

## Index

### a

- AB monomer self-condensation method 139
- acid-base interaction theory 158
- acid etching modification 177, 179–183
- adsorption theory 157
- A-glass fibers 108
- airborne radomes 236, 237, 243, 278–279
- aircraft radomes 141, 244, 249, 277–278
- 3-aminopropyltriethoxysilane (APTES) 192
- aramid fibers
  - preparation 123–124
    - dry spinning 124
    - dry spraying-wet spinning 124–125
    - wet spinning 124
  - properties 122
    - chemical stability 127
    - dielectric properties 127
    - flame retardant 127–128
    - mechanical properties 127
    - thermal stability 127
    - UV resistance 128
  - structure of 125
    - crystalline structure 126
    - fibril structure 126
    - fold structure 126
    - skin-core structure 125–126
  - types 121
    - heterocyclic 123
    - meta-aramid fibers 121–123
    - para-aramid fibers 121, 122
- aromatic polyamide fibers 120
- aromatic polyamides, preparation of 123–124
- atomic force microscopy (AFM) 164, 166
- atomic polarization 24

### b

- bag molding
  - pressure bag molding 250
  - vacuum bag-autoclave molding 250–251
  - vacuum bag molding 248–250
- benzoxazine (BOZ) 60, 69, 76
- biomass membranes 190
- bismaleimide (BMI) resins 78
  - allyl compounds 59
  - diamine chain extension 58–59
  - flexible long-chain segments 60
  - rubber elastomers 59
  - thermoplastic resins 59–60
  - thermoset resins 60
- bisphenol A type cyanate (BADCy) resins 70–72, 82–86, 164, 171, 175, 177, 201, 205, 253

### c

- C-glass fibers 108
- chemical bonding theory 158
- chemical grafting method 187
- chemical grafting modification 186–187
- chemical modification 177, 184, 186
- Clausius-Mossotti equation 23–27
- coating modification 184–196
- complex salt polymerization method 138
- contact angle method 161–164
- coupling agent treatment 184–186
- crystallography theory 113
- curing
  - molding process 243
  - RTM 257
  - winding process 263
- cyanate ester (CE) resins 26, 67–72, 184, 279
- cyanate resins 81

cyanate resins (*contd.*)  
 $\epsilon$ -fillers 82–83  
 structural modification 83–86

**d**

density flooding theory (DFT) 168  
 4,6-diamino-1,3 resorcinol hydrochloride  
 (DAR) 137  
 dielectric parameter equations,  
 wave-transparent materials  
 Clausius-Mossotti equation  
 atomic polarization 24  
 electron polarization 23–24  
 interfacial polarization 25–26  
 ion polarization 24–25  
 Maxwell-Garnett equation 26  
 orientated polarization 25  
 Lichtenecker equation 27  
 Maxwell-Garnett equation 26–27  
 diffusion theory 157–158  
 dipole polarization 25, 67  
 dopamine (DA) 190  
 dry molding 245–247  
 dry spinning 124, 128, 133–134  
 Dyneema fibers 134

**e**

E-glass fibers 5, 107–109  
 electromagnetic wave transmission 1, 5,  
 21, 26  
 electro melting process 117–118  
 electron polarization 23–24  
 environmental resistance properties 9  
 epoxy resins  
 curing agent 73  
 design and preparation 73  
 $\epsilon$  value 73  
 low  $\epsilon$  compounds, fillers or fibers 73,  
 75–78  
 polymer matrix 51–54

**f**

fabrication technology 110  
 fiber indentation/ejection test 172–174  
 filament winding 258  
 characteristics 263–264  
 classification of  
 dry winding 258–259  
 semi-dry winding 259  
 wet winding 259  
 winding process 261  
 curing 263  
 demolding 263  
 equipment inspection and program  
 input 261  
 gypsum core mold installation 262

impregnating and winding 262–263  
 metal core mold installation 262  
 polymer glue preparation 261  
 raw materials preparation 261  
 water-soluble core molds 262  
 winding rules 259  
 helical winding 260  
 hoop winding 260  
 longitudinal winding 260  
 5G communication radomes 237, 282–283,  
 285  
 flame melting process 118  
 flexible long-chain segments 60  
 Fourier transform infrared spectroscopy  
 (FT-IR) 160, 161

