

# Index

- absorption coefficient 136–137, 141, 251, 274  
acetonitrile 106–107, 109  
acetylacetone 36  
active pharmaceutical ingredients (APIs) 153, 158, 163  
actuators  
  piezoelectric 226, 228  
  pneumatic 341, 343, 345, 348  
adhesion 38, 49–50  
adhesive tests 34, 38, 47–49, 51–52, 34, 38, 47–49, 51–52  
adipose cells 174, 177, 179, 182–183, 185  
adipose contents 184–185  
airborne ultrasonic Doppler  
  method 225–229  
airborne ultrasonic transducer 213, 225–228, 230  
airborne ultrasound 218–219, 221, 225  
allergens 92, 94, 124–126  
  airborne 91–92  
allergies 36, 91–92  
allergy 36, 51, 54  
Amarastelline A 103, 105–106  
amoxicillin trihydrate 160–162  
antibodies 27, 63–64, 66, 70, 92, 94–96, 118, 121, 123  
antigen-antibody reactions 57, 63  
antigens 20, 27, 64–66, 92–93, 118, 120–121, 124  
antisera 64–66  
APIs, *see* active pharmaceutical ingredients  
artifacts 188, 191–195, 292, 295, 299, 306–307, 313  
artificial heart 355–356  
asthma 92, 124  
atomic number, effective 293  
  
basic pixel structures 234–235, 237, 239, 241  
basophil activation test (BAT) 125  
basophils 120, 124–125  
BAT, *see* basophil activation test  
bio-imaging 261–262, 264, 266, 268, 270, 272, 274  
biocompatibility 51, 54–55, 51, 369–370  
biocompatible 33, 35–36, 54  
biological materials 60  
biological substances 19, 61  
biomaterials 68–69, 76, 81, 91, 103, 341  
biomedical applications 83, 233–234, 236–238, 240, 242, 244, 246–250, 252, 254, 256  
biomolecule detection 20, 29  
biomolecules 17, 19, 27, 29  
biosensing 1, 4–5, 12, 19, 59  
biosensors 1–4, 6, 8, 10, 12–13, 17–19, 21–24, 27, 29, 57–58, 60, 76, 81, 92, 94  
based on FETs containing nanostructures 17–28  
based on SETs 19, 24–25  
based on silicon photonics 57–84

- electrical/electrochemical 2–3
- electrochemical 2
- mite allergen 91, 93–94
- ring resonator 60, 69
- blood 7, 57–58, 125, 142, 199, 361
  - arterial 134–135
  - peripheral 120, 125
- bones, separation of 297, 299–300, 304–305, 313
- BP-related osteonecrosis of the jaw (BRONJ) 214–215
  - development of 214–215, 217
- breast 172, 185–186, 188, 190, 192, 195, 197, 199–203
  - breast cancer 171–173, 175–177, 179, 181, 183, 199, 202–203
  - histopathological and dielectric characteristics of 172–183
- breast cancer detection 185
- breast cancer detector 187–188, 197, 200–201
- breast cancer screening 171–204
- breast cancer tissues 171–172, 185
  - dielectric characteristics of 171–172
- breast skin 188, 191, 203
- breast tissues 172, 178–179, 199–200
  - dielectric properties of 176, 184
  - malignant 176
  - normal 184–185
  - photograph of excised 200
- breast tumors 201
- BRONJ, *see* BP-related osteonecrosis of the jaw
- CAD, *see* computer-aided diagnosis
- CAD system, performance verification of 335
- calmodulin 104, 111–113
- cancer 57, 172, 177, 179–183, 185–186, 313
  - early detection of 57–58
- cancer cells 121, 174, 177, 182–185
- cancer surgeries 199
- canthin-5,6-dione 104–105, 109, 112
- canthin-5,6-dione derivatives 106–107, 109
- carcinomas 177, 179, 185
  - papillo-tubular 173–174
- caries 6, 10–11, 293
  - detection 1, 10–11
- catalyzation 33, 35–36, 39–40, 51–53, 35–36, 39
- catalyzation-treated silks 39–40
- CdTe 279, 282–291
- chloroform 106–107, 109
- chronic spontaneous urticaria (CSU) 125
- CMOS, *see* complementary metal–oxide–semiconductor
- CNNs, *see* convolutional neural network
- compactness 51
- complementary metal–oxide–semiconductor (CMOS) 79–81, 233, 282
- composites 34, 37–39, 43, 47–54
- computed tomography (CT) 253, 288, 297, 305–306, 308, 310–311, 313
- computer-aided diagnosis (CAD) 297–298, 300, 302, 304, 306, 308, 310, 312–313, 319–323, 325, 335, 337
- continuous wave (CW) 136, 153, 156, 251
- continuous-wave spectroscopy (CWS) 135, 137–139, 141

