

Index

a

adsorption 2, 5, 69, 94, 144, 164, 168, 208, 248, 253, 265, 273, 277, 281–285

advanced oxidation process (AOP) 2, 6, 241

aerobic process 2

Ag nanowire-embedded cloth 304

AgNP-coated Janus microbots 248

AgNP-coated Janus micromotors 247

air filtration technology 3

air pollution 1–3, 197

all-in-one design

- photothermic driven catalysis and desalination, of seawater 302
- textile for personal thermal management 305
- water harvesting system 302

all-in-one direct seawater desalination device 299

all-polymer micromotor 239

anaerobic process 2

anti-*Bacillus globigii*

- antibody-functionalized micromotors 241

antibacterial zeolite-based micromotors 247

artificial intelligence (AI)

- gating membranes 71–73
- nanomaterials 7
- actuators 9–11
- energy nanogenerator/nanosensor 7–8

- shape-memory materials 8–9
- and nanotechnology 7

atmospheric particulate matter 197

Au-Pt nanowire-based nanomotors 233

autonomous self-propulsion 227, 233

Au-WO₃@C Janus micromotors 244, 246

Au-WO₃@C Janus nanomotor 244, 245

azobenzene based gating membrane 85–87

azobenzene-functionalized PVC membrane 86

azobenzene modified AAO membrane 86, 87

azobenzenes 41

azobenzene terminated PDMAEMA polymer 50

azobisisobutyronitrile (AIBN) 271, 273, 280, 281, 283, 285

b

benzimidazole compounds 279, 280

beta-FeOOH mineralized nanofiltration membrane 184

biocatalytic nanomotor-based water-quality sensor 234

biocatalytic nanomotors 234, 235, 237

bio-inspired self-healing materials 185

biological wastewater treatment 2

bisphenol A (BPA) 94, 269, 276, 277

- bubble-propelled non-enzyme Cu/Pt-based microrfish motors 234
- bubble propulsion mechanism 229–230
- bulk polymerization 272, 284
- c**
- capsule-based healing concept 159, 160
- carbamazepine (CBZ) 278, 279
- carbon-based absorbents 252
- carbon based-Janus micromotors 252, 253
- carbon-black-based superhydrophobic gauze 177
- carbon nanotubes (CNTs) 4, 139, 213, 280
- PDEAEMA hybrid membrane 139
- Cassie–Baxter model 116, 117
- Cd²⁺ Imprinted mesoporous silica 284
- cell membrane 71, 212, 243
- chemical and biological warfare agents (CBWA) 243
- chemical coagulation 2
- chemical vapor deposition (CVD) 172, 201, 212, 213
- chitosan-based water-propelled micromotors 246
- coagulation 2, 3
- common-salt based water vapor sorbent 303
- composite organic/inorganic material based stimuli-responsive wettability 121
- contact angle (CA) 114, 115, 168, 177
- contact angle hysteresis (CAH) 114, 115, 117, 168, 177
- COOH-PPy/metal tubular motors 240
- CO₂ separation and capture, membrane technology in 167
- Coulomb interactions induced UCST polymers 32–33
- covalent-grafting techniques 72
- covalent imprinting 266, 268
- cross-linkers 163, 266, 271, 279
- crown ethers 44, 45, 89
- Cu(II)-imprinted microgel 283
- Cu/Pt concentric bimetallic micromotors 237
- cyclodextrins (CDs) 269
- d**
- 2,4-dichlorophenoxyacetic acid (2,4-D) 269, 280
- diclofenac (DFC) 277, 278
- diffusiophoresis 230–232
- disperse red 1 (DR1) 87
- disulfide 47, 48, 50, 91, 161
- DMSA-based Janus micromotors 255
- DNA functionalized micromotors 255
- dodecanethiol-coated Au/Ni/PEDOT/Pt micromotors 249
- dual-stimuli responsive polymers 49
- thermo and light 49
- thermo and pH 49–50
- thermo and redox 50
- dye-imprinted-polymers 273
- e**
- electrokinetic desalination operations 300
- electrolyte diffusiophoresis 231
- electrophoresis 228, 229, 231
- electrospinning process 128, 201
- electrospun nanofibrous air filter, for PM and toxic gas removal 210
- electrospun nanofibrous membranes 182, 201, 212
- emulsion polymerization 272, 276
- endocrine-disrupting compounds (EDCs) 273–277
- energy nanogenerator/nanosensor 7–8
- enzyme-powered biocompatible polymeric (PEDOT)/Au-catalase tubular nanomotors 234
- estrone 269, 275–277
- ethynylestradiol (EE) 275
- extrinsic self-healing materials 159–160, 162

