

Index

a

- absorbents 350
 - CO₂ adsorbents in H₂-PSAs 103
 - concepts, for application 373
 - filter performance 368–371
 - relevant protective clothing
 - applications 367, 368
 - testing chemical protection performance,
 - of filters 371–373
- acid gas removal (AGR) 103
 - process 103
- activity tests 231
 - drug-containing MOFs 231–233
 - NO-loaded samples 233, 234
 - silver coordination polymers 234, 235
- adsorbate–adsorbent interactions 73, 184
- adsorbents
 - for gas separation and purification 74
 - hydrophobic 107
 - selection criteria 111, 114
- adsorption
 - analytical methods 62, 63
 - based system 158
 - enthalpy 87
 - in flexible porous solids 58
 - direct molecular simulation 58–60
 - gate-opening pressure for 65
 - mechanism 164
 - of normal C₄ over higher alkanes and
 - alkenes 89
 - potential energy for carbon dioxide 85
 - process, interpretation 162
 - purification by 69
 - thermodynamics, for selecting MOFs for
 - sensing applications 313–315
- adsorption isotherms 61, 81, 83, 145
 - for ammonia 368
 - of C₈-alkylaromatics and *n*-octane 180
 - with gate-opening behavior 9
 - nitrogen 370, 371
- aerogels 376
- air flow method, for dry particle
 - insertion 365
- air purification 69
 - CO production from oxidation of
 - carbon 71
 - cryogenic separation 71
 - evolution of Claude Linde process 69
 - and gas separation, general principles
 - 72, 73
 - separation of components 69
 - and separation process on industrial plant
 - (SIAD) 70
- alkanes 73, 89
- alkene oxidation 202
- amide coupling 32
- amine-grafted MIL-101
 - catalytic properties 197
- 2-aminobenzenedicarboxylic acid
 - (ABDC) 13, 259
- O-(2-aminoethyl)-O'-(2-azidoethyl)
 - nonaethylene glycol 35
- 3-aminopropyltriethoxysilane 29
- 2-aminoterephthalate 32, 38
- ammonia borane (AB) 18
 - technical challenges 18
- analyte-dependent changes 310
- analytical methods, for adsorption
 - 62, 63
- anisotropic colloids 324
- anodic aluminum oxide (AAO) 132
- anodic oxidation 325
- antenna effect. *See* metal-based luminescence
- anthropogenic CO₂ emissions 105
- argon 69
- aryl chlorides 28

b

barium sulfate 252
 Basolite M050 350
 benzaldehyde
 – acetalization of 193
 – catalytic sites are not prone to reduction by 193
 – cyanosilylation of 207, 208
 – Knoevenagel condensation 196, 197, 201
 – oxidation of benzyl alcohol 206
 1,3,5-benzenetricarboxylate ligands 28
 5-1*H*-benzo[*d*]imidazoleisophthalic acid 378
 BET surface area 34, 41
 BiCo thermal binder 365
 bioluminescence 270
 biomineralization 131
 BioMOF formation, from bioactive linker 227, 228
 breathing phenomenon 54, 83
 Brønsted acidity 201
 Brunauer–Emmett–Teller (BET) specific surface areas 34, 41, 154
 buoyancy effects 157

c

calcination 353
 C₈-alkylaromatic isomers 88
 calorimetry 61
 carbonation–decarbonation cycles 106
 carbon capture and storage (CCS) 105
 carbon-free fuel. *See* hydrogen
 carboxylate-based MOFs 90
 carboxylimidazolates 34
 C₈-aromatics loop 173
 catalytic hydrogenation 205
 catalytic reactions 194
 cathodoluminescence 270
 cellulose acetate 104
 Chahine's rule 159
 chemical vapor deposition (CVD) 17
 chemical warfare agents (CWAs) 368
 chemiluminescence 270
 chemothermomechanical pulping (CTMP) process 355
 chiral L-proline derivatives 29
 chiral organic catalytic functions 199, 200
 chlorobenzimidazole ligands 112
 cisplatin 259
 Claude Linde process 69
 Claus process 104
 click chemistry 34
 – DMOF-1-NH₂ for click functionalization 37

