab on a chip for  
     environment 727  
 nanolaminates 782  
 nanolevel 294  
 nanoliquid chromatography 723  
 nanomaterial–functional groups  
     bonding types 319  
     functionalization by covalent bond  
         (chemisorption process) 320  
     functionalization by noncovalent  
         bond (physisorption  
         process) 319  
 nanomaterials 3, 128, 211, 293, 306,  
     448, 477, 528, 581, 721, 738,  
     805, 826, 827  
     acted as analytical tool 580  
 and applications 7  
     for analysis of organic compounds  
         in wastewaters 98  
     recent scientific research pursuit  
         in 8  
 based environmental  
     techniques 316, 318  
 based techniques and devices 825  
 carbon nanotubes 807  
 classification of 806  
 dendrimers 806  
 fullerenes 807  
 functionalization methods 317  
 for improving the water holding  
     capacity of soil 772

- incorporation 398  
 for increasing productivity 771  
 for inorganic compound analysis 85  
 liposomes 806  
 membranes 826  
 methods of preparation 762  
   bottom-up approaches 763  
   top-down approaches 763  
 nanoparticles, synthesis of 807  
 in pesticides 773  
 photocatalysis applications 220  
 for plant growth 772  
 quantum dots (QD) 807  
 research and development, future trends 15  
 as sensors 773  
 structure and surface modification of 449  
 technological vision and scientific objective in field of application of 8  
 used for environmental techniques, limitations of 317  
 nanomaterials, functionally active 294, 295  
 for remediation of environmental pollutants 298  
 nanomembranes 722, 826  
   fabrication of 400  
   purification of water 812  
 nanomesh formation 458  
 nanometer circuit 483  
 nanoobjects 581  
 nanoparticles (NPs) 9, 40, 234, 332, 333, 498, 517, 550, 768, 791, 806, 827  
   aggregation 493  
   applied in photocatalytic procedures 212  
   based on solid lipids 784  
   biosynthesis 545  
     by biomolecules 548  
     by microorganisms 546  
     by plants 546  
   characterization techniques 550  
   conventional approach for production 807  
   bottom-up 808  
   top-down 808  
   dispersions 714  
   distribution, based on composition 738  
   carbon-based nanomaterials 738  
   hybrid nanomaterials 739  
   metal-based nanomaterials 738  
   functionalization of 332  
   grouping of 427  
   nanocomposite-based sensors, for detection of gases 534  
   preparation, using microemulsion techniques 768  
   for remediation 778  
   as sensors and detectors 779  
   synthesis 808  
   methodologies 809  
   from plant extracts 547  
   and specific function of microorganism 549  
   using bacteria 808  
   using fungi 809  
   using plant extract 810, 811  
   toxicity based on physicochemical properties 741  
   agglomeration status 742  
   morphology 742  
   size 741  
   surface area 741  
   surface electrostatic status 742  
   for water disinfection 778  
   for water purification 779  
 nanophotocatalysis 316  
 nanopolymer spheres 82  
 nanopowders 806  
 nanoribbons 232  
 nanoscale  
   intersections 482  
   membrane 371  
   technology 714  
 nanoscience 3, 477, 713  
   and nanotechnology, recent scientific endeavor in field of 6  
 nanosensing 317  
 nanosensor technology 445, 447, 461, 774, 779, 815  
   properties of 461  
 nanoseparation devices 826  
   for environment 723  
 nanosheets 224, 232

- nanosilver (nano-Ag) 298  
 nanosized magnetites 303  
 nanosized metals 301  
     oxides 303  
 nanosized silica particles (SNPs) 787  
 nanosized TiO<sub>2</sub> 303  
 nanosomes 790  
 nanostructured ceria-zirconia catalysts  
     Ce<sub>x</sub>Zr<sub>1-x</sub>O<sub>2</sub>-NP 46  
 nanostructured coatings 714  
 nanostructured La-Li-Cr perovskite  
     catalysts 44  
 nanostructured lipid carrier 784  
 nanostructured materials 738  
 nanostructured Pt catalyst 44  
 nanostructure TiO<sub>2</sub> nanoparticles  
     SEM image of 76  
 nanosuspensions 419  
 nanotechnology 3, 5, 72, 73, 130, 393,  
     685, 721, 761, 805  
     in agriculture, potential  
         applications 772  
     applications, avenues ahead in  
         field 10  
     cognizance in field of 4  
     continuous revolution in 825  
     enables cost-effective water  
         purification processes 293  
     green and sustainable vision 730  
     for green innovation 828  
     historical perspective 762  
     in paints and coatings,  
         advancement 789  
     products, based on manufacturing  
         methods and research 714  
     scientific vision in field 4  
     for sustainable future, application  
         of 771  
             agriculture 771  
     term defined 713  
     toxicity, economy, and legalization  
         of 729  
     vision and advancements in 5  
         vision for future, frontiers 5  
 nano-TiO<sub>2</sub> photocatalyst 262  
 nanotubes 224, 765  
 nanowires 224, 232, 488, 493, 607  
 NaOH solution 234  
 naphthalene (NAPH) 138, 141  
 1,5-naphthalene disulfonate  
     dianion 612  
 1-naphthalenesulfonic acid 137  
 1-naphthol 620  
 2-naphthol 138  
 1-naphthylamine 620  
 2-naphtol thylamine 664  
 $\alpha$ -naphthylamine 728  
 National Nanotechnology Initiative  
     Workshop 6  
 National Sanitation Foundation  
     Standards 589  
 natural organic matter (NOM) 14,  
     662  
     fractions and chemical groups 675  
     removal of 674  
 natural polymers 191, 654, 655, 663  
 natural products 650  
 N-cholyl-L-valine (NaValC) 555  
 near-infrared fluorescence  
     quenching 130  
 next-generation sensors 298  
 NH<sub>3</sub> decomposition 249  
 NH<sub>2</sub>-NH<sub>2</sub> coupling 249  
 NH<sub>3</sub>-SCR performance 56  
 NiAl LDH/CNT nanocomposites  
     611  
 Ni<sup>2+</sup> and Co<sup>2+</sup> ions 555  
 nickel(II) detection limit 94  
 NiFe<sub>2</sub>O<sub>4</sub>/graphene 251  
 Ni(II) metal ion 134  
 NiO/CeO<sub>2</sub> catalysts 50  
 nitrates 71, 523, 543, 556  
 nitrenes 606  
 nitric acid 94, 105  
 nitric oxide 56, 446  
 nitrite analysis 728  
 nitrite ions 523, 556  
 nitroaromatic compounds 703  
 nitroaromatic pesticides 402  
 nitrogen 367, 415  
 nitrogen dioxide (NO<sub>2</sub>) 446  
 nitrogen-doped graphene quantum dots  
     (NGQDs)-BiOI/  
         MnNb<sub>2</sub>O<sub>6</sub> 300  
 nitrogen oxides (NO<sub>x</sub>) 39, 54  
     reduction 238  
 nitrogen sulfur oxygen 371  
 4-nitrophenol 696, 703, 705

