

Index

a

acetone, gas sensor 128, 129
 ammonia (NH₃), gas sensors 132, 133, 135
 anatase 5, 29, 183, 185, 228, 229
 atomic layer deposition (ALD) 15, 18–21, 77, 94, 175
 avalanche photodiodes 211, 212, 216

b

binary oxide semiconductors 46, 74
 brookite 5, 183

c

capacitive pressure sensors 149
 chemical warfare agents (CWAs) 116, 146–147
 chemiresistive/conductimetric pH sensor 153, 156
 CO₂, gas sensors 131–133
 Co₃O₄, metal oxide solar cells 180–181
 conduction band minimum (CBM) 40, 82, 193
 contact resistance 44, 49, 50, 70, 71, 91, 101, 218
 copper oxides
 metal oxide solar cells 173–179
 p-type metal oxide semiconductors 5–6

p-type TFTs 89–91

cupric oxide (CuO) solar cells 179–180

d

dielectric/channel interface 78, 79, 81, 85, 91, 96–98, 256

diethyl zinc (DEZ) 19

diodes

MIS diodes

 applications 57–58

 Schottky diodes 53–56

self-switching diodes 59–60

 tunneling diodes 56–57

P–N heterojunction diodes

 applications 42–44

 representative devices 40–42

Schottky diodes

 Ga₂O₃ 51, 52

 IGZO 49–51

 working mechanisms 45–46

 ZnO 46–48

doped aliovalent cations 1

dye-sensitized solar cells (DSSCs) 181

 Nb₂O₅ electrodes 189–190

 TiO₂ electrodes 183–186

 ZnO electrodes 186–189

e

e-beam evaporation 21, 22, 94, 181

electric-double-layer effects 256, 262

electroforming/forming 247

- electrohydrodynamic (EHD) jet printing
33
- electrolyte-gated transistors 78, 256, 259,
260, 262
- electron transport layer (ETL)
SnO₂ 194–195
TiO₂ 193–194
ZnO 195–197
- ethanol gas sensor 119, 125, 126
- evaporation, vacuum-based methods
21–23
- external quantum efficiency (EQE) 43,
215, 217
- f**
- fabrication techniques and principles
solution-based methods
0D oxide semiconductors 23–26
1D oxide semiconductors 26–29
2D oxide semiconductors 29–30
3D oxide semiconductors 31–34
vacuum-based methods
atomic layer deposition (ALD)
18–21
evaporation 21–23
sputtering 16–18
- formaldehyde (HCHO), gas sensor 127,
128
- g**
- gain (G) 15, 21, 25, 29, 39, 51, 58, 72, 80,
95, 96, 99–103, 213, 215–218, 223,
224, 236, 257
- gallium oxide (Ga₂O₃)
 n -type metal oxide semiconductors 5
Schottky diodes 51–52
UV photodetectors 222–228
- gas sensors
chemical warfare agents (CWAs)
146–147
environmental pollution gas detection
131–139
explosives detection 141–145
humidity detection 139–141
mechanisms of 116–125
VOCs detection 125–131
- h**
- heteroatom doping 118, 121
- high resistance state (HRS) 246
- hole transport layer (HTL), MOs
197–201
- hydrogen (H₂), gas sensor 54, 143,
144
- i**
- In₂O₃
 n -type metal oxide semiconductors
3–4
- indium–gallium–zinc–oxide (IGZO)
250, 257
thin-film transistors 51
memory 264, 265
Schottky diodes 49–51
- ion-sensitive field-effect transistors
(ISFETs) 154–156
- l**
- light-erasable IGZO memory transistors
264
- light illumination, gas sensor 42, 82,
115, 118, 122, 145, 232
- linear dynamic range (LDR) 218
- liquefied petroleum gas (LPG) 133,
145
- long-term stability 76, 81, 115, 124, 125,
130, 132, 135, 137, 139, 140, 144,
147, 153, 194, 249, 266
- lowest unoccupied molecular orbital
(LUMO) 183, 193
- low resistance state (LRS) 246–247
- m**
- memory applications
resistive random-access memory
245–254
transistor-structured memory devices
254–261
TSAS and OMTs 262
- metal-insulator-semiconductors (MIS)
applications 57–58
Schottky diodes 53–56
tunneling diodes 56–57

