

## Index

- a**
- acicular wollastonite, microphotograph 261
  - acids 119
    - acetic acid solution 67
    - acrylic acid-coated filler 127
    - effects 119
    - types 119
  - adhesion promoters 97
    - titanates 97
    - zirconates 97
  - agglomeration effect 49, 50, 463
    - formation mechanism 50
  - aggregates 352
    - pseudo-graphitic structure 352
  - aliphatic bismaleimides, effect 130
  - aliphatic mineral oil 95
    - hydrolysis 67
  - aluminum hydroxide/EVA system 123, 124
  - aluminum trihydrate (ATH) 91, 318, 319
    - applications, fire retarding processes 321
    - chemical surface treatments 323
    - filler surface-modified, properties, correlation 127
    - flame retardance 319
    - formulations, properties 81, 83
    - ground vs. precipitated 319–321
      - scanning electron micrographs 320
      - chemical analysis 320
      - cone calorimetric data comparison 321
    - summary 322
    - surface-treated ATH 322
    - thermal degradation properties 319
    - thermodynamic properties 319
  - Aman process 324, 409
  - Amberger Kaolinwerke (AKW) 250
  - American Conference of Governmental Industrial Hygienists (ACGIH) 233, 355, 391
    - American Industrial Hygiene Association (AIHA) 232
    - American Society for Testing and Materials (ASTM) 312, 335
    - 2-aminoethyl-3-aminopropyltrimethoxysilane 73
      - <sup>1</sup>H-NMR spectrum 73, 74
    - amino-functional silane 80, 81
      - polypropylene composites, comparison 84
    - $\gamma$ -aminopropyltriethoxysilane 82, 130
      - autocatalytic hydrolysis of 82
        - effect 130
    - aminosilane 79, 81–85
      - ATH-filled EVA 83
      - calcined clay-filled polyamides 82, 83
      - EVA/ATH HFFR comparison 84
      - maleated polypropylene, Reaction of 79
      - treated magnesium dihydroxide (MDH) 84
        - MDH-filled polypropylene 83–85
    - ammonium pentaborate (APB) 334
      - action 334
      - degradation 334
    - ammonium salts, advantage 118
    - amorphous diatomite 397
    - amorphous synthetic silicas, production by 396
      - pyrogenic/thermal processes 396
      - wet process 396
    - anatase/mica pigment particle 11
      - cross section 11
    - anisotropic products 40
      - flake-filled thermoplastics 40
      - short-fiber thermoplastics 40
    - antiblocking fillers 394–402
      - silica 395–402
        - applications 401
        - environmental/toxicity considerations 397
        - production 395–397

- structure/properties 397
  - suppliers/manufacturers 397
  - antiblock silicas 398
  - suppliers/manufacturers 398–400
  - antimony oxide ( $\text{Sb}_2\text{O}_3$ ) 326, 338
  - loading levels 326
  - mechanism of action 326
  - antioxidant-free systems 126
  - apatite-wollastonite glass ceramics (AWGC) 451, 452
  - composition 451
  - volume fraction 451
  - APP-based systems 332, 333
  - benefits 333
  - properties 332
  - solubility 332
  - aprotic polar solvents 471
  - aqueous silane solution 66
  - arc-discharge method 190
  - aromatic resins 474
  - bisphenol-A 474
  - artificial graphite, *see* synthetic graphite
  - aspect ratio 31, 181, 184, 360, 362
  - atomic force microscopy (AFM) 76
  - Auger electron spectroscopy (AES) 73
  - azidosilane-treated mica 173
  - properties, comparison 173
- b**
- Bakelite 269, 283, 365
  - Banbury mixers 43, 45, 67, 72
  - batch mixers, disadvantages 43
  - Beer–Lambert law 314
  - bentonite rock, morphologies 183
  - biaxially oriented polypropylene (BOPP) films 301
  - bicontinuous nanocomposites 470–472, 474
  - characteristics, phases 472
  - morphological structure 470
  - nanostructure 471
  - potential applications 474
  - epoxy/silica systems, coating applications 474
  - production methodology 470–472
  - properties 472
  - bilobal paddles, expansion/compression squeezing action 56
  - bioactive ceramics 442, 443, 449, 453
  - bioactive composites 305, 421, 491
  - bioactive filler(s) 305, 443, 444
  - bone as biocomposite 441
  - suppliers list 444
  - synthetic biomedical composites 442–444
  - bioactivity 442
  - bioactive glasses 449
  - polymer composites, composition 450
  - powder, scanning electron micrograph 450
  - bioceramic fillers 442, 452, 453
  - class 452
  - modification 453
  - types 442
  - biocomposites 7, 441, 442, 445, 446, 455
  - bioglass-reinforced polyethylene 451
  - biomedical composites 259, 441, 442
  - bismaleimides 129–130
  - structure effect 130
  - bisphenol-A 474
  - epoxy resin 476
  - TEM micrographs 476
  - bleaching agents 226
  - structure/properties 226–230
  - bonding mechanism 236
  - bone complex structure 442
  - borehole drilling 179
  - briquetting, *see* agglomeration
  - brominated flame retardants 327, 328, 339
  - aliphatic/aromatic 328
  - toxicity profile 339
  - bulk molding compounds (BMC) 43, 259, 298, 318
  - bulk resistivity 368
  - surface measurement setups 368
- c**
- calcined kaolin 246, 248, 251, 252
  - benefits 251
  - features 251
  - SEM micrograph 248
  - calcium carbonate ( $\text{CaCO}_3$ ) 98, 291, 292, 294, 296, 448
  - applications 296–303, 448
  - cost/availability 295
  - dispersion 304
  - SEM photomicrograph 304
  - environmental toxicity 295, 296
  - filled mineral oil 96
  - critical pigment volume concentration point (CPVC) 96
  - filled polyolefins 101, 105
  - titanate effects 105
  - filled polypropylene homopolymer 34, 120, 124, 133, 301
  - flexural modulus comparison 301
  - impact strength 120
  - filled thermoplastics 103
  - demonstration 98
  - flexibility 98
  - global production 295