- m*-nitrophenol (*m*-NP) 103  
*o*-nitrophenol (*o*-NP) 103  
*p*-nitro phenol 301, 402  
 4-nitrophenyl phosphate disodium salt hexahydrate 402  
*N,N*-dicyclohexyl carbodiimide (DCC) 603  
*N,N*-dimethyl formamide 808  
 $\text{N}_2/\text{N}_2\text{O}$  ratio 55  
 $\text{NO}_2$ -based soot oxidation 43  
 noble metal-based catalysts 62  
 noble metal nanoparticles (MeNPs) 245  
 noble metals 44, 45, 301  
 $\text{NO-C}_3\text{H}_6$  reactions 53  
 $\text{NO}$  conversions 55  
 NO-CO reactions 52  
 to  $\text{NO}_2$  measured under lean conditions 61  
 $\text{NO}$  decomposition 49  
 noncovalent polymer functional interactions 726  
 nonenzyme  $\text{TiO}_2/\text{rGO}$  nanocomposite 696  
 nongrouping 423  
 nonimmobilized magnetotactic bacteria 696  
 nonlinear optical applications 482  
 nonlinear optics 483  
 nonmetal doping 221  
 nonofiber 84  
 nonpathogenicity 546  
 nonpetroleum-based materials 579  
 nonpolymer-based nanocomposites 691  
 nontoxicity 253  
 nontraditional environmental engineering techniques 11  
 nonylphenol (NP) 104  
 $\text{NO}$  oxidation 41, 58, 59, 62  
 catalysis 43  
 $\text{NO}$  reduction 41  
 normal hydrogen electrode (NHE) 256  
 novel nanomaterials 825  
 novel separation processes, future trends and scientific doctrine of 13  
 $\text{NO}_x$  adsorption capacity 58  
 over supported Pt-Ba catalysts, reaction pathways for 58  
 $\text{NO}_x$  and  $\text{NH}_3$  conversions temperature dependence of 58  
 $\text{NO}_x$  conversion 58  
 of Cu-ZSM-5 and Cu-IM-5 zeolites with 55  
 during nonthermal plasma-assisted lean/rich cycling 61  
 profiles for Cu-SSZ-13, Cu-beta, and Cu-ZSM-5 57  
 $\text{N}$ -oxide azo (azoxy) 664  
 $\text{NO}_x$  reduction efficiency 53, 62  
 $\text{NO}_x$  storage 59  
 performance 59  
 reduction catalysis 60  
 in typical  $\text{Pt/BaO/Al}_2\text{O}_3$  catalyst 57  
 $\text{NO}_x$  trap catalysts 59  
 $\text{NO}_x$  uptakes as temperature function 60  
 NP-modified ZnO NWs 533  
 N/S/C Co-doped  $\text{TiO}_2$  nanomaterials, phase transition studies of 243  
 n-type metal oxides 458  
 nuclear magnetic resonance (NMR) 477  
 nuclear power 413  
 nucleation 220, 232, 239, 517, 518, 545, 550, 592  
 process 517  
 rate 234  
 nucleic acids 553  
 nucleophilic addition 609  
 nutrients 154  
 retention 154  
 rich organic matter 153  
 nylon6 nanofibers 84  
 nZVI surface 302  
 $\text{NaBH}_4$  system 302
- O**  
 ochratoxin A 558  
 octadecylammonium salt 592  
 oil components 371  
 oil-water separation 724  
 oleic acid 81, 333

- oleylamine (OAm) 333  
 oligonucleotides 614  
 on-wire lithography (OWL)  
     method 486  
     for fabrication of nanostructured  
         Ni 488  
 operation parameter optimization 378  
 optical fibers 661, 728  
 optical photograph  
     N<sub>2</sub> adsorption and pore size  
         distribution 198  
 optical sensors 129  
 optoelectronic devices 19  
 orange G (OG) 136, 628  
 orange II 323  
 organic compounds  
     adsorption of 323  
     decontamination 580  
 organic contaminants 663, 664, 826  
 organic dyes 128, 131, 524, 664  
 organic fertilizers 153  
     carbon-based fertilizers 154  
     as “biochar” 155  
 organic fluorescence 96  
 organic groups, incorporation of 333  
 organic-inorganic hybrid materials  
     307  
 organic-inorganic  
     nanocomposites 333  
 organic LED (OLED) 814  
 organic materials 19  
 organic mercury 551  
 organic molecules 141  
 organic pollutants 297, 543, 621, 651,  
     698, 721, 722  
 organic pollution 71  
 organic polymers 82, 528  
 organic solvents 580, 592  
 organic toxicants 141, 543  
 organogels 589, 592  
 organomercury compounds 551  
 organophosphates 557  
     pesticides 557, 558  
     and phosphonates (OPPs)  
         compounds 557  
         pesticides 557  
 organophosphorus pesticide 531  
 orthorhombic phase Bi<sub>5</sub>O<sub>7</sub>I spherical  
     microstructures 240  
     phase transition studies of 240  
*Oryza sativa* L. 744  
 oscillation flow  
     particle behavior 434  
 oscillations 422, 423  
     flow clustering of particles 422  
     oscillatory grouping 422, 423  
 O<sub>3</sub> sensor 533  
 osmium dioxide nanoparticles 400  
 osmolality 783  
 Oswald ripening 233  
 oxidants 652  
 oxidation 582, 603  
     of aromatic compounds 238  
     catalyst 43  
     of nanomaterials 721  
         advanced process, scientific  
             doctrine, of 11  
     reduction mechanism 545  
 oxidative degradation 661  
 oxidative etching 603  
 oxidative roasting 416  
 oxide particles 660  
 oxidizer 413  
 oxidizing agents 403, 660  
 oxygen 413  
     acetylene flame 418  
     doped g-C<sub>3</sub>N<sub>4</sub> NPs 225  
     vacancy 54  
 oxygen storage capacity (OSC) 49  
 oxytetracycline 300  
 ozone 532  
     radicals 652  
 ozonolysis 603
- p**
- paclitaxel 784  
 paint 788  
 palladium-graphene  
     nanocomposite 104  
 paraoxon 531  
 parathion 531  
 Parkinson’s syndrome 553  
*Parthenium hysterophorus* 810  
 particle agglomeration 484  
 particle conversion 421  
 particle diameter 426  
 particle-fluid mechanical  
     interactions 661