- contrast agents 292  
 convolutional neural network (CNNs) 298–299, 310, 312  
 corrosion 34, 36, 49–52, 54, 49, 51  
 corrosion resistance 34, 36, 49, 51–52, 54, 36, 51–52  
*CSU, see chronic spontaneous urticaria*  
*CT, see computed tomography*  
*CT colonography* 308  
*CW, see continuous wave*  
*CWS, see continuous-wave spectroscopy*
- DCIS, *see* ductal carcinoma in situ  
 density functional theory (DFT) 158–159  
*DFD, see* digital frequency domain  
*DFG, see* difference frequency generation  
*DFT, see* density functional theory  
 dielectric materials 4, 183  
 difference frequency generation (DFG) 153–154  
 differential ring resonator biosensor 60, 71, 73, 75  
 digital frequency domain (DFD) 243, 245  
 displacement sensors, non-contact 361  
 dots-on-nanowire memory 21–22  
 ductal carcinoma in situ (DCIS) 173–174, 199, 202
- EB, *see* electron beam  
*EFB, see* epitaxial film bonding  
 electrical conductivity 34, 36, 46, 48, 51, 34, 46, 51
- electroless plating 33–35, 52–53, 55, 33–35  
 electron beam (EB) 18, 20, 61, 261, 263–265, 270–274  
 excitation 261–263, 265, 269  
 irradiation 265, 271–272  
 transmission 272–273  
 transmittance 271–272  
 electrons 3–4, 19, 23, 28, 37, 237, 240, 249, 269–271, 280–281, 285–286  
 emulsify 35  
 enzymatic precipitation method 91, 93, 96–97, 99–100  
*epitaxial film bonding (EFB)* 83–85  
*EXA microscope* 261, 265–269, 271–273  
*exosomes* 57–58  
*extracorporeal circulation* 355, 358–359
- FBP, see* filtered back-projection  
*FD, see* floating diffusions  
*FETs, see* field-effect transistors  
 field-effect transistors (FETs) 2, 17–22, 24, 26, 28–29, 58–59  
 nanowire 18–23, 29  
*field-programmable gate array (FPGA)* 252, 320, 335–336  
*filtered back-projection (FBP)* 305–306  
 first stage 43, 47–48  
*flat panel detectors (FPDs)* 281–282  
*FLI, see* fluorescence lifetime imaging  
*FLIM, see* fluorescence lifetime imaging microscopy  
*floating diffusions (FD)* 242, 252

- fluorescence 104, 106–108, 110–112, 242–243, 246–247, 264
- fluorescence lifetime imaging (FLI) 242–243, 245
- fluorescence lifetime imaging microscopy (FLIM) 234
- fluorescent natural compounds 103–106, 108, 110, 112
- fluorescent sensors 103–104, 106–108, 110, 112
- fluorophore 103–104, 109, 111–112, 243
- Fourier-transform infrared spectroscopy (FTIR-SPR) 126–127
- FPDs, *see* flat panel detectors
- FPGA, *see* field-programmable gate array
- fruits, non-contact hardness measurement of 218–219, 221
- FTIR-SPR, *see* Fourier-transform infrared spectroscopy
- fullerenes 27–28
- gold 95, 117–118, 120, 122, 127, 271–273
- gold film 118, 123, 126–127, 271–273
- GPC, *see* gutta-percha cone
- grain size 41, 43, 48, 51, 55
- gutta-percha cone (GPC) 293, 295
- HDM, *see* house dust mite
- HDM allergens 92, 97–100  
airborne 92, 94, 96, 98, 100
- high-resolution optical microscopy 261–274
- horse radish peroxidase (HRP) 91, 97
- house dust mite (HDM) 92–93, 96
- HRP, *see* horse radish peroxidase
- hypersensitivity, immediate type 124–126
- I-TOF measurement 248–249
- IDC, *see* invasive ductal carcinomas
- imaging
- confocal 187–188, 191–192
  - confocal microwave 171, 185–187, 189, 191–193, 195, 197, 199, 201
  - fluorescence lifetime 242–243, 245
  - medical 288, 310, 313
  - radar-based 185, 187–188
  - SPR 117, 120, 122–123, 126–127
  - time-lapse 268–269
  - time of flight 247–249
- imaging devices 279, 282, 287–288, 295
- immunosensor 91–100
- infrared spectroscopy 126, 251, 253, 255
- Internet of Things (IoT) 12–13
- invasive ductal carcinomas (IDC) 173–174, 199, 202
- ion-sensitive field-effect transistor (ISFETs) 3–7, 11, 18, 21, 29
- IoT, *see* Internet of Things
- ISFETs, *see* ion-sensitive field-effect transistor
- keratinocyte growth factor (KGF) 214, 217–218
- KGF, *see* keratinocyte growth factor
- kiwifruit 218–220, 222

