

Index

- adhesive hard spheres 197–9, 201, *see also* sticky spheres
- aging 111, 171, 213, 229, 296
- aggregate/aggregation 180, *see also* flocculation kinetics 214
 - orthokinetic 190, 243
 - perikinetic 184, 190, 242
- anisotropy, *see* microstructure: anisotropy, shape anisotropy
- antithixotropy 230
- aspect ratio 155, 163, 173, 274, 275
- Asakura-Oosawa, *see* potential of particle interaction
- attractive driven glass 17, 197–200, 204, 212

- Bagley correction 294, 302
- Barker-Henderson 143
- barrier hopping 185
 - activated 99, 101, 204
- Batchelor 48, 50, 53, 89, 113
- Baxter sticky parameter 14, 16, 32, 184, 196, 199, 202
- bi-cone rheometer 377
- Bingham body 25, 244, 312, 369–70
- Bingham yield stress, *see* yield stress
- Bjerrum length 12
- body centered cubic lattice (BCC) 137
- boehmite 172
- Boger fluids 330–2, 334, 338
- Boussinesq number 377
- Brownian
 - dynamics 85
 - diffusion, *see* diffusion
 - hard spheres 15, 80–112
 - motion 4, 81
 - rotational 157, 162, 163, 174
 - translational 157
 - rods 160, 162, 164
- brush, *see* polymer

- cage/caging 99, 109, 110
- capillary geometry 294
- Carnahan-Starling equation 87
- Casson model 25

- chains/chaining 334, 366, 367, 372, *see also* string formation
- chemical length exponent 208
- clay(s) 171, 181, 208, 256, 257, 275
- coagulation, *see* aggregate/aggregation
- coaxial cylinder geometry, *see* Couette geometry
- colloid (definition) 1, 2
- colloidal glass, *see* glass
- colloidal crystal, *see* phase crystal
- colloidal interaction, *see* interactions
- colloidal stability, *see* stability: colloidal
- compressibility 87
- compressive yield stress, *see* yield stress: compressive
- cone and plate geometry 292
- confocal microscopy 87, 380
- coordination number 190, 200
- Cox-Merz analogy 30, 316, 362
- Couette geometry 293
- counterion(s) 8
- creep test 213, 236, 311
- critical flocculation/coagulation concentration 11
- critical gel 206, 379
- critical exponent 210
- Cross equation 25, 135, 141, 173
- crystal, *see* phase: crystal
- crystallization 55, 95, 100, 139, 188

- damping function 341
- Deborah number 30, 185, 279, 330
- Debye (screening) length 9, 10
- degree of dispersion 180, 345
- delayed sedimentation 201
- depletion 6, *see also* flocculation, force, potential of particle interaction
- dewetting 344
- dichroism 259
- die swell 339
- diffusing wave spectroscopy 358
- diffusion 4, 63–7
 - Brownian 81, 88
 - coefficient 146
 - gradient 66

