INDEX

Abrasion, apolar diene rubber nanocomposites, 392–393, 398–399

Accelerators:
- ethylene-propylene-diene-monomer rubber, in situ intercalation preparation, 469–474
- rubber-clay nanocomposite vulcanization and permeability, 356–358
- sulfur vulcanization, 278–282
- vulcanization reaction, organo-clay kinetics, 284–289

Acid-base equilibria, rubber-clay nanocomposites, vulcanization activation, 139–141

Acrylated oleic methylester (AOME), solution and in situ polymerization, 170

Acrylonitrile butadiene rubber (NBR)-clay nanocomposite, rheology, 250–253

Additives:
- latex compounding, natural butadiene rubber, 412
- thermoplastic polyurethane nanocomposites, thermal properties, 504–507
- adhesion properties, butyl rubber nanocomposites, 456–457

Aggregation:
- clays and clay minerals, 6
- pristine clays, rubber matrix, 189–190, 194–197

Aging, automotive rubber-clay nanocomposites, 539–541

Air barrier properties:
- automotive rubber-clay nanocomposites, 538–539
- butyl rubber clay nanocomposites, 449–452

Air-D-Fense products, 564–566

Air oven aging, bromobutyl rubber, exxpro, and nanocomposite innerliner compounds, 355–356

Alkenylamines, rubber-pristine clay composites, 197–206
Alkenyl groups, ammonium cation substituents, 215

Alkylammonium:
  chain structure and dynamics, 101–111
dynamics and diffusion, 110
molecular simulation, 111
packing density and self-assembly, 102–110
clay cationic exchange capacity, 25–27, 50–58
clay mechanical properties, 121–123
organophilic clays, 48–58
polymer layer separation and miscibility, 115–121
cleavage energy, 116–121
exfoliation, thermodynamic polymer matrix model, 115–116
surface energy, 121
thermal properties, 111–115
reversible melting transitions, interlayer alkyl chains, 111–113
solvent evaporation and thermal elimination, 113–114

Alkylphosphonium, organophilic clays, cation exchange, 50–58

Alkyl surfactants, solvent evaporation and thermal elimination, 114–115

Allophanes:
  availability, 33–35
  TO criteria, 16

Allylamine, latex compounding, rubber-clay nanocomposites, 155–157

Amines, thermal decomposition mechanism, 135

3-Aminopropyltriethoxysilane, dispersion, 386–387

Ammonium cations:
  BIMS  ionomers, 442–443
  organophilic clays, rubber vulcanization, 288–289
  organophilic clays, cation exchange, 50–58
  rubber-clay nanocomposites, 206–212
  hydrogenated tallow and benzyl groups, 213–215
  long- and short-chain alkenyl groups, 215
  long-chain alkenyl substituents, montmorillonite modification, 219–228
  montmorillonite and bentonite, 207–212
  polar montmorillonite, 215–219

Ammonium cations, tallow group composites, 220–228

Amphiphilicity, organophilic clay minerals, 46

Amphoteric surface chemistry:
  clay minerals, 24
  clay rheology, 32–33

Anionic clay minerals:
  layered structure, 21–22
  rubber-clay nanocomposites, vulcanization activation, 139–141

Anionic exchange capacity (AEC), clay minerals, 24–27

Apolar diene rubber composites:
  applications and future research, 398–399
  barrier, 393–396
  basic properties, 369–371
  characterization, 383–388
  cure characteristics, 377–379
  dispersion detection, 380–383
  fire resistance, 396–397
  friction/wear/abrasion, 392–393
  mechanical properties, 388–392
  plate structure, 397–398
  preparation, 371–377
    latex compound, 371–373
    melt blending, 374–377
    solution mixing, 373–374

Arrhenius equation:
  rubber vulcanization, curing mechanics, 291–297
  thermoplastic polyurethane nanocomposites, decomposition kinetics, 499–501

Arrhenius-Frenkel-Eyring equation, pristine clay modification, rubber-clay nanocomposites, 256–257