- L-Asn monohydrate 164–165  
*LAPS*, *see* light-addressable potentiometric sensor  
 laser Doppler velocimeter (LDV) 218–219, 225  
*LDV*, *see* laser Doppler velocimeter least significant bits (LSB) 192, 197  
 lesions 173, 214, 216, 298, 303–304, 307–309, 313  
 light-addressable potentiometric sensor (LAPS) 4  
*LIPUS*, *see* low-intensity pulsed ultrasound  
 liquid biopsy 7–8  
 living cell analysis 120–121, 123, 126  
 low-intensity pulsed ultrasound (LIPUS) 214–215  
*LSB*, *see* least significant bits  
 lung nodules 300, 305–306, 308–311  
 detection 300, 308, 310–311  
  
 machine learning 13, 298–299, 313  
 macro-imaging 242–243, 245, 247  
 maglev VADS 357, 359, 364, 370  
 magnetic bearings 355, 357, 359, 361–363, 365, 367, 369–370  
 passive 359–361  
 magnetic coupling 357, 359, 362, 368  
 magnets, permanent 359, 361–362, 364, 368  
 massive-training artificial neural networks (MTANNs) 299–313  
 mast cells 120, 124  
 mastectomy 197, 199–200, 202  
  
 medical image processing 297–313  
 metal oxide electrodes 4–5  
 metal oxides 1–6, 8, 10, 12–13  
 metallization 33–39, 41–49, 51–53, 34–35, 37–39, 41–44, 46–49, 51–52  
 sc-CO<sub>2</sub>-assisted 36, 41–42, 45–46, 48–49  
 metallize 34  
 methanol 106–107, 109–110  
 microwave imaging 171–172, 186, 202–203  
 for breast cancer screening 171–204  
 microwave inverse problem 202–203  
 microwave tomography 185, 202–203  
 microwaves 152, 175–176, 186  
 middle molecular weight (MMW) 152–153, 160  
 miniaturization 13, 135, 147, 359, 362  
 minimally invasive surgery (MIS) 341–352  
 minimally invasive surgery, robotics in 341–352  
*MIS*, *see* minimally invasive surgery  
*MLP*, *see* multilayer perceptron  
*MMW*, *see* middle molecular weight  
*MMW pharmaceuticals* 160–161, 165  
*MTANNs*, *see* massive-training artificial neural networks  
 multilayer perceptron (MLP) 298–299  
 multiple-phase sampling 234  
  
 narrow-band imaging (NBI) 319–320, 327

- natural orifice transluminal endoscopic surgery (NOTES) 351
- NBI, *see* narrow-band imaging
- near-infrared spectroscopy (NIRS) 133–136, 138, 140, 142, 144–147, 234, 251–252
- NEE, *see* neural edge enhancer
- Neocognitron 298–299, 312
- neural edge enhancer (NEE) 299, 307–308
- neural filters 298–300, 313
- neural network (NN) 298
- NIRS, *see* near-infrared spectroscopy
- NN, *see* neural network
- non-contact measurement technique 213–214, 216, 218, 220, 222, 224, 226, 228, 230
- non-lesions 298, 304, 308–309
- non-nodules 308–310
- NOTES, *see* natural orifice transluminal endoscopic surgery
- nuclei 43, 46
- nucleic acids 6–8 detection 1, 6–9
- optical absorption coefficient 135, 137
- optical fiber SPR sensors 123–124
- optical ring resonator biosensor 60–61, 63, 65, 67
- oranges 218–219
- organometallic 33, 35–36
- oximetry 133–146
- oxygen saturation 134, 137, 142, 145, 147, 254
- palladium 33, 36, 54
- peptides 104, 111–113
- permittivity 82, 175–176, 181, 183–184, 203
- complex 174, 176, 179, 185
- effective 183, 185, 190
- pharmaceuticals 152–153, 157, 160, 163–165
- phase contrast microscope 266–268
- phase-modulated spectroscopy (PMS) 136–138
- photocurrent 79–81, 154, 234, 249
- photodetectors 59, 78, 80, 85, 243
- photodiode 59, 78–81, 118, 137, 254
- photon-counting 279–280, 283–285, 289
- photon-counting imaging devices 290–291
- photon-counting signal processing 282, 285, 287
- photon-counting X-ray imaging devices 282, 293–294
- photonic crystal resonator biosensor 76–77
- photons 136, 139, 240, 279–280, 282–283, 285, 295
- photoresist 81
- platinum 36, 39, 54–55, 36, 39
- PMS, *see* phase-modulated spectroscopy
- pneumatic servo systems 345, 347
- polarization 38, 49–51
- polarization curves 38, 49–50
- potentiostat 38
- prostate-specific antigen (PSA) 18, 20, 26–27, 58, 66–68, 70–72, 74, 78
- immunodetection of 25, 27, 29
- protein 2, 19–20, 58, 63, 66, 70, 95, 111, 123, 262

