

INDEX

- AA. *See* Acetic anhydride (AA)
- Abaca
 chemical composition and physical properties, 355
 description, 288
 surface modifications, 289
- Abaca composites
 flexural properties, 289
 with PLA, 289
- Acetic acid, 116
- Acetic anhydride (AA), 328
- Acetylated chitosan, 108
- Acetylated starch, 41
- Acetylation, 274, 326
 dew-retted flax, 316
 fiber composite, 329
- Adsorption equilibrium, 138
- Agar-agar, 116
- Agave. *See* Sisal
- AGE. *See* Allylglycidyl-ether (AGE)
 modified potato starch
- Alginate
 with cellulose, 139–142
 miscibility and interactions, 140
- Alginic acid, 139
- Aliphatic polyester, 316
 degradation, 402
- Aliphatic polyester amide, 440
- Alkaline temperature-treated corn (ATS), 23, 58
- Alkali treatment, 274
 composite tensile strength, 326
 fiber, 276
 FTIR spectra, 356
 jute fibers, 325
- Alkalization, 323
- Alkyl succinic anhydride (ASA), 328
- Allylglycidyl-ether (AGE) modified potato starch, 255
- Allyl-3-methylimidazolium chloride (AMIMCl), 134
- AMF. *See* Anhydrous milk fat (AMF)
- Amide bond, 7
- Amido montmorillonite (AMMT)
 nanocomposites, 428
- AMIMCl. *See* Allyl-3-methylimidazolium chloride (AMIMCl)
- Amine, 96
- Amino acids, 7
- Amipol, 259
- AMMT. *See* Amido montmorillonite (AMMT) nanocomposites
- Amylopectin, 87
 chemical structure, 88, 212
 structure, 4, 243
- Amylose, 87
 chemical structure, 88, 212
 structure, 4, 243
- Anhydride
 grafting, 330, 331
 PHB-HV, 331
 polymers, 330
 treatment, 328
- Anhydrous milk fat (AMF), 63
- Anisotropic composites, 333
- Annealed polylactide composites
 SEM, 297
 tensile properties, 296
- Antibacterial materials, 136
- Aqueous metal-based solvent system, 133–134
- Aramide, 252

- ASA. *See* Alkyl succinic anhydride (ASA)
- Aspergillus*, 107
- Aspergillus niger*, 118, 119
- ATS. *See* Alkaline temperature-treated corn (ATS)
- Azeotropic distillation, 142
- Azotobacter mali*, 120
- BA. *See* Butyric anhydride (BA)
- BA composites
 DMA spectra, 423
 temperature values, 423
 vulcanizate mechanical properties, 422
- Bacterial polyhydroxybutyrate, 198
- Bagasse, 355
- Bamboo, 355
- BA nanocomposites
 latex grafting and intercalating, 418–419
- Bark of *Acacia mearnsii* (BK), 94
- Bast fibers, 249
 chemical components, 309, 355
 physical properties, 355
- Bayer, Otta, 88
- Bayer BAK 1095, 441
- Beech wood flour (BWF) composites, 196
- Benzoyl peroxide (BPO), 383
- Biochemical oxygen demand (BOD), 230
- Biodegradable aliphatic polyesters, 182
- Biodegradable commercial blends, 259
- Biodegradable fibers, 183
- Biodegradable films, 183
- Biodegradable polymers, 406
 categories, 350
 polyalkylene dicarboxylate, 320
 poly(alpha)hydroxy acids, 317–318
 poly(beta)hydroxyalkanoate, 319
 poly(omega)hydroxyalkanoate, 320
- Biodegradable resin, 264
- Biodegradable starch
 polyester nanocomposite material, 381–384
 polymers, 259
- Biodegradable thermoplastics, 317
- Bioderived monomer synthetic polymers, 10–11
 polylactic acid, 11
 propanediol, 11
- Biofil, 259
- Biomimetic sensor/actuator devices, 142
- Bioplast granules, 259
- Bioplast GS 902 tensile properties, 262
- Biopol, 325
- Biopolyesters, 441
- Biopolymers, 20
- BK. *See* Bark of *Acacia mearnsii* (BK)
- Black bean characteristics, 244
- Blend composition, 129–153, 458. *See also* specific named blend
- BMIMCl. *See* Butyl-3-methylimidazolium chloride (BMIMCl)
- BOD. *See* Biochemical oxygen demand (BOD)
- Botrytis cinerea*, 120
- BPO. *See* Benzoyl peroxide (BPO)
- Breaking length, 313
- Butyl-3-methylimidazolium chloride (BMIMCl), 134
- Butyric anhydride (BA), 328
- BWF. *See* Beech wood flour (BWF) composites
- CA. *See* Cellulose acetate (CA)
- CAB. *See* Cellulose acetate butyrate (CAB)
- Cadoxen, 140
- Calcium, sodium, and caseinate, 72
- Candida lambica*, 113
- Cane fiber, 355
- CAP. *See* Cellulose acetate propionate (CAP)
- Carbon, 252
- Carbon disulfide, 131
- Carbon nanotubes (CNT), 396–398
 grafting technique, 397
 nanocomposites, 397
 PLA nanocomposite preparation, 392
- Carboxymethyl cellulose (CMC), 148, 150
 applications, 48
- Carboxymethylchitin (CM-chitin), 118
- Cargill-Dow, 390
- Cargill Nature Works, 441
- Casein
 applications, 56
 with cellulose, 145
 cuprammonium hydroxide complex, 145
- Caseinate
 monoglyceride mixed, 62
 thermal denaturation, 59

- Caseinate blends and composites
 with sodium, 75
 with starch, 55–80
- Cassava tapioca, 244
- Castor oil based polyurethane, 90
 waterborne blends, 100
- CD. *See* Circular dichroism (CD);
 Conventional dispersing nanoclays
- CDA. *See* Cellulose diacetate (CDA)
- Cellulose
 adsorption abilities, 141
 alginate membrane surfaces, 141
 alginic acid ion-exchange
 membranes, 141
 applications, 49
 bacteriostatic effect, 137
 with cellulose blends and
 composites, 153
 with cellulose derivatives, 23–39
 chemical structure, 9
 description, 9, 23, 130
 esterification, 330
 fiber fabrication process, 135
 function, 309
 mechanical properties, 39
 miscibility and interactions, 140
 molecular structure, 132, 356
 nanowhiskers, 392
 natural polymers, 8
 reinforced materials, 135
 renewable resource polymeric
 materials, 8
 and SA reaction, 329
 SEM, 141
 with silane reaction, 333
 sodium alginate, 141
 solvents, 132
 structure, 132, 309
 thermal properties, 39
- Cellulose acetate (CA), 41, 151
 applications, 48
 with chitosan, 151, 152
 clear pure, 25
- Cellulose acetate butyrate (CAB),
 50, 193
- Cellulose acetate butyrate (CAB) blend
 with PHB, 194, 196, 203
- Cellulose acetate propionate (CAP),
 50, 193
- Cellulose blends and composites
 with alginate, 139–142
 with casein, 145
 with cellulose derivatives, 148–152
 cellulose ester blends, 151–152
 cellulose ether blends, 148–150
 interfacial shear strength, 274
 physical and mechanical
 properties, 259
 with cellulose/natural polymer blends,
 139–142, 153
 with chitin
 cellulose/natural polymer blends,
 135–138
 cross-section, 138
 SEM, 138
 sorption active materials, 137–139
 with chitosan
 bacteriostatic effect, 137
 cellulose/natural polymer blends,
 135–138
 with fiber, 287–299
 with natural polymer, 129–153
 cellulose/alginate blends, 139–142
 cellulose blend promising
 applications, 153
 cellulose/chitin and cellulose/
 chitosan blends, 135–138
 cellulose derivative/natural polymer
 blends, 148–152
 cellulose/Konjac glucomannan
 blends, 145–147
 cellulose/protein blends, 143–144
 with PHA, 194–196
 with PLA and abaca, 288–289
 with PLA and lyocell, 294–298
 with PLA and wood flour, 290–293
 products and applications, 153
 with protein, 143–144
 with silk fibroin, 143–144
 with soy protein isolate, 144
 with starch, 19–49
 applications, 48–49, 75–78
 cellulose derivatives, 23–39
 destructured starch, 21–23
 gas permeability, 44–47
 glass transition temperatures, 31–38
 mechanical properties, 22, 24–30,
 39, 40–41