Aspect ratio:
  butyl rubber-clay nanocomposites, 436–437
  clay aggregation and dispersion, 6
  elastomer nanocomposite gas permeability, 348–349
  organophilic clays, 47–49
  pristine silicates, 191
rheology of rubber-clay nanocomposites, 245–246
water-based nanocomposites, barrier mechanisms, 558–561
Atomic force microscopy (AFM), apolar diene rubber nanocomposites, 380–383
Automotive applications, rubber-clay nanocomposites:
aging and ozone resistance, 539–541
barrier/air retention properties, 538–539
basic principles, 525–526
disadvantages, 548–549
elastomeric components, 531
elastomeric nanocomposites, 531–548
future research issues, 548–550
organoclay minerals, 534
polyurethane-organoclay composites, 544–545
processability, 542–544
rubber, 526–531
rubber-clay vs. other nanofillers, 534
solvent resistance, 541–542
tire nanocomposites, 545–548
weight and balanced mechanical properties, 535–538
Backside temperature, thermoplastic polyurethane nanocomposite flammability, 508
Balanced mechanical property, automotive rubber-clay nanocomposites, 535–538
Barrett-Joyner-Halenda (BJH) method, clay surface area and porosity, 22–24
Barrier mechanisms:
apolar diene rubber nanocomposites, 393–396
automotive rubber-clay nanocomposites, 538–539
nitrile rubber composites, 423–424
water-based nanocomposites, 557–566
dispersion and orientation, 558–561
interfacial interactions and flexibility control, 563–565
tortuous path modeling, 561–563
Basal plane spacing, alkylammonium chains, packing density and self-assembly, 107–110
Basketballs, water-based nanocomposites, 569
Belts (automotive), rubber applications, 529
“Bentones,” organophilic clays as, 48–49
Bentonite:
availability, 33–35
commercial applications, 88–89
diffusion, 87–89
geological occurrence, 89
industrial treatment, 87–90
mining, 89–90
modification, 90–91
processing, 90–93
rubber-clay nanocomposites:
ammonium cations, 207–212
pristine clay modifiers, 190–191
rubber-pristine clay composites, 193–194, 195
primary alkenylamines, 198–202
structure, 87–89
swelling properties, 17, 20–21
Benzyl groups, ammonium cations, 213–215
Bicycle tires, water-based nanocomposites, 570
Bilayers, organophilic clays, cation exchange, 54–58
Bis(dialkylthiocarbamate)zinc(II) (ZDAC), 469
Blooming, water-based nanocomposites, 572
Bragg diffraction model, rubber-clay nanocomposite morphology, 182
Brake hose, rubber applications, 528
Brake vacuum hose, rubber applications, 527
Breakthrough time applications, water-based nanocomposites, 571–572
Brominated isobutylene-co-para-methylstyrene (BIMSM) rubber-clay nanocomposites:
butyl rubber, 438
air permeability, 452
processability, 457
reinforcement properties, 452–454
solution method, 446–447
vulcanization, 454–456
innerliner formulations, 353–356
ionomers, 439, 441–443
Brominated (Continued)
  montmorillonite nanocomposite thermodynamics, 358–362
  permeability patterns, 349–350
  pristine clay modification, 202
  rheology, 257
Bromobutyl screening compound, permeability measurement, 346–347, 353–356
Bulky inorganic oligomers, intercalation, 28
Butadiene-isoprene-isobutadiene rubber (BIIR) nanocompound, melt compounding, 163–169
Butadiene rubber (BR):
apolar diene rubber nanocomposites:
dispersion characterization, 385–387
  mechanical properties, 390–392, 393
  melt blending, 375–377
diene rubber composites, 222–225
  melt compounding, 159–160
  polar group ammonium cation modification, 217
  pristine clay modification, rubber-clay nanocomposites, 190–191
  primary alkenylamines, 200–202
  rubber-clay composites, 195
  ammonium cations, 207, 213
  rheology, 247–250
Butadiene-styrene-vinylpyridine rubber, clay interaction/affinity with, 153–157
Butyl rubbers:
copolymerization, 369–371
  ionomers, 439–443
  key properties and applications, 431–433
  low molecular mass substances, 444
  maleic anhydride-grafted polymers, 443–444
  morphology, 433–435
  permeability, 343–345
rubber-clay nanocomposites, 433–435
  adhesion properties, 456–457
  air barrier properties, 449–452
  aspect ratio talc filters, 436–437
  compatibilizer systems, 438–444
  hydrotalcite clays, 435–436
  mica clays, 437
  montmorillonite clays, 435
  preparation methods, 444–448
  processability, 457
  reinforcement properties, 452–454
  sepiolite, 438
  vermiculites, 437–438
  vulcanization properties, 454–456
  solution-based preparation, 374
Calcium silicate hydrates, layered structure, 21
Carbon black:
apolar diene rubber nanocomposite mechanics, 387–392
  automotive nanocomposites, aging and ozone resistance, 539–541
  brominated isobutylene-co-para-methyl-styrene-montmorillonite nanocomposite thermodynamics, 362
  reinforced elastomeric materials, 328–333
Carbon nanotubes:
avtomotive applications, 531
  fire resistance, 424–425
Carboxylic pendant groups, natural butadiene rubber (XNBR):
  basic properties, 409–410
  demand loading conditions, 420–421
  melt compounding, 413–414
  polarization effects, 425
Carboxyl-terminated butadiene (CTB):
apolar diene rubber nanocomposites:
  mechanical properties, 391–392
  melt blending, 375–379
  butadiene-rubber nanocomposite rheology, 250
Carboxyl-terminated butadiene acrylonitrile (CTBN) copolymer, apolar diene rubber nanocomposites, melt blending, 376–380
Carreau model, polyepichlorohydrin rubber-clay nanocomposite rheology, 259–261
Cation exchange capacity (CEC):
  alkylammonium chains, 101–111
  cleavage energy, 116–121
  clay minerals, 24–27
  purification, 93–97
  organophilic clays:
    dispersion maximization, 69–70
    rubber vulcanization, 288–289
    solution-based, 49–58
Cationic clays:
layered silicates, 21
layer organization, 8–11
nonphyllosilicate layers, 21
rubber-clay nanocomposite morphology, 182–183, 187
Cellulose whiskers, automotive applications, 531
Charge density, clay cationic exchange capacity, 25–27
Chemical protective gear, water-based nanocomposites, 571–572
Chemical treatments:
organophilic clays, 71
pristine clay modification, 191
Chlorobutyl rubber:
apolar diene rubber nanocomposites, 392
permeability, 344–345
Chlorosulfonated polyethylene (CSM), rubber applications, 527
Clay-polymer nanocomposites (CPN):
as fillers, 35–37
kaolin intercalation, 28–29
one-pot formation, 66
organophilic clays, 47–49, 72–75
solid-state intercalation, 58–59
swelling properties, 20, 31
synthetic clay availability, 35
Clays and clay minerals:
automotive nanofillers, 534
availability, 33–35
basic properties, 3–5
chemical formula, 18
as fillers, 35–37
layer organization, 8–22
allophane and imogolite group, 16–17
anionic minerals, 21–22
cationic layered silicates, 21
cationic/neutral clay materials, 8–11
chlorites, 14
interstratified minerals, 14–15
kaolinite and serpentine, 11
micas, flexible and brittle, 14
nanostructures, 20–21
nonphyllosilicate cationic layered minerals, 21
pyrophyllite and talc, 14
sepiolite and palygorskite group, 15–16
smectites, 14
swelling clays, 17, 20–21
TO and TOT groups, 11–17
vermiculites, 14
mechanical properties, 121–123
melt compounding, rubber-clay nanocomposites, microstructure evolution, 162–163
multiscale organization, 6–8
delamination/exfoliation vs. stacking, 6–8
dispersion vs. aggregation, 6
nanometric architecture, 3–4
natural clays, availability, 33, 35
organic substance reactions, 97–98
organophilic minerals:
chemical treatments, 71
clay-polymer nanocomposites, 72–75
dispersion maximization, 69–70
hydrophilic/lipophilic balance, 45–47
nanomaterials, 66–69
physical treatments, 71–72
polymer technology, 47–49
synthesis procedures, 49–66
thermal stability, 70–71
particle size modification, 99
physicochemical properties, 22–33
cation/anion exchange capacity, 24–27
interlayer intercalation and confinement, 27–30
rheology, 31–33
surface area and porosity, 22–24
surface chemistry, 24
swelling, 30–31
purification, 93–97
clay concentration, 94
swelling time, 94–95
temperature, 95–97
synthetic clays, availability, 33–35
Clay stacking, rubber-clay nanocomposite formation, 228–232
Clay-surfactant interface, alkylammonium chains, diffusion dynamics, 110
Cleavage energy, polymer layer separation and miscibility, 116–121
Cloisite organoclay, 64–65
thermoplastic polyurethane nanocomposites, 513–516
Coagulating agents, rubber-pristine clay composites, 192–194
emulsion compounds, 196–197
Coatings, reinforced elastomeric materials, 330–333
Co-coagulation methods, latex compounding, rubber-clay nanocomposites, 149–153
Cocondensation, grafted organoclays, 62–64
Coefficient of friction (COF), nitrile rubber composites, 421–422
Coefficient of thermal expansion (CTE), thermoplastic polyurethane nanocomposites, 512–513
Collapse, melt compounding, rubber-clay nanocomposites, 163
Compatibilizers:
butyl rubber nanocomposites, 438–440
melt compounding, rubber-clay nanocomposites, 161–162
olefinic nanocomposites, 467–469
reinforced elastomeric materials, 329–333
Compression set determination, reinforced elastomeric materials, 317–319
Cone calorimetry:
thermoplastic polyurethane nanocomposite flammability, 508–509
thermoplastic polyurethane nanocomposites, 496
Confinement:
clay interlayer space, 27–30
melt compounding, rubber-clay nanocomposites, microstructure evolution, 163
Consistency index, fluoroelastomer-clay nanocomposite rheology, 254–257
Continuum-based micromechanical models, reinforced elastomeric materials, 334–335
Cost issues, automotive elastomers, 548–549
Coulomb interactions, alkylammonium chains, cleavage energy, 119–121
Coupling agents, melt compounding, rubber-clay nanocomposites, 161–162
Crack propagation curves, reinforced elastomeric materials, cyclic loading, fracture mechanics testing, 327–328
Creep properties, ethylene-propylene monomer nanocomposites, 482–483
Cross-link density, reinforced elastomeric materials, 332–333
Cross-linking reactions:
melt compounding, rubber-nano clay composites, 166–169
vulcanization effects, 169–170
reinforced elastomeric materials, 330–333
rubber vulcanization, 278–283
peroxide, 282–283
sulfur, 278–282
sulfur vulcanization, 279–282
Crystallization:
apolar diene rubber nanocomposites, 389–392
reinforced elastomeric materials, 332–333
Crystallographic molecular structures, organophilic clays, cation exchange, 54–58
Curatives:
automotive elastomers, 544
melt compounding, rubber-clay nanocomposites, 162
Cure rate index (CRI), rubber vulcanization, curing mechanics, 278
Curie point, thermoplastic elastomers, 495
Curing bladders, butyl rubber reinforcement properties, 453–454
Curing kinetics:
apolar diene rubber nanocomposites, 377–379
nanocomposite vulcanization and permeability, 356–358
rubber vulcanization:
mechanics, 276–278
nitrile composites, 414–416
organoclay activation, 137–141, 283–289
reaction mechanics, 276–278
rubber cross-linking systems, 278–283
Cyclic loading, reinforced elastomeric materials, fracture mechanics, 326–328
Cyclohexylbenzothiazole sulfenamide (CBS), vulcanization and permeability, 356–358
Decomposition kinetics, thermoplastic polyurethane nanocomposites, 497–501, 498–501
Deformability, reinforced elastomeric materials, tensile testing, 310–313
Deintercalation, melt compounding, rubber-clay nanocomposites, 163
Delamination, clay aggregation and dispersion, 6–8
Delta torque, rubber vulcanization, curing mechanics, 278
Demanding loading conditions, nitrile rubber composites, 420–421
Density functional theory (DFT): alkylammonium chains, molecular simulation, 111
clay mineral mechanics, 121–123
Density properties, thermoplastic polyurethane nanocomposites, 497
Desmopan\textsuperscript{TM}, 492–493
dispersion, 502–503
thermal properties, 504–507
Diaphragms (automotive), rubber applications, 529
Dibutylthiourea (DBTU): brominated isobutylene-co-para-methyl-styrene-montmorillonite nanocomposite thermodynamics, 362
nanocomposite vulcanization and permeability, 356–358
vulcanization, 455–456
Diene rubber composites:
apolar compounds:
applications and future research, 398–399
barrier, 393–396
basic properties, 369–371
characterization, 383–388
cure characteristics, 377–379
dispersion detection, 380–383
fire resistance, 396–397
friction/wear/abrasion, 392–393
mechanical properties, 388–392
plate structure, 397–398
preparation, 371–377
polar group ammonium cation modification, 217–219
tallow ammonium cations, 220–228
Differential scanning calorimetry: rubber vulcanization, curing mechanics, 290–297
thermoplastic polyurethane nanocomposites, 497
Diffusion coefficient: butyl rubber elastomers, 345
ethylene-propylene-diene-monomer rubber gas permeability, 473–474
Diffusion dynamics, alkylammonium chains, clay-surfactant interface, 110
Diocadecyammonium, reversible melting transitions, 113–114
Diocahedral smectites, swelling properties, 17, 19–20
Direct synthesis, grafted organoclays, 62–64
Dispersion:
apolar diene rubber nanocomposites, 379–387
characterization, 383–387
detection, 380–383
clays and clay minerals, 6
nitrile rubber-clay composites, 410–414
solution-base preparations, 410–411
organophilic clays, maximization, 69–70
rubber-clay nanocomposite morphology, 184
pristine clays, 187–192
thermoplastic polyurethane nanocomposites, 501–503
water-based nanocomposites, barrier mechanisms, 558–561
Distribution, rubber-clay nanocomposite morphology, 184
pristine clays, 187–192
Dithiocarbamate vulcanization accelerator, melt compounding, rubber-clay nanocomposites, 164–169
DLVO (Derjaguin-Landau-Verwey-Overbeek) theory, clay rheology, 31–33
Double-edge-notched tension (DENT) specimens, reinforced elastomeric materials, 323–326
Douglas–Garbochi approximation, rheology of rubber-clay nanocomposites, 245–246
\(d\)-spacing, elastomer nanocomposite permeability, 351–352
Dynamic-mechanical (thermal) analysis (DM(T)A):
- nitrile rubber composites, 418–421
- reinforced elastomeric materials, 307–310