**g**

gel spinning-super-stretching method  
 132–134  
 gel time of the polymers 246  
 glass fibers 5, 107, 283  
 high-alkali glass fibers 108  
 with high elastic modulus 109  
 with high silica content 110  
 with high strength 108–109  
 with low  $\epsilon$  values 109–110  
 medium-alkali glass fibers 108  
 non-alkali glass fibers 107–108  
 preparation 110–112  
 properties of 108, 113  
 chemical stability 114  
 electrical insulation and dielectric  
 properties 113  
 heat-insulating properties 113  
 tensile strength 113  
 structure of 112  
 crystallography theory 113  
 irregular network theory 112–113  
 types 107  
 glue content 246, 247, 251, 252, 254, 262,  
 263  
 ground radomes 281  
 gypsum core mold 262

**h**

hand paste molding 244  
 features 248  
 polymer matrix 247  
 reinforced fibers 247  
 release agents 247–248  
 types 245–247  
 heat resistant properties 9  
 helical winding 260  
 heterocyclic aramid fibers 123  
 high alkali glass fibers 107, 108

high-energy ray modification 183, 198  
 high frequency plasma melting process 118  
 high Q cavity method 29–31  
 horseradish peroxidase 194

## **i**

impregnating 243, 244, 249, 262–263  
 injection-compression molding 255  
 injection pressure 256, 257  
 injection temperature 256, 257  
 inorganic fibers 107  
   glass fibers 107–114  
   quartz fibers 114–120  
 interfaces  
   acid-base interaction theory 158  
   adsorption theory 157  
   basic concept 155  
   characterization 158  
     chemical performances 160–161  
     interfacial bonding strength 169–177  
     physical performances 164, 166–169  
   chemical bonding theory 158  
   diffusion theory 157–158  
   formation 156  
   layer 168  
   mechanical bonding theory 157  
 interfacial compatibilizers  
   classification and action mechanism 198–199  
   definition 198  
   design and synthesis 199–208  
 interfacial polarization 7, 25–26, 155  
 intermediate cracking 254  
 interpenetrating network (IPN) 59, 60, 71, 205  
 ion polarization 24–25  
 irregular network theory 112–113

## **k**

Kevlar fibers 4–6, 136, 141, 183, 186, 189, 190, 192, 253, 254

## **l**

laminated molding process  
   blackening 254  
   defects and solutions 253  
   intermediate cracking 254  
   pressure 252  
   surface inhomogeneity 253–254  
   temperature 252  
   thickness deviation 254  
   time 252–253  
 Lichteneker equation 27, 43  
 longitudinal winding 259, 260  
 lysozyme 190, 192, 193

## **m**

Maxwell-Garnett equation 26–27  
 mechanical bonding theory 157  
 mechanical properties, polymer matrix  
   wave-transparent composites 9  
 medium-alkali glass fibers 108  
 meta-aramid fibers 121–124, 127  
 methanesulfonic acid system synthesis  
   method 138  
 microscopic phase interface 7  
 modern electronic information  
   technology 1  
 molding process, polymer matrix  
   wave-transparent composites 243  
   bag molding 248–251  
   curing 243–244  
   filament winding 258–264  
   hand paste molding 244–248  
   impregnating 243  
   laminated molding process 251  
     blackening 254  
     defects and solutions 253  
     intermediate cracking 254  
     pressure 252  
     surface inhomogeneity 253–254  
     temperature 252  
     thickness deviation 254  
     time 252–253  
   RTM 255–258  
   shaping 243

## **n**

nano-indentation method 173–177  
 National Aeronautics and Space  
   Administration (NASA) 249  
 Naval Air Warfare Center 249  
 non-alkali glass fibers 107–108, 279  
 non-conductive dielectric materials 33  
 non-reactive interfacial compatibilizers  
   198, 199  
 non-resonant method  
   free-space method 34–35  
   transmission line method 33–34

## **o**

organic fibers  
   aramid fibers 120–121  
     preparation of 123–125  
     properties of 127–128  
     structure of 123–126  
     types 121–123  
 poly-*p*-phenylene benzobisoxazole fibers  
   preparation of 131–133  
   properties of 135–136  
   structures of 134–135

