ACN, see activated carbon nanofibers
activated carbon 2, 4, 189, 207, 214, 230, 264–65
activated carbon nanofibers (ACN) 230–31
AFM, see atomic force microscopy
ALD, see atomic layer deposition
amorphous carbons 2, 97, 112, 128, 138
aqueous electrolytes 190, 209, 229–30, 233
asymmetric electrochemical capacitors 267–68
asymmetric supercapacitors 233
atomic force microscopy (AFM) 40, 73, 99, 251, 302–3
atomic layer deposition (ALD) 204
batteries 134, 187–89, 211, 247–48, 250, 252, 254, 256–70, 272
lithium-ion 189
vanadium redox flow 271
Bernal stacking graphene 155–56
biaxial strain 173–74
bilayer graphene 26, 39, 73, 75, 156–57
BLG, see bilayer graphene
C-face graphene 50–53
capacitors conventional 183, 187–89
electrolytic 188
carbon disordered 98, 126, 128
hybridized 164, 183–84, 194, 248
porous 189, 218–19, 224
carbon allotropes 1–3, 79
carbon nanosheets 99, 103–5, 194, 216–17
carbon nanostructures 2, 4, 96, 122, 124, 140, 297
carbon nanotube, unzipping 185, 195
carbon nanotubes 2, 79, 122, 142, 184, 256–57, 263, 266, 302
carbon nanowalls 5, 95–102, 104, 106–12, 114–16, 121–46
potential applications of 121, 134
structural characterization of 121–22, 124
synthesis of 96–97, 99
carbon segregation process 70, 72, 83, 88
catalysts 70, 79, 81, 84, 99, 115, 122–23, 134, 140, 144–46
CCS, see confinement controlled sublimation
charged impurities 25, 27–29
chemical vapor deposition (CVD) 4, 37, 68, 70–71, 84, 96, 99, 185, 191–92, 216, 224, 288, 290, 298, 307
chemically modified graphene (CMGs) 185–86, 195, 197–98, 204, 206
CMGs, see chemically modified graphene
conducting polymers 189, 202, 206, 209, 228–29, 232, 268, 301
<table>
<thead>
<tr>
<th>Term</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>conductive additives</td>
<td>139, 227, 263</td>
</tr>
<tr>
<td>confinement controlled sublimation (CCS)</td>
<td>42, 54–55</td>
</tr>
<tr>
<td>copper</td>
<td>70, 78–84, 86–88, 100, 123, 143, 298</td>
</tr>
<tr>
<td>copper foils</td>
<td>80–82, 86, 192</td>
</tr>
<tr>
<td>copper grain boundaries</td>
<td>84–85</td>
</tr>
<tr>
<td>copper substrates</td>
<td>79, 81, 84–85, 100–1, 111</td>
</tr>
<tr>
<td>CVD, see chemical vapor deposition</td>
<td></td>
</tr>
<tr>
<td>cyclic voltammetry</td>
<td>135, 137, 145, 210, 215, 222</td>
</tr>
<tr>
<td>cyclic voltammograms</td>
<td>135–36, 144</td>
</tr>
<tr>
<td>cycling stability</td>
<td>258, 260–61, 263</td>
</tr>
<tr>
<td>deoxygenation</td>
<td>198–200, 253</td>
</tr>
<tr>
<td>diamond</td>
<td>2, 4, 36, 79, 104, 184</td>
</tr>
<tr>
<td>diamond-like carbon (DLC)</td>
<td>2, 4</td>
</tr>
<tr>
<td>Dirac electrons</td>
<td>55, 280</td>
</tr>
<tr>
<td>Dirac fermions</td>
<td>3, 36</td>
</tr>
<tr>
<td>Dirac point</td>
<td>3, 12, 17, 26–28, 30, 161–62, 170, 175, 281, 283–84, 286</td>
</tr>
<tr>
<td>DLC, see diamond-like carbon</td>
<td></td>
</tr>
<tr>
<td>edge chirality</td>
<td>154–55, 176</td>
</tr>
<tr>
<td>EDL, see electrical double layer</td>
<td></td>
</tr>
<tr>
<td>EELS, see electron energy loss spectroscopy</td>
<td></td>
</tr>
<tr>
<td>EIS, see electrochemical impedance</td>
<td></td>
</tr>
<tr>
<td>energy dispersion, linear</td>
<td>17, 30</td>
</tr>
<tr>
<td>energy storage</td>
<td>4–5, 95, 153, 184, 187, 189</td>
</tr>
<tr>
<td>energy-storage devices</td>
<td>248, 269, 272</td>
</tr>
<tr>
<td>epitaxial graphene, growth of</td>
<td>35–36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56</td>
</tr>
<tr>
<td>EQE, see external quantum efficiency</td>
<td></td>
</tr>
<tr>
<td>equivalent series resistance (ESR)</td>
<td>212, 215</td>
</tr>
<tr>
<td>ESR, see equivalent series resistance</td>
<td></td>
</tr>
<tr>
<td>exfoliation</td>
<td>191, 196, 198, 200, 218, 221, 223, 248–51, 255, 266, 280</td>
</tr>
<tr>
<td>electrical transport</td>
<td>17, 27–29, 101–2</td>
</tr>
<tr>
<td>electrochemical capacitors</td>
<td>187, 189, 226, 264, 268–69</td>
</tr>
<tr>
<td>electrochemical impedance spectroscopy (EIS)</td>
<td>210, 212–13, 215</td>
</tr>
<tr>
<td>electrochemical polymerization</td>
<td>206</td>
</tr>
<tr>
<td>composite</td>
<td>258, 261</td>
</tr>
<tr>
<td>graphene-based composite</td>
<td>258</td>
</tr>
<tr>
<td>porous graphene</td>
<td>269</td>
</tr>
<tr>
<td>electrodes, superconducting</td>
<td>102</td>
</tr>
<tr>
<td>electrolyte decomposition</td>
<td>136</td>
</tr>
<tr>
<td>ionic liquid</td>
<td>218</td>
</tr>
<tr>
<td>electron doping</td>
<td>162</td>
</tr>
<tr>
<td>electron energy loss spectroscopy (EELS)</td>
<td>262</td>
</tr>
<tr>
<td>electronic coupling</td>
<td>156</td>
</tr>
<tr>
<td>electronic devices</td>
<td>95, 107, 121, 280–81</td>
</tr>
<tr>
<td>energy dispersion, linear</td>
<td>17, 30</td>
</tr>
<tr>
<td>energy storage</td>
<td>4–5, 95, 153, 184, 187, 189</td>
</tr>
<tr>
<td>energy-storage devices</td>
<td>248, 269, 272</td>
</tr>
<tr>
<td>epitaxial graphene, growth of</td>
<td>35–36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56</td>
</tr>
<tr>
<td>EQE, see external quantum efficiency</td>
<td></td>
</tr>
<tr>
<td>equivalent series resistance (ESR)</td>
<td>212, 215</td>
</tr>
<tr>
<td>ESR, see equivalent series resistance</td>
<td></td>
</tr>
<tr>
<td>exfoliation</td>
<td>191, 196, 198, 200, 218, 221, 223, 248–51, 255, 266, 280</td>
</tr>
</tbody>
</table>
external quantum efficiency (EQE) 289, 292