Dynamic storage moduli, ethylene-propylene monomer nanocomposites, temperature dependence, 481–482

Edge-group silanization, organoclay grafting, 61

Elastomers. See Rubber-clay nanocomposites

Electrolyte flocculants, latex compounding, rubber-clay nanocomposites, 149–153

Electron microscopy, water-based nanocomposites, orientation, 559–561

Emulsion compounds, rubber-pristine clay composites, 196–197

Entropy-elastic range:
- brominated isobutylene-co-para-methylstyrene-montmorillonite nanocomposite thermodynamics, 360–362
- reinforced elastomeric materials, dynamic-mechanical (thermal) analysis, 308–310

Epichlorohydrin rubber (ECO), melt compounding, 159–160

Epoxidized natural rubber (ENR):
- apolar diene rubber nanocomposites:
  - dispersion detection, 381–383
  - melt blending, 376–377
  - solution-based preparation, 374
  - automotive elastomers, 543–544
  - diene rubber composites, 222
  - melt compounding, 159–160, 414
  - reinforced elastomeric materials, 329–333
  - rheology, 243–246

Ethylene glycol monoethyl ether (EGME) adsorption, clay surface area and porosity, 23–24

Ethylene-natural rubber (ENR), rubber-pristine clay composites, 195

Ethylene-propylene-diene-monomer (EPDM) rubber:
- ammonium cations, 209–212

automotive rubber-clay nanocomposites, 536–538

basic properties, 465–466
chemical factors, 163–166
compatibilizers, 467–469
diene rubber composites, 225–228
gas barrier properties, 473–474
Kevlar-filled, kinetics, 513–514
mechanical properties, 476–479
melt compounding, 159–160
microstructure evolution, 163–169
mineral compounds, 466–467
notch sensitivity, 317
physical factors, 166–169
pristine clay modification, rubber-clay nanocomposites, 191
primary alkenylamines, 202
reinforced elastomeric materials, fracture mechanics, 322–323
rheology, 254, 474
rubber-pristine clay composites, 195
in situ intercalation preparation, 469–473
stability, 475
vulcanization reaction, organo-clay kinetics, 285–289
water-based nanocomposites, 564–566

Ethylene-propylene monomer (EPM)-clay nanocomposites:

basic properties, 465–466
compatibilizer systems, 467–469
creep properties, 482–483
mineral compounds, 466–467
preparation and characteristics, 479–480
rheology, 253–254
swelling properties, 483–486
temperature dependence, dynamic storage moduli, 481–482
temperature-dependent dynamic storage moduli, 481–482
tensile properties, 480–481

Ethylene-styrene-butadiene rubber (E-SBR):
- pristine clay modification, rubber-clay nanocomposites, 190–191
- rubber-pristine clay composites, 195

Ethylthiourea (ETU), rubber-clay nanocomposite vulcanization and permeability, 356–358

Exfoliated rubber-clay nanocomposites:
- apolar diene rubber, melt blending, 377
brominated isobutylene-co-para-methylstyrene-montmorillonite nanocomposite thermodynamics, 360–362utyl rubbers, 434–435
classification, 147–148
clay aggregation and dispersion, 454–70
formation mechanisms, 228
permeability, 347
polymer-clay morphology, 185
polymer matrices, thermodynamics model, 115–116

Fatigue behavior, reinforced elastomeric materials, 319
FENE-P model, rubber-clay nanocomposite rheology, 269–270
Filler materials:
apolar diene rubbers, 370
   mechanical properties, 389–392
butyl rubber clay nanocomposites:
talc filler aspect ratio, 436–437
vulcanization, 454–456
clay minerals as, 35–37
reinforced elastomeric materials:
clay filler mechanisms, 328–333
dynamic-mechanical (thermal) analysis, 309–310
rubber-clay nanocomposite rheology, 268–269
water-based nanocomposites, orientation, 559–561
Fire resistance:
apolar diene rubber nanocomposites, 396–397
nitrile rubber composites, 424–425
Flammability, thermoplastic polyurethane nanocomposites, 495–496, 507–511
cone calorimeter test, 508–509
IR radiant panel test, 507–508
UL 94 test, 509–511
Flammability calibration, thermoplastic polyurethane nanocomposites, 495–496
Flaps (automotives), 530
Flexibility control, water-based nanocomposites, 563–566
Flocculant cations, latex compounding, rubber-clay nanocomposites, 149–153
Flocculants:
apolar diene rubber nanocomposites, dispersion characterization, 386–387
   nanocomposite morphology, 186
natural rubber latex compounding, 372–373
   permeability, 347
Flory-Huggins polymer interaction, 287–288
Flory-Rehner equation, vulcanization reaction, organo-clay kinetics, 287–288
Fluoroelastomer-clay nanocomposites, rheology, 254–257
Fluorohectorite:
apolar diene rubber nanocomposites: dispersion detection, 380–383
   melt blending, 375–377
barrier mechanisms, 424
demand loading conditions, 420–421
natural rubber latex compounding, 372–373
olefinic rubber composites, 466–467
poly(ethylene-co-vinylacetate) (EVA) rubber-clay nanocomposite rheology, 258–259
rubber-pristine clay composites, 195, 202–206
Force field models, clay mineral mechanics, 121–123
Fracture behavior, reinforced elastomeric materials, rubber-clay nanocomposites, 322–328
cyclic loading tests, 326–328
fracture mechanics principles, 319–321
instrumented notched tensile-impact tests, 323–326
quasistatic loading, 321–323
Free energy change, melt compounding, rubber-clay nanocomposites, 158–160
Free falling dart test, reinforced elastomeric materials, 314–315
Free-radical mechanisms, sulfur vulcanization, 280–282
Freeze-drying:
   latex compounding, rubber-clay nanocomposites, 153
   organophilic clays, 71–72
Friction mechanisms:
apolar diene rubber nanocomposites, 392–393
nitrile rubber composites, 421–422
Fuel hoses (automotive), rubber applications, 527
Fuel injection hosts, rubber applications, 527–528
Fuller surface optimization, reinforced elastomeric materials, 328–333

Gas permeability:
automotive rubber-clay nanocomposites, 538–539
butyl rubber elastomers, 344–345
reinforcement properties, 452–454
solution method, 446–447
elastomer nanocomposites, 348–349
ethylene-propylene-diene-monomer rubber composites, 473–474

Gauche conformations:
alkylammonium chains, packing density and self-assembly, 107–110
organophilic clays, cation exchange, 57–58

Geminal-dimethyl group, permeability, 344–345

Geologic properties, bentonite, 89

Gibbs free energy, brominated isobutylene-co-para-methylstyrene-montmorilonite nanocomposite thermodynamics, 360–362

Glass transition temperature, reinforced elastomeric materials, dynamic-mechanical (thermal) analysis, 309–310

Glycidyl methacrylate, olefinic nanocomposites, 467–469

Grafted organoclays:
direct synthesis, 62–64
olefinic nanocomposites, 467–469
solution-based, 59–61

Gum elastomers, rubber vulcanization, 276

Guth equation:
apolar diene rubber nanocomposites, 391–392
nitrile rubber friction, 421
reinforced elastomeric materials, 334–335

Haloalkanes, thermal decomposition mechanism, 136
Halogenated butyl rubber, permeability, 344–345

Halpin-Tsai equations:
apolar diene rubber nanocomposites, 391–392
reinforced elastomeric materials, 335

Hardness testing, reinforced elastomeric materials, 315–316

Heater hoses (automotive), rubber applications, 528

Heat flow:
natural rubber vulcanization, 295–297
thermoplastic polyurethane nanocomposite flammability, 508
Heating rate tests, thermoplastic polyurethane nanocomposites, 504–507

Heat release rate (HRR):
apolar diene rubber nanocomposites, fire resistance, 396–397
ethylene-propylene-diene-monomer rubber composites, 475
organo-pillared clay nanomaterials, 67–69
thermoplastic elastomers, 491