- microporous stretched LLDPE film 302, 304
  - average WVTR vs. tensile modulus 304
  - SEM micrograph 302
- powder 50
- production methods 292–294
- properties 294
- structure 294
- suspension micrograph 96
- sustainability considerations 295, 296
- type fillers 124
- use 296
- calcium phosphate ceramics, phases 448
- calcium silicate powder 452
  - scanning electron micrograph 452
- carbon-based conductive fillers 362
- carbon black (CB) 13, 53, 91, 352–356, 358, 360
  - aggregates 354
    - approach 361
    - shape categories 354
    - weight percent 354
  - commercial sources 353–355
  - concentration 355
  - distribution and dispersion in polymers 360–362
    - microscopy/morphology 360
    - multiphase blends 361
    - percolation networks 360
    - process effects on dispersion 361
  - formation, schematic diagram 352
  - loaded polymers, applications 359
  - log resistivity vs. concentration curves 356, 358
  - manufacturers 353
  - mesoscopic distribution 356
  - in plastics 353
  - Printex XE-2 356, 362
    - threshold concentrations 356
  - safety and toxicity 355
  - surface chemistry and physics 355
  - varieties 352
- carbon black-filled polymers 103–105, 355, 360
  - conductivity phenomena 355–360
    - applications 359
    - carbon black type effects 357
    - percolation theories 357
    - polymer matrix effects 358
- carbon dioxide, toxic effects 313
- carbon elementary analysis 77
- carbon fiber(s) 189, 191, 198, 206, 362
  - applications 205
  - chemical modification/derivatization methods 195
  - composites 197, 205
    - fabrication 197
    - use 205
  - cost/availability 202
  - environmental/toxicity considerations 202–205
  - fabrication from pitch, steps 193
  - high thermal conductivity 206
  - materials 189–197
  - suppliers list 205
  - synthesis 191–195
    - from anisotropic mesophase pitch 193
    - from isotropic pitch 193
    - from phenolic resins 194
    - from rayon 194
    - vapor-grown carbon fibers 194
  - types 191–195
    - PAN-based carbon fibers 192
  - use 198
- carbon monoxide, toxic effects 313
- carbon nanofibers T189
  - applications 205
  - chemical modification/derivatization methods 195
  - cost/availability 202
  - environmental/toxicity considerations 202–205
  - materials 189–197
  - synthesis 189–191
  - types 189–191
- carbon nanotubes 189, 195, 198, 202, 204, 341, 362
  - applications 205
  - chemical modification/derivatization methods 195
  - cost/availability 202
  - environmental/toxicity considerations 202–205
  - materials 189–197
    - suppliers list 204
  - polymer nanocomposites 199
    - characterization/fabrication 199
    - development 195
    - nanofiber-reinforced 189
  - polystyrene nanoporous membranes 201
  - synthesis 189–191
  - types 189–191
- carboxylic acid anhydrides 128–129
- catalyst-free method 191
- cellulose 215, 274
  - chemical structure 274
- ceramic-like products 469

- ormocers 469
  - ormosils 469
  - ceramic grinding media 226
  - ceramic sphere 434, 436, 437
    - functions 436–438
    - photomicrograph 436, 437
    - production 435, 436
    - properties 435, 436
  - chain extension mechanism 417
  - charring agents 316
  - chemical blowing agents (CBA) 430
  - chemical modification
    - chemical modifiers 293
    - derivatization methods 195
  - clays 177, 181, 185
    - dispersion mechanisms, schematic presentation 185
    - intercalated vs. exfoliated 185
    - mineral properties 181
    - nanocomposite, appeal of 184
    - platelets 184
    - processing, flow chart 180
    - structure 181
    - swelling/nonswelling-type materials 181
  - coal-type mining techniques 377
  - coarse kaolin slurry 245
  - coefficient of friction (COF) 383, 384, 401
  - coefficient of linear thermal expansion (CLTE) 233
  - coefficient of thermal expansion (CTE) 35
  - combustion cycle 310
  - commercial micas 163
    - wet/dry ground 163
  - composites 7, 8, 28, 287
    - classification 7
    - containing particulates 28, 33
      - strength 33
    - continuous/discontinuous composites 8
    - elastic moduli 28
    - fabrication 217
    - mechanical properties 287
    - mixtures, rules 12
    - modulus 24, 28, 29
    - parameters affecting properties 8, 9
  - compounding techniques 154
    - effects 363
  - compression 106
    - properties, comparison 106
  - condensed phase fire-retarding mechanisms 310
  - conductive thermoplastics, resistivity classification 368
  - conductivity, magnetic fillers 351
  - cone-and-plate viscometer 361
    - schematic presentation 337
  - continuous fiber 25, 30
    - modulus equations, comparison 25
    - strength equations, comparison 30
  - conventional mineral fillers 460, 469
  - Cosmetic Toiletry and Fragrance Association (CTFA) 232
  - coupling modifiers, effects 117
  - crammer feeder 46, 49
  - cristobalite filled PMMA, comparison of 86
  - critical pigment volume concentration point (CPVC) 96
    - definition 96
  - critical volume fraction 355
  - cross-linked low-density polyethylene (XLPE) 234
  - cross-linking agents 4
  - crystalline silica 341
  - cyclic anhydrides 128
    - maleic anhydride 128
    - succinic anhydride 128
- d**
- dark talc 233
  - dead sea periclast (DSP) process 409
  - degree of polymerization 215
  - Department of Health and Human Services 340
  - dicumyl peroxide (DCP) 81
  - p*-dicyclohexane aminomethane (PACM) 475
  - differential scanning calorimetry (DSC) 394
  - dioxin toxicity 339
  - dispersion process 185
  - dispersive mixing 51
    - aspects 52
  - DNA 196
    - damage 338
  - dodecyl succinic anhydride 128, 129
  - double-armed batch mixer 43, 44, 46
    - mixing blades 46
  - DRIFTS spectra 120
  - dry-ground mica 163
    - flakes 168
    - phlogopite mica, SEM microphotograph 169
  - ductile resins 156
    - polyphenylene ether sulfone (PPSU) 156
  - dynamic mechanical analysis (DMA) 447

**e**

- E-glass fiber 74–76, 143–145, 148–150, 155, 159
- elastomer-modified polystyrene-containing talc, properties 237
- electromagnetic interference (EMI) 152
- electron spectroscopy for chemical analysis (ESCA) 76
- Electronics Industry Alliance 340
- Electronics Industry Association 359
- emulsion polymerization technique 377
- energy dispersive X-ray analysis (EDX) 76
- epoxy resin(s) 86, 475, 477, 478
  - functionalization 478
  - linear expansion 477
  - matrix 484
  - silane functionalization 475
- epoxy-silica hybrids 476
- epoxy/silica system 470
- ethylene-octene copolymer, Engage 361
- ethylene-propylene-diene-monomer (EPDM) 394
  - composites 320
  - combustion properties 320
  - rubber 432
- ethylene-vinyl acetate (EVA) 3, 65, 81, 83, 361
  - formulations, properties 81, 83
- European Committee for Standardization 340
- expanded polystyrene (EPS) beads 427
- extinction coefficient, definition 314
- extruder capacity 58, 59
  - polymer viscosity effect 59
  - screw 43, 55
  - talc bulk density effect 58
  - talc loading effect 58
  - twin-screw 43
- extrusion freeform fabrication (EFF) 198

