



## Index

### **a**

addition polymerization 114, 158  
all-deep eutectic soft battery (AESB) 252, 253  
all-solid-state batteries (ASSBs) 116, 120, 164, 168  
all-solid-state lithium ion battery (ASSLIB) 280  
aluminum current collectors 308  
amide groups as hydrogen bond donors 345  
anion-rich solvation structure 5–6, 10, 11, 31, 36, 39  
anodes stabilization 30–31  
anodic aluminum oxide (AAO) 293, 297  
aqueous zinc metal batteries (AZMBs) 358  
Arrhenius curve 20  
Azo-TbTh film as a separator 380

### **b**

ball milling 290, 292, 354  
battery innovation 239  
battery safety 177, 210, 217, 224, 239, 240, 244, 266, 272, 281, 316, 340, 358, 367, 374, 381  
battery separators 374  
COF 378–380  
HOF 380–381  
MOF 374–377  
Bi@C C CFs composite as SIB anode material 351  
biopolymers, in anode functional layers

cellulose 96  
chitosan 96–98  
sodium alginate 96–98  
biopolymers, in binders  
carboxymethyl cellulose (CMC) 53–54, 67–68  
carrageenan 66  
cellulose (CLS) 63–64  
chitosan (CS) 54–56, 68–70  
citrulline (Cit) 64–65  
gelatin 61–62, 76–78  
guar arabic (GG) 59  
gum arabic (GA) 57–58, 74–75  
lignin 57, 72–74  
pectin 65  
sodium alginate (SA) 56–57, 70–72  
starch 60–61, 75–76  
tragacanth gum (TG) 62–63, 78–79  
trehalose (THL) 64  
xanthan gum (XG) 59–60, 75  
biopolymers, in electrolyte additives  
cellulose 88  
citrulline 89–90  
pectin 90  
trehalose 88–89  
biopolymers in electrolytes  
cellulose 79–81  
chitosan 81–82  
gelatin 85–87  
lignin 82–85  
biopolymers, in separators  
carrageenan 95  
cellulose 91–93



biopolymers, in separators (*contd.*)  
 starch 94  
 bis(trifluoromethylsulfonyl)imide (TFSI)  
 anions 264  
 bivalent ionic conductors 215  
 borate groups function 265

**C**

carbon disulfide (CS<sub>2</sub>) 291  
 carbon nanofibers (CNF) materials 92,  
 93, 297, 298, 315, 323  
 carbon nanotube (CNT) materials  
 293–296  
 carboxylate-based SICs 216  
 carboxylate MOFs 342  
 carboxyl-based HOF materials 344  
 carboxymethyl cellulose (CMC) 53–54,  
 67–68, 161, 246  
 biopolymers in binders 53–54, 67–68  
 carrageenan  
 biopolymers in binders 66–79  
 biopolymers in separators 95  
 catalyst and catalyst supports  
 COF as 371–373  
 HOF as 373–374  
 MOF as 368–371  
 cathode electrolyte interface (CEI) layer  
 5, 7–9, 12–13, 22, 30, 31, 37–39,  
 118, 119, 131, 174, 166, 197, 199,  
 362  
 cathode interface modification 23–24  
 cathodes stabilization 30–31  
 cathode-supported UiO-66@KANF layer  
 363  
 cationic single-ion conductor (SIC) 216,  
 217, 219, 221–227, 229, 230  
 CE-COF@CNT composite 379  
 CEI-forming additives 12–13, 36–38  
 cellulose  
 biopolymers in anode functional layers  
 96  
 biopolymers in binders 63–64  
 biopolymers in electrolyte additives  
 88  
 biopolymers in electrolytes 79–81