- particle morphologies, electron micrographs 76
- particle–particle interactions 661
- particle-retaining MF 392
- particles grouping, in oscillating flow 423
- particle sizes 221, 239, 417–420, 422, 424, 426, 427, 498, 651, 763
- particle trajectories 427
- particle velocity 426, 429
- particulate matter (PM) 39, 40
- PB-functionalized graphene (PB-G) 609
- particulate organic carbon (POC) 674
- particulates 138
- air pollution 39
  - Pb(II) ions 132
  - Pb<sup>2+</sup> ions 553–555, 700
  - Pb<sup>2+</sup> removal capacity 700
  - PdAu-based nanocomposites 703
  - Pd/CeO<sub>2</sub>–ZrO<sub>2</sub>Cr catalyst 49
  - Pd/CeO<sub>2</sub>–ZrO<sub>2</sub>Ni catalyst 49
  - Pd/Ce<sub>0.68</sub>Zr<sub>0.32</sub>O<sub>2</sub> catalysts 49
  - Pd–graphene nanocomposite 104
  - Pechini’s sol-gel method modified 62
  - PEGylation 788
  - Penaeus merguiensis* 527
  - Penicillium fellutanum* 810
  - pentaethyleneglycole dodecyl ether 768
  - peptide-AuNP probes 551
  - peptides 548
  - perchlorate 629, 723
  - permeation flux 363
  - peroxides ( $\bullet\text{O}_2^{2-}$ ) 303
  - personal care products 686
  - pesticides 554, 557, 686, 722, 737
    - determination 530  - pesticide transformation product (PTP) 401
  - petroleum-based bioplastics 656
  - petroleum ether 237
  - pharmaceutical contaminants 737
  - pharmaceutical drugs degradation, photocatalyst for 263
  - pharmaceutical industries 392
  - Phaseolus radiates* 744
  - Phaseolus vulgaris* 559
  - phase transformations 239, 417
  - phase transitions 237, 418
    - anatase to rutile transformation 239
    - from BiOI to Bi<sub>5</sub>O<sub>7</sub>I 241
    - morphological effects 239
    - in TiO<sub>2</sub>, reaction boundaries of 240
    - titania phases, formation and analysis of 238  - phenanthrene 556
  - phenol 615, 620
    - compounds 300, 303, 670
    - removal of 669
    - degradation 249, 297
    - impurities 103  - phenosafranine 323
  - phenotypes of gram seeds (fruits), after harvesting 179
  - m-phenylenediamine 397
  - phonon resonant 198
  - phosphates 71, 135, 307, 728
  - phosphonates 557, 791
  - phosphoric acid 582
  - phosphorus-doped Si(100) wafers 28
  - phosphorylated NC dispersions 586
  - photoactive guest moieties 323
  - photocarriers 705
  - photocatalysis 219, 220, 303, 659, 661, 673, 698, 702
    - activity 219
    - material 216
    - mechanism 212
    - radiation applied in 216
    - on titanium dioxide 221
    - in wastewater treatment 652  - photocatalyst 211, 219, 245, 265, 307, 323, 333, 659–661, 668, 674
    - activity 667
    - for dye degradation 259
    - materials 216
    - P25 702
    - particles 659
    - photocatalytic ability, for degradation of RhB 222
    - photocatalytic activity 108, 223, 229, 249, 254, 255, 257, 269, 307, 609, 661, 698
    - of Ag-decorated Fe<sub>3</sub>O<sub>4</sub>/TiO<sub>2</sub>-coated cenospheres 253
    - of Ag NPs 218
    - of BiOX 256

- photocatalyst (*continued*)  
 converting CO<sub>2</sub> with CO, CH<sub>3</sub>OH,  
 and CH<sub>4</sub> 268  
 photocatalytic applications 231  
 using nanoparticles 214  
 photocatalytic degradation  
   mechanism of rhodamine B 264  
   of pollutants 221  
   of tetracycline 266  
 photocatalytic efficiency 216, 228,  
 256, 297, 303  
 photocatalytic materials 225  
 copper-based materials 236  
 microstructure of 237  
 solvothermal synthesis of 235  
 synthesis of 220  
 titania-based catalyst 237  
 photocatalytic mineralization 698  
 photocatalytic nano-TiO<sub>2</sub> 298  
 photocatalytic performance, of ZnO/  
   oxygen-doped g-C<sub>3</sub>N<sub>4</sub>  
   NPs 225  
 photocatalytic procedure, factors  
   affecting 219  
 photocatalytic process 663  
 photocatalytic reactors 660  
 photocatalytic reduction 268, 301  
   of CO<sub>2</sub> with H<sub>2</sub>O on Ag<sub>3</sub>PO<sub>4</sub>/g-  
     C<sub>3</sub>N<sub>4</sub> composite 269  
 photocatalytic self cleaning  
   effect 220  
 photocatalytics process 213  
 photocatalytic systems 658  
 powders 658  
 system 674  
   for water decomposition 257  
 photochemical reactor systems 660  
 photocorrosion 653  
 photodecomposition 249  
 photodegradation 103, 557, 698, 706  
   adsorption process 666  
   of dye 304  
   efficiency 246  
   performance 230  
   of rGO–Ag nanocomposite for  
     RhB 230  
   of RhB dye 247  
 photoelectric effect 774  
 photoelectrochemical cells 775  
 photoelectrochemical technology 297  
 photoelectro–Fenton (PEF) 106  
 photoinduced molecular  
   transformations 652  
 photo-Kolbe oxidations, of organic  
   acids 238  
 photoluminescence 154, 216, 256, 673,  
 674  
 photooxidation 304, 666  
   degradation 666, 668, 674  
   tests 233  
 photoreaction 228  
 photoreactors  
   design of 660  
   system 660  
 photosensitive bioinspired  
   nanocomposite  
   materials 696  
 photostability 653  
 photovoltaic cells 719, 726  
 photovoltaic effect 719  
 photovoltaic (PV) technology 774, 775  
 physicochemical properties 293  
 physicochemical remediation 778  
 physicochemical techniques 651  
 physisorption technique 132, 776  
 phytomedicine 178  
 piperazidine 397, 398  
*Piper betle* 557  
 plant growth 154  
 plant nanobionics 154  
 plasma coupling, between adjacent  
   nanoparticles 482  
 plasma etching 488  
 plasma resonance 476  
 plasma vaporization 81  
 plasmonic enhanced photocatalysis 218  
 plasmonic materials, for Raman  
   enhancement 481  
 plasmon resonance 488  
 plasticizers 543, 671  
 plastics 788  
 platelets 785  
 platinum group metal (PGM) 58  
 platinum hollow nanoparticle chain  
   (Pt-HNPC) 107  
*Platynereis dumerilii* 745  
*Plectonema boryanum* 808  
*Pleurotus sajor caju* 559