- Cellulose blends and composites
 (*Continued*)
 melting temperatures, 43–44
 physical and mechanical properties, 259
 sodium caseinate vs. other edible films, 79
 starch derivatives, 21–23
 thermal properties, 23, 39, 42–43
 thermoplastic-like starch, 21–23
 WVTR, 45–47
- Cellulose derivatives
 with cellulose, 23–39, 148–152
 method, 118
 with starch, 261, 263
- Cellulose diacetate (CDA), 39, 41
- Cellulose fiber
 with PLA composites, 287–299
 tensile properties, 256
- Cellulose microfibril plasticized starch composites
 behavior, 40
 temperatures, 42
- Cellulose xanthate, 136
- CGC. *See* Chitosan–glucose complex (CGC)
- Chayote, 244
- Chitin
 with cellulose blends and composites, 135–138
 chemical structure, 108
 chemistry, 10
 description, 10
 industrial processing, 108
 natural polymers, 9
 with PHB, 229
 preparation, 229
 reinforced materials, 135
 renewable resource polymeric materials, 9
 structure, 10
- Chitin xanthate
 antibacterial materials, 136
- Chitosan (CS), 374
A. niger growth, 119
 agar-agar and garlic, 116
 antibacterial activity, 120
 antimicrobial properties, 112–116
 antioxidant activity, 117
 bacteriostatic effect, 137
 chemical structure, 108
 derivatives, 118–121
 description, 107
 food industry application, 111
 hydrophobic coating material, 150
 with maleated polyhydroxybutyrate blends, 231
 natural polymers, 9
 preparation, 231
 properties and application, 107–121
 renewable resource polymeric materials, 9
 sources, 107
 structure, 108–110
 turbidity time, 114
 WAXD profiles, 233
- Chitosan (CS) blends and composites
 bacteriostatic effect, 137
 with CA, 151, 152
 with cellulose, 135–138
 with PHB, 228
 cytocompatibility, 235
 environmental biodegradation, 230
 films, 232–235
 intermolecular hydrogen bonds, 231
 miscibility, 229
 physical properties, 233
 preparation, 229, 231, 232
 SEM, 234
 thermal and crystallization behavior, 230
 thermal behavior, 232
 WAXD profiles, 233
- Chitosan–glucose complex (CGC), 110
- Chitosan microspheres
 with PHB, 234
 SEM, 234
- Circular dichroism (CD), 145
- CISS. *See* Critical interfacial shear stress (CISS)
- Clay, 384
 blends, 384
 elongation tests, 405
 exfoliation process, 371
 hectorite, 380, 393
 MAHPCl, 384
 nanocomposites, 395, 405, 418
 starch and glycerol, 378

- tensile properties, 383
 tensile tests, 384
 thermoplastic starch, 384
- Cleanex, 39
- Clear pure cellulose acetate, 25
- Clostridium diploidiella*, 120
- Clupea harengus*, 117
- CMC. *See* Carboxymethyl cellulose (CMC)
- CM-chitin. *See* Carboxymethylchitin (CM-chitin)
- C18-MMT4, 403
- CNT. *See* Carbon nanotubes (CNT)
- Coextrusion
 flows, 454
 procedure, 442–444
 system, 442
- Coir fibers, 305
 alkali treatment, 325
 properties, 306
- Cold plasma treatment, 322
- Communis, 355
- Composites, 129–153. *See also* specific named composites
 discrete phases, 304
- Compression molding, 357
 schematic, 357
- Cone calorimeter, 429
- Coniferous, 355
- Continuous binding phase, 304
- Conventional dispersing nanoclays, 377
- Conventional transmission electron microscope (CTEM), 395
- Copolymer hydrogels, 121
- Copper ion adsorption, 152
- Corn
 characteristics, 244
 composition, size and diameter, 243
 flour, 91
 with PEA, 260
 shape, composition, and properties, 351
 tensile properties, 256
- Cornstarch, 91, 265, 378–379
 WAXS, 5
- Corona treatment, 322
- Corynebacterium michiganense*, 136
- Cotton
 chemical components, 309, 355
 composition, 251
 physical properties, 355
 properties, 252
- Coupling agents
 chemical structure, 332
 description, 328
- CP. *See* Cross ply (CP) 300
- CP-MAS. *See* Cross polarization magnetic angle sample (CP-MAS)
- Critical interfacial shear stress (CISS), 453
- Cross ply (CP) 300, 262, 263, 272, 273
 flexural properties, 265
- Cross polarization magnetic angle sample (CP-MAS), 71
- CS. *See* Chitosan (CS)
- CTEM. *See* Conventional transmission electron microscope (CTEM)
- Cuprammonium hydroxide solution, 145
- Curing agent, 118
- DB. *See* Dry blending (DB)
- DBP. *See* Dibutyl phthalate (DBP);
 Di-*n*-butyl phthalate (DBP) diluent
- DBPO. *See* Dibenzoyl peroxide (DBPO)
- DDS. *See* Drug delivery system (DDS)
- Degree of gelatinization, 245
- Degree of substitution (DS), 48
- Dent corn, 243
- Department of Energy (DOE), 129
- Deconstructurized starch, 21–23. *See also*
 Thermoplastic starch (TPS)
- Dibenzoyl peroxide (DBPO), 331
- Dibutyl phthalate (DBP), 150
- Diclofenac sodium (DS), 149
- Die geometry, 453, 454
- Die temperature, 454
- Differential scanning calorimetry (DSC),
 23, 229, 362
- Dihydric phenols, 337
- Diisocyanate terminated polycaprolactone based prepolymer (NCO-PCL), 94
- Dimethylacetamide (DMAc), 133
 solution, 137
 solvent system, 133
- Dimethylol propionic acid (DMPA), 99
- Dimethyl sulfoxide (DMSO), 231
- Di-*n*-butyl phthalate (DBP) diluent, 203
- Diphenylmethane diisocyanate (MDI), 90
- Dispersed reinforcing phase, 304

- DMA. *See* Dynamic mechanical analysis (DMA)
- DMAc. *See* Dimethylacetamide (DMAc)
- DMPA. *See* Dimethylol propionic acid (DMPA)
- DMSO. *See* Dimethyl sulfoxide (DMSO)
- DMTA. *See* Dynamic mechanical thermal analysis (DMTA)
- DOE. *See* Department of Energy (DOE)
- Drug delivery system (DDS)
heterostereocomplex, 184
- Drug delivery system biodegradable microspheres
enantimeric polyactides
stereocomplexation, 183
- Dry blending (DB)
nanoclays, 377
- DS. *See* Degree of substitution (DS);
Diclofenac sodium (DS)
- DSC. *See* Differential scanning calorimetry (DSC)
- DTA. *See* Dynamic thermal analysis (DTA)
- Dynamic flexural testing, 334
- Dynamic mechanical analysis (DMA), 42
PLA nanocomposites, 399
- Dynamic mechanical thermal analysis (DMTA), 31–36, 42, 64, 70, 72, 73–74, 229
- Dynamic thermal analysis (DTA), 31–36, 64, 70
- EAPap. *See* Electro-Active Paper (EAPap) actuators
- EC. *See* Ethylcellulose (EC)
- ECO. *See* Epichlorohydrin co ethylene oxide (ECO)
- Edible antimicrobial coating, 113
- Edible films, 55
thermal degradation, 66
- EGDA. *See* Ethyleneglycol dimethacrylate (EGDA)
- E-glass
fibers, 312
properties, 306
- EHEC. *See* Ethylhydroxyethyl cellulose (EHEC)
- Electric discharge methods, 322
- Electro-Active Paper (EAPap) actuators, 142–143
- EMMT. *See* Epoxy montmorillonite (EMMT)
- Enantiomeric polyactides
stereocomplexation, 165–184
applications, 181–184
biodegradable fibers, 183
biodegradable films, 183
biodegradable hydrogels, 184
biodegradation, 178–180
drug delivery system biodegradable microspheres, 183
formation, 167–173
induction, 174–176
nucleation agents, 184
physical properties, 176–177
- Encapsulation, 447
- Epichlorohydrin co ethylene oxide (ECO), 201
- Epoxidized soybean oil (ESO), 41, 42
- Epoxy montmorillonite (EMMT), 41, 42
- EPR. *See* Ethylene propylene rubber (EPR)
- Escherichia coli*, 112, 120, 136, 137
- ESO. *See* Epoxidized soybean oil (ESO)
- Esparto, 355
- Ethanolamine plasticized starch, 375
- Ethylcellulose (EC), 50, 148
- Ethyleneglycol, 92
- Ethyleneglycol dimethacrylate (EGDA), 255
- Ethylene propylene rubber (EPR), 194
- Ethylene vinyl acetate (EVA), 194
- Ethylhydroxyethyl cellulose (EHEC), 48
- Eucalyptus urograndis*, 253
- EVA. *See* Ethylene vinyl acetate (EVA)
- Exfoliated polyactide nanocomposites, 395
- Extrusion, 357
- Extrusion molding
schematic, 358
- Extrusion rate, 453, 454
- Fantest, 92
foam scanning electron micrographs, 93
with glycols, 93
- Feedblock, 443
- FFSA. *See* Formyl-2-furan sulfonic acid (FFSA)