biopolymers in separators 91–93  
 cellulose nanocrystals (CNC) 52, 80, 81,  
 88, 129  
 cellulose separators 80, 92  
 chitosan  
 biopolymers in anode functional layers  
 96–98  
 biopolymers in binders 54–56, 68–70  
 biopolymers in electrolytes 81–82  
 citrulline (Cit)  
 biopolymers in binders 64–65  
 biopolymers in electrolyte additives  
 89–90  
 classical molecular dynamics (CMD)  
 simulation 2  
 cobalt nanoparticle-embedded PTCOF  
 oxygen electrocatalysts  
 (CoNP-PTCOF) 371, 372  
 cobalt 2,5-thiophenedicarboxylate  
 coordination polymer (Co-TDC)  
 anode 349  
 COF@carbon nanotube (COF@CNTs)  
 composite material 353  
 complex nitrate-based additives 14–15  
 complex nitro-based additives 15  
 composite electrolytes 128, 168, 214,  
 225, 228, 272–275, 362  
 CoNP-PTCOF 371, 372  
 copolymerization 19, 73, 132, 166, 167,  
 174, 248, 254, 291, 292  
 copper-based metal-organic framework  
 (Cu-MOF-74) 362  
 Coulombic efficiency 14, 16, 69, 81, 92,  
 199, 245, 252, 253, 255, 262, 264,  
 266–268, 274, 275, 279, 280, 289,  
 291, 296, 297, 301, 304, 309, 310,  
 312, 318, 325, 326, 328, 350, 354,  
 377  
 covalent organic frameworks (COFs)  
 201, 205, 206, 225, 341–343, 352,  
 353, 364–367, 372, 378, 379, 381  
 as battery separator 378–380  
 covalent-organic frameworks (COF)  
 materials

as catalyst and catalyst supports 371–372  
 as electrode materials 352–355  
 as electrolytes and electrolyte additives 364–367  
 feature 342  
 types 343–344  
**CPAU** 77  
 cross-linked network gel polymer electrolyte (CNGPE) 253  
 cyanuric acid melamine (MCA) functional layer modification strategy 381

**d**  
 DAAQ-ECOF 354  
 DA cycloaddition reaction 270  
 dead lithium 3, 4, 11, 164, 325, 330  
 deep eutectic solvent (DES) 27, 36, 85, 132, 252, 262, 263, 271, 363  
 density functional theory (DFT) 28, 117, 193, 264, 300, 352  
 desolvation activation energy 65, 90  
 desolvation barrier, reduction of 4, 6  
 diaminotriazine (DAT) 344, 356, 358  
 differential scanning calorimetry (DSC) 2, 74, 194, 257, 270  
 diglycidyl ether of bisphenol A (DGEBA) 265  
 direct method 193  
 DMA@LiTFSI electrolyte 365  
 donor number (DN) solvent 7  
 dual-ion batteries (DIBs) 24  
 dual-network structured self-healing gel polymer electrolyte (DN-SHGPE) 249, 250  
 dual-salt strategy 25

**e**  
 electric double layer (EDL) 12, 32, 89  
 electrochemical deposition 24, 291–293  
 electrochemical impedance spectroscopy (EIS) 266, 275, 281, 347, 364, 365, 375  
 electrochemical stability, PA-based electrolyte 131

electrochemical window 22, 95, 113, 126, 171, 173, 176, 177, 190, 193, 197, 202, 207, 211, 217, 222, 223, 226, 263, 267, 270, 271, 274, 368  
 electrode binders 275–281  
 electrode materials 345  
 COF as 352–356, 364–367  
 HOF as 367–368  
 MOF as 345–351  
 electrolyte additives 1, 11, 30, 39, 52, 87–90, 359–364, 367–368  
 electrolyte decomposition 22, 117, 119, 312  
 electron-deficient Lewis acid 16  
 electrostatic self-assembly 294  
 emulsion styrene-butadiene rubber (ESBR) 110  
 energy storage, POF materials for 340–341  
 entropy-driven solubilization strategy 16  
 epoxy resin (EPR) 156–157, 161–162, 167–170, 223  
 synthetic polymers in electrolytes 167–170  
 synthetic polymers in binders 156–157, 161–162  
 ethoxylated trimethylpropane triacrylate (ETPTA) 28  
 ethyl  $\alpha$ -cyanoacrylate (ECA) 273  
 ethylenediaminetetraacetic acid (EDTA)-modified MOF-808 377