– generic post-functionalization route, from amino-derived MOFs 38
 cluster models 109
 CMIL materials, for asymmetric aldols reactions 30
 coadsorption, applications 63–66
 – ideal adsorbed solution theory 64
 – osmotic framework adsorbed solution theory 63, 64
 – predicted coadsorption properties, of coordination polymer 64, 65
 – predictions of mixture, of CO₂ and CH₄ in 66
 co-adsorption experiments, for CO₂/CH₄ and CO₂/CO selectivities 109
 CO₂ capture agents 99
 CO₂ capture process
 – by absorption with chemical solvent 106
 – H₂ from syngas, production 101–103
 – metal–organic framework (MOF) 108–115
 – MOFs, opportunities for 99
 – post-combustion capture 105–108
 – pressure swing adsorption (PSA) 99–101
 – removal from natural gas 103–105
 – schematic presentation 106
 CO₂–CH₄ mixtures 83
 – tetrahydrothiophene removal from 90
 CO₂ in flue gases 105
 – requirements for adsorbents for 107, 108
 combinatorial synthesis 26
 combustion processes 99
 complementary metal–oxide–semiconductor (CMOS) fabrication 311
 complex hydrides, alanate 154
 composite beads, containing MOF powders 374
 computed tomography (CT) 252, 261
 – contrast agents 252
 condensation
 – of aldehyde to amino moiety of UCMC-1-NH₂ 33
 – of amine to formyl moiety of ZIF-90 34
 CO₂/N₂ selectivity 108
 continuous chromatographic countercurrent process 174
 continuous fixed-bed reactor 205
 controlled drug release technology 221–227
 – antitumoral molecules, encapsulated from nanoparticles of 226
 – cancer/AIDS drugs, encapsulated in different porous MOFs 225
 – drug capacities on iron carboxylate nanoparticles 226
 – ibuprofen as model drug 222, 223

- delivery kinetics 224, 225
- encapsulation kinetics 224
- metal-organic framework (MOF)
- flexible, excellent candidates for 224
- use of porous 222
- ordered mesoporous silica materials 221
- ordered porous materials for 221
- pore openings of MIL-53 solid: water 223
- pore size and pore volume, of different porous solids 223
- stability of solids 224
- coordination polymers 3, 4, 251
- copper(II) coordination polyhedra 84
- copper net-supported HKUST-1 membrane 138
- CPO-27 materials, heat of adsorption 115
- cryogels 376
- crystallographic density 158
- Cu^{2+} paddle-wheel cluster 6
- Cu-S coordinative bonds 86
- cyclic hydrocarbons 73
- cyclohexane catalytic oxidation 203
- cyclohexene
 - allylic oxidation 194
 - epoxidation 193, 202
 - oxidation with H_2O_2 202
- cytotoxicity assays 259

d

- dehydration of HKUST-1 29
- dehydration-rehydration cycle 294
- densification process 166
- depressurization 103
- 5,5'-dicarboxy-substituted binol ligands 198
- dichlorogold(III) complex 40
- diethylenetriamine 29
- N,N*-diethylformamide (DEF) 35, 132
- diethylformamide molecules 15
- diffusion coefficients 127
- 2,3-dimethyl-2,3-dinitrobutane 297
- N,N*-dimethylformamide (DMF) 133, 135
 - solvent for synthesis of MOFs 108
- dimethyl terephthalate (DMT) 174
- 2,4-dinitrotoluene (DNT) 297
- 1,4-dioxane 132
- dip-coating 363
 - technique 133
- 5-diphenylphosphanylisophthalic acid 378
- dipole-induced dipole interactions 85
- 2015 DOE system 166
- doping, of metal sites 15
- drug delivery 251
- drug-matrix interactions 224

dry gel method

- steam-assisted crystallization (SAC) 128
- vapor-phase transport (VPT) 128
- Dubinin-Astakhov (DA) micropore filling model 162
- dynamic quenching 273

e

- elastic modulus
 - vs. hardness materials 146
- electric dipole moment 86
- electrochemical route, to synthesize MOFs 325
- electroluminescence 270
- π -electron stacking 3
- electrospinning 356–358
- ellipsometry 323
- enantioselectivity 24, 198, 200
- energy transfer 273, 274
- equilibrium shift principle 145
- ethidium bromide monoazide 35
- ethylbenzene (EB) 88, 173, 175, 181, 183, 184
 - adsorption isotherms 180, 182
 - chromatograms 179
 - liquid mixture separation 186
 - separation curves 185
- ethylene adsorption, for food storage 350, 351
- ethylenediamine 29
- ethylene emission, by fruit 350
- EXAFS analysis 41
- excitation energy transfer 274
- expansion coefficients 146
- extruded MOF bodies 374, 375