**f**

- fatty acids 119
  - coatings 118
    - dry coating 118
    - wet coating 118
  - surface layers, structure 119–122
  - treated fillers 122
- fiber(s) 22, 29, 49, 159
  - bearing plants 214
  - environmental impact data 159
  - extraction procedures 214
  - metering and feeding 49
  - modulus 22–27
  - preparation methods 220
  - strength 29–33
  - fiberglass 43, 49, 53, 55, 57, 111, 152, 153, 164, 187, 318, 437
  - filled polymer 36, 55
    - melt rheology 36–38
      - shear rate 37
      - size and shape 37, 38
    - viscosity 55
  - fillers 9, 13–15, 33, 35, 36, 43, 44
    - classification 13
    - dispersion, definition 99
    - effects 9–11, 36–41
      - polymers processing characteristics 36–41
    - functions 15
    - moisture 44
    - particle morphology 13
    - permeability 36
    - pressure profile 52
    - pretreatment 44, 45
    - reactive groups 134
    - silanes, reactivity of 69–70
    - surface modification 63
    - surface treatments 38, 39, 66, 70, 71
      - slurry procedure of 71
    - thermal effects 35
    - time effects 35
    - toughness considerations 33, 34
    - tribological properties 35
    - TSE configuration 52
  - fire-resistant polycarbonate 420
  - fire retardants 309, 335, 342, 343
    - agents 310
      - action mechanisms 315–317
        - chemical effects in gas phase 316
        - condensed phase 315
      - brominated/chlorinated organic compounds 325
    - combustion cycle 310
    - flammability of polymers 314
    - fuel 311
      - performance 335
      - polymeric materials 326
      - polymers combustion 310
    - producers 342, 343
    - smoke 311
      - strategy 309, 311
      - toxicity of smoke 335
      - use 343
      - visibility of smoke 314
  - fish-bone structure approach 194
  - flake-containing composites, strength 33
  - flake graphite pinacoid structure 382
    - scanning electron micrograph 382
  - flame ionization detector 76

- flame retardants 315, 317
    - chemical mechanism 318
    - classification 317–336
      - halogenated fire retardants 325–329
      - low melting temperature glasses 334
      - melamines 329
      - metal hydroxides 317–325
      - molybdenum-containing systems 335
      - nanosized fire retardants 335
      - phosphorus-containing flame retardants 329–334
      - zinc/boron systems 329
    - retardancy 316
    - testing techniques 336
    - tools/testing 336
    - toxicity 337–343
      - antimony trioxide 338
      - brominated fire retardants 338
      - chlorinated fire retardants 339
      - metal hydroxides 338
      - molybdenum-containing fire retardants 341
      - nanosized FRs 341
  - flax fibers 213, 214, 160
    - environmental impact 160
  - flexural tests 487
  - Food Chemicals Codex 338
  - force-deflection curves 485
  - force-displacement curves 484
  - full width at half maximum (FWHM) 355
  - fumed silica 409, 412, 416, 419. *see also* fumed silicon dioxide
    - application 419
    - environmental/toxicological considerations 416
    - production 409
    - structure/properties 412
  - fumed silicon dioxide 409, 412
  - functional fillers 12–17, 19, 264, 351, 373, 443, 444
    - applications 14–17
    - bioceramics 444–452
      - bioactive glasses 449–451
      - calcium carbonate 448
      - calcium phosphate ceramics 448
      - hydroxyapatite 444–447
    - classification 12–14
    - interface, importance 20–21
    - mechanical properties, modification 21–36
    - polymer composites, parameters affecting 19
    - roles 351
  - functionalized organic microspheres 434
    - surface functionalization 433, 434
  - functionalized polymers 132–137
    - functionalized polyolefins 132–135
- g**
- Gardner impact strength 253
  - gelation mechanism, examination of 469
  - gel permeation chromatography 464
  - generally recognized as safe (GRAS) 251, 295, 401
  - geological maps 179
  - Gibbs free energy 462
  - glass ceramics, Ceravital™ 452
  - glass fiber 53, 143, 148–150, 153, 160
    - applications 154–157
    - characterization 148
    - chemical composition 150
    - concentrations 154
    - content 154, 155
    - cost/availability 149–152
    - demand 149
    - density 160
    - diameter, effect 159
    - eco-indicator 160
    - environmental impact 158–161
    - environmental/toxicity considerations 152, 153
    - function 154, 155
      - Charpy impact strength 155
      - tensile modulus 154
    - length retention 57
    - production methods 144–147
    - properties 148–150
    - reinforced engineering thermoplastics 155, 156
      - flexural modulus, comparison 155
      - flexural strength, comparison 156
      - impact strength, comparison 156
    - reinforced thermosets 298
    - sizings, composition 147
    - structure 148, 149
    - suppliers 149, 151–152
    - use 484
  - glass filaments, surface energy 144
  - glass filled styrene-maleic anhydride copolymers 57
  - glass spheres 428, 438
    - suppliers 438
  - Gleophyllum trabeum* 279
  - global positioning satellite (GPS) techniques, use 179
  - 3-glycidyloxypropyltrimethoxysilane 69, 86
  - γ-glycidyloxytrimethoxysilane (GOTMS) 475, 483
    - use 475

- Good-Girifalco equations 20  
 graphene layers, molecular scale structure 194  
 graphite 375, 376  
 – amorphous graphite 377, 383, 386  
 – crystalline vein graphite 377, 382, 386  
 – flake graphite 376, 382, 386  
 – intumescent flake graphite 382, 386  
 – suppliers/manufacturers 388  
 – synthetic graphite 377, 383, 386  
 – morphology 383  
 – vein graphite 377  
 graphitic mechanism 357  
 green house gas emissions (GHG) 158  
 ground calcium carbonate (GCC) 291, 292  
 – production processes 292  
 ground calcite 294  
 – properties 294  
 – suppliers 294, 295  
 guided bone regeneration membrane (GBR) 455
- h**
- halogenated fire retardants 325–329  
 – bromine-containing fire retardants, applications 326  
 – chlorine-containing flame retardants 327  
 – mechanism of action 325, 327  
 – synergy with antimony trioxide 326  
 halogen-free flame-retardant (HFFR) 80  
 hand sorting technology 225  
 HAPEX™ 445, 451  
 hardwood, schematic presentation 273  
 heat deflection temperature (HDT) 233, 262  
 heat distortion temperature 35, 157  
 heat expandable microspheres 428, 432  
 – performance 432  
 heat release rate (HRR) 320  
 high aspect ratio (HAR) 164  
 – fibers/ribbons/platelets, comparison 23  
 high-density polyethylene (HDPE) 234, 279, 298, 357  
 high expansion temperature microspheres 429  
 – cross-sectional scanning electron micrographs 429  
 high-impact polystyrene (HIPS) 3  
 high-intensity magnetic separation (HIMS) 245  
 high molecular weight polymers 472  
 high-pressure carbon monoxide (HIPCO) process 191  
 high-purity talc, wet methods 226  
 high-strength polymer composites, formation 196  
 hollow glass spheres 435  
 hollow organic spheres 429, 431, 432, 437  
 – applications in thermoplastics 429–431  
 homopolymer polypropylene 230  
 – thermal stability 230  
 human bone 442  
 Hybrid Plastics Inc. 463  
 hydrated alumina, *see* aluminum trihydrate  
 hydrogen bonding 82  
 – silanes 69  
 hydrogen bromide (HBr) 313  
 – toxic effects 313  
 hydrogen cyanide, toxic effects 313  
 hydrogen fluoride (HF) 313  
 – toxic effects 313  
 hydrophobic fumed silica coatings 409  
 – dimethyldichlorosilane (DMDS) 409  
 – hexamethyldisilazane (HMDS) 409  
 – trimethoxyoctylsilane (TMOS) 409  
 hydrophobic minerals, testing of 77  
 hydrophobic polymers 293  
 – polyethylene (PE) 293  
 – polypropylene (PP) 293  
 hydrophobicity 98  
 hydrotalcite(s) 7, 409, 410, 412, 413, 415, 416, 420  
 – applications 420, 421  
 – double-layered metal hydroxide structure, schematic 413  
 – environmental/toxicological considerations 416  
 – scanning electron micrograph 7  
 – structure/properties 412–414  
 – suppliers/manufacturers 415  
 – use 420  
 hydrous kaolin 250, 252, 256  
 – benefits 250  
 – features 250  
 hygroscopicity 217  
 hysteresis loop 407
- i**
- image analysis methods 360  
 initial boiling point (IBP) 111  
 injection-molded glass fiber composites 157  
 – properties 157  
 – reinforced polyolefin 157  
 injection molding 4, 5, 40, 172, 233  
 – LLDPE, color 256  
 – polyethylene, properties 299  
 – SEM fracture surface 300  
 inorganic fibers, glass fibers 216