**f**  
 Fe-ZIF-8 374, 375  
 Fe-ZIF-8/PP separator 374, 375  
 fine-tuning agent 1  
 flame retardant 24, 29–32, 35, 39, 107, 125, 129, 134, 135, 139, 145, 155, 161, 164, 171, 176–179, 181, 199, 202, 207, 220, 271, 381  
 fluorinated additives  
 anion-rich solvation structure 5–6  
 high oxidation stability 4–5  
 improvement of safety performance 2  
 reduction of desolvation barrier 4, 6

fluorinated additives (*contd.*)  
 SEI-forming additives 2–4  
 fluorine-rich Covalent Organic Framework (F-COF) 354, 355  
 fluoroethylene carbonate (FEC) 25, 33, 34, 132, 177, 208, 274  
 and glyme 7–8  
 HF gas generation 8  
 incompatibility with other electrodes 8, 9  
 and Lewis base 7, 8  
 loss of impedance 8  
 and other fluorinated electrolytes 6–7  
 recycling issues 9  
 Fourier transform infrared (FTIR) 10, 22, 74, 97, 163, 194, 222, 349  
 freeze-drying 141, 179, 299  
 functional ultrathin separator (FUS) 377

***g***

$\gamma$ -butyrolactone (GBL) solvent 29  
 Garnet electrolytes 212  
 gelatin 60–62, 76–78, 85–87  
 biopolymers in binders 61–62, 76–78  
 biopolymers in electrolytes 85–87  
 gel polymer electrolytes 79, 198, 244, 256, 281  
 glyme, FEC 7–8  
 graphene materials 299–304  
 graphene/phenol formaldehyde resin 303  
 guar arabic (GG) 59  
 biopolymers in binders 59, 75  
 gum arabic (GA)  
 biopolymers in binders 57–58, 74–75

***h***

HATN-XCu electrode materials 350  
 HCPE 273, 274  
 HF gas generation 8  
 hierarchically porous catalytic metal-organic framework (HPC-MOF) 370, 371  
 high concentration electrolyte (HCE) 10, 203

high-conductivity graphene (HCG) 299  
 high decomposition activation energy 18–19  
 high DN value 13, 15, 16  
 high oxidation stability 3–5, 22, 24  
 HOF-based multifunctional cathode catalyst 373  
 HOF-DAT material 356  
 HOF-FJU-1 373  
 HOFs-8 356, 358  
 “host-guest recognition” gel polymer electrolyte (GPE) strategy 361  
 hydrogel electrolyte 80–83, 85–87, 245, 246, 248, 249, 254, 255, 366, 367  
 hydrogen-bonded organic frameworks (HOF) materials advantages 343  
 as battery separator 380–381  
 as catalyst and catalyst supports 373  
 as electrolytes and electrolyte additives 367–368  
 types 343–344  
 hydrothermal methods 86, 299, 300, 305, 368, 376

***i***

IISERP-COF22 355  
 inorganic-rich SEI formation 10–12  
 in situ ion exchange method 193  
 in situ sol-gel method 224  
 in-situ synthesis 86  
 intercalation method 318  
 ionic concentration polarization 215  
 ionic gel electrolyte membranes (IGEMs) 203  
 ionic liquids  
 advantages of 193  
 catalog of 191–192  
 catalyst 196  
 chemical synthesis 194  
 development of 190–191  
 drug delivery 196  
 electrochemistry 194  
 electrolyte 198–206  
 electrolyte additive 197–198

lubricants 195–196  
 organic-inorganic composite 210–215  
 organic solvent electrolyte 206–210  
 separation technology 195  
 synthesis and characterization method  
     of 193, 194  
 $I_2$ @PFC-72-Co cathode 374  
 isosorbide nitrate (ISDN) 14

**j**

JUC-610-CON 372

**k**

Kevlar nanofibers (KANFs) as MOFs  
363

**l**

layer-by-layer self-assembly 96  
 Lewis base, FEC 7, 8  
 lignin  
     biopolymers in binders 57, 72–74  
     biopolymers in electrolytes 82–85  
 lithiophilicity 313, 326  
 lithium battery electrolyte 176, 196, 197  
 lithium bis(trifluoromethanesulfonyl)  
     imide (LiTFSI) 11, 20, 21, 25, 26,  
     131, 132, 159, 173, 174, 176, 177,  
     208, 209, 211, 214, 222, 245, 253,  
     258, 259, 262, 267, 365, 371  
 lithium–carbon dioxide (Li–CO<sub>2</sub>) batteries  
373  
 lithium diallylborate 223  
 lithium garnet 211  
 lithium-ion batteries (LIBs) 1, 339  
 lithium metal  
     compatibility of 32–33  
     protective layer 25, 27  
 lithium–metal batteries 16, 113,  
287–288, 328  
 lithium nitrate 15, 16  
 lithium oxynitride 19  
 lithium plating/stripping 11, 361, 364  
 lithium polysulfide (LiPS/LPs) 13, 78,  
162, 277, 287, 374  
 migration 311