f

- Fabry-Pérot interferometer 312
- faujasite-type zeolites 177
- Fe(btc) aerogel monolith 378
- fibroline process 364
- film attachment, for MOFs 315–318
- film thickness
 - measurement 327
 - and morphology, for selecting MOFs 318
- flexible MOFs
 - adsorption isotherms of 82
 - for enhanced adsorption selectivity 81–86
 - possible applications of 54, 55
 - terephthalates 83
 - zero-order kinetics 178
- flexible porous solids 56
 - adsorption in 58
- flue gases 107
- fluorescence quenching 273

food storage 350, 351
 formate route 132
 Förster resonance energy transfer 274
 fossil fuels 101, 105
 – combustion 105
 framework
 – aluminosilicate framework 71
 – concept of 4
 – dynamics in hybrid organic–inorganic materials 53
 – with high surface area 5, 6
 – for mixed-ligand systems 14
 – soft-type PCP 14
 – theoretical methods, describing adsorption and flexibility 55, 56
 – GCMC method 56
 – ideal adsorbed solution theory 55
 – of $[\text{Zn}_4\text{O}(\text{bdc})_3]$ 15
 Friedel–Crafts alkylation 206

g

gadolinium carboxylate NMOFs 253–257
 gas dehydration 69
 gasification 102
 gas impurities 69
 gas purification 69
 gas separation 51–52
 – design of MOFs for 73, 75, 77
 – performances 144
 – physicochemical parameters 76
 gate-opening 54, 178
 – materials 55
 – pressure 82
 gate-type adsorption profile 82
 glass transition temperature 309
 global warming 102
 gmelinite (GME) topology 112
 grafting, of amide functional groups 196–198
 grand canonical Monte Carlo (GCMC) simulation 56, 61, 160
 gravimetric hydrogen adsorptions, schematic representations 157
 guest encapsulation
 – within NMOFs 263
 – peptide–polyoxometalate (POM) spheres for 263
 – temperature-controlled 288
 guest–guest interactions 58
 guest-induced flexibility, taxonomy 62, 63
 guest-induced luminescence 287
 – charge transfer 290–291
 – encapsulation

– of lanthanide ion luminophores 291–293
 – of luminophores 288–290
 guest-induced swelling 53

h

H-bonds 3
 heat of absorption 105
 Henry constants 112, 180
 heterogeneous catalysis 28, 71
 heterogeneous porphyrinic catalysts 196
 1,1,1,3,3,3-hexafluoroisopropanol (HFIP) 374
 hexatopic carboxylate ligands 6
 high-pressure compressed gas system 167
 high-temperature carbonation–decarbonation cycles 106
 ^1H NMR spectroscopy 208
 Hofmann clathrate films 328
 homochiral MOFs 198
 – chiral organic catalytic functions 199, 200
 – CMIL-1, catalytically active 29
 – with intrinsic chirality 198
 – metalloligands 200, 201
 host–guest interactions 58, 89
 Huisgen cycloaddition 34, 36, 37
 hybrid organic–inorganic frameworks 54
 hydrocarbon separation 88
 hydrodesulfurization reaction 91
 hydrogen
 – adsorption enthalpy, comparison 165
 – adsorption isotherms 163
 – bonds 85
 – fuel cell electric vehicles (FCEVs) 151
 – Gemini, modified PSA process 102
 – pressure vessels 152
 – production of H_2 from syngas 101–103
 – steam reforming plant 101
 – storage capacity 160
 – storage technologies 158
 – challenges 151, 152
 – two-bed PSA system 102
 hydrogen sulfide 69
 hydrophilic polymers 255, 263
 hydrophobic adsorbents 107
 hysteresis 85

i

ideal adsorbed solution theory (IAST) 55, 56, 64
 imine condensation 33
 – hydrophobization of SIM-1 with C_{12} -alkylamine 35
 immobilization of MOFs