- inorganic fillers/organic additives 311, 326, 395
  - inorganic oxide network 481
  - inorganic silica 461
    - POSS densities comparison 461
  - in situ* filler formation 453
    - sol-gel methods 453
  - in-situ*-generated fillers 469
    - bicontinuous phase nanocomposites 469
  - interlaminar shear tests 484
  - International Agency for Research on Cancer (IARC) 340, 392, 400
  - International Molybdenum Association (IMOA) 388
  - International Program for Chemical Safety (IPCS) 340
  - intramolecular condensation reactions, reaction scheme 481
  - intrinsically conductive polymers (ICPs) 362, 363
  - intumescence 316
    - ingredients 316
    - formation 316
  - inverted random void model 357
  - in vitro* evaluation of bioactivity 443
    - mechanisms 443
    - procedure 443
  - ion-exchange reaction 180
  - IR spectroscopy 72
    - spectrometric analysis 127
  - isopropyl triisostearoyl titanate 95
  - isostearic acid, molecular footprint area 122
  - isotropy 24, 31
- k**
- kaolin 241, 242, 254, 255
    - applications 251–257
    - booklets 242
    - classification 243
    - cost/availability 250–251
    - environmental/toxicity considerations 251
    - evaluation 255
    - grades, properties 249
    - interlaminar bonding 242
    - platelets, SEM micrograph 245
    - production methods 243–247
      - beneficiation 243–246
      - calcination 246–247
      - primary processing 243
      - surface treatment 247
    - products 246
    - properties 247, 248
      - improvement 254–256
    - slurry 243, 245
    - structure 242
      - suppliers 248–250
    - kneading paddle arrays 54, 55
      - dispersion face 55
      - elements, screws comparison 54
- l**
- lamellar composites 22, 29
    - continuous reinforcements 22–24, 29–31
    - discontinuous reinforcements 24–27, 31–33
    - modulus 22–27
    - strength 29–33
  - Langmuir-type isotherm 122
  - LICA 38, 92, 99, 101, 109, 110
    - varying dosages, viscosity effects 110
  - lifecycle assessment tools 159
  - light-burned MgO submicron particles 411
    - SEM 411
  - lignin 215, 274
  - limiting oxygen index (LOI), definition 314
  - linear density polyethylene (LDPE) 3, 264
  - linear low-density polyethylene (LLDPE) 99, 234, 299
    - films 301
  - liquid coating systems 419
    - thickening mechanism 419
  - liquid crystal polymer (LCP) 264, 393
  - long fiber reinforced thermoplastics (LFRTTP) 157
  - Low Earth Orbit 466
  - low melting temperature glass flame-retardant system 334
  - low molecular weight hydrocarbons 312
  - low specific area fillers 38
  - Luzenac<sup>®</sup> R7 talc 229
- m**
- macrocrystalline talc 235
  - Maddock mixing element 51
  - magic angle spinning (MAS) 73
  - magnesia, *see* magnesium oxide
  - magnesium hydroxide 319, 324, 325
    - applications 325
    - PP copolymer 130
    - production 324
    - thermal degradation properties 319
  - magnesium oxide 408, 411, 415, 416
    - applications 416–419
    - environmental/toxicological considerations 415–416
    - production 408–409
    - properties 412
    - role 417
    - structure/properties 411–412
    - suppliers/manufacturers 414



- magnetic field 367
- magnetic fillers 366
- magnetic particles 367
- magnetic remanence 367
- magnifin process 324
- maleic anhydride 133
- marrow stromal cells (MSC) 451
- material declaration guide 340
- material safety data sheets (MSDS) 296, 415
- Maxwell model 36
- mechanochemical grafting 124, 131
- melt mixing method 197
- metakaolin 246, 255
- metal fibers 365, 366
  - aspect ratio 365
- metal-filled composites 366
- metal-filled polymers 365
- metal hydroxides 317–325
  - aluminum trihydrate 318
  - magnesium hydroxide 324
  - zinc stannates 325
- metal oxide network 471
  - antimony oxide 101
- metal particle composites 363–366
  - random vs. segregated particle distributions 364
- metal segregation, effect 363
- methacryloxy functional silane 79, 85
- methacryloxysilane 77, 80, 85, 86
  - filled PMMA resin systems 85
  - silica-filled UV-cured acrylates 85–86
- mica 11, 165, 167, 172
  - blocks 165
  - filled thermoplastics 171
    - processing methods 171
  - surface modification 11
- mica flakes 6, 8, 11, 40, 163
  - applications 171–174
    - other functions 173
    - primary function 172
  - cost/availability 170–171
  - environmental/toxicity considerations 171
  - production methods 165, 166
  - properties 166–170
  - scanning electron micrograph 11
  - structure 166–170
    - comparison 167
  - suppliers 170
- microcomposites 6, 7
- micron-size carbon fibers 192
  - classification 192
  - polymeric precursors 192
    - molecular structures 192
  - synthesis process 192
- Mine Safety And Health Administration (MSHA) 232
- mineral-filled high density polyethylene (HDPE) 254
  - mechanical properties, comparison 254
- mineral-filled polyamides 82
- mineral-filled polypropylene copolymer 254
  - mechanical properties 254
- mineral fillers 459
  - surface treatment 459
- modifiers 116, 117
  - chemical type 117–137
    - coupling modifiers 116, 117
    - noncoupling modifiers 116
    - reinforcement promoters 117
  - effects 116, 117
- moisture vapor transmission rate (MVTR) 236
- molybdate dopant 479, 480
  - effect 480
  - types 479
- molybdenite/molysulfide (MoS<sub>2</sub>) 379, 387
  - lubricating behavior 379
  - lubrication performance 379
  - suppliers/manufacturers 387
- molybdenum disulfide (MoS<sub>2</sub>) 374
- molybdenum oxide (MoO<sub>3</sub>) 335
  - char-former 335
- monomeric aminosilane layers, SEM 75
- monomeric silanes, production/structures 64, 65
- montmorillonite agglomerate 16
  - scanning electron micrograph 16
- montmorillonite clay 180–182
  - characteristics 182
  - constituent 181
  - morphologies 183
- Mooney equation 39
- Mori–Tanaka equations 26
- multiple-wall carbon nanotube (MWNT) 190, 191, 195, 196, 199, 201
  - arc-grown 191
  - noncatalytic carbon arc-discharge method 190
  - $\pi$  bonds 199
  - plasma-enhanced CVD (PE-CVD) growth 191
  - production by Fe-catalyzed chemical vapor deposition process 201
- muscovite 166–169
  - chemical analysis 168
  - properties 167, 169
  - structure 166