lithium salt 5, 9, 22, 28, 29, 32, 33, 36,  
208  
 dissolution 21, 22  
 lithium salt + solvent 215  
 lithium-sulfur (Li–S) batteries 13, 54,  
161, 277, 302, 304, 305, 312, 314,  
320, 370, 374

localized high-concentration electrolytes  
(LHCE) 10  
 long term durability 53, 75, 114, 377  
 low-dimensional cathode materials  
290–293

composite methods for 290–293

low-dimensional composite anode  
     materials 324–328

nanocomposite lithium metal anodes  
325–327

SEI and failure mechanism 324–325  
 3D-printing anodes 328

low-dimensional composite current  
     collectors

design of 320–322  
 nanocomposite 322–324

low-dimensional composite materials  
288–289

in separators  
     one-dimensional materials 312–315  
     two-dimensional materials 315–320  
     zero-dimensional materials  
310–312

lysine-modified catecholin lignin  
(AL-Lys-D) 72

**m**

MA-BTA@Zn electrode 358  
 mass spectrometry titration (MST) 4  
 $M\text{-E}$ @Celgard separator 377  
 mechanical kneading method 17  
 melt guest-mediated metal–organic  
     framework (MGM-MOF) 363  
 metal–organic frameworks (MOFs) 201,  
212, 341–342, 350  
     as battery separator 374–377  
     materials 341

- metal-organic frameworks (MOFs)  
(*contd.*)
  - as catalyst and catalyst supports 368–371
  - as electrode materials 345–351
  - as electrolytes and electrolyte additives 359–368
  - multipfunctionality 341
  - structural advantage 341
  - types 342
 metal selenide (e.g.  $(\text{CoFe})\text{Se}_2$ )@carbon nanofiber (CNS) composites 350
   
2-methacryloyloxyethyl phosphorylcholine (MPC) 254
   
methoxy polyethylene glycol maleimide (mPEG-MAL) 256–257
   
methylene methanedisulfonate (MMDS) 38
   
 $\text{MgMOF}@\text{PPy}@\text{CC}$  electrode 346
   
Michael addition reaction 162
   
 $\text{Mn-MOF-74-FcA}$  369, 370
   
MOF@CC@PP separator 375
   
molecular transporter 220
   
multi-walled carbon nanotubes (MWCNTs) 313
   
MXene materials 304–309, 318, 326
- n**
- nanocomposite current collectors 322–324
   
nanocomposite lithium metal anodes 325–327
   
 $\text{NCM622//Li}$  batteries with M-E@Celgard separator 377
   
nickel cobaltite/carbon nanofiber ( $\text{NiCo}_2\text{O}_4/\text{CNF}$ ) composites 314
   
 $\text{Ni SA/NOC/Se}$  cathode 349
   
 $\text{NiS/SnO}_2/\text{MOF}$  (NSM) electrode 346
   
nitrile additives
  - cathode interface modification 23–24
  - crystallinity of 28
  - electrochemical window 22
  - electrolyte decomposition 22
  - ionic association, weakening of 24
  - ion transport, facilitation of 20–21
 lithium salt dissolution 21, 22
   
low flammability 22–23
   
low mechanical strength 28
   
plasticization 19–20
   
polymer flexibility 23
   
prone to polymerization 28
   
SEI formation 24
   
 $\text{Zn}^{2+}$  structure 24
   
nitrile and lithium metal compatibility of 25–27
   
incompatibility of 25
   
nitro additive
  - CEI-forming additives 12–13
  - inorganic-rich SEI formation 10–12
  - lithium-sulfur batteries 13
  - in solvation and desolvation structures 9–10
  - water molecules, stabilization of 14
 nitro-C60 derivative 15
   