- for filtration applications 353
- MOF@fiber composite materials 354
- electrospinning of MOF@polymer composite fibers 356–359
- MOF-containing paper sheets 354, 355
- MOF@pulp fibers 355, 356
- MOF fixation in textile structures 359, 360
- dry particle insertion 363–367
- pretreatment 360, 361
- wet particle insertion 362, 363
- industrial MOFs synthesis 339
 - electrochemical synthesis 345, 346
 - hydrothermal approach 344, 345
 - laboratory-scale synthesis 343
 - linker molecules 340–343
 - metal sources 340
 - shaping process 347–349
- inorganic adsorbents, for gas separation 74
- inorganic hydroxides 69
- inorganic membranes, classification 121
- inorganic porous materials 71
- interdigitated framework $\text{Cu}_2(\text{dhbc})_2(\text{bpy})$, 3D crystal structure 83
- intrinsic biodegradability 252
- iodinated NMOFs 260–262
- ion sensing 295
- IRMOF-3 catalyst 197
- iron carboxylate NMOFs 258–260
- IR spectroscopy 193
- isoalkanes 73
- isophthalic acid (IPA) 174

k

- kinetic energy 365
- kinetic selectivity 73
- kinetic trapping mechanism 165
- Knoevenagel condensation 29, 196, 197
- Knudsen diffusion 125
- Knudsen separation factor 141
- kraft pulping 355

l

- Langmuir–Blodgett assembly of preformed MOF 2D single layers 331
- Langmuir model 110, 157
- lanthanide-based nanocages 203
- lanthanide luminescence 287
 - and antenna effect 282
 - as probe of metal-ligand coordination sphere 287
- lanthanide nucleotide NMOFs 262, 263
 - formation 262
- Le Chatelier principle 143
- Leonard-Jones potential 125

- Lewis acid 192, 207
- Lewis acidic frameworks 6–8
- ligand-based luminescence 274
 - ligand-to-metal charge transfer in MOFs 280, 281
 - metal-to-ligand charge transfer in MOFs 281
 - in MOFs 274–281
 - solid-state luminescence of organic molecules 274, 275
- ligand-base solid solution 14
- ligand ratio 14
- lignin 355, 356
- liquefied natural gas (LNG) 103
 - production 103
- liquid-phase epitaxy (LPE) growth 328
- liquid/solid interface 325
- luminescence 27, 254, 269, 270, 274, 278, 282, 287, 291
 - quenching 296, 312
- luminescent MOFs, applications 293
 - barcode labeling 300
 - chemical sensors 293–298
 - detection of explosives 297, 298
 - ion sensors 294–296
 - oxygen sensors 296, 297
 - small-molecule 294–296
 - nonlinear optics 300
 - radiation detection 298
 - solid-state lighting 298–300

m

- magnetic behavior 15
- magnetic resonance imaging (MRI) 235, 252, 262
- magnetic susceptibility measurements 326
- manganese carboxylate NMOFs 257, 258
- manganese ions 252
- mass transport 125
- MCM-41- NH_2 catalyst 198
- mechanical dewatering methods 363
- mechanical properties, for selecting MOFs for sensing applications 320
- 12-membered ring (MR) straight channels 134
- membrane permeation processes 69
- membrane separation and distillation (MDI) 122
- membrane separation processes 121, 124
 - ideal separation factor 124
- mercaptans 104, 105, 113
- mesoporous silicate (MS) materials 23
- mesoscopic porosity 324
- metal-based luminescence 282