- p*-nitrophenol, 3,5-dinitrosalicylic acid 402
- Poiseuille flow 362, 363
- poisoning diagnosis 473
- polar contaminants 615
- polarity 724
- polarization 27
- light excitation 491
- pollutants 12, 127, 294, 298, 300, 353, 366, 372, 543, 551, 554, 583, 615, 623, 661, 676, 685, 698, 721, 724
- removal 249
  - sorbent interaction 651
- pollution 130, 353, 528, 721
- control 103, 127
- polyacrylic acid 497
- polyacrylonitrile 779
- poly(allylamine) 323
- polyamide 398
- thin-film composite 402
- poly(amido amide) (PAMAM) 787
- dendrimers 788
- poly(amido amine) 333
- polyamidine thin-film composite
- membranes 401
- polyaniline (PANI) 609
- nanoparticles 399
- polyaromatic hydrocarbon (PAH) 556, 650
- poly(arylene disulphide) 609
- polybenzimidazole membranes 399
- polybrominated biphenyls 650
- polycaprolactone 668
- polychlorinated biphenyls 303, 650
- polycondensation 740
- polycyclic aromatic amines 664
- polycyclic aromatic hydrocarbon (PAH) 141, 300, 371, 372, 620
- poly(diallyldimethylammonium chloride) (PDDA) 103
- poly(4-(2,5-di(thiophen-2-yl)-1H-pyrrol-1-yl)benzenamine) (poly(SNS-NH<sub>2</sub>) 531
- polyelectrolyte multilayer (PEM) 527
- polyester-based nanocomposite
- nanofiltration
  - membranes 398
- polyester-based thin-film composite
- membranes 397
- polyetherimide/amino-functionalized silica nanocomposite
- membrane 398
- polyethersulfone membranes 331, 397–399
- polyethylene columns 587
- polyethylene glycol 725, 784
- polyethylene glycol-phosphatidylethanolamine 784
- polyethyleneimine-functionalized CNTs 129
- Poly(ethylene oxide)-based SPEs 776
- polyethylene sheets 661
- polyethylenimine 323, 399
- polyglutamic acid 551
- polyglycolide (PGA) 784
- PGA-capped AuNPs 551
- Polygonum multiflorum* 791
- polyhydroxyfullerol 178
- polylactide 83
- polymer electrolyte membrane fuel cell (PEMFC) 776
- fuel cells 776
- polymer-grafted inorganic NPs 333
- polymeric materials 661
- polymeric membranes 392, 393, 724
- polymeric nanoparticles 784
- polymeric photovoltaic cells 719
- polymerization 603, 739
- interfacial 397
  - reactions 806
- polymerization, *in situ* 333
- polymers 225, 316, 777
- based nanocomposites 688
  - ball milling process 691
  - for decontamination of
    - pollutants 692  - direct compounding
    - synthesis 689  - in situ* fabrication technique 689
  - in situ* synthesis process 690
- based nanomaterials 83
- clay nanocomposites, prepared via
- both *in situ* and ex situ
  - syntheses 691
- coating 326

- polymers (*continued*)  
 in functionalization 319  
 grafting 319  
 nanoadsorbents 82  
 nanomaterial hybrids 320  
 nanotechnology 726  
 nanoparticles, conjugated 74  
 supported nanocomposites  
   environmental applications 722  
 templates 694  
 polymethyl methacrylate  
   (PMMA) 609, 728  
 poly[N-(2-hydroxypropyl)  
   methacrylamide]  
   (PHPMA) 603  
 polypeptide secondary structure upon  
   binding 130  
 polypyrrole 534  
 polypyrrole-reduced graphene oxide  
   composite (PPy-RGO) 627  
 polysaccharides 548, 663, 666, 671  
   biopolymers 665  
 polystyrene (PS) 108  
   film 141  
 poly(4-styrenesulfonate) 611  
 polystyrene/TiO<sub>2</sub>NWs  
   nanocomposites 108  
 polysulfone 398  
 polytetrafluoroethylene (PTFE) 232, 420  
   membrane 363  
 polythene (PE) 662  
 polythymine 526  
 poly(venylsulfonate) anions 612  
 poly(vinyl alcohol) (PVA) 267, 333,  
   370, 606, 779  
   MWCNT composite 129  
 polyvinylchloride 93  
 poly(vinylidene fluoride) (PVDF)  
   membrane 363, 370  
 polyvinyl pyrrolidone (PVP) 228  
   poly(*N*-vinyl-2-pyrrolidone) 333  
 pore size 371, 396, 401, 455, 720, 722  
   distribution 228, 363  
 porins 531  
 porosity 622  
 porous alumina-based ceramic  
   membranes 724  
 porous Bi<sub>5</sub>O<sub>7</sub>I microspheres 240  
 porous GO/chitosan materials (PGOC)  
   materials 133  
 portability 721  
 postsynthetic functionalization  
   (grafting) 318  
 postsynthetic grafting 321  
 potable water 391, 393, 543, 722  
 potassium 419  
   modified ceria-zirconia catalyst 46  
 powders 413  
   activated carbon 100  
   synthesis route, conventional 693  
 power conversion efficiency 719  
 p–p interactions 621  
 PPy nanoparticles 534  
 precipitation 79, 81, 82, 366  
   crystalline TiO<sub>2</sub> 238  
 precision 445  
   filter 381  
 predicted environmental  
   concentration 10  
 pressure-driven membrane  
   process 358, 371, 374, 391,  
   392  
 prion proteins 554  
 pristine CdS particles 702  
 pristine Cu<sub>2</sub>O nanocubes/Ag-Au/Cu<sub>2</sub>O  
   nanocomposites  
   TEM and HRTEM images of 302  
 pristine Cu<sub>2</sub>O nanocubes and Ag-Au/  
   Cu<sub>2</sub>O nanocomposites  
   SEM images of 302  
 problem-solving capacities 293  
 process efficiency 724  
 prometryn 401  
 propellant samples 419  
 propylene 51  
 protein-coated GO sheets 195  
 protein-mediated nanocomposite 701,  
   702  
   protein-mediated bioinspired  
    nanocomposites (PMN) 701  
 proteins 518  
 proton antitransporters 518  
 protonation 165  
   deprotonating transition 204  
   deprotonation reactions 204  
 protoplasts  
   *C. Roseus* uptake of MWCNT-  
   FITC 170