- organic fibers (*contd.*)
    - synthesis of 137–139
    - ultrahigh molecular weight polyethylene fibers
      - preparation of 139–140
      - properties of 141–142
      - structure of 140–141
      - synthesis of 129–130
  - organic-inorganic hybrid coatings 187, 194–196
  - orientated polarization 25
- p**
- para-aramid fibers 121–125, 127, 141
  - perturbation method 28–29, 31
  - phenolic (PF) resins 54–58
  - phenolic resins, design and preparation 78
  - physical modification, reinforced fibers 177–183, 186
  - plasma modification 178–180, 183
  - plasticized melt spinning method 131
  - polar surface free energy 162
  - poly(*p*-phenylene-2,6-benzobisoxazole) 139
  - polyaryletherketone (PAEK) resins 72
  - polymer content of the prepregs 246
  - polymerization process of PBO polymers
    - AB-type monomer self-condensation method 139
    - complex salt polymerization method 138
    - methanesulfonic acid system synthesis method 138
    - polyphosphate system synthesis method 137–138
    - trimethylsilylation method 138–139
  - polymerization slurry 130
  - polymer matrix 3, 247
    - of aircraft radomes 277–278
    - bismaleimide resins 58, 78
      - allyl compounds 59
      - diamine chain extension 58–59
      - flexible long-chain segments 60
      - rubber elastomers 59
      - thermoplastic resins 59–60
      - thermoset resins 60
    - cyanate ester resins 67–72
    - cyanate resins 81
      - $\epsilon$  fillers 82–83
      - structural modification 83–86
    - epoxy resins 51–54
      - curing agent 73
      - design and preparation 73
      - $\epsilon$  value 73
      - low  $\epsilon$  compounds, fillers or fibers 73, 75–78
    - phenolic resins 54–58, 78
    - physical and chemical properties 3, 52
    - polytetrafluoroethylene resins 63–64
    - silicone resins 61–63, 79, 81
    - unsaturated polyester resins 64–67, 81
    - viscosity and service cycle 51
  - polymer matrix wave-transparent composites
    - applications 2
    - composition 2–7
    - factors influencing 7–8
    - filament winding 258
      - characteristics of 263–264
      - dry winding 258–259
      - helical winding 260
      - hoop winding 260
      - longitudinal winding 260
      - semi-dry winding 259
      - wet winding 259
      - winding process 261–263
      - winding rules 259
    - materials design 238
      - laminates design 340–241
      - performances for single layer 239–240
      - raw materials selection 238–239
    - molding process 243
      - bag molding 248–251
        - curing 243–244
        - hand paste molding 244–248
      - impregnating 243
      - laminated molding 251–254
      - shaping 243
  - RTM 255
    - characteristics 258
    - curing 257
    - double pump injection 257–258
    - injection and filling 256–257
    - preformed blank manufacture 255, 256
    - single pump injection 257
  - structural design 235, 241
    - environmental condition 237
    - external factor 242–243
    - integrated process 236
    - load condition 236–237
    - principles 242
    - properties 236
    - reliability and economy 238
    - technological requirements 242

- polyphosphate system synthesis method 137–138
- poly-*p*-phenylene benzobisoxazole (PBO) fiber 136
  - chemical stability 142
  - 4,6-diamino-1,3 resorcinol hydrochloride 137
  - dielectric properties 141
  - hygroscopicity and dimensional stability 142
  - mechanical properties 141
  - polymerization process 137
    - AB-type monomer self-condensation method 139
    - complex salt polymerization method 138
    - methanesulfonic acid system synthesis method 138
    - polyphosphate system synthesis method 137–138
    - trimethylsilylation method 138–139
  - preparation 139–140
  - structures 140–141
  - thermal performance 141–142
- polytetrafluoroethylene (PTFE) resin
  - common polymer matrix 63–64
  - polymer matrix with low dielectric constant 81
- pressure bag molding 250, 264
- printed circuit boards (PCBs) 79, 283–284

## q

- quartz fibers
  - application 117
  - development history 115–116
  - melting and wire drawing 118
  - preparation of 117
    - electro melting process 117–118
    - flame melting process 118
    - high frequency plasma melting process 118
  - properties of 115
    - chemical stability 120
    - electrical insulation and dielectric properties 120
    - heat resistances 120
    - mechanical property 120
  - raw material 114
  - structure 118–119
  - types 116, 117
- quasi optical cavity method 31–32