**n**

- nanoclays 177, 186, 187
  - applications 184–187
  - concept/technology 177, 178
  - cost/availability 183
  - dispersion monitoring, by transmission electron microscopy 186
  - emerging markets 177
  - environmental/toxicity considerations 184
  - multifunctional character 187
  - perception 184
  - production method 178–181
    - purification/surface treatment 179, 180
    - raw/intermediate materials 178
    - synthetic clays 180, 181
  - structure/properties 181–183
  - suppliers 183
  - surface areas 177
- nanocomposites 6, 177, 184–186, 469, 473, 478, 481
  - concept 177, 185
  - corrosion protection characteristics 481
  - cross-sectional view 200
  - inorganic phase 469
  - internal fracture surface, TEM image 200
  - manufacturing challenges 187
  - performance factors 184
  - phase bicontinuity, effects 478
  - strength 473
- nanofillers 109, 203
  - dispersion 109–111
    - initial boiling point (IBP) 111
    - nanoparticle loading 110
    - titanate dosage 110
    - type of interface 109
  - use 203
- nanomaterials, development 341
- nanotube chemical vapor deposition synthesis 195
- NanoXcel, development 187
- National Institute for Occupational Safety and Health (NIOSH) 233, 263, 355, 374, 375, 415
  - medical survey 263
  - web site 374, 375
- National Institute of Standards and Technology (NIST) 312
- National Sanitation Foundation (NSF) 297
- natural clays 181
- natural fibers 213–219, 221
  - applications (primary/secondary functions) 219–222
  - chemical constituents 216
  - cost/availability 219
    - diverse nature 218
    - effect on mechanical performance of polypropylenes 221
    - environmental/toxicity considerations 219
    - equilibrium moisture content 217
    - European consumption 213
    - mechanical performance 220
    - moisture/durability 216–218
    - photochemical degradation 218
      - disadvantage 218
    - production methods, steps 214
    - properties 215–218
      - chemical components 215
      - density 216
      - fiber dimensions 216
      - mechanical performance 216
    - reinforced thermoplastic pellets, production 220
    - structure 214
    - suppliers 218
    - use 219
- natural gas, combustion 352
- natural montmorillonite clays 179
  - by *in situ* alteration of volcanic ash 179
- natural silicas 396
  - amorphous 396
  - crystalline 396
- near-molecular scale carbon nanotubes 198
  - discovery 198
  - mechanical/electrical properties 198
- neoalkoxy titanates 92, 100
  - repolymerization effect 100
- N-gas models, development 312
- N-gas value 312
- Nielsen equation 39
- noncoupling additives, stearic acid 128
- noncrystallizable polymer 361
  - atactic polystyrene 361
- nongovernmental organizations (NGO) 158
- non-Newtonian liquids 36
- nonpolar polymers 168
- nonvolatile organic compounds 465
- nonwoven fabrics 303, 304
- North American composite industry 218
- North Carolina State University (NCSU) 304
- nylon 6,6/clay compounds, properties of 83
- nylon 6/clay nanocomposites (NCC) 178
- nylon 66,6 composites 35
- nylon 6 nanoclay materials 178
  - *in situ* preparation process 178
  - solvent-assisted process 178
  - strength 178
  - tensile properties 178

- o**
- occupational exposure limits (OEL) 355
  - Occupational Safety and Health
    - Administration (OSHA) 153, 232, 282, 355, 391
  - octyltriethoxysilane/TiO<sub>2</sub> system 76
    - gas chromatogram of 76
  - oligomeric aminosilane layers, SEM 75
  - oligomeric cationic aminosilane 74
    - AES line scan 75
  - oligomeric silanes 66, 81
    - structures 66
  - oligomeric vinylsilanes 81
  - organic acid carbon chain length effect 121
  - organically modified fillers 407
  - organic/inorganic additives 373
    - surface property 373
  - organic/inorganic fibers 217
    - mechanical properties 217
  - organic-inorganic hybrids 476, 478
    - networks 478
  - organic phosphate esters 340
  - organic polymers 461, 474
    - Young's modulus 461
  - organic spherical fillers 425
    - functions 427–429
    - production 425–427
    - properties 425–427
  - Organization for Economic Development and Cooperation (OECD) 339
  - organosilanes, structure of 64
  - ortho-neopentyl glycol (NPG) 256
  - orthorhombic aragonite 294
  - osteoblast cells, *in vitro* experiments 445
  - osteon-reinforced interstitial bone 442
  - osteoprotective fillers 445
    - bioactive glasses 445
  - oxidative bleaching agents 246
    - ozone 246
    - sodium hypochlorite 246
- p**
- particle-particle interactions 38
  - particle size distributions (PSD) 365
  - particulate composites 27, 32
    - modulus equations, comparison 27
    - strength equations, comparison 32
  - perfluorinated microemulsion polymerization technology 377
  - permissible exposure limits (PEL) 263, 355
  - peroxide-cured EPDM system 79
  - phase-separated macro-molecular network 471
  - phenolic microspheres 433
    - applications, coatings 433
    - phenolic resole resins 427
    - phenolic stabilizer 81
    - m*-phenylenebismaleimide 129, 130
      - cross-linking agent 129
      - effect 129
      - melting point 130
    - phlogopite 165, 167–169
      - chemical analysis 168
      - mica 167
      - properties 167, 169
    - phosphato titanates 101–103, 107, 301
      - monomolecular deposition 103
    - phosphorus-containing flame retardants 329–334
      - ammonium polyphosphate 331
      - mechanism of action 330
      - phosphorus-containing organic compound 331
      - red phosphorus 331
    - photoluminescence intensity 202
    - phyllosilicate mineral 241
      - characterization 241
      - kaolin 241
    - pine wood flour 271, 280
      - scanning electron micrograph 271
      - thermogravimetric analysis 280
    - plastics 13, 14, 43, 148, 270, 295
      - Berstorff ZE90-A TSE 58
      - continuous fiber reinforcements 148
        - comparative properties 148
      - critical properties, flexural modulus 14
        - heat resistance 14
      - current applications 270
      - extruder capacity 59
        - polymer viscosity 59
      - Farrel FTX 80-twin-screw extruder 57
      - feeding 45–51
      - filler 13, 43
        - chemical families 13
          - extruders 43
        - GCC grades 295
        - market size 270
        - melting 51
        - mixing 51–55
        - pressure generation 55–57
      - platelet aspect ratio 31
      - pneumoconiosis symptoms 233
      - Poisson's ratios 24
      - polyacrylonitrile (PAN) precursor 192
        - conversion stages 192
      - polyamideimide (PAI) 3
      - polycaprolactone (PCL) 454
      - polycarbonate-based plastics 366