- lanthanide luminescence 282
- metal luminophores 282
- metal carboxylate-based membranes 132, 137, 138
- metal-centered luminescence 282–286
- metal ions 3, 191
- metal–ligand bonds 155, 159
- metal–ligand interactions 28
- metalloligands 200, 201
- metalloporphyrins 25, 203, 204
- metal nanoparticles 204–206
- metal-organic frameworks (MOFs) 3, 99, 108–115
 - as adsorptive hydrogen storage options 154–156
 - advantages 154
 - applications 113
 - for bioapplications 216–221
 - building by post-synthetic modification 23–26
 - challenges 116
 - characterization 157
 - classification 82
 - containing organometallics 39
 - with coordination unsaturated metal centers 86–88
 - design 147
 - diagnostics, applications
 - magnetic resonance imaging 235, 236
 - optical imaging 236, 237
 - dynamic materials in 52–54
 - features, and physicochemical properties 41
 - films for sensing applications 311
 - functionalization 113
 - rate, and material efficacy 43, 44
 - functionalized materials, characterization of 44, 45
 - gas-phase loading with perylene derivative 27
 - for H₂-PSA 109–113
 - large synthesis and stability 108, 109
 - membranes, application 137
 - gas separation 137–141, 144
 - limitations 143, 145, 146
 - shaped structured reactors 141, 142
 - mesoporous 206–208
 - MOF-177 5, 28, 109, 165, 206, 319, 339, 341
 - MOF-5 thin films, SEM images 131
 - molecule interactions 310
 - monolithic, gels 375–378
 - opportunities for separation processes 73
 - Pd-containing MOF 41
 - piano stool arene–chromium complex 31
 - post-functionalization
 - by covalent bonds 31–39
 - by host–guest interactions 26–28
 - post-modification, of IRMOF-3 with salicylaldehyde 39
 - properties 99
 - stability 108
 - supported chiral titanium–BINOL complex 30
 - supported Cu/Fe catalysts, post-synthetic modification 40
 - symmetric anhydrides, differing from IRMOF-3 family 33
 - synthesis of UMCM-1-supported Pd^{II} complexes 42
 - synthetic restrictions 43
 - tubular support 122
- metal–organic polymers 339
- metal-to-metal charge transfer (MMCT) 286, 287
- methanol 135
- methylaromatics 89
- methyl benzoylformate 24
- methylcellulose 375
- 5-methylisophthalate ligands 193
- methyl siloxane 375
- microcantilevers (MCLs) 311
- microelectromechanical systems (MEMS) 311
- microporous adsorbents 167
- microporous metal–organic frameworks (MMOFs) films 136
- microwave-assisted solvothermal synthesis 134
- midazolate-2-carboxaldehyde 33
- MIL-53 179
 - pore structure 182
- MIL-101 6, 7, 28, 29, 112, 124, 201, 202, 222, 240, 323
 - encapsulating nanoparticles 206
 - post-synthetic modification 199
- MIL-88B crystals, growth 131
- MIL-47 pore system 181
 - X-ray powder diffraction patterns 181
- mixed ligands 13–16
 - structure of [Zn₄O(bdc)_x(abdc)_{3–x}] 14, 15
- mixed matrix membranes (MMMs) 143
- mixed metals 13–16
- molecular metal–organic hybrid 4
- molecular sieve membranes synthesis 127–136
 - MOF membranes and films, preparation 129–136
 - zeolite membranes synthesis 128, 129
- molecular sieves 69, 73

- MOF materials as 79–81
- molecular simulation methods 58–60
- in flexible porous solids 58
- monoethanolamine (MEA) process 105
- drawbacks 106
- in post-combustion CO₂ capture 105
- Monte Carlo simulation 57, 59
- multifunctional frameworks 10
- preparation of 13

n

- nanomaterials 251–253
- nanoparticles 256
 - encapsulation 27, 28
 - MOF-supported Pd nanoparticles 28
 - Ru nanoparticles 206
 - synthesis 237, 238
- nanoscale metal–organic frameworks (NOMEs) 252
- 2,6-naphthalenedicarboxylate 35
- natural gas 103
 - CO₂–CH₄ separation, requirements for adsorbents 104, 105
 - CO₂ removal from 103
 - MOFs for CO₂ removal from 113
 - storage for automobile applications 349, 350
- negative thermal expansion 52, 53
- nephrogenic systemic fibrosis (NSF) 252
- nicotinic acid 228
- nitric oxide 228
 - adsorption/desorption isotherm 230
 - insufficient/excess in human body, diseases related 229
 - interacting with available CUSs 230
 - release profiles for Ni and Co CPO-27 230, 231
 - storage 230
- nitric oxide synthase (NOS) 228
- 4,4',4''-nitrilotris(benzene-4,1-diyl)tris(ethyne-2,1-diyl)trisophthalate (ntei) 6
- nitrogen adsorption isotherms 370, 371
- N–O ligand 39
- nucleation–growth mechanisms 143

o

- on-board cryo-adsorptive hydrogen storage. *See also* storage systems, for hydrogen fuel
- hydrogen storage options 152
- material research results 159–165
- metal–organic frameworks, research status 151
- research problem, and significance 151–154