- Fiber. *See also* specific named fiber
 with cellulose blends and composites,
 287–299
 cellulose chain organization, 310
 cellulose fabrication process, 135
 chemical treatment, 361
 filled thermoplastic starch, 359
 fragile fracture surface, 359
 properties, 252
 surface treatments, 315
- Fick's diffusion equation, 149
- Film
 applications, 121
 dynamic mechanical thermal
 analysis, 76
 exhibiting wavy instabilities, 449
 free starch, 374
 RC, 136
 tensile strength, 374
 and variable experimental design, 80
- Flame retardancy mechanism
 cone calorimeter data, 430
- Flat coathanger die, 443
- Flax
 chemical components, 309
 composition, 251
 optical micrographs, 338
 with PHB blends and composites,
 337, 338
 plant stem cross-section, 306, 307
 properties, 252, 306
 SEM, 337
- Flax fibers, 264
 schematic, 307
 SEM, 327
- Foam peanuts, 218
- Food coating applications, 121
- Food industry application, 111
- Formamide, 375
- Formyl-2-furan sulfonic acid (FFSA), 122
- Fourier transform infrared (FTIR)
 spectroscopy, 66, 174, 194, 230,
 231, 337
- Free hydroxyl groups, 48
- Free starch film, 374
- FTIR. *See* Fourier transform infrared
 (FTIR) spectroscopy
- Fullerene, 397
- Fusarium oxysporum*, 120
- GAB. *See* Guggenheim–Anderson–de
 Boer (GAB) equation
- Gamma irradiation
 calcium and sodium caseinate, 72
 propylene glycol and triethylene
 glycol, 79
- Garlic, 113
 and acetic acid, 116
 agar-agar, 116
 and chitosan, 116
 respiration rates, 116
- Gelatinization
 starch, 6
 starch nanocomposites, 376, 377
 starch polymers, 245
 XRD traces, 376
 yield strength vs. break elongation, 377
- Glass
 fibers, 312
 properties, 252, 306
 starch cellulose blends, 31–38
 transition temperature vs. glycerol and
 water content, 246
- Glucose, 9
- Gly. *See* Glycerol (Gly)
- Glycerol (Gly), 63
 and clay, 378
 and montmorillonites, 374
 vs. PEG, 79
 plasticized thermoplastic starch, 44,
 375, 380
 and starch, 378
 tunicin whiskers composite films, 44
 and wheat, 374
- Glyceryl triacetate (GTA), 334
 optical micrographs, 338
 with PHB blends and composites,
 337, 338
 SEM, 337
- Glycols with fantest, 93
- GMMT. *See* Organommodified
 montmorillonite (GMMT)
- Gordon–Taylor (G-T) equation, 65
- Grafted poly(L)lactide, 398
- Grain films, 79
- Grass fiber, 355
- Green environment, 304
- Greenpol, 259
- Green processes, 153, 154

- Green solvents of cellulose, 131
- GT. *See* Gordon–Taylor (G-T) equation
- GTA. *See* Glyceryl triacetate (GTA)
- Guava, 113
 - pulp texture, 115
 - skin color, 115
 - starch/chitosan coating, 115
 - storage time, 115
- Guggenheim–Anderson–de Boer (GAB) equation, 64
- Hackling, 308
- Half-die solidified sprue, 451
- HAP. *See* Higher amylose content potato starch (HAP)
- Heat release rate (HRR), 429
- HEC. *See* Hydroxyethyl cellulose (HEC)
- Hectorite clay, 380, 393
- Hemicellulose, 254
 - description, 310
 - structure, 310
- Hemp
 - chemical components, 309
 - chemical composition and physical properties, 355
 - composition, 251
 - fiber, 327
 - properties, 252
- Hencky strain rate dependence, 406
- Henequen
 - chemical components, 309
 - composition, 251
- Herring, 117
- Heteropolysaccharide, 139
- Heterostereocomplex drug delivery system, 184
- Hexafluoro-2-propanol (HFIP), 229
- Hexamethylenetetramine. *See* Resorcinol and hexamethylenetetramine
- HFIP. *See* Hexafluoro-2-propanol (HFIP)
- High-amylose corn
 - characteristics, 244
 - composition, size and diameter, 243
- High-amylose rice, 244
- Higher amylose content potato starch (HAP), 247
- High resolution transmission electron microscope (HRTEM), 395
- HMDI. *See* Methylene bis(4-cyclohexylisocyanate) (HMDI)
- HMMT. *See* Organomontmorillonite (HMMT)
- Homocrystallization, 174
- HPC. *See* Hydroxypropyl cellulose (HPC)
- HPMC. *See* Hydroxypropylmethyl cellulose (HPMC)
- HRR. *See* Heat release rate (HRR)
- HRTEM. *See* High resolution transmission electron microscope (HRTEM)
- HTO. *See* Hydrated titanate (HTO)
- Hybrid structures, 417
- Hydrated titanate (HTO), 399
- Hydrolytic degradation, 180
- Hydroxyethyl cellulose (HEC), 148
 - description, 149
 - SEM, 150
- Hydroxypropylated starch, 353
- Hydroxypropyl cellulose (HPC), 50
- Hydroxypropylmethyl cellulose (HPMC), 50, 148
- Ibuprofen (IB), 149
- Injection molding, 357
- In-line slit die viscometer rheometer, 445
- Instability amplitude, 454
- Intensive mixing, 250
- Interface deformation, 447
- Interfacial adhesion, 457–458
- Interfacial bonding additives, 337
- Interfacial instability, 450
- Ion exchange equilibrium principle, 140
- Ionic liquids, 131
 - solvent system, 134
- Irradiation
 - calcium and sodium caseinate, 72
 - propylene glycol and triethylene glycol, 79
- Izod impact testing, 295–296
- Jute
 - alkalization shrinkage, 325
 - chemical components, 309, 355
 - composition, 251