- metal oxide functional layers, solar cells
 DSSCs 181–190
 PSCs 191–201
- metal–oxide–semiconductor field-effect transistors (MOSFETs) 67–69, 72, 154
- metal oxide solar cells
 Co₃O₄ 180–181
 Cu₂O 173–179
 CuO 179–180
- metal-semiconductor-metal (MSM)
 photodetectors 211–216, 227, 229, 236
- methane (CH₄)
 explosive detection 141–146
 gas sensor 141
- MOs HTL 197–201
- mobility (μ) 7, 16–21, 32–34, 49, 54, 60, 67, 69–99, 101, 173, 175, 191, 197
- n**
- Nb₂O₅ DSSCs 189–190
- negative bias stresses with light illumination (NBIS) 82
- nickel oxide, *p*-type TFTs 96–98
- NiO, UV photodetectors 234–237
- NiO_{*x*}, *p*-type metal oxide semiconductors 7–8
- NO₂, gas sensor 137
- noble metals, gas sensors 119–120
- noise equivalent power (NEP) 218
- n*-type metal oxide semiconductors
 Ga₂O₃ 5
 In₂O₃ 3–4
 SnO₂ 3
 TiO₂ 4–5
 ZnO 1–2
- n*-type oxide TFTs
 composition 74–76
 history of 72–74
 low power consumption 77–80
 solution-based TFTs 84–89
 stability 81–84
- o**
- n*-octadecyltrichlorosilane (OTS) 81
- 1D oxide semiconductors 26–29
- on-off ratio ($I_{\text{ON}}/I_{\text{OFF}}$) 72
- oxide CMOS 101–103
- oxide NMOS/PMOS 98–101
- oxygen nonstoichiometry 1
- p**
- perovskite quantum dots (PQDs) 264
- perovskite solar cells (PSCs) 171, 191–193, 197, 199
- photoconductors 211–219
- phototransistors 211–213, 216–217
- pH sensors
 ISFET 155–156
 performance characterizations 153–154
 potentiometric 154–155
 working mechanisms 153–154
- piezoresistive pressure sensors 148, 152
- p*-(*i*)-*n* photodiodes 211, 212, 215–216
- plasma-enhanced chemical vapor deposition (PECVD) 67
- P–N heterojunction diodes
 applications 42–44
 representative devices 40–42
- power conversion efficiency (PCE) 173, 175, 179
- pressure sensors
 SnO₂ and TiO₂ 152
 performance characterizations 148–151
 working mechanisms 148–151
 ZnO-based pressure sensors 151–152
- p*-type metal oxide semiconductors
 copper oxides (CuO/Cu₂O) 5–6
 NiO_{*x*} 7–8
 tin monoxide (SnO) 6–7
- p*-type oxide TFTs
 copper oxides 89–91
 nickel oxide 96–98
 tin monoxide 92–96
- pulsed laser deposition (PLD) 73, 120, 171, 179

r

reference electrode (RE) 153
 relative humidity (RH) 139
 resistive random-access memories (RRAMs)
 performance characterization 248–249
 representative devices 249–254
 resistive switching mechanisms 246–248
 response time/response speed 217
 responsivity (R) 43, 57, 58, 214, 217–222, 224–229, 233–238
 Rh-doped WO_3 sensors 143
 rocksalt (B1) 2
 rutile 3, 5, 23, 25, 29, 152, 183, 192, 228

s

Schottky barrier height (SBHM) 45, 57
 Schottky diodes
 Ga_2O_3 51–52
 IGZO 49–51
 metal–insulator–semiconductors (MIS) 53–56
 working mechanisms 45–46
 ZnO 46–48
 Schottky photodiodes 211–214, 218
 self-assembled monolayer (SAM) 81
 semiconductor memories 245, 246
 sensors
 gas sensors
 chemical warfare agents (CWAs) 146–148
 environmental pollution gas detection 131–139
 explosives detection 141–146
 humidity detection 139–141
 mechanisms of 116–125
 VOCs detection 125–131
 pH sensors
 chemiresistive/conductimetric method 156
 ISFET 155–156
 performance characterizations 153–154