Herman’s orientation parameters, elastomer nanocomposite permeability, 351–352

Hexadecyl trimethylammonium bromide, dispersion, 386–387

High-speed tearing energy (HSTE), reinforced elastomeric materials, 324–326

Hofmann elimination, organoclay thermal decomposition, 136–137

Hofmann-Klemen (HK) effect, clay cationic exchange capacity, 27

Hoses:
automotive, rubber applications, 527–528
water-based nanocomposites, 570

“House-of-cards” agglomerates:
clay aggregation and dispersion, 6
latex compounding, rubber-clay nanocomposites, 152–153

Hydrogenated nitrile butadiene rubber (HNBR):
ammonium cations, 209, 213–215
diene rubber composites, 219
automotive nanocomposites, aging and ozone resistance, 539–541
barrier mechanisms, 423–424
basic characteristics, 409–410
cure characteristics, 415–416
demand loading conditions, 420–421
fire resistance, 424–425
friction/wear mechanisms, 421–422
mechanical properties, 418–421
melt compounding, 413–414
chemical factors, 163–166
compatibilizers or coupling agents, 161–163
physical factors, 166–169
pristine clay modification, primary alkenylamines, 202
vulcanization reaction, organo-clay kinetics, 285–289
Hydrophilic/lipophilic balance (HLB), organophilic clay minerals, 45–47
Hydrotalcite (HT), 4
anionic properties, 21–22
butyl rubber-clay nanocomposites, 435–436
Hydroxyl-terminated polybutadiene (HTPB) oligomer, rheology, 248–250
Illite, TOT criteria, 14
Imogolite group, TO criteria, 16
Impact loading, reinforced elastomeric materials, toughness behavior, 313–315
Imperm® organoclay, 65
Incompatibility, reinforced elastomeric materials and, 306–307
Inflation pressure retention (IPR), elastomer nanocomposite permeability, 346
Innerliner compound:
air oven aging, 355–356
butyl rubber clay nanocomposites, 449–452
permeability measurement, 345–346, 353–356
processability, 457
In situ intercalation preparation, ethylene-propylene-diene-monomer rubber, 469–473
In situ polymerization:
automotive rubber-clay nanocomposites, 536–538
butyl rubber clay nanocomposites, 448
elastomer nanocomposite preparation, 352
rubber-clay nanocomposites, 170
Instrumented notched tensile-impact (INIT) test, reinforced elastomeric materials, fracture mechanics, 323–326
Intercalation cations, latex compounding, rubber-clay nanocomposites, 148–149
Intercalated rubber-clay nanocomposites:
apolar diene rubbers, 370–371
butyl rubbers, 434–435
classification, 147–148
clay interlayer space, 27–30
clay-polymer nanocomposites, 73–75
ethylene-propylene-diene-monomer rubber, in situ intercalation preparation, 469–473
formation mechanisms, 228–229
melt compounding, microstructure evolution, 162–163
morphology:
clay modification, 184
flocculated nanocomposites, 186
polymer-clay composites, 185–186
nitrile rubber, mechanical properties, 419–421
organophilic clays, cation exchange, 49–58
crystalllographic molecular structures, 54–58
solid-state intercalation, 58–59
permeability, 347
polymer chain interlayers, 229–230
rubber vulcanization, 289
solution and in situ polymerization, 170
Interface area function (IAF), reinforced elastomeric materials, 335–336
Interface-enhanced styrene-butadiene-rubber-clay nanocomposites, mechanical properties, 156–157
Interfacial tension:
organophilic clay minerals, 46
water-based nanocomposites, 563–566
Interlayer intercalation and confinement:
alkylammonium chains:
packing density and self-assembly, 102–110
reversible melting transitions, 111–113
Interlayer (Continued)
clay minerals, 27–30
organoclays, silane grafting, 61
rubber-clay nanocomposite formation:
low molecular mass substances, 230–232
polymer chains, 229–230
Interparticle associations, clay rheology, 32–33
Interstratified clay minerals, criteria, 14–15
Intracarass pressure (ICP), tire permeability, 354–356
Ionic exchange:
clay cationic exchange capacity, 26–27
organophilic clays, cation exchange mechanisms, 53–58
Ionomers, butyl rubber nanocomposites, 439–443
IR radiant panel test, thermoplastic polyurethane nanocomposites, 507–508
Isoconversion method, thermoplastic polyurethane nanocomposites, 500–501
Isodimensional nanofillers, automotive applications, 531
Isoelectric point (IEP), clay rheology, 32–33
Isoprene-isobutadiene rubber (IIR)/clay nanocompound:
apolar diene rubber nanocomposites, 392
barrier mechanisms, 396
copolymerization, 369–371
dispersion, 387–388
melt compounding, 158–160, 166–169, 377
pristine clay modification, rubber-clay nanocomposites, 190–191
solution-based preparation, 374
vulcanization, 455–456
Isoprene rubber (IR):
ammonium cations, 213
apolar diene rubber nanocomposites, melt blending, 375–377
copolymerization, 369–371
permeability, 343–345
rheology, 243–246
tear behavior, 317
Kaolinite:
criteria, 11
intercalation, 28–29
Kevlar-filled ethylene-propylene-diene monomer, kinetics, 513–514
Kinetics, thermoplastic polyurethane nanocomposites, 513–516
Kissinger equation, natural rubber vulcanization, 295–297
Kraus plot, rubber-clay nanocomposite rheology, 246
Krieger’s empirical model equation, rheology of rubber-clay nanocomposites, 244–246
Labyrinth effect, apolar diene rubber nanocomposites, barrier mechanisms, 394–396
Lamellae structure, rubber-clay nanocomposite formation, 228–232
Laponite:
dispersion, 8
plasma-treated clays, 69
Laser flash diffusivity, thermoplastic polyurethane nanocomposites, 497
Latex compounding method (LCM):
apolar diene rubber composites, 371–373
butyl rubber nanocomposites, 447–448
future trends, 171
natural rubber-clay nanocomposite rheology, 245–246
nitrile rubber-clay composites, 411–412
rubber-clay nanocomposites, 148–157
coaugulation methods, 149–153
interaction/affinity between rubber and clay, 153–157
mechanisms, 148–149
rubber-pristine clay composites, 192–194
prevulcanized latex, 194
Layered clays, rubber-clay nanocomposite morphology, multiscale organization, 184
Layered double hydroxides (LDH):
automotive rubber-clay nanocomposites, 537–538
butyl rubber-clay nanocomposites, 436
clay minerals, 4
hydrotalcite, 21–22
olefinic rubber composites, 466–467
reinforced elastomeric materials, 332–333
surface area and porosity, 23–24
Layered silicates, x-ray diffraction analysis, 182
Layer separation and miscibility, polymers, 115–121
  cleavage energy, 116–121
  matrix exfoliation, thermodynamics model, 115–116
  surface energy, 121
Length-to-width ratio, permeability, 348
Leonov viscoelastic model, rubber-clay nanocomposite rheology, 269
Linear polymer degradation, thermoplastic polyurethane nanocomposites, 498
Lipophilicity, organophilic clay minerals, 45–47
Load-deformation diagram, reinforced elastomeric materials, 314–315
Local osmotic transition (LOT), clay swelling, 30–31
Long-chain alkenyl groups:
  ammonium cation substituents, 215
  rubber-clay nanocomposites, ammonium cation modification, 219–228
Low molecular weight compounds:
  butyl rubber polymers, 444
  intercalation of, 184
  rubber-clay nanocomposite formation, 230–232
LPG vapor hose, rubber applications, 528
Macroscopic clay structure, 5
Maleic anhydride-grafted polymers, 443–444
  adhesion properties, 456–457
  ethylene-propylene-diene-monomer rubber, 479
  reinforced elastomeric materials, 329–333
Mass loss rate, ethylene-propylene-diene-monomer rubber composites, 475
Masterbatch processing, organoclays:
  epoxidized natural rubber, 414
  thermal decomposition mechanism, 136–137
Maximum torque value, rubber vulcanization, curing mechanics, 278
Maxwell-Wagner polarization effects, nitrile rubber composites, 425
MDR rheometry, innerliner compound vulcanization, 356
Mechanical properties:
  apolar diene rubber nanocomposites, 387–392
  clays and clay minerals, 121–123
  ethylene-propylene-diene-monomer rubber, 476–479
  nitrile rubber composites, 416–421
  reinforced elastomeric materials, 307–322
  compression set determination, 317–319
  dynamic-mechanical analysis, 307–310
  fatigue behavior, 319
  fracture mechanics, 319–321
  hardness testing, 315–316
  tear behavior, 316–317
  tensile testing, 310–313
  toughness behavior, impact loading conditions, 313–315
  rubber vulcanization, 290–297
Melt compounding method (MCM), rubber-clay nanocomposites, 55–170
  apolar diene rubber nanocomposites, 374–377
  butyl rubbers, 445
  future trends, 171
  hydrogenated nitrile butadiene rubber, pristine clay modification, 202
  mechanisms, 157–160
  mixing curative effects, 162
  nitrile rubber-clay composites, 412–414
  organic modification, matrix rubber vulcanization, 169–170
  permeability, 352
  pristine clay distribution and dispersion, 190–191
  aggregated composites, 194–197
  coagulating agents, 196–197
  rubber-pristine clay composites, 192–194
  thermoplastic clay nanocomposites comparisons, 160–162
  vulcanization and microstructure evolution, 162–169
Mercaptobenzothiazole (MBT), rubber-clay nanocomposite vulcanization and permeability, 356–358
Mooney viscosity, brominated isobutylene-co-para-methylstyrene-montmorillonite nanocomposite thermodynamics, 358–362