- static charge decay rate 366
- polychlorinated biphenyls (PCBs) 327
- polyester gel 257
- filler performance, comparison 257
- polyetheretherketone (PEEK)
  - composites 446
- polyethylene (PE) 309
  - thermooxidative degradation mechanism 309
- polyethylene imine (PEI) 196
- poly(ethylene 2,6-naphthalate) (PEN) 419
- polyhedral oligomeric silsesquioxanes (POSS) 459, 461–463, 466
  - advantage 466
  - cage 459, 461, 466
    - density 461
    - formation 459
  - commercialization 459
  - effect 466
  - environmental/safety considerations 464
  - functionalized 462
  - molecular fillers 462
  - molecular silica 462, 465
  - molecule, central rigid cage 460
  - organic-inorganic hybrid properties 461
  - polarities 463
  - POMS 462
  - potential 463
  - primary function 464
  - production 459
  - properties 460–463
    - overview 460
  - secondary function 466
  - structure 460–463
  - suppliers/cost 463
  - syntheses 459
  - trisilanols 462, 465
    - dispersant 465
  - type 464
  - vitrification 466
- polyhydroxyaminoether (PHAE) 200
- polyhydroxybutyrate (PHB) matrix 447
- polyimide matrix 487
- polyimide nanocomposites 482
  - performance enhancement of composites 482
- polyimide/silica hybrids 483–486
  - SEM micrographs 483
  - use 486
- polyimide/silica systems 480, 482
  - polymer composites, use 480
    - coatings for glass fibers 484
    - polyimide/silica matrix 486
  - silica nanocomposites 482
    - components, chemical structure 482
- polymer(s) 309, 310, 315, 351, 363, 402, 480
  - class 480
  - combustion components 317
  - limiting oxygen index values 315
  - melting of 49
  - modification 118
  - processing, steps 4
  - recrystallization 92
  - thermal oxidative degradation 309
  - use 310
- polymer-CB composite, conductivity of 357
- polymer composites 5–19
  - components 6–8
  - types 6–8
- polymer-containing ammonium polyphosphate 333
  - char formation 333
- polymeric materials, combustion 309
- polymer interfacial chemistry 351
  - significant effects 351
- polymerization inhibitor 125
- polymer matrix 10, 196–202
  - composites 197–202
    - fabrication 197
      - mechanical/electrical property 198–202
  - reinforcing fiberyn 10
- polymer processing aids (PPAs) 234
- polymethylmethacrylate (PMMA) composites 197
- polyimide/silica hybrid 487
  - TGA thermograms 487
- polyolefin 80, 123, 133, 234
  - films 301, 302
  - matrix 298
  - microporous films 302, 303
  - moldings 298–301
- cis*-poly(phenylacetylene) model 203
- trans*-poly(phenylacetylene) model 203
- polypropylene (PP) 97, 129, 146, 269, 278, 309, 359, 431
  - compounded pellets 278
    - moisture sorption 278
  - flexural modulus 431
  - foamed vs. unfoamed 431
  - influence of type 359
  - resins, densities 431
- polypropylene-talc systems 235, 236
  - stiffness/toughness properties 236
- polystyrene (PS) 50, 237
  - pellets 50
  - shear viscosity 37
- polytetrafluoroethylene (PTFE) 87, 375, 377, 383, 390

- electrical properties 384
  - environmental resistance 384
  - features and benefits 375
  - mechanical properties 384
  - suppliers/manufacturers 390, 391
  - surface properties 383
  - thermal properties 383
  - polyvinyl chloride (PVC) 3, 237, 296–298, 309, 407
  - application of talc 237
  - extrusion 297
  - filler levels 297
  - polyvinyl pyrrolidone (PVP) 196
  - positive temperature coefficient (PTC) 103
  - positive temperature coefficient of resistance (PTCR) 359
  - POSS<sup>®</sup>, *see* polyhedral oligomeric silsesquioxanes
  - precipitated calcium carbonate (PCC) 291–293, 297
  - characterization 297
  - products 293
  - premier periclas process 409
  - Printex XE-2 357
  - processing aids, definition 407
  - processing/shear techniques 184
  - proton exchange membrane (PEM) fuel cell 189
  - pure talc 226, 228
  - chemical composition 228
  - pyrolysis-gas chromatography (Py-GC) 76
  - pyrophosphato titanates 101, 102, 107
- q**
- quaternary ammonium compound 182
  - structure 182
- r**
- radiant panel test 337
  - Raman spectroscopy 72, 73
  - recommended exposure limits (REL) 263, 355
  - reinforced plastics/composites (RP/C) 143
  - reinforced reaction injection molding (RRIM) 259
  - reinforced thermoplastics (RTP) 28, 144
  - modulus enhancement factor 28
  - reinforcing filler 9, 11
  - repolymerization 91, 92, 99, 101
  - catalysis 92
  - definition 99
  - effect 101
  - resin system 64, 474
  - filler systems 72
  - rheological behavior 85
  - types 474
  - resin injection molding (RIM) 149
  - resistivity, measurements 367
  - rheology modifiers, *see* rheology stabilizers
  - rheology stabilizers 407, 408
  - ribbon composites 25, 30
  - modulus equations, comparison 25
  - strength equations, comparison 30
  - Rio Tinto minerals 230
  - R talc 230
- s**
- saturated monocarboxylic acids 117–122
  - scanning electron micrographs (SEMs) 74, 384, 445
  - semicrystalline polymers 41
  - shear controlled orientation injection molding (SCORIM) 443, 445
  - sheet molding compounds (SMCs) 298, 318
  - shielding effectiveness 365
  - shive 214
  - sedigraphic light scattering water techniques 229
  - short fiber 27, 32
  - modulus equations, comparison 27
  - strength equations, comparison 32
  - silane(s) 65–70, 72, 78, 123
  - applications 80
  - alkylsilanes 87
  - aminosilanes 81–85
  - epoxysilanes 86
  - fluoroalkylfunctional silanes 87
  - methacryloxysilanes 85, 86
  - polyetherfunctional silanes 87
  - sulfur-containing silanes 87
  - vinylsilanes 80, 81
  - EPDM systems 79
  - hydrolysis 67–69
  - loadings 72
  - mineral fillers, combining methods 70–72
  - monomers 67
  - polymers, types 78
  - reactivity 68
  - selection 78–80
  - titanate, six functional sites of 92
  - types 66
  - oligomeric silanes 66, 67
  - waterborne silane systems 66
  - silane addition method 252
  - effect 252, 253
  - silanols 65, 66, 68
  - inorganic substrate 70