- open metal sites (OMSs)
 - coupling, and polarity gradients in 86
 - high interaction with adsorbate 86
 - useful for enhancing efficiency in 86
- optical imaging 252
- organic amines 69
- organic functional groups 73
- organic ligands 177, 195
- organic lightemitting diodes (OLEDs) 298
- organic linkers 156
- organic polymer films 309
- organic reactions catalysts
 - organic framework linkers, catalytic functionalization 195–198
- organic reactions catalysts, MOF 191
 - with catalytically active metal nodes 191–195
 - encapsulated catalytically active guests 201–206
 - homochiral 198–201
 - mesoporous 206–208
- osmotic ensemble 56
 - isothermal–isobaric ensemble 57
 - pseudoensembles 57
 - restricted, use of 60–62
 - semi-grand ensemble 57
 - uses in molecular simulation 57, 58
- osmotic framework adsorbed solution theory 63, 64
- oxides 13, 30, 69, 131, 216, 252, 318, 326, 340, 343

p

- padding
 - apparatus 361
 - principle 361
- palladium atom 41
- palladium-loaded catalysts
 - catalytic activities 207
- paper sheets 354, 355
- particle spraying 366
 - energy loss 367
- particle-spraying 365
- Pd-based catalyst 28
- Pd-supported MOF-5 28
- permeation. *See also* air purification; immobilization of MOFs
 - in H₂–*n*-C₄H₁₀ binary mixture 126
 - mixed gas permeation 125
 - profiles 126
 - realistic permeation test with vapors 372
 - vs. pressure and temperature 126
 - Wicke–Kallenbach permeation cell with 1:1 mixture of H₂ and N₂ 135

- phenylacetylene 37
 - photoluminescence 270–274
 - piezoluminescence 270
 - polydimethylsiloxane (PDMS)
 - membranes 143
 - poly(ethylene terephthalate) (PET) 88, 374
 - polyethylenimine (PEI) solution 133
 - polyimide 104
 - polymer components 365
 - polymeric binder 374
 - polymeric organo-gels 376
 - polymer–MOF composite 374
 - polyoxometalates 17, 201–203
 - polyoxotungstates immobilization 202
 - polystyrene 88
 - polyvinylpyrrolidone (PVP) 254
 - pore dimensions, for selecting MOFs for
 - sensing applications 312
 - pore size 92, 365. *See also* permeation
 - Knudsen diffusion 125, 126
 - mass transport and separation mechanism as
 - function of 125
 - surface diffusion mechanism 125
 - viscous flow and 125
 - porosity 4–5
 - and conductivity/dielectricity 12
 - and magnetism 10–12
 - porous adsorbents characterization, methods
 - adsorption isotherms, measurements 77
 - Brunauer–Emmett–Teller (BET)
 - equation 78
 - Clausius–Clapeyron equation 78
 - Dubinin–Radushkevich method 78
 - establishment of permanent porosity 77
 - gas chromatographic methods 78
 - monocomponent isotherms 78
 - separation efficiency 78
 - variable-temperature spectroscopic
 - methods 78
 - porous coordination polymers (PCPs) 3
 - [Al(bdc)(OH)] (MIL-53) 15
 - control of structural flexibility 14
 - core–shell system of 16, 17
 - [Cu₃(btc)₂] (HKUST-1) 15, 17
 - design of frameworks, perspectives 18, 19
 - and nanoparticles 17, 18
 - porous flexibility. *See also* flexible porous solids
 - and catalysis 12, 13
 - porous MOFs, in controlled delivery of
 - drugs 222
 - porphyrin functional groups 195, 196
 - post-combustion CO₂ capture
 - MEA process, drawbacks 106
 - MOFs for 113, 115
 - PSA and VSA processes in 106, 107
 - POST-1 synthesis, ligand employed in 199
 - pressure swing adsorption (PSA)
 - systems 99–101, 103, 121, 123. *See also* adsorption
 - basic steps 100
 - characteristics 104
 - and membrane technology 123
 - pure component isotherms and working
 - capacities 100
 - steps 100
 - two-bed system 102
 - proton exchange membrane fuel cells
 - (PEMFCs) 121
 - Prussian Blue compounds 4
 - pure component isotherms,
 - representation 100
 - purified terephthalic acid (PTA) 174
 - 2-pyridinecarboxaldehyde 33, 41
 - pyridine ligands 29
- q**
- quadrupole moment, of CO₂ 85
 - quartz crystal microbalances (QCMs) 311
 - quenching 237, 259, 263, 273, 288, 291, 294, 295. *See also* dynamic quenching; fluorescence quenching; luminescence quenching
- r**
- radioluminescence 270
 - raffinate 100
 - Raman spectroscopy 326
 - Rapid Köthen sheet mold 354
 - real gas law 157
 - reference catalyst 205
 - resins 174
 - response time, of sensor 319
 - rho*-zeolite-like metal–organic framework
 - (*rho*-ZMOF) 203
 - Rietveld refinement 183
 - Ru nanoparticles 206
- s**
- scanning electron microscopy (SEM) 254, 355, 358
 - Al₂O₃ support 123
 - crystals grow on surface of bead 142
 - iodinated NMOFs 261
 - lanthanide nucleotide NMOFs 262
 - MMOF membrane 136
 - of MOF-5 thin films 130
 - sheet 355
 - SIM-1 membrane 135