f

- Fenton's method 241
- Fe/Pt-based self-propelled micromotors 241
- Fe-pyridinedicarboxamide-containing PDMS (Fe-Py-PDMS) 170
- ferrocene (Fc) 47, 50, 91
- fibrous air filter 198, 199
- fibrous membranes 3, 122, 128, 138, 139, 173, 198
- filtration membranes
 - classification 69
 - with responsive and intelligent gates 70–71
- fluoresceinamine (FLA) 238
- forward osmosis (FO) membranes 70
- free radical polymerization (FRP) 36, 79, 139, 271, 272
- functional monomers, in MIP 269–271

g

- grafting-from method 72, 91
- grafting-to method 72, 73
- graphene-based Janus micromotors 253
- graphene oxide (GO)
 - based micromotors 254
 - rolled-up micromotors 250

h

- heterogeneous nucleation-assisted
 - hierarchical growth, of flowerlike MOFs 210
- hybrid electrospun PVDF-Ag-Al₂O₃
 - nanofibrous air filter 213
- hybrid photothermal water sorbent 303
- hybrid PLA/TiO₂ electrospun
 - nanofibrous air filter 212
- hydrogel-embedded tight ultrafiltration membrane 178
- hydrogen bonding induced UCST
 - polymers 33
- hydrogen-bubble-propelled Janus micromotor 250

- hydrophilic molecularly imprinted
 - polymers 273, 275
- hydrophilic self-healing 174–176
- hydrophobic HAP nanowire aerogel filter 215
- hydrophobic self-healing 172–174
- hydroxyapatite (HAP) nanowire-based
 - inorganic aerogels 214
- hygro-responsive membranes 121, 139

i

- icephobic surface 170
- inorganic photo-responsive materials 42–43, 133–135
- intelligent actuators 9
- intelligent environmental nanomaterials 11–13
 - gating membrane 12
 - molecular imprinting 13
 - nanofibrous membrane air filters 13
 - self-healing materials 12–13
 - self-propelled nanomotors 12
 - switchable oil-water separation 12
- intelligent gating membranes 12
 - fabrication methods 71–73
 - one-step formation method 73
 - post-modification method 72–73
- ion strength responsiveness 92–95
- metallic ion responsiveness 89–91
- pH, ion strength dual responsiveness 97–98
- photo responsiveness 85–89
- pH-responsive polymeric materials 80–85
- pH, temperature dual responsiveness 95–97
- redox responsiveness 91–92
- temperature, ion strength dual responsiveness 97
- temperature, pH, ion strength multi responsiveness 99
- thermo-responsiveness 74–80
- intelligent oil/water separation materials 120
- intelligent responsiveness
 - overview 27–28
 - in polymer systems 28–29

- intelligent supramolecular mesoporous materials 93
 - interaction-based filtration mechanism, for soy-protein-based nanofabrics 211
 - intrinsic self-healing materials 160–162
 - ion concentration polarization (ICP) 299
 - ion-recognizable copolymers 44
 - poly(NIPAM-*co*-AAB₁₈C₆) 44–45
 - poly(NIPAM-*co*-AAB₁₅C₅) copolymer 45
 - ion strength responsive ultrathin nylon capsule membranes 92
 - ion-strength-responsive zwitterionic polymer 46, 47
 - irradiation parameters 40
- j**
- Janus membrane (JM) 129, 179, 181
- l**
- layer-by-layer (LbL) 10, 81, 166, 238, 300
 - assembled polyelectrolyte polymer multilayer materials 255
 - LCST thermo-responsiveness 30–32
 - light-driven micro/nanomotors 231, 243
 - light responsive gating membrane 85, 88
 - light responsive polymers 41
 - liquid-repellent surfaces 168, 171
 - liquid wettability, in air 115–117
 - lysozyme-modified fuel-free nanomotors 247
- m**
- magnetic chitosan/poly(vinyl alcohol)/Ni(II) beads 284
 - magnetic Janus membrane (MJM) 130
 - magnetic micromotor-based sensor 237
 - magnetic molecularly imprinted polymers 273, 275
 - Marangoni effect 250
 - membrane fouling 73, 100, 182
 - membrane separation 3, 36, 46, 69–70, 86, 100, 182, 282
 - membrane technology 6, 69, 167
 - mercury ion responsive PAA hydrogel coated oil/water separation mesh 140
 - metal-block PS-*b*-P4VP nanofiltration membrane 81
 - metal ion responsiveness 43–45, 89–91
 - metal-organic framework (MOF) based nanofibrous air filter
 - for simultaneous PM and toxic gas removal 208–212
 - Mg/Au Janus micromotors 237
 - Mg-based seawater-driven Janus micromotors 251
 - microbubble propulsion mechanism 229–230
 - microcapsule-type extrinsic self-healing agent 163
 - microencapsulated self-healing agents 159
 - microfiltration (MF) membranes 69–70
 - microfish motors 234, 235
 - micro/nanomotors 227
 - based microabsorbent 249
 - external fields driven 231–233
 - fluorescent molecules/quantum dots, functionalization of 238
 - merits 228
 - microbubble propulsion mechanism 229–230
 - self-diffusiophoresis propulsion mechanism 230–231
 - self-electrophoretic mechanism 228–229
 - MnFe₂O₄ pot-like micromotor 250
 - MnO₂/PE/PP composite filter 212
 - MOF-based nanofibrous air filters 208, 209
 - MOF based PAN filters 211
 - molecular imprinting 13
 - covalent imprinting 266–268