Morphology, rubber-clay nanocomposites: ammonium cation modification, 206–212
basic principles, 181
butyl rubbers, 433–435
cationic clay properties, 182–183
clay distribution and dispersion, 183
long-chain alkenyl substituents, ammonium cation-modified montmorillonite, 219–228
low molecular mass substances, 183
montmorillonite modification, 212–215
multiscale organization, layered clays, 183
polar group ammonium cations, montmorillonite modification, 215–219
polymer-clay composites, 183–186
primary alkenylamines, 197–206
pristine clays, 186–197
proposed mechanisms, 228–232
thermoplastic polyurethanes, 494–495
x-ray diffraction analysis, 182
Multiaxial deformation behavior, reinforced elastomeric materials, 314–315
Multifunctional additives (MFA), rubber-clay nanocomposites, vulcanization activation, 138–141
Multiscale organization:
clays and clay minerals, 6–8
delamination/exfoliation vs. stacking, 6–8
dispersion vs. aggregation, 6
rubber-clay nanocomposite morphology, layered clays, 184
m-xylylenediamine (MXD), latex compounding, rubber-clay nanocomposites, 155–157

Nanocor organoclay, 65
Nanofil compounds, cyclic loading, fracture mechanics testing, 327–328
Nanomaterials:
clay-polymer morphology and classification, 185–186
clays as, 20–21
mechanical data, 121, 123
organo-pillared clays, 66–69
plasma-treated clays, 69
organoclay nanocomposites, 72–75
nanoMax™, 65
Nanopolymers, clays as, 20–21
Nanoscale, clays and clay materials, 5
Natural butadiene rubber (NBR):
automotive rubber-clay nanocomposites, 535–538
resistance, 541–542
barrier mechanisms, 424
basic characteristics, 409–410
diene rubber composites, 225
fire resistance, 424–425
friction/wear mechanisms, 421–422
latex compounding, 411–412
mechanical properties, 416–421
nitrile rubber-clay composites:
chloroform solvents, 411
cure characteristics, 414–416
vulcanization, 287–288
Natural clays, availability, 33–35
Natural rubber (NR):
ammonium cations, 213
apolar diene rubber nanocomposites, 393
barrier mechanisms, 394–396
automotive rubber-clay nanocomposites, 535–538
diene rubber composites, 221–222
latex compounding, 371–373
mechanical properties, 387–392
melt blending process, 374–377
polar group ammonium cation modification, diene rubber composites, 217
pristine clay modification, rubber-clay nanocomposites, 190–191
primary alkenylamines, 198–200
reinforced elastomeric materials:
cyclic loading, fracture mechanics testing, 327–328
fracture mechanics, 325–326
rubber-clay nanocomposites:
ammonium cations, 207
rheology, 243–246
solution-based preparation, 373–374
sulfur vulcanization, 278–282
tear behavior, 317
vulcanization kinetics, 292–297
Nanomaterials (Continued)
  water-based nanocomposites, tennis balls, 567–568
Natural rubber/chloroprene (NR/CR) blends, vulcanization reaction, organo-clay kinetics, 284–289
Natural rubber-ethylene natural rubber blends, rubber-pristine clay composites, 195
Negatively charged clay layers, 4
Neutral clays, layer organization, 8–11
Newtonian behavior, rheology of rubber-clay nanocomposites, 244–246
Nitrile rubber rubber-clay nanocomposites:
  barrier properties, 423–424
  basic principles, 409–410
  cure characteristics, 414–416
  fire resistance, 424–425
  friction/wear properties, 421–422
  future research issues, 425–426
  mechanical properties, 416–421
  preparation methods and dispersion, 410–414
  latex compounding, 411–412
  melt blending, 412–414
  solution-base methods, 410–411
Nitrogen physisorption:
  clay aggregation and dispersion, 8
  nitrile rubber composites, 423–424
Nonphyllosilicate cationic layered minerals, layered structure, 21
Nucleophilic substitution, rubber-clay nanocomposites, vulcanization activation, 139–141
Octadecylamine (ODA):
  apolar diene cure characteristics, 377–379
  latex compounding, rubber-clay, 157
  melt compounding, rubber-clay nanocomposites, vulcanization effects, 169–170
  nitrile rubber-clay composites, melt mixing, 413–414
  rubber-pristine clay composites, primary alkylamines, 197–206
Octadecylammonium (ODA), poly(ethylene-co-vinylacetate) (EVA) rubber-clay nanocomposite rheology, 258–259
  Octadecyltrimethylammonium mica, reversible melting transitions, 111–113
Octahedral sheets:
  anionic clay minerals, 21–22
  clay layer organization, 9–11
  nonphyllosilicate cationic layers, 21
Olefin rubber-clay nanocomposites:
  basic properties, 465–466
  compatibilizer systems, 467–469
  creep properties, 482–483
  gas permeability, 473–474
  mechanical properties, 476–479
  mineral compounds, 466–467
  organoclay thermal decomposition, 136–137
  preparation, 479–480
  rheological properties, 474
  in situ intercalation method, 469–473
  stability, 475
  swelling properties, 475–476, 483–486
  temperature dependence, dynamic storage moduli, 481–482
  tensile properties, 480–481
One-pot clay-polymer nanocomposite formation, 66
Onsager orientation distribution, elastomer nanocomposite permeability, 351–352
Onset decomposition temperature, organo-clay thermal decomposition, 133–135
Optimal clay concentration, clay mineral purification, 94
Optimum cure time, rubber vulcanization, curing mechanics, 278
Orbital ball-on-plate test, nitrile rubber composites, 421–422
Organically modified montmorillonite (OMMT):
  butyl rubber nanocomposites, solution method, 445–447
  reinforced elastomeric materials, dynamic-mechanical (thermal) analysis, 309–310
Organic cation decomposition, rubber-clay nanocomposites, 128–135
Organic clay minerals:
  automotive applications, 534
  chemical treatments, 71
clay-polymer nanocomposites, 72–75
commercial products, 64–66
dispersion maximization, 69–70
hydrophilic/lipophilic balance, 45–47
melt compounding, rubber-clay
nanocomposites, 158–160
thermoplastic-clay nanocomposite
comparisons, 160–162
vulcanization effects, 169–170
nanomaterials, 66–69
one-pot CPN formation, 66
physical treatments, 71–72
polymer technology, 47–49
postsynthesis modifications, 64
rubber-clay nanocomposites:
cation decomposition, 128–135
vulcanization activation, 137–141
solid-state intercalation, 58–59
solution-based grafting, 59–61
synthesis procedures, 49–66
thermal decomposition
mechanism, 135–137
thermal stability, 70–71
vulcanization reaction, 283–289
Organic-inorganic interface, alkylammonium chains, packing density and self-assembly, 108–110
Organic montmorillonite (OMMT)
nanocomposites:
apolar diene rubber
nanocomposites, 390–392
butyl rubber nanocomposites, 439
reinforced elastomeric
materials, 330–333
compression set
determination, 318–319
solution and in situ polymerization, 170
Organic species, clay intercalation, 28
Organic substances, clay reactions, 97–99
Organo-pillared clay nanomaterials,
66–69
Orientation parameters, water-based nanocomposites, barrier mechanisms,
558–561
Oscillating disc rheometer (ODR), rubber
crosslinking, curing mechan-
is, 277–278, 290–297
Osmotic transition (OT), clay
swelling, 30–31
Ozawa equation, natural rubber
crosslinking, 295–297
Ozone cracking time, apolar diene rubber
nanocomposites, 397–398
Ozone resistance, automotive rubber-clay
nanocomposites, 539–541
Packing density, alkylammonium chains, 102–110
Padé approximation, rheology of rubber-clay
nanocomposites, 245–246
Palygorskite, TOT criteria, 15–16
Paraffin-like structures, organophilic clays, cation exchange, 54–58
Particle separation:
latex compounding, rubber-clay
nanocomposites, 148–153
melt compounding, rubber-clay
nanocomposites, 163
Particle size:
clays and clay materials, 5
organic clays, modification, 99
reinforced elastomeric
materials, 331–333
Particulate dispersion, elastomer nanocomposite permeability, 346
Payne effect:
reinforced elastomeric materials, dynamic-
mechanical (thermal)
analysis, 309–310
rubber-clay nanocomposites, rheological
behavior, 242, 263–268
Pellethane™, 491–493
dispersion, 501–503
kinetics, 514–516
thermal properties, 504–507
Percolation threshold, apolar diene rubber
nanocomposites, 391–392
Performance evaluation, rubber-clay nanocomposite permeability, 362–364
Permeability:
automotive rubber-clay
nanocomposites, 538–539
butyl rubber clay
nanocomposites, 449–452
rubber-clay nanocomposites:
basic principles, 343
BIMSM montmorillonite
thermodynamics, 358–362
Permeability (Continued)
butyl rubber elastomers, 343–345
elastomer nanocomposites, 352
exfoliated nanocomposites, 347
flocculated nanocomposites, 347
gas permeability, 348
intercalated-flocculated nanocomposites, 347
intercalated nanocomposites, 347
Nielsen’s model, 348
Onsager orientation distribution function, 351
order parameters, 348–349
orientation parameter, 349–350
plate formation, 347–352
small-angle x-ray scattering, 349–350
temperature and compound materials, 352–356
tire innerliner compound, 345–346
tire permeability, 346, 362–364
tortuosity effect, 347–348
vulcanization effects, 356–358
Permeation behavior, reinforced elastomeric materials, compression set determination, 318–319
Peroxide vulcanization, curing kinetics, 282–283
Phenolic resins, rubber-pristine clay composites, 192
Phenomenological kinetics, rubber vulcanization, 290–297
Phosphine ionomer, butyl rubber nanocomposites, 439–443
Phyllosilicates, TOT criteria, 14
Physical treatments, organophilic clays, 71–72
Physisorption isotherm, clay surface area and porosity, 22–24
Pin-on-plate (POP) sliding wear test, nitrile rubber friction/wear mechanisms, 421–422
Plasma-treated clays, nanomaterials, 69
Platelet aggregation:
clays and clay minerals, 6
rubber-clay nanocomposites, basic properties, 241–242
Plate orientation, elastomer nanocomposite gas permeability, 349–351
Pneumatic devices, water-based nanocomposites, 566–570
basketballs, 569
bicycle and specialty tires and tubes, 570
soccer balls, 568–569
tennis balls, 567–568
Point of zero charge (PZC), clay rheology, 32–33
Polar group ammonium cations, montmorillonite rubber composites, 215–219
Polyepichlorohydrin rubber-clay nanocomposites, rheology, 259–261
Poly(ethylene-co-vinylacetate) (EVA) rubber-clay nanocomposite, pristine clay modification, 257–259
Polyethylene terephthalate (PET), reinforced elastomeric materials, 330–333
Polymer nanocomposites:
automotive applications, 531
intercalation, 29–30
layer separation and miscibility, 115–121
cleavage energy, 116–121
matrix exfoliation, thermodynamics model, 115–116
surface energy, 121
low molecular weight butyl rubbers, 444
organophilic clays, 47–49
reinforced elastomeric materials, chain behavior, 329–333
resins, thermoplastic elastomer nanocomposites, 491–493
rubber-clay nanocomposites:
chain intercalation, 229–230
morphology and classification, 184–186
organic cation decomposition, 128–135
Polysulfide ions, rubber-clay nanocomposites, vulcanization activation, 140–141
Polyurethane:
automotive nanocomposites, 544–545
automotive rubber-clay nanocomposites, 535–538
natural rubber latex compounding, 373
thermoplastic-polyurethane-clay nanocomposites, 261–262
Porosity, clay minerals, 22–24
Porous clay heterostructures (PCH), post-synthesis modifications, 64
Positively charge clay layers, 4
INDEX