- fibers, 325
- physical properties, 355
- properties, 252
- Kaolinite
 - composite, 379
 - fractured surfaces, 379
 - intercalation, 380
 - with starch, 379
 - with TPS, 379
 - water solubility, 379
- Kelly–Tyson equation, 272
- Kenaf
 - chemical components, 309, 355
 - composite, 288
 - composition, 251
 - physical properties, 355
 - with PLA composites, 288
- KGM. *See* Konjac glucomannan (KGM)
- Kneading, 250
- Konjac glucomannan (KGM), 145–146
 - SEM, 148
- Lactic acid bacteria, 116
- LACTRON, 408
- Langmuir adsorption isotherm, 138
- Latex grafting and intercalating, 421
- Layered starch-based nanocomposites, 369–385
- Leaf fibers, 249, 305
 - chemical components, 309
- Lignin
 - description, 310
 - structure, 311
- Lignocellulosic natural fibers, 308
 - groups, 287
- Line, 308
- Lipids, 3
 - list, 20, 130
- Listeria monocytogenes*, 112
- Lithium chloride
 - solution, 137
 - solvent system, 133
- Low-molecular-weight stereoblock polylactide, 176
- Lyocell
 - composites, 296, 297
 - fabric, 297, 299
 - with PLA
 - Izod impact strength, 297, 298
 - SEM, 298
 - soil-burial test, 299
 - tensile properties, 296
- Lysozyme adsorption, 150
- MAH. *See* Maleic anhydride (MAH)
- MAHPCL. *See* Maleic anhydride polycaprolactone (MAHPCL)
- Maize
 - characteristics, 244
 - starch, 78
 - tensile properties, 257
- Maleated polyhydroxybutyrate blends with CS
 - preparation, 231
- Maleated polypropylene (PP-g-MA)
 - esterification, 330
- Maleic anhydride (MAH), 328, 383
- Maleic anhydride polycaprolactone (MAHPCL), 384
 - tensile properties, 383
- MaterBi, 259
- MaterBi LF01U, 264
 - tensile properties, 262
- MaterBi Y, 264, 268, 276, 278
 - rheological behavior, 271
 - short sisal, 267
- MaterBi Y101
 - flax fibers, 261
 - flexural properties, 265
 - sisal fibers, 261
 - tensile properties, 262
- MaterBI Y101U, 265
 - impact properties, 266
- MaterBi Z, 268, 276, 278
 - flexural creep behavior, 267
- MaterBi ZF03
 - sisal fibers, 261
 - tensile properties, 262
- MaterBI ZI01U, 262
- Matrix, 304
- MC. *See* Methyl cellulose (MC)
- MCC. *See* Microcrystalline cellulose (MCC)
- mcl. *See* Medium-chain-length (mcl) polyhydroxyalkanoate monomers

- MDI. *See* Diphenylmethane diisocyanate (MDI)
- Mean wave amplitude, 455
- Medium-chain-length (mcl)
polyhydroxyalkanoate monomers, 193
- MeI. *See* Methyl iodide (MeI)
- Melt blending, 438
- Melt-spun polylactide stereocomplex
fibers, 183
- Mercerization, 323
- Methyl cellulose (MC), 42, 148
- Methylene bis(4-cyclohexylisocyanate)
(HMDI), 96
- Methyl iodide (MeI), 122
- Microbial fermentation polymers, 11–12
PHA family copolymers, 12
polyhydroxyalkanoate, 12
renewable resource polymeric materials,
11–12
- Microbial poly(3)hydroxybutyrate blends
with natural chitosan biodegradable,
227–234
characterization and properties,
229–230, 231, 233
emulsification casting method, 232
precipitation blending method, 231
preparation and properties, 229–234
solution-casting method, 229
- Microcrystalline cellulose (MCC), 42, 50
- Microelectromechanical systems, 142
- Milk protein concentrate (MPC), 77
- Mineral layered starch-based
nanocomposites, 369–385
- Miscanthus* fiber, 265
- Mitsui Toatsu (Mitsui Chemicals)
solvent-based process, 390
- MMT. *See* Montmorillonite (MMT)
- Modulated temperature differential
scanning calorimetry (TMDSCO), 39
- Monoalcohol, 96
- Monsanto Biopol D600G, 441
- Montmorillonite (MMT), 374, 393,
394, 395
biodegradability, 403
composites, 430
cone calorimeter, 430
glycerol and wheat, 374
grafting and intercalating method, 422
nanocomposites, 370–377, 422
solid-phase-modified values, 420
sorbitol intercalation, 376
starch, 370–377
- MPC. *See* Milk protein concentrate (MPC)
- Mucor*, 107
- Multi-walled carbon nanotubes
(MWCNT), 398
with PLA nanocomposites, 397
with PLLA nanocomposites, 401
solvent casting method, 397
Young's modulus, 401
- MWCNT. *See* Multi-walled carbon
nanotubes (MWCNT)
- Nanoalumina, 392
- Nanoclay, 392
- Nanocomposite. *See also* specific named
nanocomposite
blends, 382
formation, 376
- Native polylactide composites
tensile properties, 296
- Native starch (NS), 23
description, 242
thermal properties, 58
- Native wheat starch, 440
- Natural biodegradable polymers, 20
- Natural chitosan biodegradable blends
with microbial poly(3)hydroxybutyrate,
227–234
- Natural fiber, 354–355
applications, 354–355
breaking length vs. elongation, 313
chemical components, 309, 355
chemical modifications, 324
classification, 8
composition, 251, 354
dimensions, 268
energy-dissipation mechanisms, 253
mechanical properties, 289
mixing, 254
modifications, 354–355
moisture effect, 315
physical properties, 355
processing, 268
properties, 252, 306, 354
structure, 354
thermal stability, 314
thermal treatments, 314

- Natural fiber and poly(3)hydroxybutyrate biocomposites and copolymers, 304–341
- bast fiber chemical components, 308–310
- bast fiber structure, 306–307
- biodegradable polymers, 316–320
- chemical modification, 323–341
- factor affecting, 314–315
- high-strength composite problems, 321–341
- mechanical fibers, 311–315
- novel biodegradable composites, 304
- physical modification, 322
- plant fiber structure, 306–307
- polyalkylene dicarboxylate, 320
- poly(alpha)hydroxy acids, 317–318
- poly(beta)hydroxyalkanoate, 319
- poly(omega)hydroxyalkanoate, 320
- traditional composites, 304
- types, 305
- Natural fiber composites, 260–278
- aqueous and soil-burial degradation, 276–277
- components, 277
- creep properties, 266
- fiber dimensions, 272
- fiber dimensions effect on mechanical properties, 273
- fiber treatments, 272–275
- flexural properties, 265
- impact properties, 265, 266
- mechanical properties, 260–266
- processing conditions, 267–270
- rheological behavior, 271
- tensile properties, 275, 262
- Natural polymer
- cellulose, 8
- chitin and chitosan, 9
- list, 3, 130
- natural rubber, 2–3
- protein, 7
- renewable resource polymeric materials, 1–9
- starch, 4–6
- Natural polymer blends and composites
- with cellulose, 129–153
- products and applications, 153
- Natural rubber (NR), 416
- description, 3
- latex, 418
- natural polymers, 2–3
- renewable resource polymeric materials, 2–3
- Natural rubber (NR) composites
- cone calorimeter, 430
- DMA spectra, 423
- organomontmorillonite, 427
- temperature values, 423
- vulcanizate mechanical properties, 422
- Natural rubber (NR) montmorillonite nanocomposites, 416–430
- aging resistance testing, 419
- characterization, 419–420
- dynamic mechanical analysis, 419
- latex grafting and intercalating, 420–423
- materials, 418
- mechanical properties, 419
- mixing and curing grafting and intercalating, 424–425
- mixing and curing reacting and intercalating, 426
- processing and procedures, 418
- results, 420–429
- rubber process analyzer, 420
- solid-phase method, 420
- TEM, 419
- x-ray diffraction, 419
- Natural rubber (NR) nanocomposites
- aging behavior, 428
- cone calorimeter data, 430
- grafting and intercalating method, 422
- latex grafting and intercalating, 418–419
- mixing and curing grafting and intercalating, 419
- mixing and curing reacting and intercalating, 419
- TEM, 427
- temperature sweep curves, 429
- Natural rubber (NR) vulcanizates
- mechanical properties, 425
- TEM, 426
- NCO-PCL. *See* Diisocyanate terminated polycaprolactone based prepolymer (NCO-PCL)
- Neat components
- rheological behavior, 446