Index

389

- rotary 168, 174
- shear-induced 63
- self 63
 - short time 98, 104
 - transverse 63
- tracer 63
- transport 63
- diffusion flux model 64
- diffusivity, *see* diffusion
- dilatancy 252, 254, 260, 281
- dimensional analysis 38, 80
- director 169
- disks 155, 156, 162
- dispersion (definition) 2
- dispersion quality, *see* degree of dispersion
- dispersion stability, *see* stability: colloidal
- DLCA 190
- DLVO, *see* potential of particle interaction
- Doi-Edwards theory 168, 172
- double-wall Couette 377
- double layer 8, 128, 172
- dynamic arrest 101, 110, 142, 166, 169, 197
- dynamic viscosity, *see* viscosity: dynamic
- dynamic yield stress, *see* yield stress:
 - dynamic
- edge fracture, *see* shear fracture
- effective aspect ratio 155, 161
- effective backbone 208
- effective layer thickness 138
- effective medium 51
- effective radius
 - hard sphere 14, 32, 129, 131, 134, 143, 148
 - hydrodynamic 135, 138, 203
- effective volume fraction 123
 - hard sphere 126, 131, 134, 148, 172
 - hydrodynamic 138
- effective viscometric volume fraction 203
- Einstein 4, 43, 44, 70
- Einstein-Smoluchowski equation 4
- electric double layer, *see* double layer
- electric field responsive shear thickening 276
- electrolyte 8, 9, 11, 82, 132, 375
- electrophoretic mobility 9
- electrorheological systems 365–71
- electrostatic stabilization, *see* stability:
 - electrostatic
- electrosteric stabilization, *see* stability:
 - electrostatic
- electroviscous effect 123, 173
 - first, *see* primary
 - primary 123, 127–9, 172
 - secondary 123
 - tertiary 123
- ellipsoids 376, 379, *see also* spheroids
- excluded volume 133, 168, 173
- extensional flow, *see* flow: extensional
- extensional thickening 275
- extrudate swell, *see* die swell
- face-centered cubic lattice (FCC) 16, 54, 115, 137
- fiber(s) 155–75, 342, 372
- field-responsive systems 276, 365
- floc(s) 17, 180–201, 215
- floc elasticity 192
- flocculation 180, *see also* aggregate/aggregation
 - bridging 14, 215
 - depletion 182, 203, 215
 - rate 17
 - secondary minimum 181, 191
- Flory-Huggins 147
- flow
 - around particles 41, 330
 - compressional 162
 - creeping 41, 70, 95, 281
 - elongational, *see* extensional
 - extensional 21, 157, 162, 165, 191, 341, 380
 - oscillatory 26–9
 - reversal 61
 - shear (definition) 21
- flow-induced migration, *see* migration
- fluid-liquid transition, *see* phase: transition
- fluid inertia 67–8
- fluidity 327
- force
 - attractive 13, 180, 181
 - Brownian 3, 99
 - capillary 376
 - depletion 6, 343
 - dispersion 6–7, 181
 - electrostatic 82, 128
 - gravitational 5
 - hydrodynamic
 - London-van der Waals 7
 - polarization 367
 - repulsion 12, 262
 - surface 6
 - solvation 182
 - thermodynamic 86, 89
- Fourier analysis 317
- fractal 183, 189–93, 196, 203
- fractal dimension 189
- friction 57, 60, 175
- gap size effects 276
- gel(s) 17, 158, 186, 195–7, 206–11, 236
- gel point 186, 187
- gel ringing 237, 298
- gelation 169
 - thermal 182, 206
 - time 206
- generalized Newtonian fluid (definition)
 - 24–5
- generalized Stokes-Einstein relation 358–9
- giant electrorheological effect (GER) 365, 368
- glass 15, 158, 169, 238, 281, 282
 - attractive, *see* attractive driven glass
 - repulsive 125

390 Index

- glass transition 15, 169, 185, 188, 197
 - hard sphere 109–12
 - ideal 96, 110
- grafting density, *see* polymer: graft(ing) density
- Hamaker constant 7
- hard sphere 14, 85–112, 271, 359, *see also*
 - potential of particle interaction
- Hartmann number 128, 172
- Helmholtz-Smoluchowski equation 131
- Herschel-Bulkley model 25, 171, 241, 312
- high frequency modulus, *see* modulus/moduli
- high frequency viscosity, *see* viscosity
- high shear viscosity, *see* viscosity
- hopping 196, *see also* barrier hopping
- hydrocluster 258, 277
- hydrostatic pressure, *see* pressure
- hysteresis loop 231, 234
- instrument inertia 237, 298
- integral models 244
- interactions 6, *see also* force, potential of particle
 - interaction
 - attractive 181, 202, 271, 279
 - colloidal 6–15
 - dispersion 7
 - electrostatic 9, 132
 - 2D 374
 - excluded volume 15
 - hydrodynamic 6, 46–9, 90–1, 103–5, 114–15, 139, 167, 168, 259, 337
 - polymer-mediated 343
 - repulsion/repulsive 108, 133, 270
- interfacial viscoelasticity 373
- intermediate scattering function 109
- intermittent flow 232
- intrinsic viscosity, *see* viscosity
- inverse plasticity 253
- ion mobility 128
- ionic Péclet number
- ionic strength 124, 130, 132, 147, 173
- jamming 95, 98, 195, 281, 282
- Jeffery orbits 160, 161, 163
- Krieger-Dougherty equation 58, 65, 166, 170, 172, 378
- large amplitude oscillatory flow (LAOS) 238, 273, 310, 316–17, 342, 379
- latex 257, 259
- linearity limit 209, 315
- liquid crystal 160, 169
- light scattering 109, 192, 214, 275, 358
- Lycurgus cup 2
- localization length 210
- loss angle 28, *see also* phase: angle
- lubrication force/hydrodynamics 258–63, 274, 277, 279
- magnetic rod rheometer 377
- magnetorheological fluid(s) 371–3
- Maron-Krieger-Quemada equation, *see* Quemada equation
- Maron-Pierce equation 58
- Mason number 370
 - magnetic 372
- maximum packing fraction 38, 52, 54, 84, 141, 145, 158, 169–70, 338, *see also* random close packing
- maximally random jammed state 54
- Maxwell model 28, 166, 242
 - generalized 28, 241
- Maxwell-Wagner model 367
- MCT, *see* mode coupling theory
- memory function 244
- micromechanics/micromechanical theory 90, 104, 109, 113, 168
- microrheology 357–64
 - active 357, 360
 - laser tweezer method 360
 - magnetic bead method 360
 - moduli 359
 - nonlinear 361
 - passive 357, 359
- microstructure 31, 236, *see also* phase, radial
 - distribution function
 - anisotropy 52, 61, 92–4, 108, 240, 356, 357
 - Brownian hard spheres 92, 105, 108, 113, 359
 - electrostatically stabilized 132
 - flocculated 187–201, 229
 - non-Brownian 52–4
 - shear-thickening dispersions 255, 259, 262, 265, 274
 - two-dimensional dispersions 374, 380
- microviscosity 361
- migration 63–8, 296, 300, 326
 - gradient 63
 - in viscoelastic media 333–4
 - inertia driven 67
 - models 64
- mobility 113
- mode-coupling theory (MCT) 99–101, 197–201, 210, 281, 282
- modified Cox-Merz rule 317
- modulus/moduli (definition) 26
 - dynamic 111, 142–6, 166, 206, 207–11, 340
 - elastic 109, 124
 - hard sphere 111
 - high frequency 102, 103, 136, 147, 157, 207
 - plateau 186, 371
 - storage 27, 102, 103, 186, 237
 - surface 379
 - viscous 27
 - zero frequency 136
- Mooney 71
 - equation 72
 - plot 300–5