## r

- reactive interfacial compatibilizers 199
  - reinforced fibers 4, 247
    - chemical performances 177
    - composition and functional groups 160–161
    - inorganic fibers 107
    - interfacial compatibilizers 198
    - organic fibers 120
      - aramid fibers 120–128
      - poly-*p*-phenylene benzobisoxazole fibers 136–142
      - ultrahigh molecular weight polyethylene fibers 128–136
    - physical performances 177
      - polymer matrix wave-transparent composites 168–169
      - surface morphology and roughness 164, 166–168
    - quartz fibers 114
      - application 117
      - chemical stability 120
      - development history 115–116
      - electrical insulation and dielectric properties 120
      - electro melting process 117–118
      - flame melting process 118
      - heat resistances 120
      - high frequency plasma melting process 118
      - mechanical property 120
      - melting and wire drawing 118
      - raw material 114
      - structure 118–119
      - types 116, 117
    - surface free energy 161–164
    - surface functionalization 177–198
    - surface morphology and roughness 164, 166–168
    - surface tension and surface energy 163
  - resin transfer molding (RTM)
    - characteristics 258
    - curing 257
    - double pump injection 257–258
    - injection and filling 256–257
    - preformed blank manufacture 255, 256
    - single pump injection 257
  - resistance, impact 243
  - rubber elastomers 54, 58, 59, 72
- ## s
- scanning electron microscopy (SEM) 164, 166
  - semi-dry winding 259

- shape memory polyurethane (SMPU) 160
  - shipboard radomes 279–280
  - silicone resins 61–63, 79
  - single fiber fracture test 169–171
  - single fiber pull-out test 170–172
  - single functional coatings 187–190
  - single-layer wave-transparent model 36–38
  - solid-state extrusion method 131–132
  - Spectra® fibers 134
  - surface crystallization growth method 132
  - surface inhomogeneity 253–254
  - synergistic modification 196–198
- t**
- tan  $\delta$  values 8
  - thermal stress 9, 241, 242
  - thermoplastic polymer toughening 70
  - thermoplastic resins 54, 58–60, 84
  - thermosetting resins 60, 64, 65, 69, 205
  - 3rd Generation Partnership Project (3GPP) 282
  - transmission line method 33–34
  - trimethylsilylation method 138–139
  - two-layer wave-transparent model 38–43
  - two-phase interface 1, 2, 6, 7
- u**
- ultrahigh molecular weight polyethylene (UHMWPE) fibers 6, 128
    - biocompatibility 136
    - chemical stability 136
    - continuous polymerization process 129
      - catalyst configuration 129
      - polymerization 129
      - screening, mixing and packaging 130
      - separation and drying 129
      - solvent recovery 130
    - dielectric properties 135
    - intermittent polymerization process 130
      - catalyst configuration 130
      - polymerization 130
      - stripping, drying and packing 130
    - mechanical properties 135
    - preparation 131
      - gel spinning-super-stretching method 132–134
      - plasticized melt spinning method 131
      - solid-state extrusion method 131–132
      - super stretching or local stretching method 132
      - surface crystallization growth method 132
    - structure 134–135
    - thermal stability 135–136
    - unsaturated polyester (UP) resins 64, 81, 261
      - initiation stage 65
      - microgel formation stage 65
      - microgel stage 66
      - post-gel stage 66
      - transition stage 65–66
- v**
- vacuum bag-autoclave molding 250–251
  - vacuum bag molding 248–250
  - vehicle radar antenna 281
  - vinyl-like monomers 65
  - viscosity of the prepregs 246, 247
  - volatiles content 239, 246
- w**
- water-soluble core molds 262
  - wave-transparent materials
    - dielectric parameter equations for
      - Clausius-Mossotti equation 23–26
      - Lichtenecker equation 27
      - Maxwell-Garnett equation 26–27
    - dielectric properties
      - free-space method 34–35
      - non-resonant method 33–34
    - wave-transparent mechanism of 22
    - wave-transparent model
      - single-layer 36–38
      - two-layer 38–43
    - wave-transparent mechanism of wave-transparent materials 21–22
    - wave-transparent model
      - single-layer 36–38
      - two-layer 38–43
    - wave-transparent performances, parameters 8
    - wet molding 245
    - wet spinning 124, 134
    - wet winding 259, 264
    - winding process 261, 262, 264
    - winding rules 259
    - wood-plastic composites (WPC) systems 199
- x**
- X-ray diffraction (XRD) 160
  - X-ray photoelectron spectroscopy (XPS) 160, 161, 164