- Neat polylactide
 biodegradability, 403
- NFD. *See* Nifedipine (NFD)
- Nifedipine (NFD), 149
- N*-methylmorpholine-*N*-oxide (NMMO),
 131, 139
 solvent system, 133
- NMMO. *See* *N*-methylmorpholine-*N*-oxide
 (NMMO)
- NMR. *See* Nuclear magnetic resonance
 (NMR)
- Non-blended poly(L)lactide and
 stereocomplex crystals
 unit cell parameters, 169
- Normal potato thermoplastic starch
 (NPS), 247
- Novon, 259
- NPS. *See* Normal potato thermoplastic
 starch (NPS)
- NR. *See* Natural rubber (NR)
- NS. *See* Native starch (NS)
- Nuclear magnetic resonance (NMR), 71
- OHTO. *See* Organohydrated titanate
 (OHTO) nanocomposite
- OMLS. *See* Organically modified layered
 silicates (OMLS)
- OMSFM. *See* Organically modified
 synthetic fluorine mica (OMSFM)
- Organically modified layered silicates
 (OMLS), 402
- Organically modified synthetic fluorine
 mica (OMSFM), 395
- Organic salts, 131
- Organohydrated titanate (OHTO)
 nanocomposite, 399
- Organommodified montmorillonite (GMMT),
 418, 420
 composite, 427
 nanocomposite
 mixing and curing reacting and
 intercalating, 419
 TEM, 427
 temperature sweep curves, 429
- Organomontmorillonite (HMMT),
 418, 424
 mechanical properties, 425
 mixing and curing grafting and
 intercalating, 419
 nanocomposite, 419
 TEM, 426
 vlucanizates, 425, 426
- Original polylactide composites
 SEM, 297
- Oscillatory rheometry, 39
- Oxidized starch imine derivatives, 50
- PA. *See* Phthalic anhydride (PA)
- PALF. *See* Pineapple leaf fiber (PALF)
- Payen, Anselme, 132
- PBA. *See* Polybutylene adipate (PBA)
- PBS. *See* Polybutylene succinate
 (PBS)
- PBSBA. *See* Polybutylene succinate
 co butylene adipate (PBSBA)
- PCHMA. *See* Polycyclohexyl methacrylate
 (PCHMA)
- PCL. *See* Polycaprolactone (PCL)
- PDLA. *See* Poly(D)lactides (PDLA)
- PDLLA. *See* Poly(DL)lactides (PDLLA)
 blends
- PEA. *See* Polyester amide (PEA)
- Pectins, 311
- PEG. *See* Polyethylene glycol (PEG)
- PEO. *See* Polyethylene oxide (PEO)
- PEP. *See* Polyepichlorohydrin (PECH)
- Perkin Elmer apparatus MDA-7, 76
- Pervaporation, 142
- PES. *See* Polyethylene succinate (PES)
- Petroleum-derived raw materials, 87
- PFRR. *See* Polymers from renewable
 resources (PFRR)
- PHA. *See* Polyhydroxyalkanoate (PHA)
- PHB. *See* Polyhydroxybutyrate (PHB)
- PHB-g-MA. *See* Polyhydroxybutyrate
 gamma maleated (PHB-g-MA) blends
- PHB-HV. *See* Polyhydroxybutyrate
 co hydroxyvalerate (PHB-HV)
- PHBV. *See* Polyhydroxybutyrate
 hydroxyvalerate (PHBV)
- PHO. *See* Poly(3)hydroxyoctanoate (PHO)
 blends and composites
- Phthalic anhydride (PA), 328
- Pineapple leaf fiber (PALF), 309
- PLA. *See* Polylactide (PLA)
- PLACN. *See* Polylactide nanocomposites
 (PLACN)
- Plasmodium berghei*, 50

- Plasticized starch, 96, 438
 film, 42
 formulations, 441
 GP measurements, 75
 preparation, 441
 sodium caseinate blends, 75
- Plasticized wheat starch (PWS), 41, 441
- Plasticizer
 absorption, 334
 edible films, 79
 natural fiber modification, 334
 protein interaction, 79
 type and content, 245
- Plasticizer flax systems, 338
- PLLA. *See* Poly(L)lactides (PLLA)
- PLS. *See* Polymer layered silicate (PLS)
- PLS3. *See* Polymer layered silicates 3 (PLS3)
- PMIRRAS. *See* Polarization modulation infrared reflecting-absorption spectroscopy (PMIRRAS)
- PMMA. *See* Polymethyl methacrylate (PMMA)
- Polarization modulation infrared reflecting-absorption spectroscopy (PMIRRAS), 175
- Polyalkylene dicarboxylate
 biodegradable polymers, 320
 chemical structure, 321
- Polybutylene adipate (PBA), 99, 193
- Polybutylene succinate (PBS), 289, 320
 and PHB, 202
- Polybutylene succinate co butylene adipate (PBSBA), 320, 438, 440, 441
- Polycaprolactone (PCL), 89, 258, 320, 383
 chemical structure, 320
 Solway CAPA 680, 441
- Polycaprolactone (PCL) blends and composites
 composite and matrix tensile strength ratio, 263
 interfacial shear strength, 274
 with PHA, 199
 physical and mechanical properties, 259
 with starch, 259, 263, 382
 tensile tests, 384
 with thermoplastic starch clay, 384
- Polycyclohexyl methacrylate (PCHMA), 193
- Polyepichlorohydrin (PECH), 192, 201
- Polyepichlorohydrin co ethylene oxide, 201
- Polyester
 based polyurethanes, 89
 content, 459
 list, 20
- Polyester amide (PEA), 258, 440
 Bayer BAK 1095, 441
 composition, 351
 layer thickness ratio, 450
 PLS PEA coextruded films, 452
 PLS2 PEA films, 455
 PLS3 PEA 3-layer system, 451
 properties, 351
 rheological properties, 448
 shape, 351
 viscosity ratio, 450
- Polyester amide (PEA) blends
 with corn, 260
 with potato, 260
- Polyethylene
 properties, 98
- Polyethylene glycol (PEG), 92, 334, 352
- Polyethylene glycol (PEG) blends
 with PHB, 202
 optical micrographs, 338
 SEM, 337
- Polyethylene oxide (PEO), 193, 199
 starch coating, 216
- Polyethylene succinate (PES), 320
- Polyglycolic acid, 317
- Polyhexamethylene adipate, 89
- Polyhydroxyalkanoate, 12
- Poly(omega)hydroxyalkanoate, 320
- Polyhydroxyalkanoate (PHA)
 bacterial cells, 192
 chemical structure, 213
 description, 191, 213
 family copolymers, 12
 granules, 192
 microbial fermentation polymers, 12
 molecular structure, 192
 monomers
 mcl, 193
 synthesized, 193
 physical properties, 193
 structure, 12
 surface energy data, 214

- Polyhydroxyalkanoate (PHA) blends and composites, 191–202
 with cellulose, 194–196
 composites, 203
 with PCL, 199
 with PLA, 197–198
 polymer blends, 201–202
 with starch, 194–196, 211–223
 applications and production, 221
 biodegradability, 219–220
 future, 221
 gelatinized, 217
 granular, 214–216
 laminates for foams, 217–218
 mechanical property data, 215
 properties, 211
 recycling, 219–220
 sustainability, 219–220
 thermal and mechanical properties, 195
- Polyhydroxybutyrate (PHB), 191, 227
 bacterial, 198
 damping factor, 336
 description, 319
 ECO, 201
 nucleation and crystallization, 203
 and PBS, 202
 storage module, 335
 ultrahigh-molecular-weight, 198
 unmodified composites
 optical micrographs, 342
 SEM, 341
 WAXD profiles, 233
- Polyhydroxybutyrate (PHB) blends and composites
 adhesion parameter, 336, 340
 with CAB, 194, 203
 with CEI, 196
 with chitin, 229
 with CS, 228, 231
 cytocompatibility, 235
 environmental biodegradation, 230
 films, 232–235
 intermolecular hydrogen bonds, 231
 miscibility, 229
 physical properties, 233
 preparation, 229, 231, 232
 SEM, 234
 thermal and crystallization
 behavior, 230
 thermal behavior, 232
 WAXD profiles, 233
 with CTS microspheres, 234
 damping factor, 339, 340
 with flax
 optical micrographs, 338
 SEM, 337
 with GTA
 optical micrographs, 338
 SEM, 337
 isothermal crystallization, 196
 maleated with CS, 231
 with PDLLA, 199
 with PEG, 202
 optical micrographs, 338
 SEM, 337
 with PEP, 201
 with PHBV, 200
 with PHO, 200
 plasticizer flax systems
 optical micrographs, 338
 SEM, 337
 with PVPh, 202
 with SA, 194
 storage modulus, 339
 with TBC
 optical micrographs, 338
 SEM, 337
- Poly(beta)hydroxybutyrate, 319
- Poly(3)hydroxybutyrate and natural chitosan biodegradable blends, 227–234
 characterization and properties,
 229–230, 231, 233
 emulsification casting method, 232
 precipitation blending method, 231
 preparation and properties, 229–234
 solution-casting method, 229
- Poly(3)hydroxybutyrate biocomposites and copolymers, 304–341
 bast fiber chemical components,
 308–310
 bast fiber structure, 306–307
 biodegradable polymers, 316–320
 chemical modification, 323–341
 factor affecting, 314–315
 high-strength composite problems,
 321–341
 mechanical fibers, 311–315
 novel biodegradable composites, 304