few-layer graphene (FLG) 4, 75, 156, 158

few-layer graphene films 70–71, 73–74, 83

FLG see few-layer graphene
turbostratic 156–57

fullerenes 2, 122, 184–85

geometric surface areas (GSA) 144–46

GFs, see graphene foams

GICs, see graphite intercalated compounds
glass substrates 73–74
glassy carbon 126–28
glassy carbon electrode 144
glucose 197
glucose oxidase 309

graphene
activated 266–67
activation of 267
applications of 250, 271
band structure of 13, 38
chemical synthesis of 247–56, 258, 260, 262, 264, 266, 268, 270, 272
conductivity of 26, 28, 159, 217
density of states of 26, 113
disordered 155, 166
doped 160, 283, 286, 289
electronic band structure of 15, 17, 29, 176
electronic properties of 4, 154, 280, 287
electronic structure of 155
epitaxial 26, 35–38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 68, 191
epitaxial growth of 191, 298

exfoliated 69, 76
Fermi level of 21, 160, 287
fluorinated 167–68
fluorination of 167
free-standing 38, 190, 285
high electrical conductivity of 13, 264
high-quality 46–47, 49, 56, 75, 88, 193, 216, 299
hydrogenated 167–68
large-area 67–68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 299
multilayer 4, 38–39, 44–45, 50, 55, 81
nitrogen-doped 265
photocurrent generation in 286–87
photonic absorption of 284–85
porous 265, 269
pristine 154, 159, 162, 164, 168, 174, 185–86, 196, 202, 204, 219, 253, 265, 300, 307
Raman spectroscopy of 155
single-crystal 77, 84–85, 87
single layer 4, 18, 23, 98, 155–59, 172–73, 291
single-layer 2–3, 68, 75, 78–82, 185, 190–91, 247–50, 284–85, 289–90, 298