- pseudo-first-order model 202  
 kinetic model 194  
*Pseudomonas stutzeri* 808  
 pseudo-second-order model 129, 132,  
 133, 135, 203  
*Psidium guajava* Linn 231  
 Pt catalyst 44  
 CO and HC oxidation on 41  
 Pt-decorated DPF samples 44  
 Pt/K/Al<sub>2</sub>O<sub>3</sub> catalysts 60  
 Pt nanoparticles 41  
 p-toluenesulfonic acid 137  
 Pt particle size 44  
 Pt-V diesel oxidation catalysts 41  
 p-type of graphene oxide 461  
 Pt-ZnO hybrid nanocomposites 247,  
 249  
 Pt-ZnO hybrid photocatalysts 247, 249  
 publicly owned municipal treatment  
 work (POTW) 650  
 pyrene 556  
 1-pyrenebutanoic acid 605  
 1-(2-pyridilazo)-2-naphthol 96  
 pyrocatechol 528  
 pyrolysis 155, 178, 416, 668  
 pyrotechnical industry 414
- q**  
 quantum dot (QD) 298, 299, 323, 738  
 photovoltaic applications 814  
 QD-based LEDs (QDLEDs) 814  
 QD-based solar cells (QDSCs) 814  
 quantum size effects 40  
 quartz 661  
 crystal microbalance  
 measurements 92  
 substrate 527  
 quasi-fiber ZnO 306  
 quaternary oxide photocatalysts 258
- r**  
 radiation absorbance 216  
 radioactive elements 373, 737  
 radioactive ions 586  
 radioactive wastewater 373  
 treatment 374  
 Raman detection  
 on gold core–shell nanoparticles  
 coated with Pt and Si 486  
 Raman enhancement 481, 499  
 Raman instrument 477  
 Raman scattering 475, 476  
 Raman signal 476  
 Raman spectra 474, 827  
 of enzyme-TiO<sub>2</sub>/rGO and control-  
 TiO<sub>2</sub>/rGO  
 nanocomposites 697  
 for multiple WO<sub>3</sub> structures 456  
 resonance 197  
 spectrometer 499  
 spectroscopic techniques 95, 550,  
 591  
 Ramjet engines 414  
 rapid detection 528  
 reactants' fractional conversion, on  
 LaCo<sub>0.5</sub>Cu<sub>0.5</sub>O<sub>3</sub> with 51,  
 52  
 reactive oxygen species (ROS) 298,  
 741, 749  
 reactive red 4 (RR4) 667  
 dye 667  
 reactor 661  
 real-time monitoring 473  
 recalcitrant organic pollutants 650  
 recent scientific research pursuits, in  
 membrane science 13  
 recovery times 336  
 recyclable boron burning 413  
 recyclable nanophotocatalysts 262  
 recycle boron 413  
 redox potentials 254  
 reduced graphene oxide (RGO) 229,  
 299, 628  
 Ag/TiO<sub>2</sub> nanotubes/Ti plates with  
 high photocatalytic  
 activity 249  
 rGO membrane 332  
 refractory organic pollutants 650  
 renewability 191  
 renewable energies 726  
 sources 719  
 renewable raw materials 649  
 renewable resources 656  
 based bioplastics 656  
 based biopolymers 658  
 resilient polymer wastes 655  
 resorcinol 102  
 retinyl acetate (RA) 784

- reverse osmosis (RO) 14, 83, 354, 359, 360, 391, 687  
 inorganic membranes 371  
 membrane 392  
 module 367, 391  
 pretreatment equipment 367  
 process for salinity wastewater 367  
 Reynolds number 424  
*Rhizopus oryzae* 810  
 rhodamine B (RhB) 101, 136, 254, 262, 300, 323, 591, 628  
 degradation 263  
 dye 216, 218, 695  
 photocatalytic degradation of 245  
 photodegradation 257  
 rhodamine B hydrazide (RBH) 523, 529  
 rhodium-containing catalysts 52  
*Rhodopseudomonas capsulate* 809  
 riboflavin-stabilized silver nanoparticles (R/AgNPs) 524  
*Ricinus communis* 558  
 RNA-GO nanosheets 138  
*Rosa indica-wichuriana* 555  
 rose bengal 222
- S**
- Saccharomyces cerevisiae* 695  
 salinity 368  
*Salmonella typlus* 808  
 salt intrusion 294  
 sample sizes 580, 720, 721  
 sanitation 71  
 scanning electron microscope (SEM) 84, 155, 396, 495, 523, 550  
 scanning tunneling microscope (STM) 20, 762  
 scientific thoughts and scientific progress, future flow 15  
 screen-printed carbon electrode (SPCE) 528  
 screen-printed carbon platinized electrode (SPCPtE) 528  
 screen-printed electrode (SPE) 102  
 screen-printing process 766  
 seawater  
   detection of other chemicals in 728  
   nitrate analysis 728  
   nitrite analysis 728
- sedimentation 369, 373  
 selective catalytic reduction (SCR) 53  
   activities 53, 54  
   catalyst 53  
   system 40  
   technology 53  
 selectivities 557, 722  
   colorimetric sensing 555  
 selenium (Se) nanoparticles 519  
 selenium particle (SeP) 529  
 self-assembled nanoparticle chains 490  
 semiconductors 211, 244, 254, 658, 762, 774  
   for heterogeneous photocatalysis 244  
 heterojunctions 256  
 heterostructures 244  
 hybrid 245  
 mediated photocatalytic decomposition, of organic contaminants 653  
 nanocomposites 244  
 oxide 477  
 photocatalysts 653  
 photosensitization of 218  
 quantum dots 591  
 surface, generalized possible reactions occurring 653  
 Se nanoparticles 519  
 sensing ability 552  
 sensing/monitoring methods 298  
   in petroleum industries 446  
 sensors 722  
   for gases 532  
   for heavy metals 525  
   for pesticides 530  
 Se oxyions 519  
 sequestration 153  
 sericin anionic nanoparticles 791  
 sewage 353  
*Shewanella oneidensis* MR-1 703  
 Shockley-Queissar limit 719  
 Si adatoms 24  
 Si atoms 27  
 Si-based semiconductor systems 19  
 Si-based solar cells 726  
 Si—C interaction 25  
 Si-F compound 20  
 silanes 333