- physical modification, 322
- plant fiber structure, 306–307
- polyalkylene dicarboxylate, 320
- poly(alpha)hydroxy acids, 317–318
- poly(beta)hydroxyalkanoate, 319
- poly(omega)hydroxyalkanoate, 320
- traditional composites, 304
- types, 305
- Polyhydroxybutyrate co hydroxyvalerate (PHB-HV), 319, 321
 - chemical structure, 319
 - and maleic anhydride, 331
- Polyhydroxybutyrate gamma maleated (PHB-g-MA) blends
 - crystallization, 232
 - with CS, 232
 - thermal behavior, 232
- Polyhydroxybutyrate hydroxyvalerate (PHBV), 191, 258, 289, 325
 - Monsanto Biopol D600G, 441
 - water vapor permeability, 216, 218
- Polyhydroxybutyrate hydroxyvalerate (PHBV) blends
 - hydrolytic degradation, 201
 - with PHB, 200
 - with PHO, 201, 216
- Poly(3)hydroxyoctanoate (PHO) blends and composites
 - with PHB, 200
 - with PHBV, 216
 - hydrolytic degradation, 201
- Polylactic acid. *See* Polylactide (PLA)
- Polylactide (PLA), 258, 317
 - biodegradability, 403
 - biderived monomer synthetic polymers, 11
 - Cargill Nature Works, 441
 - chemical structure, 318
 - crystal structure, 170
 - description, 11, 165
 - dilute solution, 171
 - flexural properties, 401
 - melting temperature, 318
 - physical properties, 391
 - polymer blends, 166
 - SEM, 407
 - shear rate-dependent viscosity, 405
 - soil-burial test, 299
 - stereoblock isotactic, 168
 - stereocomplex, 170, 171
 - stereocomplexed hydrogels, 184
 - storage modulus temperature dependence, 400
 - structure, 11
 - tensile properties, 177
 - thermoplastic character, 408
- Polylactide (PLA) based nanocomposites, 389–408
 - applications, 408
 - biodegradability, 402–403
 - carbon nanotubes, 396–397
 - characterization, 393–395
 - clay, 392–395
 - foam processing, 406–407
 - melt rheology, 403–404
 - nanofibers, 398
 - preparation, 393–395
 - properties, 392–393, 399–401
 - structure, 392–393
- Polylactide (PLA) blends and composites with abaca
 - cellulose blends and composites, 288–289
 - flexural properties, 289
 - with cellulose fiber, 287–299
 - with abaca, 288–289
 - with lyocell, 294–298
 - with wood flour, 290–293
 - dynamic viscoelastic curves, 293
 - flexural properties, 290
 - Izod impact strength, 298
 - with kenaf, 288
 - with lyocell, 294–298
 - Izod impact strength, 297, 298
 - SEM, 298
 - soil-burial test, 299
 - with PHA, 197–198
 - with WF, 290–293
 - dynamic viscoelastic curves, 293
 - flexural properties, 292
 - tensile properties, 292
- Polylactide (PLA) matrix
 - OMLS fillers, 404
 - respirometric test, 402
- Poly lactide nanocomposites (PLACN)
 - elongation tests, 405
 - flexural properties, 401
 - grafting to technique, 397

- Poly(lactide nanocomposites
(PLACN) (*Continued*)
with MWCNT, 397
shear rate-dependent viscosity, 405
solvent casting method, 397
strain rate dependence, 406
temperature dependence, 400
XRD patterns and bright-field
images, 394
- Poly(D)lactides (PDLA), 166
SEM, 176
synthesis and molecular structure, 168
- Poly(D)lactides (PDLA) blends
with PLLA, 179
DSC thermograms, 172
melting enthalpies, 175
phase-transitions, 174
proteinase K-catalyzed enzymatic
degradation rate, 181
regularization, 174
storage modulus, 178
tensile strength, 177
WAXS profiles, 170
- Poly(DL)lactides (PDLA) blends
with PHB, 199
PHB blends, 199
- Poly(L)lactides (PLLA), 166, 228
elongation-at-break, 179
grafted, 398
non-blended stereocomplex crystals, 228
residual tensile strength, 179
SEM, 176
spherulites, 173
storage modulus, 178
synthesis, recycling and degradation, 166
synthesis and molecular structure, 168
TEM, 398
tensile strength, 177
TGA, 398
Young's modulus, 179
- Poly(L)lactides (PLLA) blends
dry, 450
layer thickness ratio, 450
with PDLA, 179
DSC thermograms, 172
melting enthalpies, 175
phase-transitions, 174
proteinase K-catalyzed enzymatic
degradation rate, 181
regularization, 174
storage modulus, 178
tensile strength, 177
WAXS profiles, 170
viscosity ratio, 450
- Poly(L)lactides (PLLA) nanocomposites
with MWCNT, 401
Young's modulus, 401
- Polymer blends
method, 131
PLA, 166
- Polymer flow rates, 444
- Polymeric foams, 406
- Polymeric materials, 400
- Polymer layered silicate (PLS), 417
and biopolyester layers, 456
composition peel strength, 457
- Polymer layered silicates 3 (PLS3), 448
based films peel strength, 456
- Polymer layered silicates 3 (PLS3)
blends, 458
- Polymers from renewable resources
(PFRR), 287
- Polymethyl methacrylate (PMMA), 193
- Polyphenols, 20
- Polypropylene glycol (PPG), 89
- Polysaccharides, 3, 87
list, 20, 130
- Polytetrafluoroethylene (PTFE), 229
- Polytetramethylene oxide (PTMEG), 89
- Polyurethane
blends, 95–100
grafted with starch, 95
plastics, 88
- Polyvinyl acetate (PVAc), 192
- Polyvinyl alcohol (PVA), 192, 232
- Poly(p)vinylphenol (PVPh) blends
with PHB, 202
- Potato, 243
blends with PEA, 260
characteristics, 244
composition, 351
properties, 351
shape, 351
starch, 78, 94, 373
tensile properties, 257
- PPG. *See* Polypropylene glycol (PPG)
- PP-g-MA. *See* Maleated polypropylene
(PP-g-MA)

- Pristine layered silicates, 393, 417
- Propanediol, 11
- Propylene glycol, 92
- Protein, 3
 - cellulose blends and composites, 143–144
 - development, 8
 - films, 79
 - list, 20, 130
 - microstructure, 7
 - natural polymers, 7
 - processing, 8
 - properties, 7
 - renewable resource polymeric materials, 7
 - structural organization, 7
- Proteinase K, 180
- Pseudomonas aeruginosa*, 112
- Pseudonatural cationic polymer.
 - See* Chitosan
- PTFE. *See* Polytetrafluoroethylene (PTFE)
- PTMEG. *See* Polytetramethylene oxide (PTMEG)
- Pullulan, 61
 - solids, 65
 - thermomechanical behavior, 64
- Puncture tests, 74
- PVA. *See* Polyvinyl alcohol (PVA)
- PVAc. *See* Polyvinyl acetate (PVAc)
- PVPh. *See* Poly(p)vinylphenol (PVPh)
 - blends
- PWS. *See* Plasticized wheat starch (PWS)
- Pyricularia oryzae*, 120
- Pyricularia piricola*, 120
- qC18-Mica4, 403
- qC18-MMT4, 403
- Quartz crystal microbalance (QCM), 175
- Ramie
 - chemical components, 309
 - composition, 251
 - properties, 252
- RC. *See* Regenerated cellulose (RC)
- RCCH. *See* Regenerated cellulose chitin blend films (RCCH)
- Reactive mixing intercalation
 - method, 425
- Reed fiber
 - chemical composition and physical properties, 355
- Regenerated cellulose (RC)
 - F1, 143
 - F2, 143
 - film, 136
 - SEM, 148
- Regenerated cellulose chitin blend films (RCCH), 136
- Relative humidity, 373–376, 378
- Renewable resource (RR), 130
- Renewable resource polymeric materials, 1–13
 - bioderived monomer synthetic polymers, 10–11
 - cellulose, 8
 - chitin and chitosan, 9
 - microbial fermentation polymers, 11–12
 - natural polymers, 1–9
 - natural rubber, 2–3
 - PHA family copolymers, 12
 - polyhydroxyalkanoate, 12
 - polylactic acid, 11
 - propanediol, 11
 - protein, 7
 - starch, 4–6
- Resorcinol and hexamethylenetetramine, 418
 - mechanical properties, 425
 - mixing and curing grafting and intercalating, 419
 - nanocomposite, 419
 - structural formula, 424
 - TEM, 426
 - vlucanizates, 425, 426
- RH. *See* Relative humidity; Resorcinol and hexamethylenetetramine
- Rice
 - characteristics, 244
 - chemical composition and physical properties, 355
 - composition, size and diameter, 243
 - shape, composition, and properties, 351
- RR. *See* Renewable resource (RR)
- Rubber nanocomposites, 418
- SA. *See* Starch acetate (SA); Succinic anhydride (SA)