- defined 265
 - environment applications 273–285
 - essential elements of 268–271
 - goal of 265
 - noncovalent imprinting 266–268
 - molecular imprinting technology (MIT) 265, 266, 285
 - molecularly imprinted polymer
 - nanoparticle (MIP-NP) 280–281
 - molecularly imprinted polymers (MIPs)
 - based catalytic micromotor 237
 - cross-linkers 271
 - endocrine-disrupting compounds 274–277
 - features 265
 - free radical polymerization (FRP) 271, 272
 - functional monomer 269–271
 - heavy metals 281–285
 - initiators 271
 - natural and synthetic dyes 273–274
 - pharmaceuticals and pesticide 277–281
 - porogenic solvents 271
 - schematic illustration 267
 - selective recognition site 266
 - sol-gel process 273
 - target templates 268–269
 - three-dimensional networks 265
 - motor-based biocatalytic pollutant remediation 252
 - motor plasmonic photocatalyst (MPP) 244
 - multifunctional nanofibrous air filter 204
 - multi stimuli-responsive polymers 50
 - thermo, light and pH 50–51
 - thermo, light and redox 51–52
 - mussel-inspired injectable hydrogel 166
- n**
- nanoadsorbents 5, 6
 - nanofibrous membrane air filters 13, 199–201
 - for PM_{2.5} removal
 - with antibacterial functions 212–214
 - electrospinning 201
 - fabrication methods 200–201
 - filtration mechanism 199–200
 - high thermal stability 203–204
 - mass production 206
 - schematic illustration 200
 - self-powered air filter 206–208
 - thermal management 204–205
 - transparent air filter 202–203
 - nanofiltration (NF) membranes 70, 119, 184
 - nanomaterials
 - advantages 5
 - defined 4
 - nano-photocatalysts 6
 - nanoporous polyethylene (nanoPE) 304, 305
 - nanosized drug carriers 4
 - nanotechnology
 - applications 4–5
 - artificial intelligence 7
 - definition 4
 - in environmental science and engineering 5–6
 - evolution history 3–4
 - neurotoxic organophosphates 281
 - noncovalent imprinting 266–268
 - nonylphenol 276
- o**
- oil mist filtration 214, 215
 - oil-removal micro/nanomotors 250
 - oil spill accidents 113
 - oil/water separation
 - on aligned ZnO nanorod array-coated mesh 133
 - ammonia-responsive 136
 - carbon dioxide-responsive 138
 - dual/multi-responsive system 143
 - electric field responsiveness 141–143
 - hygro-responsive membranes 121, 139
 - inorganic photo-responsive materials 133–135

- oil/water separation (*contd.*)
 - intelligent materials 120
 - ion responsive 140–141
 - organic photo-responsive materials 135–136
 - of PAA hydrogel coated mesh 142
 - of PAM hydrogel coated mesh 119
 - pH-responsive materials 126–132
 - solvent responsive 139–140
 - temperature responsive materials 122
 - wettable materials for 118–120
- oil wettability 117, 127
- oily wastewater 113, 114
- on-the-fly' remediation process 242
- organic photo-responsive materials 135–136
- oxidation 2, 6, 47, 48, 50, 84, 144, 212, 240–242, 244, 250, 266