- ZIF-7 membrane 134
 - ZIF-69 membrane 134
 - secondary building units (SBUs) 129, 154
 - seeding processes 129
 - seeding-supported crystallization 127
 - self-assembled organic monolayers (SAMs) 130
 - carboxylate-terminated areas 131
 - deposition of HKUST-1 silane-based SAMs on 131
 - deposition of MOF-5 crystals 130
 - heterogeneous nucleation 130
 - organosilanes 130
 - oriented growth of MIL-88B 131
 - separation factor 124
 - separation mechanism 125
 - separation processes 100
 - role in 123
 - shaping, for MOFs 239
 - approaches 240, 241
 - chemiluminescence measurements, NO release 241
 - homogeneous powders, pellets, or tablets 240
 - NO-loaded hydrocolloid 241, 242
 - thin films 240
 - Sieverts' method, to determines amount of hydrogen uptake 157
 - silicone resins 375
 - silylation, of OH bridging groups in MIL-53(Al) 39
 - SIM-1 membrane 135, 142
 - simulated moving bed (SMB) technology 174
 - single-crystal X-ray crystallography 4
 - sodalite (SOD) topology 112
 - soft porous coordination polymers 14
 - soft porous crystals 8–10, 54
 - sol–gel chemistry 375, 376
 - sol–gel technique 128
 - solid oxide fuel cells (SOFCs) 121
 - solvent-free aza-Michael condensation 198
 - solvent-resistant nanofiltration (SRNF) 143
 - solvothermal synthesis 130
 - metal carboxylate-based membranes 131, 132
 - microwave-assisted 134, 238
 - shaping 239
 - sorbate–solid interactions 51
 - spin-cross over phenomenon 326
 - π – π stacking interactions 207
 - steam-assisted crystallization 128
 - steam reforming furnace 101
 - steric constraints 181
 - steric effect 73
 - steric restrictions 183
 - Stern–Volmer equation 273
 - storage systems, for hydrogen fuel 101, 151, 152
 - adsorbed hydrogen phase, nature of 162–165
 - development 101
 - from laboratory-scale materials to engineering 165–167
 - MOFs as adsorptive hydrogen storage options 154–156
 - options for on-board applications 152
 - requirements 153
 - structure–hydrogen storage properties correlations 159–162
 - thermodynamic assessment of porous MOFs for 156–158
 - structure-directing agent (SDA)
 - for zeolites 127
 - styrene 88
 - hydrogenation 204
 - substrate surfaces, chemical modifications 136, 137
 - superparamagnetic iron oxides (SPIOs) 252
 - supramolecular structures 339
 - surface acoustic wave (SAW) sensors 311
 - surface diffusion mechanism 125
 - surface engineering 239
 - surface plasmon resonance (SPR) 327
 - syneresis 376
- t**
- terephthalic acid 329
 - 5-tertbutylisophthalic acid 378
 - tetrachloroethene 61
 - tetraethyl orthosilicate (TEOS) 254
 - 2,3,5,6-tetraiodo-1,4-benzenedicarboxylic acid 260
 - thermal drying processes 363
 - thermal expansion coefficients 53
 - thermal stability 6, 15, 73, 178, 316
 - thermogravimetric analysis (TGA) 32
 - thin film growth 320
 - from aged solvothermal mother solutions 320–323
 - assembly 323–325
 - in confined spaces 329–331
 - different methods, comparison of 331
 - electrochemical deposition 325
 - heteroepitaxial growth 328, 329