- Sabai, 355
- Salmonella enteritidis* suspension, 112
- Salmonella typhimurium*, 112
- Saponite (SAP), 393, 395
- SAXS. *See* Small angle X-ray scattering (SAXS)
- SCA. *See* Starch cellulose acetate (SCA)
- scl. *See* Short-chain-length (scl) polyhydroxyalkanoate monomers
- Scutched flax, 308
- SDV. *See* Slit die viscometer (SDV) rheometer
- SEC. *See* Size-exclusion chromatography (SEC)
- Seed fibers, 250
- Seed flax, 355
- Seed hull fiber, 355
- SF. *See* Silk fibroin (SF)
- Short-chain-length (scl) polyhydroxyalkanoate monomers, 193
- Short sisal, 267
- flexural creep behavior, 267
- Silane coupling agents
- anisotropic composites, 333
- treatment, 332
- Silane with cellulose, 333
- Silica nanocomposite, 429
- Silicates
- interlayer spacing, 421
- pristine layered, 393, 417
- XRD, 421
- Silk fibroin (SF), 143
- with cellulose, 143–144
- Single-walled carbon nanotubes (SWCNT), 397
- Sisal
- chemical composition and physical properties, 355
- chemical treatments, 274
- composition, 251
- fiber, 249, 274, 306
- properties, 252, 306
- SEM, 249
- Sisal starch cellulose derivative blend composites, 274
- Sisal starch polycaprolactone blend, 274
- Size-exclusion chromatography (SEC), 147
- Skim milk powder (SMP), 77
- Slit die viscometer (SDV) rheometer, 445
- SM. *See* Synthetic mica (SM)
- Small angle X-ray scattering (SAXS), 394
- Smart cellulose, 142
- SMP. *See* Skim milk powder (SMP)
- Sodium alginate, 149
- bead, 150
- Sodium blends, 75
- Sodium caseinate
- analysis, 60
- bilayer films, 63
- derivatives, 59–60
- DSC, 71
- edible films, 63
- effects, 77
- films, 61, 64, 71
- FTIR spectra, 70
- mechanical properties, 59–60
- with starch blends and composites, 55–80
- derivatives, 57–58, 59–60
- gas permeability, 72–74
- glass transition temperature, 73
- irradiation, 72–74
- mechanical properties, 57, 59–60, 63–65, 67–70
- thermal properties, 58, 61, 66–71
- thermomechanical behavior, 64
- Sodium fluorohectorite, 376, 377
- Sodium hydroxide, 134
- Sodium montmorillonite, 376, 377
- gelatinized starch nanocomposites, 376, 377
- XRD traces, 376
- yield strength *versus* break elongation, 377
- Sodium nitrite, 118
- Solid-phase-modified montmorillonite, 420
- Solvent casting, 352, 357
- Solvent-free process, 390
- Sorbitol intercalation, 376
- Soybean characteristics, 244
- Soy protein, 8
- Soy protein isolate (SPI), 144
- cellulose blends and composites, 144
- Spherulites
- PLLA, 173
- radius growth rate, 173
- SPI. *See* Soy protein isolate (SPI)
- Staphylococcus aureus*, 120, 136, 137

- Starch, 21–23, 57–58, 87–101. *See also*
 Thermoplastic starch (TPS)
 biodegradability preservation, 354
 biosynthesis, 212
 castor oil-based waterborne polyurethane
 blend, 100
 characteristics, 6, 244
 chemical structure, 4
 and clay, 378
 components, 277
 composite, 258
 composition, 243, 351
 containing polyurethane foams, 94
 dairy-based food products, 78
 description, 21, 438
 destructure, 21–23
 diameter, 243
 DSC, 61
 ethanolamine plasticized, 375
 fiber blends morphology, 358
 fiber length, 361–362
 fiber treatment effect on tensile
 properties, 275
 filled polyurethane elastomers and
 plastics, 89–91
 filled polyurethane foams, 91–93
 films, 361–362
 flexural properties, 264
 and foams, 87–101
 gelatinization, 6
 and glycerol, 378
 grafted with polyurethanes, 95
 granule, 87, 90, 350
 matrix tensile strength, 258
 mechanical properties, 22, 57
 modification, 6, 353
 molecular structure, 351
 montmorillonite nanocomposites,
 370–377
 morphologies, 5
 nanocomposites layered materials,
 378–380
 natural polymers, 4–6
 pasting, 78
 physical structure, 5
 and polyurethane novel plastics, 87–101
 processing transition, 5
 properties, 351
 renewability, 354
 renewable resource polymeric
 materials, 4–6
 shape, 351
 size, 243
 surface energy data, 214
 surface textures, 90
 thermal properties, 23, 58
 thermoplastic, 21–23
 water resistance, 101
 Starch acetate (SA), 22
 with PHB, 194
 Starch based biopolymers, 350–354
 composition, 350–351
 multilayers, 457
 peel strength, 457
 processing method, 352–354
 properties, 350–351
 structure, 350–351
 type, 352–354
 Starch based films, 352
 fibers, 360–361
 gas permeation, 360
 mechanical properties, 360
 Young's modulus, 360
 Starch based foams, 353
 fibers, 360–361
 gas permeation, 360
 mechanical properties, 360
 Young's modulus, 360
 Starch biopolyester multilayer coextrusion,
 437–458
 characterization, 444–446
 materials, 440
 melt rheology, 446
 melt-state behavior, 446–454
 optical microscopy, 446
 peel test, 444
 processing and procedures, 441–443
 results, 446–458
 solid-state behavior, 455–458
 surface tension, 446
 Starch blends and composites, 260–278
 aqueous degradation, 276–277
 with caseinate, 55–80
 with cellulose, 19–49
 applications, 48–49, 75–78
 destructure starch, 21–23
 gas permeability, 44–47
 glass transition temperatures, 31–38