Postsynthesis modification, grafted organoclays, 62–64
Power-law index, fluoroelastomer-clay nanocomposite rheology, 254–257
Power steering return hose, rubber applications, 528
Precursor organic cation salts, organoclay thermal decomposition, 133–135
Preshear parameters, isopropylene rubber-clay nanocomposite rheology, 245–246
Pressure accumulators, water-based nanocomposites, 570
Preswelled organic clay materials, melt compounding, rubber-nanoclay composites, physical factors, 169
Prevulcanized latex, rubber-pristine clay composites, 194
procedures for, 197
Primary alkenylamines, rubber-pristine clay composites, 197–206
fluorohectorite modification, 200–206
montmorillonite and bentonite, 198–200
Primary amine (PRIM), olefinic nanocomposites, 468–469
Primary organic montmorillonite (P-OMt), apolar diene rubber nanocomposites, 390–392
Pristine clay, rubber-clay nanocomposite morphology:
aggregated clay organization, rubber materials, 189–190
cationic clays, 187
distribution and dispersion, 187–189
latex composites, 192–194
matrix distribution and dispersion, 190–194
melt compounding, 190–191
organic modifiers, 182–183
rubber solution composites, 192
Processing methods, rubber-clay nanocomposites:
automotive elastomers, 542–544
butyl rubbers, 457
future trends, 170–171
latex compounding, 148–157
coaulation methods, 149–153
interaction/affinity between rubber and clay, 153–157
mechanisms, 148–149
melt compounding, 157–170
mixing curative effects, 162
organic modification, matrix rubber vulcanization, 169–170
thermoplastic clay nanocomposites comparisons, 160–162
vulcanization and microstructure evolution, 162–169
overview, 147–148
solution intercalation and in situ polymerization intercalation, 170
thermoplastic elastomers, 491
Proton exchange membrane fuel cells, plasma-treated clays, 69
Pseudoplastic behavior, automotive elastomers, 542–544
Pseudotrimolecular arrangement, organophilic clays, cation exchange, 57–58
Purification, clays and clay minerals, 93–97
clay concentration, 94
swelling time, 94–95
temperature, 95–97
Pyrophyllite, TOT criteria, 14
Quasistatic loading, reinforced elastomeric materials, fracture mechanics, 321–323
Quaternary amine (QUAT), olefinic nanocomposites, 468–469
Quaternary ammonium cations, thermal decomposition mechanism, 135–137
Quaternary organic montmorillonite (P-OMt), apolar diene rubber nanocomposites, 390–392
Quaternary phosphonium salts, organophilic clays, rubber vulcanization, 289
Radiant panel testing, thermoplastic polyurethane nanocomposites, 496
microstructure evolution, 511–512
R-curves, reinforced elastomeric materials, fracture mechanics, 322–323
Reactive chamber pattern, apolar diene rubber nanocomposites, melt blending, 375–377
Reinforced elastomeric materials, rubber-clay nanocomposites:
  basic principles, 305–307
  butyl rubber nanocomposites, 452–454
  fracture behavior, 322–328
  cyclic loading tests, 326–328
  fracture mechanics principles, 319–321
  instrumented notched tensile-impact tests, 323–326
  quasistatic loading, 321–323
  mechanisms, 328–333
  theories and modeling, 333–334
  viscoelastic and mechanical testing, 307–322
  compression set determination, 317–319
  dynamic-mechanical analysis, 307–310
  fatigue behavior, 319
  hardness testing, 315–316
  tear behavior, 316–317
  tensile testing, 310–313
  toughness behavior, impact loading conditions, 313–315
Relaxation time, polyepichlorohydrin rubber-clay nanocomposite rheology, 259–261
Resins:
  low molecular mass substances, 444
  thermoplastic elastomer nanocomposites, 491–493
Rheology:
  clay materials, 31–33
  ethylene-propylene-diene-monomer composites, 474
  rubber-clay nanocomposites:
    acrylonitrile butadiene rubber, 250–253
    basic principles, 241–242
    data thresholds and experiments, 263–269
    epoxidized natural rubber and polyisoprene rubber, 243–246
    ethylene-propylene nanocomposites, 253–254
    fluoroplastic elastomer-clay, 254–257
    future research, 270
    polybutadiene rubber, 247–250
    polyepichlorohydrin, 259–261
    poly(ethylene-co-vinylacetate) (EVA), 257–259
    poly(isobutylene-co-para-methylstyrene) (BIMS), 257
    polymer-clay nanocomposites, 269–270
    styrene-butadiene composites, 246–247
    styrene-ethylene-butylene-styrene (SEBS) block copolymer-clay nanocomposites, 262–263
    thermoplastic polyurethane, 261–262
Rolling-on-plate (ROP) configuration, nitrile rubber composites, 421–422
Rubber boots (automotive), 529
Rubber-clay nanocomposites:
  automotive applications:
    aging and ozone resistance, 539–541
    barrier/air retention properties, 538–539
    basic principles, 525–526
    disadvantages, 548–549
    elastomeric components, 531
    elastomeric nanocomposites, 531–548
    organoclay minerals, 534
    polyurethane-organoclay composites, 544–545
    processability, 542–544
    rubber, 526–531
    rubber-clay vs. other nanofillers, 534
    solvent resistance, 541–542
    tire nanocomposites, 545–548
    weight and balanced mechanical properties, 535–538
    vulcanization reaction, organo-clay kinetics, 283–289
Rubber-clay nanocomposites (RCNs):
  Bentonite, 87–89
  chemistry:
    basic principles, 127–128
    microstructure evolution, 163–169
    organic cation decomposition, 128–135
    rubber vulcanization activation, organic cations, 137–141
    thermal decomposition mechanism, 135–137
  morphology:
    ammonium cation modification, 206–212
basic principles, 181