- liquid-phase epitaxy 325–328
 - thin films metal–organic framework (MOF)
 - manufacture
 - application 137–143
 - limitations 143–146
 - mass transport and separation
 - mechanism 123–127
 - membrane technologies, advantages and limitations 121–123
 - molecular sieve membranes
 - synthesis 127–136
 - toluene
 - alkylation 195
 - in condensation of an aldehyde to 33
 - conversion 195
 - disproportionation 174
 - transesterification reaction, catalytic
 - properties 199
 - transition metals 6, 73
 - nodes 192–194
 - transmission electron microscopy (TEM) 256, 258, 324
 - triboluminescence 270
 - 3-[(trimethylsilyl)ethynyl]-4-[2-(4-pyridinyl)ethenyl]pyridine 35
 - 2,4,6-trinitrotoluene (TNT) 297
 - 1,3,5-tris(3-ethynylbenzonitrile) benzene ligand 26, 27
- u**
- UMCM-1-supported Fe^{III} and Cu^{II}
 - complexes 40, 41
 - UMCM-1-supported Pd^{II} complexes 42
- v**
- vacuum swing adsorption (VSA) 100
 - van der Waals interactions 3, 153, 178, 310
 - vapor-phase transport 128
 - vapor pressure 54, 85
 - vapor test set-up 372
 - Vegard's law 13
 - vehicular hydrogen storage
 - system 152
 - volatile organic compounds (VOCs) 88
 - capture 89, 90
 - Volkswagen Caddy EcoFuel 349
- w**
- waste gas 101
 - water vapor isotherm of $\text{Zn}(\text{bdc})$
 - (dabco)_{0.5} 371
 - Wicke–Kallenbach permeation cell 135
 - Wicke–Kallenbach technique 141
- x**
- xerogels 376
 - X-ray crystal structure, of $\text{Mn}(\text{HCOO})_2$ 81
 - X-ray powder diffraction (XRPD) 32, 109, 133, 253, 270
 - of 30 cycle $[\text{Zn}(\text{BME-bdc})(\text{dabco})_{0.5}]$ deposited on 329
 - one-dimensional structures MOFs 260
 - of thin films of HKUST-1 322
 - xylene isomers separation 88, 173–176
 - limitations 176
 - MOFs properties vs. zeolites 176–178
 - *o*-, *m*- and *p*-xylene 174
 - using MIL-47 and MIL-53 178–185
 - low-coverage gas-phase adsorption properties 179, 180
 - molecular packing 180–184
 - xylene-mixtures, separation of 184–185
- z**
- zeolite adsorbents 104
 - zeolite films preparation 129
 - zeolite imidazolate frameworks (ZIFs) 133
 - zeolite membrane
 - direct nucleation–growth 128
 - synthesis 127, 128
 - limitations 123
 - pore plugging 129
 - secondary growth 129
 - *in situ* synthesis 129
 - variety 128
 - zeolites 23, 24, 52, 73, 221, 355
 - expansion coefficients 145
 - zeolitic adsorbents 180
 - zeolitic imidazolate frameworks (ZIFs) 155
 - zero-order kinetics 178
 - ZIF-8 films, of various thicknesses 323
 - ZIF-69 framework 134
 - ZIF-7 membrane
 - cross-section SEM images of 134
 - ZIF-8 $[\text{Zn}(\text{2-methylimidazole})_2]$ 89
 - zinc imidazolate-based membranes 133–135, 138–141
 - gases, permeances 138
 - zirconia membranes 121
 - ZMS-5 membrane 127
 - Zn-loaded porphyrin ligands 196
 - Zn_4O clusters 6
 - ZSM-5 type membranes 123