- reactivity of 68
- silicas 395, 400
  - advantage 395
  - amorphous silica, OSHAs current limit 401
  - based bicontinuous nanocomposites, production 472
  - dust 400
  - fillers, drawback 419
  - formation mechanism 470
    - from hydrolyzed tetraethoxysilane by sol-gel process 470
  - properties 395
  - role 395
- silicate mineral 21
  - reactivity 21
  - structure 21
- silicic acid esters 69
  - condensation of 69
- silicon tetrachloride 396
  - vapor phase hydrolysis 396
- siloxane network 478
- silver-coated conductive glass fibers 152
- silylated filler surfaces 72
  - acid-base titration 77
  - carbon analysis 77
  - colorimetric tests 77
  - hydrophobicity, empirical tests 77
  - pyrolysis-gas chromatography (Py-GC) 76
  - silane/colorant combined surface modification 77, 78
  - spectroscopy 72
    - Auger electron spectroscopy 73–76
    - FTIR/Raman spectroscopy 72, 73
    - MAS-NMR spectroscopy 73
- simulated body fluid (SBF) 444
- single-screw extruders (SSEs) 45, 47, 49, 53, 54
  - agglomerates formation 49
  - mixing enhancers 53
- single-wall carbon nanotubes (SWNTs) 189, 191, 195, 196, 198, 199, 202, 206
  - armchair 190
  - chiral 190
  - diamond-like thermal conductivity 206
  - sonication of 199
  - types 189
  - zigzag 190
- smectite clay, structure 182
- smoke 311–314, 318
  - carbonaceous solid particles 312
  - definition 311
  - density measurement, optical method 314
  - liquid droplets 312
    - suppressant effect 318
    - toxicity 312–314
- softwood 273
  - lignin structure 275
  - schematic diagram 273
- sol-gel method 454, 469, 481
- solid freeform fabrication (SFF) technique 198
- solid lubricants/tribological additives 374–394
  - applications 392–394
  - boron nitride 375, 377, 384, 392
    - environmental/toxicity considerations 397–401
    - production 377
    - scanning electron micrograph 385
    - structure/properties 384
    - suppliers/manufacturers 389
    - use 375
  - characteristics 384
  - coefficient of friction 375, 385
  - cost/availability 386
  - graphite 375, 376, 379, 392
    - environmental/toxicity considerations 388
    - production 376
    - structure/properties 379–383
  - molybdenite 374, 376, 378, 388
  - crystal structures 378
    - environmental/toxicity considerations 388–391
    - mines/ore bodies types 376
    - physical/chemical properties 379
    - principle of action 378
    - production 376
    - structure/properties 378
  - physical/chemical properties, comparison 380, 381
  - polytetrafluoroethylene 375, 377, 383, 392
    - environmental/toxicity considerations 392
    - production 377
    - structure/properties 383
  - suppliers/manufacturers 386
- solid lubrication mechanism 374
- solid organic microspheres 428
- solid rocket fuel 102
- solid thermoplastic particles 426
  - polyacrylate 426
  - polystyrene 426
- SOLPLUS C800 124
- solution-evaporation method 197
- Southwest Research Institute (SwRI) 312
- spider silk 6

- spray-drying 427
  - SSE mixing enhancers 53
  - starch with ethylene vinyl alcohol (SEVAC) 445–447
    - scanning electron micrographs 446, 447
    - state-of-the-art laser image analysis technology 225
  - static secondary ion mass spectrometry (SSIMS) 75, 355
    - spectra 355
  - statistical process control tools 180
    - control factors 180
  - stearic acid coating, phases 293
  - strain value 473
  - stress concentrators 33
  - styrenics 237
  - sulfur-containing silanes 87
  - sulfur-cured EPDM systems 79
  - supernatant liquors 122
  - surface-modified kaolins 247
  - surface property modifiers 373
  - surface-treated kaolin 253
  - Suzorite™ process 165
  - SWNT-PMMA nanocomposite 199
    - optical micrographs of 199
  - SWNT-polymer nanocomposites 198
  - synergistic flame retardancy 187
  - synthetic CaCO<sub>3</sub> 292
  - synthetic clays 180, 181
    - preparation 180
  - synthetic fibers, development 213
  - synthetic hydrocalcites 410, 413
    - empirical formulae 410
    - submicron particles 413
      - scanning electron micrograph 413
  - synthetic microcomposite 8
  - synthetic silica gel 397, 402
    - fumed silica vs. diatomite 398
    - structure 397
- t**
- tactoids 184, 185
  - talc 58, 225, 227–229, 231, 234, 235, 238
    - antitack agent 238
    - applications 233–237
      - by polymer matrix 234–238
    - bulk density, effect of 58
    - characteristics 228
    - cost/availability 230
    - disadvantages 235
    - environmental/toxicity considerations 232
    - extraction step 225
    - hydrophobic nature 228
    - market applications 238
      - molecular structure 227
      - open-pit mining 225
      - primary/secondary benefits 234
      - production methods 225
      - products 229
        - particle size distribution 229
      - suppliers 230, 231
      - surface chemistry 229
    - talc-filled composites 228
    - talc-filled homopolymer/copolymer PP 235
      - properties 235
    - talc-filled masterbatches 233
    - talc-filled polyolefin 236, 237
      - applications, range of particle sizes 237
    - talc-plastic composite 225
    - tetrachlorosilane, optical fibers 64
    - tetraethoxysilane 472, 474, 476
      - condensation reactions 474
      - use 476
    - tetraethyl orthosilicate 454
    - tetrahydrofuran (THF) 476
      - solvent absorption behavior 476
    - thermal diffusivity 281
    - thermal properties 39
    - thermal stability 40
    - thermoexpandable microspheres 426, 430, 434
      - scanning electron micrographs 426
      - schematics 426
      - suppliers 434
    - thermoplastic composites 40
    - thermoplastic elastomer (TPO) 184, 186, 187, 237, 430
      - flexural modulus vs. filler concentration 186
      - SEBS/SBS 430
      - TPOs 430
      - TPUs 430
    - thermoplastic films 401
    - thermoplastic olefin elastomer matrix 229
    - thermoplastic polyesters 82
    - thermoplastic polyolefins 264
    - thermoplastic resin 5
    - thermoplastics 3–5, 105, 283–288, 329, 430, 437, 463
      - density 430
      - functional inorganics/organics 105–107
      - low-density polyethylene 329
      - processing methods 4, 5
    - thermosets 5, 282, 283, 333
      - processing methods 5
    - thermosetting filler systems 85
    - thermosetting resins 3, 4
    - thixotropic coating 407