nitrogen-containing heterocyclic MOFs 342
   
 $\text{NKU-1000}$  material 367, 368
   
 $N$ -methylacetamide (NMA) 253
   
nonpolar sulfur 290
   
non-solvent induced phase separation (NIPS) 224
   
nuclear magnetic resonance (NMR) spectroscopy 4, 194
   
 $N$ -vinyl pyrrolidone (NVP) 113, 114
- o**
- one-dimensional materials in cathode
  - carbon nanofibers (CNF) 297–298
  - carbon nanotube (CNT) 293–296
 one-step printing process 296
   
organic borate-based SIC 217
   
organic-inorganic composite 210–215, 225–228
   
organic nitro additive
  - complex nitrate-based additives 14–15
  - complex nitro-based additives 15
  - high decomposition activation energy 18–19
  - low solubility 15–16

sacrificial additives 17–18  
 organic solvent electrolyte 197, 206–210  
 oxygen evolution reaction (OER) activity  
 369, 371

**p**

PBPE 266, 267  
 PCNF@MoS<sub>2</sub> composite 347  
 pectin  
   biopolymers in binders 65  
   biopolymers in electrolyte additives  
     90  
 PGC 77  
 phosphate ester additives  
   cathodes and anodes stabilization  
     30–31  
   compatibility of 32–33  
   flame retardant 29–30  
   incompatibility with anodes 32  
   solvation structure regulation 31–32  
 physical confinement effects 310, 313  
 plastic-crystalline electrolyte (PCE) layer  
 23, 28  
 polyacrylics (PA)  
   synthetic polymers in anodes 143  
   synthetic polymers in binders  
     111–112, 122–124  
   synthetic polymers in electrolytes  
     131–133  
 polyacrylonitrile (PAN) 20, 38, 80,  
 112–113, 129–131, 139–140, 142,  
 322, 347  
   synthetic polymers in anodes 142–143  
   synthetic polymers in battery separators  
     139–140  
   synthetic polymers in binders  
     112–113  
   synthetic polymers in electrolytes  
     129–131  
 polycarbonate propylene glycol ether  
 (PPCAGE) 219  
 polydopamine (PDA) 305  
 polyethylene glycol (PEG) 22, 56, 132,  
 133, 159, 171, 220, 224, 225, 246,  
 247, 257, 263, 274, 292

poly(ethylene glycol) methyl ether  
   acrylate (PEGA) 262  
 polyethylene oxide (PEO)  
   synthetic polymers in binders  
     158–159  
   synthetic polymers in electrolytes  
     173–176  
 polyethylene terephthalate (PET)  
   synthetic polymers in battery separators  
     178–179  
   synthetic polymers in binders  
     159–160  
 polyethylenimine (PEI) 161  
   synthetic polymers in binders  
     157–158, 162–164  
 polyformaldehyde (POM) 27  
 polyimide (PI)  
   synthetic polymers in battery separators  
     179–180  
   synthetic polymers in binders  
     160–161, 166–167  
   synthetic polymers in electrolytes  
     176–177  
 polylactic acid precursor (PAP) 268  
 polymer flexibility 23  
 polymer-MOF single-ion conducting solid  
   polymer electrolyte (SICSPE) 360  
 polyolefin (PO)  
   synthetic polymers in battery separators  
     136–138  
   synthetic polymers in binders  
     114–115  
 polypropylene (PP) separator 308, 312,  
 374  
 polysulfide (PS) 13  
   redox reactions 319  
   shuttle effect 57–61, 310  
 polytetrafluoroethylene (PTFE)  
 109–110, 117–118, 380  
   synthetic polymers, in binders  
     109–110, 117–118  
 polyurethane (PU) 260  
   synthetic polymers in binders 158,  
     164–165