graphene-based composite materials 186, 202, 233

graphene-based electrode material for LIB 257

graphene-based electrode materials 272

graphene-based materials, development of 232–33

graphene-based supercapacitor 264

graphene devices 279–82, 284, 286, 288, 290, 292
graphene electrodes 264–65, 267, 269
graphene electronics 50
graphene films
- pre-grown CVD multi-layer 86–87
- single-layer 70, 79, 81, 85
- stacked multi-layer 82
- uniform 57
- wafer-scale bilayer 83
graphene flakes 69
graphene foams (GFs) 194
graphene grain boundaries 85–86
graphene grains 80, 84–87
- single-crystal 85–86
  - bilayer 83
  - high-quality 56, 81
graphene islands 40, 51–53, 55
graphene nanoribbons 23, 169, 195–96, 300
graphene nanosheets 230, 248, 257–59, 268
  - freestanding 192
graphene networks 186, 262
graphene nucleation 45, 85–86
  - electrochemical reduction of 253
  - reduction of 197, 250–51
  - thermal treatment of 253, 264
graphene oxide sheets 251, 261, 266, 268, 270
graphene photodetectors 279, 282, 287, 289–91
graphene plasmonics 291
graphene quantum dots 300
graphene ribbons 194
graphene scaffold 260–61
  - exfoliated 112
  - few-layer 71, 84–85, 112, 192, 255, 298
  - free-standing single layer 98
  - oxidized 198, 221–22, 263
  - pristine 216
  - reduced 253, 260
graphene stack photodetector 282, 290
graphene synthesis 73, 190, 194, 270
graphene synthesis methods 68–69
  - direct exfoliation of 248–49
  - exfoliated 255–56
  - pristine 98, 248–49, 303–4
graphite crystals 68
graphite flakes, multilayered 221–22
graphite intercalated compounds (GICs) 254
graphite oxide 4, 68–69, 167, 186, 195, 199, 218, 221–24, 249–50, 254
  - exfoliation of 199, 249–50
  - reduction of 69, 199, 218
  - single-layer 250
graphite sheets, two-dimensional 121–22
graphitic carbons 136, 184
graphitization
  - degree of 128
high degree of 128, 133–34, 144, 146

GSA, see geometric surface areas

high resolution transmission electron microscopy (HRTEM) 44–45, 98, 157

highly oriented pyrolytic graphite (HOPG) 69, 81, 107–8, 112, 127–28, 190, 280

hole transport layer (HTL) 315–16

HOPG, see highly oriented pyrolytic graphite

HRTEM, see high resolution transmission electron microscopy

HTL, see hole transport layer

hydrazine 69, 197, 202, 252, 298, 301, 304

hydrazine reduction 301–2

hydrocarbons 68, 70, 79, 88

polycyclic aromatic 194

indium tin oxide (ITO) 76, 82, 286, 310

ITO, see indium tin oxide

JJA, see Josephson junction array

Josephson junction array (JJA) 103–5

Klein tunneling 3, 22–24, 174

Kohn anomalies (KAs) 160, 162

LEEM, see low-energy electron microscopy

LIBs, see lithium-ion batteries

lithium-ion batteries (LIBs) 5, 121–23, 134–35, 146, 189, 225, 256, 258, 263, 269, 271

low-energy electron microscopy

(LEEM) 41–43, 84

magnetoresistance 105–6

manganese oxide 209–10, 226, 230

MCS, see mesoporous carbon spheres

mesoporous carbon spheres (MCS) 224

nanoelectronics, graphene-based 191

nanographite grains 99

OCV, see open-circuit voltage

open-circuit voltage (OCV) 212, 312–13

optoelectronics 82, 88, 286–87

PAH, see polycyclic aromatic hydrocarbons

PCE, see power conversion efficiency

PECVD, see plasma-enhanced chemical vapor deposition

photocurrent generation 282–83, 287–91

plasma-enhanced chemical vapor deposition (PECVD) 99, 122, 134

plasmon resonance 291–92

polyaniline 229–31, 268

polycyclic aromatic hydrocarbons (PAH) 194

polymerization 206, 228

porous carbon architecture, 3D hierarchical 224

power conversion efficiency (PCE) 311–13, 315

pseudocapacitance 208–9, 221–22, 225, 228, 264, 269

pseudospin 16

Pt catalysts 140–42

Pt loading 141, 144–45
Pt nanoparticles 141–43, 146
QIC, see quantum interference corrections
quantum Hall effect 55
quantum interference corrections (QIC) 24–25
Raman scattering 154–55
reversible hydrogen electrode (RHE) 144–45
RHE, see reversible hydrogen electrode
scanning electron microscope (SEM) 98, 107, 122, 252, 265
scanning tunnelling microscopy (STM) 40–42
SEI, see solid electrolyte interface
SEM, see scanning electron microscope
semiconductors 37, 289, 292
silicon 43, 46–47, 49, 54, 56, 191, 260
silicon carbide 35, 69, 191
solid electrolyte interface (SEI) 135
step bunching 43, 45, 49, 56
STM, see scanning tunnelling microscopy
sulfur 198, 203, 270–71
supercapacitor applications 184, 206, 208, 223, 228, 233, 265
supercapacitor devices 184, 211, 220, 225, 231–32
activated graphene-based 266
supercapacitor electrodes 207–9, 211, 213, 215–17, 219, 221, 223, 225, 227, 229, 231
TEM, see transmission electron microscopy
thermal conductivity 36, 247
thin film transistors 307–8
transmission electron microscopy (TEM) 5, 121–22, 124, 129, 143–44, 250
transparent electrodes 68, 74, 82, 193, 312
trigonal warping of the electronic spectrum 15, 17, 25–26
trilayer graphene, intercalated 163–64
weak localization 24–26
X-ray diffraction (XRD) 141, 143–45, 250, 303
X-ray photoelectron spectroscopy 77, 304
XRD, see X-ray diffraction
zero-bias resistance (ZBR) 109–10, 112–13
zigzag edge 21, 169–72