 potentiometric 154–155
 working mechanisms 153–154
 pressure sensors
 performance characterizations 148–151
 SnO_2 and TiO_2 152
 working mechanisms 148–151
 ZnO-based pressure sensors 151–152
 signal-to-noise ratio (SNR) 216, 217
 solar cell
 metal oxide functional layers
 DSSCs 181–190
 PSCs 191–201
 metal oxide solar cells
 Co_3O_4 180–181
 Cu_2O 173–179
 cupric oxide (CuO) 179, 180
 principles 172–173
 solution-based methods
 0D oxide semiconductors 23–26
 1D oxide semiconductors 26–29
 2D oxide semiconductors 29–30
 3D oxide semiconductors 31–34
 specific detectivity (D^*) 216, 217, 227, 267
 sputtering 15–19, 21, 22, 41, 51, 61, 73, 74, 79, 81, 90, 92–94, 132, 155, 171, 175, 179, 181, 187, 199, 200, 219, 221, 224, 229, 258
 subgap states (SBGs) 82
 subthreshold swing (SS) 17, 70, 72, 74, 78, 80, 81, 90, 94–96

t

3D oxide semiconductors 31–34
 threshold voltage (V_{TH}) 40, 41, 51, 69–72, 81, 88, 89, 94, 97–99, 101, 254, 255, 258, 259, 264
 thin-film transistors (TFTs)
 circuit applications
 oxide CMOS 101–103
 oxide NMOS/PMOS 98–101
 device structures and mechanisms 68–72

- n*-type
 - composition 74–76
 - history of 72–74
 - low power consumption 77–80
 - solution-based TFTs 84–89
 - stability 81–84
 - p*-type
 - copper oxides 89–91
 - nickel oxide 96–98
 - tin monoxide 92–96
 - tin dioxide (SnO₂)
 - ETLs 194–195
 - n*-type metal oxide semiconductors 3
 - UV photodetectors 232–234
 - tin monoxide (SnO)
 - p*-type TFTs 92–96
 - p*-type metal oxide semiconductors 6–7
 - titanium dioxide (TiO₂)
 - DSSCs 183–186
 - ETLs 193–194
 - n*-type metal oxide semiconductors 4–5
 - UV photodetectors 228–231
 - toluene, gas sensor 129, 130
 - transistor-structured artificial synapse (TSAS) 262
 - transistor-structured memory devices
 - representative devices 256–261
 - working mechanisms 254–256
 - turn-on voltage (V_{ON}) 42, 45, 60, 70, 72, 76, 220, 235
 - 2D oxide semiconductors 29–30
- U**
- ultraviolet (UV) photodetectors
 - device structures
 - avalanche photodiodes 216
 - MSM photodetectors 214–215
 - photoconductors 212–214
 - phototransistors 216–217
 - p*-(*i*)-*n* photodiodes 215–216
 - Schottky photodiodes 214
 - materials and performance
 - gallium oxide (Ga₂O₃) 222–228
 - tin dioxide (SnO₂) 232–234
 - TiO₂ 228–232
 - WO₃ 231–232
 - zinc oxide 218–222
 - NiO_x 234–237
 - parameters of 217–218
- V**
- vacuum-based methods
 - atomic layer deposition (ALD) 18–21
 - evaporation 21–23
 - sputtering 16–18
 - valence band maximum (VBM) 6, 7, 40, 82, 264
 - volatile organic compounds (VOCs)
 - detection 125–131
- W**
- wafer-based Cu₂O solar cells 175
 - WO₃, UV photodetectors 231–232
 - wurtzite (B4) 2, 25
- Z**
- zero- V_{GS} 99
 - zero-dimensional (0D) oxide
 - semiconductors 23–26
 - zinc blende (B3) 2
 - zinc oxide (ZnO)
 - DSSCs 186–189
 - ETLs 195–197
 - gas sensors 120
 - n*-type semiconductor 1–3
 - p*-*n* heterojunction diode 39–44, 58
 - pressure sensors 151–152
 - Schottky diodes 46–48
 - UV photodetectors 218–222