- polyurethane (PU) (*contd.*)  
   synthetic polymers in electrolytes 170–173
- polyurethane binder (PUB) 277
- polyvinyl alcohol (PVA)  
   synthetic polymers in battery separators 140–141  
   synthetic polymers in binders 111, 119–122  
   synthetic polymers in electrolytes 133–135
- polyvinylidene difluoride (PVDF)  
   synthetic polymers in battery separators 138–139  
   synthetic polymers in binders 108–109, 115–117  
   synthetic polymers in electrolytes 125–129
- polyvinyl pyrrolidone (PVP)  
   synthetic polymers in binders 113–114
- porous networked HAN-Cu-MOF anode 348
- porous organic framework (POF)  
   materials  
   advantages 340–341  
   application in electrode materials 345–359  
   covalent organic frameworks 342  
   hydrogen-bonded organic frameworks 343  
   metal-organic frameworks 341–343  
   PTB-DHZ-COF40 353
- q**  
 quasi-MOF nanospheres 370
- r**  
 radial distribution function (RDF) 22  
 Raman spectroscopy 10, 263, 316, 374, 375  
 reactive ion exchange method 193  
 redox-active hydrogen-bonded organic framework (HOF-HATN) 358, 359
- reversible addition-fragmentation chain transfer (RAFT) polymerization 261, 262
- ring-opening polymerization 85, 158, 160, 168, 292
- s**  
 Seebeck coefficient 256  
 self-extinguishing time (SET) tests 2  
 self-healing hydrogel polymer electrolyte (SHGPE) 245, 246  
 self-healing materials  
   benefits of 240–242  
   chemically bonded 243–244  
   composite electrolytes 272–275  
   electrode binders 275–281  
   gel polymer electrolytes 244–256  
   with multiple repair mechanisms 244  
   overview of 239–240  
   physically bonded 243  
   scaling and commercializing 242–243  
   solid polymer electrolytes 256–271  
   stability and durability of 242  
 self-healing mechanism 124, 244, 245, 250, 252, 256, 261, 263–267, 270, 271, 274, 277, 280  
 self-healing poly(ether-thiourea) (SHPET) 276  
 single-atom catalysts (SACs) 302, 319  
 single-ion conductive 215, 216  
   catalog of 216–217  
   organic 217–225  
   organic-inorganic composite 225–228  
 single-wall carbon nanotube (SWCNT) 301, 313  
 SiO<sub>2</sub>-template method 303  
 sodium alginate (SA)  
   biopolymers in anode functional layers 96–98  
   biopolymers in binders 56–57, 70–72  
 sodium dendrite 250, 380  
 sodium-ion batteries (SIBs) 20, 56, 57, 139, 340, 362  
 sodium sulfide (Na<sub>2</sub>S) 292  
 sodium thiosulfate (Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>) 292

- soft X-ray absorption spectroscopy (sXAS) 22
- solid-electrolyte interphase (SEI)  
and failure mechanism 324–325  
forming additives 2–4, 34–36
- solid polymer electrolytes (SPEs) 19, 112, 201, 256–271, 361  
additives 19–20
- solid state battery electrolyte 197, 258
- soluble styrene-butadiene rubber (SSBR) 110
- solution polymerization 110, 112–114
- solvation structure regulation 31–32
- starch  
biopolymers in binders 60–61, 75–76  
biopolymers in separators 94
- styrene-butadiene rubber (SBR)  
synthetic polymers in binders 110, 118–119
- sulfate ester additives  
CEI-forming additives 36–38  
SEI-forming additives 34–36
- sulfobetaine vinylimidazole (SBVI) 254
- sulfonate-based SICs 216
- sulfonated reduced graphene oxide (SRGO) 315
- sulfonic acid-rich covalent organic framework (SCOF-2) modified batteries 378
- sulfonimide-based SICs 216
- sulfur–carbon mixture cathode 319
- sulfur-reduced graphene oxide (S-rGO)  
cathode 299
- synchro-dry technique 291
- synthetic polymers, in anodes  
polyacrylics 143  
polyacrylonitrile 142–143
- synthetic polymers, in battery separators  
polyacrylonitrile 139–140  
polyethylene terephthalate 178–179  
polyimide 179–180  
polyolefin 136–138  
polyvinyl alcohol 140–141  
polyvinylidene difluoride 138–139
- synthetic polymers, in binders  
epoxy resin (EPR) 156–157, 161–162  
polyacrylics (PA) 111–112, 122–124  
polyacrylonitrile (PAN) 112–113  
polyethylene oxide (PEO) 158–159  
polyethylene terephthalate (PET) 159–160  
polyethylenimine (PEI) 157–158, 162–164
- polyimide (PI) 160–161, 166–167
- polyvinylidene difluoride (PVDF) 108–109, 115–117
- polyolefin (PO) 114–115
- polytetrafluoroethylene (PTFE) 109–110, 117–118
- polyurethane (PU) 158, 164–165
- polyvinyl alcohol (PVA) 111
- polyvinyl pyrrolidone (PVP) 113–114
- styrene-butadiene rubber (SBR) 110, 118–119
- synthetic polymers, in electrolytes  
epoxy resin 167–170  
polyacrylics 131–133  
polyacrylonitrile 129–131  
polyethylene oxide 173–176  
polyimide 176–177  
polyurethane 170–173  
polyvinyl alcohol 133–135  
polyvinylidene difluoride (PVDF) 125–129
- t**
- TAPt-COF material 372
- TCOF-S-Gel electrolyte 366, 367
- terephthalaldehyde (TPA) 257, 265, 380
- thermopower enhancement 256
- three-dimensional covalent organic frameworks (3D COFs) 343
- 3D-printing anodes 328
- Ti-based MOFs 361
- titanium carbide 305
- TpPa-SO<sub>3</sub>Li@PE separator 378
- TQBQ-COF electrode 353
- traditional battery materials, limitations of 339–340