cationic clay properties, 182–183
clay distribution and dispersion, 183
long-chain alkenyl substituents, ammonium cation-modified montmorillonite, 219–228
low molecular mass substances, 183
montmorillonite modification, 212–215
multiscale organization, layered clays, 183
polar group ammonium cations, montmorillonite modification, 215–219
primary alkenylamines, 197–206
pristine clays, 186–197
proposed mechanisms, 228–232
x-ray diffraction analysis, 182

permeability:
basic principles, 343
BIMSM montmorillonite thermodynamics, 358–362
butyl rubber elastomers, 343–345
elastomer nanocomposites, 352
exfoliated nanocomposites, 347
flocculated nanocomposites, 347
gas permeability, 348
intercalated-flocculated nanocomposites, 347
intercalated nanocomposites, 347
Nielsen’s model, 348
Onsager orientation distribution function, 351
order parameters, 348–349
orientation parameter, 349–350
plate formation, 347–352
small-angle x-ray scattering, 349–350
temperature and compound materials, 352–356
tire innerliner compound, 345–346
tire permeability, 346, 362–364
tortuosity effect, 347–348
vulcanization effects, 356–358
physisorption, 163–169
processing methods:
future trends, 170–171
latex compounding, 148–157
melt compounding, 157–170
overview, 147–148

solution intercalation and in situ polymerization intercalation, 170
reinforcing components:
basic principles, 305–307
elastomer fracture behavior, 322–328
mechanisms, 328–333
theories and modeling, 333–334
viscoelastic and mechanical properties, 307–322
rheology:
acrylonitrile butadiene rubber, 250–253
basic principles, 241–242
data thresholds and experiments, 263–269
epoxidized natural rubber and polyisoprene rubber, 243–246
ethylene-propylene nanocomposites, 253–254
fluoroelastomer-clay, 254–257
future research, 270
polybutadiene rubber, 247–250
polyepichlorohydrin, 259–261
poly(ethylene-co-vinylacetate) (EVA), 257–259
poly(isobutylene-co-para-methylstyrene) (BIMS), 257
dynamic vulcanization:
polymer-clay nanocomposites, 269–270
styrene-butadiene composites, 246–247
styrene-ethylene-butylene-styrene (SEBS) block copolymer-clay nanocomposites, 262–263
thermoplastic polyurethanes, 261–262
rubber cross-linking systems, 278–283
Rubber matrices, pristine clays:
aggregation, 189–190
distribution and dispersion, 187–189
Rubber solution, rubber-clay nanocomposites, 192

Salts, rubber-clay nanocomposites, organic cation decomposition, 128–135
Scanning electron microscopy (SEM), apolar diene rubber nanocomposites, dispersion detection, 380–383
Schallamach pattern, nitrile rubber composites, 421–422
“Schizophrenic molecules,” organophilic clay amphiphilicity, 46
Scorch time:
rubber vulcanization, curing mechanics, 278
sulfur vulcanization, 279–282
Seals (automotive), rubber applications, 528–529
Self-assembly, alkylammonium chains, 102–110
Semi-rigid clay networks, reinforced elastomeric materials, 333
Separated phase microcomposites, morphology and classification, 185
Separated rubber-clay nanocomposites, 147–148
Sepiolite:
butyl rubber clay nanocomposites, 438
TOT criteria, 15
Serpentine, criteria, 11
Shear viscosity:
butadiene-rubber nanocomposite rheology, 249–250
polypelchlorohydrin rubber-clay nanocomposites, 259–261
rubber-clay nanocomposite rheology, 268–269
Shore A hardness:
reinforced elastomeric materials, 315–317
thermoplastic polyurethane nanocomposites, 504–507
Short-chain alkenyl groups, ammonium cation substituents, 215
Silicates:
apolar diene rubbers, 370–371
elastomer nanocomposite gas permeability, 348–349
nitrile rubber-clay composites, 410
pristine clay modification, rubber-clay nanocomposites, 191
rubber-pristine clay composites, 195
rubber vulcanization, 290–297
Single-edge-notched tension (SENT) specimens, reinforced elastomeric materials, fracture mechanics, 321–323
Size parameters, latex compounding, rubber-clay nanocomposites, 149–157
Slurry additives, rubber-pristine clay composites, 193
coaagulating agents, 196–197
Small angle X-ray scattering (SAXS):
apolar diene rubber nanocomposites, dispersion characterization, 386–387
elastomer nanocomposite gas permeability, 349–350
Small molecules, clay intercalation, 27–28
Smectites:
rheology, 31–33
swelling properties, 17, 19–20
TOT criteria, 14
SN2 substitution reaction, organoclay thermal decomposition, 137
Soccer balls, water-based nanocomposites, 568–569
Sol-gel transition (SGT), clay swelling, 30–31
Solid-state intercalation, organophilic clays, cation exchange, 58–59
Solution-based cation exchange, organophilic clays, 49–58
Solution intercalation:
apolar diene rubber processing, 373–374
butyl rubbers, 445–447
nitrile rubber-clay composites, 410–411
rubber-clay nanocomposites, 170, 192
permeability, 352
Solvents:
apolar diene rubber processing, 373–374
automotive nanocomposites, resistance, 541–542
evaporation, alkyl surfactants, 114–115
Sonication, organophilic clays, 71–72
Spatial distribution, melt compounding, rubber-clay nanocomposites, 163
Specific heat analysis, thermoplastic polyurethane nanocomposites, 497
Specific surface area (SSA):
clay aggregation and dispersion, 70
clay surface area and porosity, 22–24
Sports balls, water-based nanocomposites, 566–570
  basketballs, 569
  bicycle and specialty tires and tubes, 570
  soccer balls, 568–569
tennis balls, 567–568
Stability, ethylene-propylene-diene-monomer rubber, 475
Stacking, clay aggregation and dispersion, 6–8
Staining, water-based nanocomposites, 572
Star-branched butyl (SBB) polymers:
  automotive rubber-clay nanocomposites, 538
  characteristics, 431–433
Stiffness, reinforced elastomeric materials, 335–336
Storage modulus:
  ethylene-propylene monomer nanocomposites, temperature dependence, 481–482
  isopropylene rubber-clay nanocomposite rheology, 245–246
  poly(ethylene-co-vinylacetate) (EVA) rubber-clay nanocomposite rheology, 258–259
  reinforced elastomeric materials, dynamic-mechanical (thermal) analysis, 308–310
  rubber-clay nanocomposite rheology, 268–269
Strength testing, reinforced elastomeric materials, tensile testing, 310–313
Stress-strain analysis, styrene-butadiene-rubber-clay nanocomposites, 155–157
Structure-property relationships, thermoplastic elastomers, 491
Styrene-butadiene-rubber-clay nanocomposites:
  ammonium cations, 209, 213
  diene rubber composites, 217, 219
  diene rubber composites, 225
  latex compounding, 155–157
  melt compounding, 159–160
  pristine clay modification, primary alkenylamines, 200–202
Styrene-butadiene-rubber (SBR)-clay nanocomposites:
  aging and ozone resistance, 539–541
  apolar diene rubber nanocomposites:
    barrier mechanisms, 395–396
    dispersion, 386–387
    mechanical properties, 391–392
    melt blending, 376–377
  automotive rubber-clay nanocomposites, 535–538
  copolymerization, 369–371
  reinforced elastomeric materials:
    fracture mechanics, 325–326
    tensile testing, 311–313
    toughness behavior, 313–315
  rheology, 246–247
  solution-based preparation, 374
Styrene-ethylene-butylene-styrene (SEBS) block copolymer-clay nanocomposites, 212–215
Substituent modification, montmorillonite rubber-clay nanocomposites, 262–263
Substitution reactions, rubber-clay nanocomposites, vulcanization activation, 140–141
Sulfur curatives:
  apolar diene rubbers, mechanical properties, 389–392
  melt compounding, rubber-nanoclay composites, 166–169
  olefinic nanocomposites, 467–469
  vulcanization, 278–282
Surface active ingredients, rubber-clay nanocomposites, vulcanization activation, 138–141
Surface area, clay minerals, 22–24
Surface energy, polymer layer separation and miscibility, 121
Surface temperature, thermoplastic polyurethane nanocomposite flammability, 508
Surfactant/CEC ratio:
  alkylammonium chains:
    diffusion dynamics, 110
    solvent evaporation and thermal elimination, 113–115
  clay-polymer nanocomposites, 73–75
  organophilic clays, dispersion maximization, 69–70
Surfactant properties:
  butyl rubber nanocomposites, 439
  latex compounding, rubber-clay nanocomposites, 155–157
Swelling clays:
  basic principles, 30–31
  butyl rubber nanocomposites, 439
  ethylene-propylene-diene-monomer rubber composites, 475–476
  ethylene-propylene monomer nanocomposites, 483–486
  interlayer intercalation and confinement, 27–30
  layered structure, 17, 22–23
  polymer intercalation, 29–30
Swelling time, clay mineral purification, 94–95
Synthetic clays, availability, 33–35