- silica-based materials 323  
 silica-based nanomaterials 321  
     functionalization and  
         applications 320  
 silica gel 661  
 silica materials 786  
 silica nanoparticles 398, 740  
 silicate 728  
 silicone rubber membrane 365  
 silicon oxide ( $\text{SiO}_2$ ) nanorods 519  
 silt pollution index 368  
 silver-based photocatalysts 222  
 silver-based semiconductors 307  
 silver nanoparticles ( $\text{AgNPs}$ ) 393, 398,  
     535, 545, 791  
     assembled nanospheres 483  
     dimers' hot spot 489  
 silver orthophosphate ( $\text{Ag}_3\text{PO}_4$ ) 254  
 silver (I) oxide 222  
 silver-PEGylated dendrimer  
     nanocomposite  
     membrane 301  
 silver-PEGylated polyethylene  
     glycol 301  
 silver sol 498  
 silylation process 324  
 single  $\text{C}_{60}\text{F}_{18}$  molecule  
     STM images of 22  
 single-junction inorganic (Si) solar  
     cell 719  
 single-walled carbon nanotube  
     (SWCNT) 74, 174, 300, 523,  
     599, 603, 606, 720, 785  
     for inorganic molecule analysis,  
         electrochemical applications  
         of 93  
 peptide-functionalized sensor 130  
 spectroscopic applications, for  
     analysis of organic  
     molecules 104  
 single-walled nanotube (SWNT) 718,  
     807  
     oxidized 718  
 $\text{SiO}_2/\text{gold}$  nanoparticles 493  
 Si substrate 533  
 Si surface 27, 35  
 $\text{Si}(111)\text{-}7 \times 7$  surface  $\text{C}_3\text{-C}_{60}\text{F}_{36}$   
     fluorofullerene molecules 33  
 small unilamellar vesicle (SUV) 807  
     smart packaging 781  
 smoke particles 423  
 Smoluchowski's equation 433  
 $\text{SnO}_2$  NP-modified nitrogen-doped  
     RGO ( $\text{SnO}_2/\text{N-RGO}$ ) 533  
 $\text{SnS}_2/\text{CPVA}$  nanocomposite 267  
 sodium 391, 419  
 sodium azide 415  
 sodium borohydride 135  
 sodium dodecylbenzene sulfonate  
     (SDBS) 91  
 sodium dodecyl sulfate 402  
     functionalized graphene oxide 131  
 sodium hydrosulfite 136  
 sodium nitrate 415  
 sodium silicate ( $\text{Na}_2\text{SiO}_3$ ) 740  
 soil carbon 154  
 soil contaminations 153  
 soil erosion 294  
 soil pH 154  
 soil structure 154  
*Solanum lycopersicum* 746  
 solar cells 293  
     applications 220  
     based on quantum dots (QD solar  
         cells) 719  
 solar energy 660, 698, 775  
     for Cr(VI) 243  
     for hydrogen production 775  
     induced evaporation 81  
     in photovoltaic technology 774  
     utilization 323  
 solar light irradiation 263, 658  
 solar-thermal systems 774  
 sol-gel-assisted electrospinning 225  
 sol-gel hydrothermal  
     electrospinning 225  
 sol-gel method 225, 234, 692, 740,  
     768  
     steps involved in sol-gel 768  
         aging 769  
         casting 769  
         densification 769  
         drying 769  
         gelation 769  
         mixing 769  
         of synthesis 226, 768  
 solid fibers 584  
 solid fuel 419

- solid lipid nanoparticles 784, 790, 791  
 solid–liquid separation 366  
 solid phase effluents 649  
 solid-phase extraction (SPE) 481, 584,  
     723  
 solid polymer electrolyte (SPE) 776  
 solid propellants 413  
     rocket 414  
 solid-state pyrolysis 77  
 solvothermal synthesis 235, 769  
     chemical factors 769  
     thermodynamical factors 770  
 sonication 79, 221  
 sonoelectrochemistry 770  
 sonolysis 651  
 soot catalyst conditions 47  
 soot conversion 47  
 sorbent materials 725  
 sorbents 722  
 sorption 675  
     capacity for Cu(II) 141  
     efficiency of PMN, and conventional  
         nanocomposites 702  
 soybeans 191  
     products as food 191  
 soy protein 191, 192, 194  
 specific chromophoric reagents 524  
 specific surface area (SSA) 191  
     GS0, GS1, GS4, and GS8 199  
 spherical Ag colloidal superstructures  
     self-assembly of Ag NPs 497  
 spherical Fe<sub>3</sub>O<sub>4</sub>/BC  
     nanocomposites 700  
*Spinacia oleraceae* L. 175  
 spinel cobalt (II) oxide (Co<sub>3</sub>O<sub>4</sub>) 454  
 spinels (AB<sub>2</sub>O<sub>4</sub>) metal oxides 534  
 square wave anodic stripping  
     voltammetry (SWASV) 90,  
     96, 526  
     nanoceria plant nanobionics 176  
 square wave voltammetry (SWV) 90,  
     523  
 stable grouping 423  
 $\pi$ – $\pi$  stacking 609  
 stainless steel 661  
*Staphylococcus aureus* 779  
*Staphylococcus currens* 808  
 Star-shaped ZnO/Ag hybrid  
     nanostructures 248  
 steric exclusion 333  
 sterilization 392  
 Stokes relaxation time 425  
 Stone–Wales (or 7-5-5-7) defect  
     on CNT sidewall 602  
*Streptococcus thermophilus* 517  
 structure-specific magnetic  
     nanocrystals 694  
 4-styrenesulfonate anion-intercalated  
     MgAl LDH 611  
 succinimidyl ester 605  
 sulfanilic acid 728  
 sulfapyridine solvate 592  
 sulfasalazine 218  
 sulfate 42  
 sulfide (S<sup>2-</sup>) 557  
 sulfonated nanocellulose,  
     preparation 588  
 sulfonated NC dispersions 587  
 sulfonation 332  
 sulfonic acid 587  
 sulfonylurea 99  
 sunlight irradiation 256  
 sun protection factor (SPF) 791  
 supercapacitors 719, 720, 777  
 supercritical CO<sub>2</sub> and TiO<sub>2</sub>  
     nanoparticles into polymeric  
         host, direct  
         impregnation 690  
 superhydrophobic sponges, with  
     oleophilic properties 589  
 superoxide anion radical (O<sub>2</sub>•-)  
     45, 530, 548  
 superoxide anions ( $\bullet$ O<sub>2</sub><sup>-</sup>) 303  
 superparamagnetic composite 132  
     GO-Fe<sub>3</sub>O<sub>4</sub> 137  
 superparamagnetism 599  
 superwetting materials 724  
 supramolecular techniques 140  
 surface copolymerization 480  
 surface-enhanced Raman scattering  
     (SERS) 218, 474, 477, 480,  
     826  
 detection 480  
     of environmental pollutants 479  
 hot spot 482  
     structures, development trend  
         of 483  
 surface interception 358