- p**
- PAN nanofibers 203, 210
- paraoxon 281, 282
- particulate matter (PM) 197
- Pb(II)-imprinted thiol-functionalized silica gel sorbent 282, 283
- PDMAEMA hydrogel coated oil/water separation mesh 139
- PEO-grafted P2VP network films 175
- peptide-metal organic framework (MOF) motor system 235, 236
- personal thermal management 304–305
- phase inversion process 84, 178, 250
- pH-induced reversible special wettability 126
- photocatalysis 6, 176, 181, 212
- photocatalytic micro/nanomotors 243, 244
- photocatalytic oxidation, in water treatment 6
- photocatalytic propulsion, in micro/nanomotors 231
- photocatalytic self-cleaning 181–183
- photochemical reaction 40, 244
- photoisomerization reactions 40
- photothermal-responsive Au nanorods/PNIPAM hybrid ultrathin membranes 124
- pH-responsive acidic polymers 38–39
- pH-responsive basic polymers 36–38
- pH-responsive intelligent gating membranes 80, 84, 96
- pH-responsive Janus membrane (pH-rJM) 130
- pH-responsive oil-water separation materials 126
 - carboxyl-based system 129–131
 - pyridine-based polymers 126–128
 - tertiary amine-based pH-responsive systems 131–132
- pH-responsive polymeric materials 80
 - polyacid gating membrane 83–85
 - polybase gating membranes 80–83
- pH-responsive polymers 34–36, 38, 49–51, 80, 126
- phthalate esters (PAEs) 237
- physical cracks, self-healing of 163–171
- piezoelectric materials 7, 8
- PI nanofiber membranes (PINFMs) 204
- plant tissues 242
- PM_{2.5} 197, 199
- PMMA-*b*-PNIPAM copolymer coated steel mesh 122
- PMMA-*b*-P4VP fibrous membranes 128
- PNIPAM-based materials 178
- PNIPAM based nanofibrous membranes 122
- PNIPAM-*b*-PMAA based responsive gates 99
- PNIPAM/PPy modified sponges 125
- poly(2-methacryloyloxyethyl phosphorylcholine) (PMPC) 178, 179
- poly(ethylene oxide) (PEO) 178
- poly(ionic liquids) (PILs) 91, 93, 140

- poly(*N*-isopropylacrylamide) (PNIPAM) 30, 33, 44, 49, 50, 74–76, 79, 95, 97, 122, 124–126, 166, 178
- poly(ionic liquid) based porous hybrid membrane 140
- poly(NIPAM-*co*-AAB₁₈C₆) copolymer chains 89
- polyferrocene 48
- poly(NIPAM-*co*-AAB₁₅C₅)-grafted membrane 91
- polyhedral oligomeric silsesquioxane (POSS) 9, 139, 173
- polymers, shape-memory 9
- polymers, water soluble 29
- poly[(2-*N*-morpholino)ethyl methacrylate] (PMEMA) 38
- polystyrene-*block*-poly(*N,N*-dimethylaminoethyl methacrylate) (PS-*b*-PDMAEMA) 96
- polyzwitterionic polymers 32, 33
- polyzwitterions 32–33, 45, 46
- porogenic solvents 268, 271
- porous membrane filter 198, 199
- porous polysulfone polymer capsule 250
- precipitation polymerization 272, 277, 279–281
- primary photochemical reactions 40
- P4VP-grafted melamine sponge 128
- pyridine-based polymers 126
- q**
- quantum dot (QD)-based microsensors 239
- r**
- reactive dyes 273, 274
- redox-responsive systems 48
- redox sensitive compounds 48
- reduction 1, 47, 48, 50, 52, 80, 89, 141, 168, 174, 244, 253
- reverse osmosis (RO) membranes 70, 299
- rGO-coated micromotors 253
- Rhodamine 6G (Rh6G) 164, 166, 241
- roll-to-roll blow-spinning technique 201, 206
- s**
- SDS-stabilized emulsions (SDS-SE) 131
- self-assembly monolayer (SAM)-modified tubular micromotor 249
- self-cleaning, of contaminated surfaces 176
- photocatalysis 181–183
- superhydrophilicity 178–181
- superhydrophobicity 177
- self-diffusiophoresis propulsion mechanism 230–231
- self-electrophoretic mechanism, of micro/nanomotors 228–229
- self-healing anti-smudge coating 174
- self-healing electrospun *N*-perfluorooctyl-substituted PU fibrous membrane 173
- self-healing environmental materials 12–13
- self-healing materials and anti-fouling films 166
- biomimetic 157
- classification 162
- definition 158
- extrinsic 159–160
- inorganic materials 158
- intrinsic 160–162
- IPN elastomer 171
- physical cracks 163–171
- superhydrophobic coatings 172, 173
- superhydrophobic fabrics 174
- supramolecular gel 166
- self-powered air filter 206–208
- self-propelled dual-function biocatalytic motors 242
- self-propelled gold/nickel/polyaniline/platinum (Au/Ni/PANI/Pt) microtubular nanomotors 239
- self-propelled micro/nanomotors 227
- efficient antibacterial agents 247
- for enhanced organic contamination degradation 241–245
- as environmental sensors 233–241