- thixotropic loop, *see* hysteresis loop
- threshold limit value (TLV) 233, 355, 391
- time-weighted average (TWA) 391
- TiO<sub>2</sub> extension 256, 257
- tissue engineering applications 442, 443
- bioactive fillers 443
  - bioceramics for 442
  - examples of polymers 442
- tissue engineering biomaterials
- nanostructured bioactive fillers 454
- titanate molecule 91, 92, 95, 98, 101
- application considerations 98, 99
  - coupling agents 91, 94
    - chemical structures 94
  - effects 108
  - functional effects 92, 95–99, 102
    - adhesion 97
    - binder functional groups 94
    - CaCO<sub>3</sub>-filled thermoplastics 103
    - carbon black-filled polymers 103–105
    - coupling agent chemical description 93
    - dispersion 95–97
    - hydrolyzable group/substrate reactive group 92
    - hydrophobicity 98
    - monolayer coupling, dispersion effect 96
    - organosilanes 92
    - phosphato titanates 101
    - pyrophosphato 101
    - repolymerization effect 99–101
    - thermoplastics and thermosets 105–107
    - thermoplastic-specific functional groups 94
    - titanate application 98, 99
    - zirconate coupling agents 94
  - synergistic benefits 101
- titanium/zirconium couple, esters 91
- titanocene 92
- toothed gear mixing elements 56
- toxic chemicals, production 337
- Toyota Central Research and Development Laboratories 177, 178
- tracheids 272
- transition metal catalyst, growth forms 194
- transmission electron microscopy (TEM) 394
- transverse impact strength 34
- trialkoxysilanes 65, 68, 69
- hydrolysis of 65, 69
- tricalcium phosphate (TCP) 448
- conventional melt processing technologies 448
- trichlorosilane 64
- trigonal-hexagonal scalenohedral system 412
- triple start corotating intermeshing screws 48
- tungsten disulfide 379
- tunneling-percolation model (TPM) 357
- twin-screw extruders (TSEs) 46, 47
- advantages of 46
  - classification of 47
  - corotating intermeshing type 48
  - glass fibers 53
    - dispersion of 53
  - mixing elements 53, 57
    - effect of 57
- two-stage thickening mechanism 417
- chain extension mechanism 417
  - coordinate complex formation 417
- tyloses 272
- U**
- UL 94 testing protocols 336
- ultrahigh molecular weight high-density polyethylene (UHMWHDPE) composite plastics 392
- ultrasonic techniques 197
- ultratalc 609 227
- micrograph 227
- 10-undecanoic acid 128
- Union Carbide mixing element 51
- unmodified filler surfaces 115
- unsaturated acids 126
- carboxylic acid 123–128
    - effect 126
  - coupling agent 123
  - oligomeric acid, influence 125
- unsaturated polyester resins 63
- unsaturated polyester oligomer 418
- torque, changes 418
- untreated CaCO<sub>3</sub>-filled mineral oil 97
- pigment volume concentration curves 97
- urea-formaldehyde microcapsules 433
- US Environmental Protection Agency (EPA) 340
- US Food and Drug Administration (FDA) 232
- US Montana talcs 227
- V**
- van der Waals forces 190, 226
- vapor-grown carbon fibers (VGCfs) 194
- velvet effect 433
- vinyl oligomeric silane, chemical structure of 67
- vinylsilane 79, 80, 81, 256
- adhesion 80
  - EVA/ATH HFFR containing 81
    - comparison of 81
  - surface-treated kaolin 256



- virgin glass filaments 145, 146
    - tensile strength 145, 146
  - viscosity stabilizers 408
  - volume fillers 102
    - CaCO<sub>3</sub> 102
    - carbon black 102
  - volume resistivity 255
- W**
- water-borne oligomeric fluoroalkyl siloxane systems 87
  - water-borne oligomeric siloxane 67
  - waterborne silane systems 66, 71
  - water vapor transmission rate (WVTR). 303
  - water-washed calcined/silane-treated kaolin 249
    - chemical composition 249
    - physical properties 249
  - water-washed hydrous kaolin, chemical composition 249
  - wet grinding process 166, 292
  - wet-ground mica, 163
  - wet kaolin production process, overview 244
  - white graphite, *see* boron nitride
  - wollastonite (CaSiO<sub>3</sub>) 259, 261, 262, 265, 452
    - applications 264–266
    - effects 265, 266
      - thermoplastics 265
      - thermosets 265
    - environmental/toxicity considerations 263
    - filler grades, chemical analyses 261
    - production 260
    - properties 260–262
    - structure 260–262
    - suppliers/cost 262, 263
    - surface chemistry 262
    - typical properties 262
  - wollastonite silane, types 266
  - wood 219, 220, 272–274, 277, 278, 280
    - anatomy 272–274
    - chemical components 274–276
    - durability 278–280
    - environmental benefits 219
    - equilibrium moisture content 277
    - thermal expansion 280
    - use 220
  - wood cellulose 280
    - thermogravimetric analysis 280
  - wood fiber *vs.* wood flour 284
  - wood flour 269–272, 276, 277, 280, 283, 285
    - applications 282–288
    - cost/availability 282
    - density 276
    - effect 285, 286
    - environmental/toxicity considerations 282
      - hygroscopicity 277
      - moisture 276, 278
        - sorption 277
      - packaging 271
      - particle size 271, 283
        - effects 283
      - production methods 270–272
      - properties 272–282
        - structure 272–282
      - suppliers 281
      - thermal properties 280, 281
  - wood flour extenders 282
  - wood-plastic composites (WPC) 270, 278, 284, 430
    - plastics 270
  - workplace hazardous materials information system (WHMIS) 416
  - World Health Organization (WHO) 339
- X**
- XC-72R conductive black 107
    - resistivity 107
  - X-ray photoelectron spectroscopy (XPS) 355
- Y**
- yellowness index (YI) 401
  - Young–Dupre equations 20
  - Young’s modulus 473, 474, 481
- Z**
- zero force compaction/densification technology 233
  - zinc phosphate glasses 334
  - zirconate 91, 92, 94, 100, 108, 109. *see also* titanate
    - additives 92
    - coupling agents 94, 109
    - effects 108
    - repolymerization effect 100
  - zirconocene 92, 100