- surface modification 480, 722, 827  
 surface plasmon model 483  
 surface plasmon resonance (SPR) 223, 245, 476, 550, 599  
 effect 218  
 surface relaxation 40  
 surface thermodynamics 240  
 surface water 293  
 surfactants 333, 725, 739, 767  
 Triton X-114 mixed  
 hemimicelles 96  
 suspended solids 71  
 materials 391  
 pollutants 354  
 sediment particles 423  
 suspension quality 419  
 sustainable electricity storage 776  
 batteries 776  
 sustainable environment  
 greener approach 20, 805  
 sweep gas membrane distillation (SGMD) 362  
 swelling capacity 671  
 swelling index (SI) 673  
 synthetic hydrocarbons 413  
 synthetic polymers 654, 693
- t**
- tartrazine, degradation rate 224  
 teflon 661  
 temperature-time conditions 239  
 TEMPO radical 583, 590  
 Tenax TA 141  
 tensile strength 692  
 ternary metal oxides 229  
 photocatalysts 224  
 ternary Pt-graphene/TiO<sub>2</sub>  
 nanocomposites 629  
 tetra-*n*-butyl titanate 399  
 tetrachloroauric (HAuCl<sub>4</sub>)  
 solution 551  
 tetracycline 137, 199, 200, 300  
 tetracycline adsorption  
 on GS0 and GS6, influence of  
 pH 204  
 influence of pH 204  
 tetracycline hydrochloride (TCH) 303  
 tetraethoxysilane 399  
 tetraethylenetetramine 323, 397, 398  
 tetraethylorthosilicate  
 (Si(OC<sub>2</sub>H<sub>5</sub>)<sub>4</sub>) 740  
 tetramethyl bisphenol A 397  
 tetrathiafulvalene (TTF) 528  
 textile wastewater process 369, 370  
 theoretical efficiency 775  
 thermal aging 60  
 thermal conductivity 130  
 thermal decomposition 79  
 thermal diffusion saturation 416  
 thermal evaporation 373  
 thermal exfoliation unzipping  
 CNTs 457  
 thermal reduction of GO 230  
 thermal remediation 778  
 thermal stability 47  
 thermal UV irradiation 79  
 thermal vaporization 81  
 thermodynamics 94, 129, 134, 135  
 isotherm 138  
 parameters 133  
*Thermomonospora* sp. 809  
 T-Hg-T base pair 526, 552  
 thin-film composite coating (TFC) 301  
 thiocholine (TCh) 532  
 thiolation of CNTs, by modification of  
 carboxylated tubes 326  
 thiol-functionalized chitosan  
 (CS-SH) 92  
 thiol-functionalized nanophotocatalyst  
 (3-mercaptopropyltrie  
 thoxysilane) MPTES/  
 TiO<sub>2</sub> 333  
 thiol group 336  
 thiophenol-modified Ag-Al<sub>2</sub>O<sub>3</sub>  
 template 494  
 thiosulfate 524  
 three-dimensional-graphene oxide  
 (3D RGO) hydrogel 132  
 three-dimensional structure 489  
 three-way catalyst (TWC) 39, 48  
 thymine-1-acetic acid (T-COOH) 336  
 Ti-Al-B alloys 416  
 Ti<sup>4+</sup> cation 242  
*Tigriopus japonicas* 745  
 tin dioxide (SnO<sub>2</sub>) 452  
 TiO<sub>6</sub> octahedra in anatase and  
 rutile 238  
 TiO thin films 216

- titania 371, 774  
     based materials 225, 417  
     based photocatalyst 221  
     based systems 775  
     film 527  
     mesoporosity 527  
     mixed oxide 81  
     nanoparticles 776  
     photocatalysts 238  
     production 776  
 titanium dioxide ( $\text{TiO}_2$ ) 245, 653  
     heterojunctions 222  
     nanoparticles 393, 398, 813  
 titanium isopropoxide 232  
 titanium nanocomposites  
     ( $\text{PTh/Sn-TiO}_2$ ) 217  
 titanium oxide ( $\text{TiO}_2$ ) 450, 791  
     based composites 222  
     based photocatalysts 654  
     cellulose acetate (TCA) film 668  
     chitosan photosystem 666  
     chitosan ratios 666  
     lattice 242  
     matrix 221  
     mediated heterogeneous  
         photocatalysis  
         technology 675  
 nanoparticles 75, 519, 607, 689  
     aggregates 669  
     with Ru/Rh NPs 249  
     TEM image of 76  
 nanowire ( $\text{TiO}_2\text{NW}$ ) 108  
     gas sensor, SEM image of 451  
 oxidized CS-ECH system 673  
 PCL composite 669  
 photocatalysis principle 653  
 polymorphs 239  
 possesses 303  
 powders 661  
 precursors 661  
 support 53  
 synthesis methods, and effect on  
     sensor properties 452  
 titanium precursor 232  
 titanium tetraisopropoxide 237  
 Tobacco mosaic virus (TMV) 519  
 tocopherol 791  
 toluene 138, 532, 533, 615  
 tomato seedlings
- MWCNTs, surface functionalities  
     of 172  
 tortoise-shaped flattened  $\text{C}_{60}\text{F}_{18}$   
     fluorofullerene 21  
 total dissolved solid 369  
 total energies 24  
     density 414  
 total organic carbon (TOC) 651  
 total pore volume  
     of GS0, GS1, GS4, and GS8 199  
 total suspended solid 369  
 toxicants 543, 544  
 toxic contaminants 698  
 toxic gases 138, 445, 461  
     detection 445  
     offline analysis of 445  
 toxicity 141, 155, 180, 544, 742  
     heavy metals 527  
 trace environmental pollutants 473  
 trajectories 428, 433  
 transducer 718  
 transition metals 45, 322  
     doping process 224  
 transition nanometals 301  
 transition temperatures 239  
 transmembrane pressure (TMP) 371,  
     402, 403  
 transmission electron microscopy  
     (TEM) 155, 396, 523, 550  
     micrographs of ceria powders  
         synthesized 77  
 transparent conductors 224  
 transportation 761  
     ability 738, 827  
 treatment processes 71  
 treatments plants stages  
     primary treatment 72  
     secondary treatment 72  
     tertiary treatment 72  
 1,2,4-trichlorobenzene(TCB) 138  
 2,4,6-trichlorophenol (TCP) 138  
 triclosan (5-chloro-2-(2,4-  
     dichlorophenoxy)  
     phenol) 103  
*Tridax procubans* 559  
 triethoxyfluorosilane 324  
 triethylenetetramine 397, 398  
 trihalomethane 99, 403  
 trimers 482

trimesoyl chloride 397  
*N*-(trimethoxysilylpropyl)  
  ethylenediamine triacetic acid  
  (EDTA-silane) 626  
1,3,6-trinitropyrene (TNP) 221  
2,4,6-trinitrotoluene (TNT) 556  
trioctylphosphine 333  
TTX degradation, effect of pH  
  concentration 219  
tungstate 307  
tungsten oxide ( $\text{WO}_3$ ) 454  
tunneling conductivity 30, 34  
Tyndall effect 550  
tyrosinase 528, 555  
tyrosine 548