Talc fillers:
  butyl rubber clay nanocomposites, 436–437
  TOT criteria, 14
Tallow groups, ammonium cations, 213–215
diene rubber composites, 220–228
Tear and fatigue analyzer (TFA), reinforced elastomeric materials, cyclic loading, fracture mechanics testing, 326–328
Tear behavior, reinforced elastomeric materials, 316–317
Tear strength, reinforced elastomeric materials, 331–333
Temperature:
  butyl rubber nanocomposites, air permeability, 452
  clay mineral purification, 95–97
  ethylene-propylene monomer nanocomposites, dynamic storage moduli, 481–482
  nanocomposite permeability, 352–356
  natural rubber vulcanization, 295–297
Tennis balls, water-based nanocomposites, 567–568
Tensile testing:
  apolar diene rubber nanocomposites, 389–392
  ethylene-propylene-diene-monomer rubber, 476–479
  reinforced elastomeric materials, 310–313
  Ternary systems, clay-polymer nanocomposites, 73–75
  Tetraalkylammoniums, solid-state intercalation, 59
Tetrahedral sheets:
  cationic layered silicates, 21
  clay layer organization, 9–11
  Tetramethylthiuram disulfide (TMTD), vulcanization and permeability, 356–358
Thermal properties:
  alkylammonium chains, 111–115
  reversible melting transitions, 111–113
  solvent evaporation and thermal elimination, 113–115
  alkyl surfactants, 114–115
  organophilic clays, 70–71
  rubber-clay nanocomposites: organic cation mechanism, 128–135
  organoclays, 135–137
  thermoplastic polyurethane nanocomposites, 495, 503–507
  diffusivity, 497
Thermodynamics, brominated isobutylene-co-para-methylstyrene-montmorillonite nanocomposite, 358–362
Thermogravimetric analysis (TGA):
  thermoplastic elastomers, 489–491, 495
  thermoplastic polyurethane nanocomposites:
    decomposition kinetics, 499–501
    thermal properties, 504–507
  Thermophysical properties, thermoplastic polyurethane nanocomposites, 496–497, 512–513
Thermoplastic elastomer (TPE) nanocomposites:
  automotive applications, 544–545
  basic properties, 489–491
  calibration, 495
  decomposition kinetics modeling, 497–501
  experimental analysis, 495
  flammability properties, 495–496, 507–511
  kinetic parameters, 512–516
  materials selection, 491–493
melt compounding, 160–162
microstructures, 511–512
morphology, 494–495
nanoparticles, 493
dispersion, 501–503
thermal properties, 503–507
physical properties, 496–497, 512–513
polymer resins, 491–493
processing, 493–494
water-based nanocomposites vs., 566
Thermoplastic polyurethane nanocomposites (TPUN):
basic properties, 489–491
flammability, 495–496, 507–511
cone calorimeter test, 508–509
IR radiant panel test, 507–508
UL 94 test, 509–511
kinetics, 513–516
microstructure analysis, 511–512
morphology, 494–495
nanoparticles, 493
resins, 491–493
rheology, 261–262
thermophysical properties, 496–497, 503–507, 512–513
Thiuram vulcanization accelerator, melt compounding, rubber-clay nanocomposites, 164–169
Thixotropy, clay rheology, 33
Tires:
bicycle and specialty tires, water-based nanocomposites, 570
butyl rubber clay nanocomposites, 452
reinforcement properties, 453–454
improvement in, 346
innerliner compound, 345–346
nanocomposite performance evaluation, 362–364
organoclay nanocomposites, 545–548
rubber applications, 529–530
TO (tetrahedral-octahedral) clay groups, 11–17
nonphyllosilicate cationic layers, 21
Toluene, apolar diene rubber processing, 373–374
Torque delta:
natural vulcanization, 292–297
reinforced elastomeric materials, 331–333
Tortuosity effect:
apolar diene rubber nanocomposites, barrier mechanisms, 394–396
elastomer nanocomposite permeability, 347–348
nitrile rubber composites, 424
water-based nanocomposite modeling, 561–563
TOT (tetrahedral-octahedral-tetrahedral) clay groups, 11–17
surface area and porosity, 23–24
Toughness behavior, reinforced elastomeric materials, impact loading conditions, 313–315
Trans conformations, organophilic clays, cation exchange, 57–58
Transmission electron microscopy (TEM): apolar diene rubber nanocomposites, dispersion detection, 380–383
organophilic clay nanocomposites, 73–75
thermoplastic polyurethane nanocomposites, 489–491
Tributyl phosphate (TMt), fire resistance, 396–397
Bis-(3-Triethoxysilylpropyl)-tetrasulfide (TESPT):
apolar diene rubber nanocomposites, 391–392
rheology, 246–247
Triisopropanolamine (TA), latex compounding, rubber-clay nanocomposites, 155–157
Trimethylammonium, reversible melting transitions, 111–113
Trimethyloctadecylammonium chloride (TMO), organoclay thermal decomposition, 133–135
Trioctahedral smectites, swelling properties, 17, 19–20
Tubing (automotive), rubber applications, 529–530
UL 94 test, thermoplastic polyurethane nanocomposites, 496, 509–510 posttest microstructures, 512
Unsaturated organic ammonium chloride (UOAC), latex compounding, rubber-clay nanocomposites, 155–157
Van der Waals interactions:
alkylammonium chains, cleavage energy, 119–121
butyl rubber elastomers, 345

Vermiculites:
butyl rubber clay nanocomposites, 437
latex compounding, 448
TOT criteria, 14

Viscoelastic testing, reinforced elastomeric materials, 307–322
compression set determination, 317–319
dynamic-mechanical analysis, 307–310
fatigue behavior, 319
hardness testing, 315–316
tear behavior, 316–317
tensile testing, 310–313
toughness behavior, impact loading conditions, 313–315

Viscosity:
butadiene-rubber nanocomposite rheology, 249–250
fluoroelastomer-clay nanocomposite rheology, 254–257
Mooney viscosity, brominated isobutylene-co-para-methylstyrene-montmorillonite nanocomposite thermodynamics, 358–362
poly(ethylene-co-vinylacetate) (EVA) rubber-clay nanocomposite rheology, 258–259
rubber-clay nanocomposites, rheological behavior, 242

Viscosity percolation threshold, rheology of rubber-clay nanocomposites, 244–246

Vulcanization:
brominated isobutylene-co-para-methylstyrene-montmorillonite nanocomposite thermodynamics, 358–362
butyl rubber clay nanocomposites, 454–456
ethylene-propylene-diene monomers, 469–474
innerliner compounds, 355–356
melt compounding, rubber-clay nanocomposites:
microstructure evolution, 162–163
OMC influence on, 169–170
nitrile-rubber composites, cure characteristics, 414–416
rubber-clay nanocomposites:
basic principles, 275–276
kinetics, 290–297
organoclay activation, 137–141, 283–289
reaction mechanics, 276–278
rubber cross-linking systems, 278–283
vulcanization, 356–358

Water-based nanocomposites:
barrier properties, 557–566
dispersion and orientation, 558–561
interfacial interactions and flexibility control, 563–565
tortuous path modeling, 561–563
blooming and staining reduction, 572
breakthrough time applications, 571
chemical protective gear, 571–572
hoses, 570
pressure accumulators, 570
sports balls and pneumatic applications, 566–570
basketballs, 569
bicycle and specialty tires and tubes, 570
soccer balls, 568–569
tennis balls, 567–568
thermally processed elastomers vs., 566

Water removal, latex compounding, rubber-clay nanocomposites, 152–153

Waves of detachment, apolar diene rubber nanocomposites, 392–393

Wear mechanisms:
apolar diene rubber nanocomposites, 392–393
nitrile rubber composites, 421–422

Weight loading:
automotive rubber-clay nanocomposites, 535–538
thermoplastic polyurethane nanocomposite flammability, 507–508

Weight loss data, thermoplastic polyurethane nanocomposites, thermal properties, 504–507

Wide-angle x-ray diffraction (WAXD) peaks:
latex compounding, rubber-clay nanocomposites, 149–153
melt compounding, rubber-nanoclay composites, physical factors, 166–169
reinforced elastomeric materials, 333
thermoplastic polyurethane nanocomposites, 489–491
dispersion, 501–503
Window channels (automotive), rubber applications, 529

X-ray diffraction analysis:
apolar diene rubber nanocomposites, dispersion characterization, 383–387
ethylene-propylene-diene-monomer rubber, in situ intercalation preparation, 469–473
rubber-clay nanocomposite morphology, 182

Zero-shear viscosity, polyepichlorohydrin rubber-clay nanocomposite rheology, 259–261
Zinc dimethyl dithiocarbamate (ZDMC), vulcanization and permeability, 356–358
Zinc oxides:
melt compounding, rubber-clay nanocomposites, 165–169
rubber-clay nanocomposites, vulcanization activation, 138–141
vulcanization reaction, organo-clay kinetics, 285–289