Index

391

- nanocomposites 230, 241, 315, 343
- nanoparticles 122, 133, 135, 182, 187, 270, 329, 344, 365
- Navier's slip coefficient 318
- nearest neighbor distribution 53
- Newtonian fluid (definition) 19, 23
- normal stress coefficients 29, 60
- normal stress difference 29, 60–2, 84, 92–4, 108, 165, 167, 170, 339
 - first 29, 84, 107, 126, 165, 262, 267, 327, 336, 337
 - measurement 292, 299
 - second 29, 84, 107, 165, 267, 327, 336, 337
- order-disorder transition 258, 259
- orientation 155, 160, 335, 340
- orientation distribution 156, 161, 163, 166, 169, 172, 173
- orientation tensor 174
- osmotic pressure 3, 10, 32, 60, 114–15, 146, 262
 - hard spheres 86, 92, 115
- overshoot stress, *see* stress: overshoot
- parallel disk geometry 292
- particle(s)
 - inertia 36, 45, 68, 95, 328
 - monolayer 373
 - motion 43, 90
 - non-spherical 155–73, 274, 334, 379
 - Reynolds number, *see* Reynolds number
 - roughness 50, 53, 57, 262
 - shape 155, 162
 - size 37, 280
 - size distribution 38, 47, 59, 271
 - bimodal 58, 271, 334, 372
 - multimodal 59
- Péclet number 30, 81, 83, 105
 - dressed 81
 - ion 128
 - microrheological 362, 363
- peak stress, *see* stress: overshoot
- percolation 16, 195–200, 209
- percolation threshold 196
- phase
 - angle 28
 - behavior 15–17, 95, 158, 187–201
 - crystal 125, 136, 380
 - diagram, *see* behavior
 - separation 16, 17, 195
 - transition 53, 95, 102, 169
 - fluid-crystal 15, 16, 87, 96
 - isotropic-nematic 169
 - solid-liquid 125, 188
- Pickering-Ramsden emulsions 373
- plateau modulus, *see* modulus: plateau
- plate-like particles 169, 171, 173, 190
- Poisson-Boltzmann equation 8
- polyampholyte 147
- polydispersity 16, 38, 51, 96, 103, 161, 188, 202, 273
- polyelectrolytes 123, 147, 182
- polymer 12, 137, 271, 325–46
 - adsorbed/adsorption 137, 182, 269
 - associative 182
 - brush 12–13, 139, 271, 280, 344
 - filled 241, 343–6
 - grafted 13, 147
 - graft(ing) density 137, 344
 - layer, *see* brush
 - liquid crystal 170
 - melt 343
 - solubility 182, 201
- polymethylmethacrylate particles (PMMA) 87, 98, 103, 107, 111, 126, 139, 144, 201, 278, 364
- polystyrene particles 123, 126, 132, 191, 378
- potential of particle interaction 144, 279
 - Asakura-Oosawa 13
 - adhesive hard sphere, *see* sticky sphere
 - depletion 13, 200
 - DLVO 11, 181, 211
 - excluded volume, *see* hard sphere
 - electrostatic 8, 10, 128
 - hard sphere 14, 32, 85, 143, 263
 - sticky sphere 14, 32
 - square well 14, 32, 187, 193, 202, 205
 - surface 10, 11, 128
 - Yukawa 198
 - zeta 8, 10
- power law index 24
- pressure 23
 - hard sphere fluid 86
 - particle 60, 281
 - thermodynamic 146
- primary minimum 11
- PRISM model 201
- Quemada equation 58, 170
- Rabinowitsch-Mooney correction 294
- radial distribution function 53, 85–9, 108, 113, 133, 134, 136, 146, 207, 266
- radius of gyration 13, 189, 191
- random close packing 16, 53, 54, 95
- rapid Brownian flocculation 17
- rate equation 242–3
- rate of rotation 156, 161
- rate of strain 20
- RLCA 190
- recoil, *see* recovery
- recovery 237, 311
- re-entrant behavior 198
- regularization methods 302, 303, 305
- relative viscosity, *see* viscosity: relative
- relaxation 110
 - frequency 142, 206
 - function 341
 - modulus, *see* modulus/moduli
 - time 28, 29, 142, 166, 331
- repulsion, *see* force: repulsion