**u**

ultracapacitors 719  
ultrafiltration 354, 358, 373, 391  
ultrafine aluminum 421  
ultralarge  $\text{ZnO}$  macroflower 224  
ultralight graphene oxide 299  
ultrasensitive detection 482  
ultrasensitive SERS hot spot 484  
ultrasonication 230, 300  
ultrasonic impregnation 220  
ultrathin leaf-like nanobelts 224  
ultraviolet  
  A/vis radiation 301  
  disinfection 298  
  filters 790  
  illumination 238  
  irradiation 79, 257, 805  
  light emitting devices 224  
  radiation 72  
  responsive semiconductor 249  
  UV-visible diffuse reflectance  
    spectrum (UV-vis DRS) 244  
  vis absorption spectra 108, 218  
  visible spectrophotometry 523  
  visible spectroscopy (UV-vis) 420,  
    550, 550, 552, 559  
umbilical cord 3  
uncatalyzed soot samples 46  
United States Environmental Protection  
  Agency (US EPA) 402,  
    543  
unmodified chitosan 671  
uranium 723

**v**

vacuum conditions 445  
vacuum evaporative crystallization  
  (VEC) 369  
vacuum membrane distillation  
  (VMD) 362  
valence band (VB) 652  
validation 427  
vanadates 307  
vanadium(V) 587  
van der Waals bonds 602  
van der Waals forces 20, 300  
van der Waals interactions 129, 136  
vaporization 79  
vapor viscosity 362  
vegetable proteins 191  
vermiculite 613  
*Verticillium luteoalbum* 809  
vibrating sample magnetometer  
  (VSM) 95  
*Vibrio cholerae* 559, 809  
viscoelastic properties 527  
visible light irradiation 224, 244, 256  
volatile organic compound (VOC) 138,  
  220, 304, 621, 722, 737  
voltammetry 523  
*Volvariella volvacea* 810  
 $\text{V}_2\text{O}_5\text{-WO}_3/\text{TiO}_2$  catalysts 53  
VWTi catalysts 53

**w**

wallastonite 613  
waste laboratory reagents 294  
wastewaters 353, 371, 372, 391, 560,  
  664  
  containing phenolics 670  
  discharge 543  
  inorganic pollutants, ground/  
    surface 400  
  oily, paint industry 371  
  organic 353, 369, 400  
  photocatalytic purification of 705  
  production 391  
  purification, significance of  
    nanotechnology for 72  
  remediation 550, 685  
  detection of aromatic  
    compounds 555  
  detection of dyes 558

- wastewaters (*continued*)  
 detection of heavy metal ions 550  
 detection of inorganic pollutants 556  
 detection of organophosphates 557  
 detection of toxins 558  
 sludge biochar 166  
 treatment methods 71, 354, 366, 371, 374, 649  
 applications of membrane process for 366  
 biological treatment 650  
 chemical methods 651  
 novel devices for 374  
 physical treatment techniques 651  
 semiconductor-mediated photocatalytic oxidation mechanisms 652  
 water absorption 420  
 water–CNT interface 629  
 water conduction 154  
 water contaminations 135, 550, 698  
 water decontamination 300  
 water electrolysis 775  
 water eutrophication 369  
 water filtration 392 membranes 667  
 water-insoluble cross-linked networks 671  
 water permeation 132, 332  
 water–photocatalyst interaction 661  
 water pollution 127, 153, 724, 777 treatment 777  
 water purification system 580, 687, 698  
 water quality 367, 372  
 water reclamation 722  
 water recycling technologies 650  
 water retention capacity 154  
 water-soluble carbon dot (wsCD) 179  
 water-soluble carbon nanoionons 178  
 water-soluble carbon nanoparticle (wsCNP) 165 treated wheat plant 168  
 water-soluble carbon nanotubes 176  
 water-soluble metal salts 768  
 water-soluble versions 154
- water splitting photoelectrochemical cells 726  
 water treatment, application 400  
 wave configuration 422  
 weak grouping 423  
 wearable sensors 523, 717  
 $\text{WO}_3\text{-CuWO}_4$  mixed composite 307  
 World Health Organization (WHO) 686  
 WTi catalysts 53  
 wurtzite zinc-gallium oxynitrides (ZnGaNO) particles 233
- X**  
*Xanthoceras Sorbifolia* 553  
 xenobiotic 664 substances 670  
*Xenopus laevis* 744  
 X-ray diffraction (XRD) 47, 94, 550 of  $\text{Cr-TiO}_2$ ,  $\text{Fe-TiO}_2$ , and  $\text{V-TiO}_2$  242  
 of gold nanostars 485 spectra of GS0 and GS6 196 of  $\text{TiO}_2$  thin film 451  
 X-ray photoelectron spectroscopy 523  
 xylene 105, 532, 533 isomers 141  
 $o$ -xylene 105
- Z**  
 zearalenone 558  
 zeolites 55, 128, 393, 615, 661, 776 framework 323  
 zero-dimensional structure 485  
 zero-emission vehicles 776  
 zero-valent iron nanoparticles (nZVI) 812  
 $\text{NaBH}_4$  system 301  
 zero-valent metals like iron (ZVI) 778  
 zero-valent nanocopper-loaded  $\text{TiO}_2$  301  
 zeta potential measurements 90, 399  
 zinc oxide ( $\text{ZnO}$ ) 224, 305, 452  
 $\text{AgI/Ag}_2\text{CO}_3$  nanocomposites 263  
 $\text{Ag}_3\text{VO}_4/\text{Fe}_3\text{O}_4$  nanocomposite 255 based photocatalyst 224  
 crystals 224, 231  
 $\text{GO/ZnO}$ . PL emission 246 lattice 224

- material 336  
nanocapsules 108  
nanocrystals 245  
nanoparticles 77, 231, 304, 398, 517,  
    518, 744, 791  
nanostructures 77, 224  
    prepared with zinc acetate SEM  
        images of 78  
nanowires 231  
    sensor properties of 453  
oxygen-doped g-C<sub>3</sub>N<sub>4</sub> 225  
particles 225  
physical properties 224  
thin film 245  
ZnGaNO composite 233  
ZnGaNO heterostructure 234  
ZnGaNO particles 234  
zirconia 371, 791  
    doped ceria catalysts 46  
zirconium-hydroxide/graphene  
    composites 139  
ZnCl<sub>2</sub> solution 234  
ZnFe<sub>2</sub>O<sub>4</sub>/graphene 251  
ZnFe<sub>2</sub>O<sub>4</sub> nanoparticles 234  
Zn/Ga/CO<sub>3</sub>  
    nitridation of 233  
ZnGaNO/ZnGa<sub>2</sub>O<sub>4</sub> composite 233  
Zn<sup>+2</sup> ions 779  
ZnS-CdS-Zn<sub>1-x</sub>Cd<sub>x</sub>S  
    heterostructures 252  
ZnWO<sub>4</sub>/graphene hybrid  
    materials 629