- tragacanth gum (TG) 62–63, 78, 79  
 biopolymers, in binders 62–63, 78–79  
 transmission electron microscope (TEM)  
     5, 12, 15, 38, 128, 349  
 trehalose (THL)  
     biopolymers in binders 64  
     biopolymers in electrolyte additives  
         88–89  
 triazine-cyclotriphosphazene-based COFs  
     (Q3CTP-COFs) 372  
 triethylene glycol dinitrate (TEGDN) 14  
 trifluoroacetate anion (TFA<sup>-</sup>) 16  
 trifunctional furan (TF) 255  
 trifunctional maleimide (TMI) 255  
 triglycidyl isocyanurate (TGIC) 161  
 tris(trimethylsilyl) phosphite (TMSP) 7,  
     30, 31  
 two-dimensional covalent organic  
     frameworks (2D COFs) 343  
 two-dimensional materials  
     in cathode  
         graphene materials 299–304  
         MXene materials 304–309  
     two-dimensional metal-organic  
         frameworks (2D-MOFs) 348
- U**  
 UIO/Li-IL solid-state electrolyte 361  
 ultrasonic-assisted multiple wetness  
     impregnation 291  
 UPy dimers 249, 263  
 ureidopyrimidinone 248
- V**  
 vacuum filtration 299, 306, 308, 312,  
     316, 318
- vapor deposition method 307  
 vertically aligned carbon nanotubes  
     (VACNT) 322  
 Vienna ab initio simulation package  
     (VASP) 22  
 vinyl hybrid silica nanoparticles (VSN)  
     280  
 vinylene carbonate (VC) 9  
 Vogel–Fulcher–Tammann (VFT) curve  
     20
- X**  
 xanthan gum (XG)  
     biopolymers in binders 59–60, 75  
 X-ray photoelectron spectroscopy (XPS)  
     2, 5, 123, 253, 305, 349  
     analysis 2
- Z**  
 zinc-air batteries (ZABs) 80, 134, 246,  
     371, 372, 381  
     with CoNP-PTCOF 371  
 zinc-iodine (Zn-I<sub>2</sub>) batteries  
     with I<sub>2</sub>@PFC-72-Co cathode  
         373–374  
 zinc-ion batteries (ZIBs) 24, 31, 52, 56,  
     62, 63, 65, 79–81, 85–92, 96, 99,  
     118, 140, 244, 255, 264, 304, 359,  
     366, 374  
     cathode materials 355  
 ZnSe@N-PCNFs composites 348  
 Zn<sup>2+</sup> structure 24, 32, 90  
 Zwitt-COF 366  
 zwitterionic covalent organic framework  
     371  
 zwitterionic polymer networks 254