- self-propelled micro/nanomotors
(*contd.*)
- molecule/ion removal 251–257
 - oil droplet removal 248–251
- self-propelled nanomotors 12, 14, 241
- self-propulsion, of Janus colloidal particle 232
- shape-memory materials 7–9, 49
- sieve effect 120
- silk nanofiber air filter 213
- silver-exchanged zeolite micromotors 254
- sliding angle 114, 115, 174, 177
- slippery liquid-infused porous surface (SLIPS) 168, 169
- sodium dodecyl sulfate loaded PSf capsule 251
- sodium polyacrylate-grafted poly(vinylidene fluoride) (PAAS-*g*-PVDF) hydrogel membrane 80, 178
- solar steam generation 3D-printed, all-in-one evaporator for 300–301
- solar thermal collector nanocomposites 301
- sol-gel process 271, 273, 275, 282, 283
- soy protein isolate (SPI)/polyimide-6 (PA6)/Ag nanofibrous air filter 213
- soy protein/PVA electrospun nanofibers 212
- spiropyran 40–42, 50, 85, 88
- spiropyran based gating membranes 87–89
- spiropyran-containing PMMA grafted glass filter 88
- spiropyran-grafted poly(ether sulfone) ultrafiltration membrane 88
- stimuli-responsive wettability 121, 132
- superhydrophilicity-induced self-cleaning 178–181
- superhydrophobic fabrics 137, 174
- superhydrophobicity-induced self-cleaning 176–178
- superhydrophobic zirconium film 137
- superoleophobic filters 214
- surface graft polymerization 80, 83
- surface-initiated atom transfer radical polymerization (SI-ATRP) method 122
- surface wettability 114, 171
- definition 114
 - self-healing of 171
 - states on solid surfaces 115
- surfactant-free emulsions (SFE) 131, 134
- surgical nanorobot 4
- suspension polymerization 272, 273
- synthetic intelligent gating membranes 71
- t**
- temperature responsive oil/water separation materials 122, 126
- TENG-assisted positively charged PI electrospun nanofibrous air filter 207
- tertiary amine-based pH-responsive systems 131–132
- tertiary amine methacrylate based polymers 36
- thermal-responsive PNIPAM hydrogel 122
- thermophoresis 232
- thermo-responsiveness of polymer 29
- LCST 30–32
 - UCST 32–33
- thermo-responsive polymers 122
- TiO₂/Au/Mg micromotors 243
- TiO₂ doped PVDF electrospun nanofibrous membrane 182
- TiO₂/Pt Janus submicromotors 243, 244
- transparent air filter 202
- triblock copolymer poly(styrene-*co*-acrylonitrile)-*b*-poly(ethylene oxide)-*b*-poly(styrene-*co*-acrylonitrile), for water filtration 163
- triboelectric air filter (TAF) 207, 208
- triboelectric nanogenerator (TENG) 8, 177, 206

- triboelectrification effect 206
- triple responsive PNIPAM based copolymers 51
- U**
- UCST thermo-responsiveness 32–33
- ultrafiltration (UF) membranes 70, 178
- ultrasound-propelled porous gold nanowire motors 247
- underwater superoleophobic PNIPAM-clay nanocomposite hydrogel 179
- UV-responsive SWCNT/TiO₂ ultrathin film 134
- V**
- viscosity, of light oil 114
- W**
- water contact angle
 - of octadecyltrichlorosilane/PNIPAM modified sponge 125
 - of PNIPAM modified flat surface 122
- water-driven bubble-propelled micromotor 230
- water-driven Janus micromotors 230, 255
- water filtration PES membrane 163
- water-fuelled TiO₂/Pt Janus submicromotors 243
- water pollution 1
- water-propelled Al/Ga/Ti motors 230
- water-responsive artificial actuator 10
- water soluble polymers 29
- Wenzel model 117
- wettability 114
 - liquid 115–117
 - oil 117–118
 - stimuli-responsive 121
- wettability-based oil/water separation 118–120
- wetting effect 120
- Z**
- zerovalent-iron/platinum (ZVI/Pt) Janus nanomotors 242
- ZnO-based photo-responsive oil/water separation devices 133
- ZnO functionalized PTFE filters 212, 213
- zwitterionic polyelectrolytes 178
- zwitterionic polymers 30, 33, 46, 47, 92, 93