- Starch blends and composites (*Continued*)
- mechanical properties, 22, 24–30, 39, 40–41
 - melting temperatures, 43–44
 - physical and mechanical properties, 259
 - sodium caseinate vs. other edible films, 79
 - starch derivatives, 21–23
 - thermal properties, 23, 39, 42–43
 - thermoplastic-like starch, 21–23
 - WVTR, 45–47
 - with cellulose derivative, 23–39, 261
 - composite and matrix tensile strength ratio, 263
 - creep properties, 266
 - fiber dimensions, 272
 - fiber treatments, 272–275
 - flexural properties, 265
 - impact properties, 265, 266
 - mechanical properties, 259–266, 269–270, 273
 - with PCL, 259
 - with PHA, 194–196, 221
 - physical properties, 259
 - with polycaprolactone, 382
 - composite and matrix tensile strength ratio, 263
 - with polyhydroxyalkanoate, 211–223
 - applications and production, 221
 - biodegradability, 219–220
 - future, 221
 - gelatinized, 217
 - granular, 214–216
 - laminates for foams, 217–218
 - mechanical property data, 215
 - properties, 211
 - recycling, 219–220
 - sustainability, 219–220
 - processing conditions, 267–270
 - rheological behavior, 271
 - with sodium caseinate, 55–80
 - derivatives, 57–58, 59–60
 - gas permeability, 72–74
 - glass transition temperature, 73
 - irradiation, 72–74
 - mechanical properties, 57, 59–60, 63–65, 67–70
 - thermal properties, 58, 61, 66–71
 - soil-burial degradation, 276–277
 - tensile properties, 261, 262
- Starch cellulose acetate (SCA)
- tensile properties, 262
- Starch cellulose fiber composites, 242–278
- aqueous and soil-burial degradation, 276–277
 - chemical composition, 242–244
 - fiber dimensions, 272
 - fiber treatments, 272–275
 - gelatinization, 245
 - mechanical properties, 260–266
 - natural fibers, 248–249
 - polymer matrix, 258–259
 - polymers, 242–247
 - processing conditions, 267–270
 - retrogradation, 247
 - rheological behavior, 271
 - structure, 242
 - tensile properties, 256
 - thermoplastic starch, 245–247
- Starch chitosan matrix, 113
- Starch coating
- PEO, 216
- Starch derivatives, 21–23, 57–58
- applications, 49
 - destructured starch, 21–23
 - mechanical properties, 22, 57
 - starch cellulose blends, 21–23
 - thermal properties, 23, 58
 - thermoplastic-like starch, 21–23
- Starch fiber composites, 349–362
- applications, 354–355
 - characterization, 358–362
 - composition, 350–351, 354
 - film transparency, 358
 - modifications, 354–355
 - natural fibers, 354–362
 - preparation methods, 356–357
 - properties, 350–351, 354
 - starch-based biopolymers, 350–353
 - structure, 350–351, 354
 - water absorption, 359
 - water sensitivity, 359
- Starch-g polycaprolactone copolymers
- synthesis, 95

- Starch matrix
 disperse clay particles, 373
 fiber alignment, 362
 fiber content, 361
 foam, 362
 thermal behavior, 362
- Starch polycaprolactone, 261
- Starch polymers, 242–247
 chemical composition, 242–244
 gelatinization, 245
 retrogradation, 247
 structure, 242
 thermoplastic starch, 245–246
- Starch polysaccharide, 96
- Stearic acid treatment, 316
- Stereoblock isotactic polylactide, 168
- Stereocomplexed polylactide
 crystal structure, 170
 dilute solution, 171
 hydrogels, 184
 synthesis and molecular structure, 168
- Stereocomplex formation, 175
- Stereocomplex single crystal, 171
- Strain-induced hardening, 405
- Succinic anhydride (SA), 328
 and cellulose, 329
- Sulfuric acid, 94
- Surfactants, 3
 list, 130
- SWCNT. *See* Single-walled carbon nanotubes (SWCNT)
- Synthesized starch-urethane polymers, 94
- Synthetic fiber properties, 252
- Synthetic mica (SM), 395
- Tapioca
 composition, size and diameter, 243
 shape, composition, and properties, 351
- TBC. *See* Tributyl citrate (TBC)
- TDI. *See* Toluene diisocyanate (TDI)
- TDP. *See* Thiodiphenol (TDP)
- TEA. *See* Triethanolamine (TEA)
- Technology Road Map, 129
- TEGB. *See* Triethylene glycol bis(2-ethylhexanoate) (TEGB)
- TEM. *See* Transmission electron microscope (TEM) analysis and images
- Temperature differential scanning calorimetry, 39
- Template polymerization, 176
- Tenacity (breaking stress), 313
- Tetrahydrofuran (THF), 395
- Tetramethylpyrazine phosphate (TMPP), 150
- TGA. *See* Thermogravimetric analysis (TGA)
- Thalassiosira fluviatilis*, 109
- Thermogravimetric analysis (TGA), 362
- Thermoplastic acetylated starch (TPAS), 374
- Thermoplastic-like starch, 21–23
- Thermoplastic polyester-urethane (TPU), 97
 native starch, 98
 properties, 97, 98
 TPS blends, 97, 98
- Thermoplastic processing, 352
- Thermoplastic starch (TPS), 95–100, 245, 370, 384, 438
 bag, 373
 blends, 100, 384
 castor oil-based waterborne polyurethane, 100
 with clay, 384
 clay composites, 381
 intercalation, 375
 with kaolinite, 379
 mechanical behavior, 245
 modulus tensile strength and elongation, 379
 montmorillonite nanocomposite plasticized, 372, 373
 PCL, 262
 with PCL, 384
 PEA blends, 260
 polymers, 245–246
 preparation, 246
 SEM, 100
 shear modulus, 381
 TEM, 372
 tensile properties, 262, 383

- Thermoplastic starch (TPS) (*Continued*)
 tensile tests, 384
 water absorption, 381
 Young's modulus, 381
- THF. *See* Tetrahydrofuran (THF)
- Thiodiphenol (TDP), 337
- Thiourea chitosan, 120
- Thwing-Albert peel tester, 444
- TMDSCO. *See* Modulated temperature differential scanning calorimetry (TMDSCO)
- TMMT. *See* Tributyl phosphate montmorillonite (TMMT)
- TMP. *See* Trimethylolpropane (TMP)
- TMPP. *See* Tetramethylpyrazine phosphate (TMPP)
- Toluene diisocyanate (TDI), 89
- TPAS. *See* Thermoplastic acetylated starch (TPAS)
- TPS. *See* Thermoplastic starch (TPS)
- TPU. *See* Thermoplastic polyester-urethane (TPU)
- Transmission electron microscope (TEM)
 analysis and images, 371, 372, 375, 383, 394–396, 426–427
- Tributyl citrate (TBC), 334
 with PHB
 optical micrographs, 338
 SEM, 337
- Tributyl phosphate montmorillonite (TMMT), 420, 429
 composites, 430
 cone calorimeter, 430
 nanocomposites, 430
- Triethanolamine (TEA), 63
 stress-strain curve, 60
- Triethylene glycol bis(2-ethylhexanoate) (TEGB), 196
- Trimethylolpropane (TMP), 89
- Twin-screw extrusion, 250
- U. *See* Ultrasonics (U)
- UHMW-PHB. *See* Ultrahigh-molecular-weight polyhydroxybutyrate (UHMW-PHB)
- Ultrafine layered titanate
 PLA nanocomposite preparation, 392
- Ultrahigh-molecular-weight polyhydroxybutyrate (UHMW-PHB), 198
- Ultrasonics (U)
 nanoclays, 377
- Unmodified fiber composite
 SEM, 329
- Unmodified polyhydroxybutyrate composites
 optical micrographs, 342
 SEM, 341
- Unsaturated montmorillonite (USMMT)
 composites, 422, 423
 DMA spectra, 423
 intercalating, 418–419
 latex grafting, 418–419
 nanocomposites, 418–419
 temperature values, 423
 vulcanizate mechanical properties, 422
- Urea aqueous solvent system, 134
- US Department of Energy, 129
- USMMT. *See* Unsaturated montmorillonite (USMMT)
- Vehicle manufacturers, 304
- Vero cells, 146
- Water homogeneous distribution, 71
- Water vapor transmission rate (WVTR), 45–47
- WAXD. *See* Wide angle X-ray diffraction (WAXD)
- WAXS. *See* Wide angle X-ray scattering (WAXS)
- Waxy corn, 243
- Waxy rice, 244
- Waxy wheat, 244
- WF. *See* Wood flour (WF)
- Wheat
 characteristics, 244
 chemical composition, 355
 composition, 243, 351
 diameter, 243
 glycerol, 374
 montmorillonites, 374
 physical properties, 355
 properties, 351
 shape, 351
 size, 243
 starch, 440
 starch plasticized, 374
 tensile properties, 256

- Whey protein isolate (WPI), 77
- Wide angle X-ray diffraction (WAXD), 196, 394
- Wide angle X-ray scattering (WAXS), 5
- Wood fiber, 327
 - chemical composition and physical properties, 355
- Wood flour (WF)
 - with PLA composites
 - dynamic viscoelastic curves, 293
 - flexural properties, 292
 - tensile properties, 292
 - SEM, 291
- WPI. *See* Whey protein isolate (WPI)
- WVTR. *See* Water vapor transmission rate (WVTR)
- Yam starch, 244
- Young's modulus
 - MWCNT nanocomposites, 401
 - PLLA, 179
 - starch based films, 360
 - TPS, 381
- Zein, 254