- protons 1, 3–4, 6–7, 9–10  
*PSA, see prostate-specific antigen*
- refractive index (RI) 61–62, 69, 117–118, 120, 122–123, 127, 274  
 reliability 51–52  
 ring resonators 61, 68–69, 71, 76, 85  
 rings 59–60, 72, 76  
 robots 248, 341–342, 348–349, 351–352  
   master-slave 341, 348–349  
 robustness 34  
 rolling circle amplification 8–9
- SAB, *see* surface activated bonding  
 SBF, *see* simulated body fluid  
 sc-CO<sub>2</sub> 33–37, 39–46, 48–49, 51–52  
 second stage 43, 46–48  
 semiconductor detector 281, 283–287  
 sensors  
   fluorescent 103, 105, 108–109, 112  
   PhC resonator 77–78  
   silicon photonics technology 81  
   silk 33–34, 36–44, 46–54  
   simulated body fluid 38  
   simulated body fluid (SBF) 38–39, 49–51  
   SiN waveguide 79–81  
   single-electron transistors 17, 19  
   single-photon avalanche diode (SPADs) 233, 248, 251  
   single-port access surgery (SPA) 351
- slot ring resonator biosensor 68–69  
 solid-tubular carcinomas 173–174  
*SPA, see* single-port access surgery  
 SPADs, *see* single-photon avalanche diode  
 spatially resolved spectroscopy 136–139, 141, 234, 254  
*SPR, see* surface plasmon resonance  
 SPR sensor chip 118, 121, 126–127  
 SPR sensors 118–121, 126–127  
 SPRI sensors 118–127  
 stimulated Raman spectroscopy 234, 251, 253, 255  
 storage diodes 49, 240, 242, 252  
 strawberries 218–219  
 stroma cell 174, 177, 185  
 super-resolution microscope 262–263, 265, 274  
 supercritical carbon dioxide 33–34  
 support vector machines (SVMs) 298, 319, 321–325, 330, 337  
 support vectors 321, 324, 328, 334–335  
 surface acoustic wave  
   immunosensor, reusable 94–95  
 surface activated bonding (SAB) 83  
 surface plasmon resonance (SPR) 58–59, 117–118, 120, 122, 124, 126–128  
 surfactant 35–37, 41  
 surgical robots 341–342, 348–349, 351  
 SVMs, *see* support vector machines
- TCSPC, *see* time-correlated single-photon counting

- textile 33–34, 36–38, 40, 42, 44, 46, 48, 50, 52–54
- THz laser spectrometer 151–166
- time-correlated single-photon counting (TCSPC) 233
- time of flight imaging for biomedical applications 247, 249
- time-resolved CMOS image sensors 233–256
- time-resolved spectroscopy (TRS) 136–138
- tissue oxygenation 135, 137
- tissue sensing adaptive radar (TSAR) 186
- tissues 133–138, 140, 142, 144–147, 175–177, 179, 182–187, 199, 251, 253
- adipose 177, 179–185, 197, 199–200
- biological 134, 175
- cancer 174, 177, 179, 181, 183–185
- gingival 216–217
- glandular 174, 184
- normal 171–172, 176, 181, 184, 199
- soft 173, 297, 300, 305, 313
- stroma 181–183
- tumor 176–177, 183, 199
- total sensing system 78–79, 81, 83
- TRS, *see* time-resolved spectroscopy
- TSAR, *see* tissue sensing adaptive radar
- tumor 172, 176, 184, 199–202, 332–333
- ultrasonic transducers 213–230
- ultrasound 214, 216
- ultrasound therapy 214–215, 217
- VADs, *see* ventricular assist devices
- ventricular assist devices (VAD), disposable 355, 366–369
- ventricular assist devices (VADs) 355–362, 364, 366, 368–370
- implantable 362, 366
- wafer bonding (WB) 83
- water 38, 59, 68, 74–75, 97, 106–107, 109–110, 134, 178
- WB, *see* wafer bonding
- wearable devices 34–35
- X-ray 38–41
- X-ray diffraction (XRD) 38–41, 157–158, 161
- X-ray films 280
- X-ray image tube 281
- X-ray imaging 279–281, 284, 286–289, 291, 295
- high-performance 288–293
- X-ray mammography 171–172
- X-ray photons 279, 282–283, 285–286, 288
- XRD, *see* X-ray diffraction
- Young's modulus 81–82, 228