392 Index

- Reynolds 260
 - number 67
 - particle 45, 67, 95, 281, 282
- rheological constitutive equation 19
- rheo-optical techniques 256, 257, 266, 267, 380,
 - see also* dichroism
- rheopexy 230, 253
- rheo-SANS, *see* SANS
- rods 155, 156, 162, 166, 167, 169, 190, 274, *see also*
 - fibers
- rotational Péclet number 162, 163
- rotary diffusivity 162
- rotation 155, 335
 - anomalous 332
- roughness, *see* particle: roughness
- Rutgers-Delaware rule, *see* modified Cox-Merz rule
- SAOS, *see* small amplitude oscillatory flow
- SANS 108, 139, 265, 274
- scaling/scaling factors 40, 139, 146, 172, 205–10, 259
- Schulze-Hardy rule 12
- second order fluid 335
- second virial coefficient 32, 146
- secondary minimum 11
- sedimentation, *see* settling
- Segré-Silberberg effect 67, 334
- separation length 129, 172
- settling 5, 43, 296, 297, 313, 334
 - velocity 68
- shape anisotropy 158, 376
- shear bands 169, 282, 295
- shear fracture 296, 299
- shear modulus, *see* modulus/moduli
- shear rate (definition) 21
 - apparent 304
 - critical 256–7, 268
 - effective 337
 - reduced 105
- shear rejuvenation 213, 229
- shear stress, *see* stress/stress contributions
- shear thickening 24, 82, 94, 108, 252–83, 338, 357
 - continuous 271
 - critical strain 274
 - critical stress 268, 271, 274, 279–80
 - discontinuous 257, 273, 275, 276, 282, 298
 - elastohydrodynamic limit 277
 - field responsive 253
- shear thinning 24, 82, 105, 134, 141, 162, 163, 165, 342
- silica particles 9, 87, 97, 101, 102, 103, 105, 106, 108, 133, 183, 264, 267
- simple shear flow 21
- simulation
 - Brownian dynamics 263
 - lattice Boltzmann 281
 - Molecular dynamics 100, 263, 343
 - Monte Carlo
 - Stokesian dynamics 55, 96, 98, 107, 130, 172, 203, 258, 266, 282
- size effects 297
- size ratio 58
- slip 19, 44, 103, 273, 277, 278, 282
 - layer thickness 319
 - length 282, 319
 - measurement 300–5
 - velocity 300, 303, 304
- small amplitude oscillatory flow 237
- Smoluchowski, *see* von Smoluchowski
- softness 134, 142, 146, 278
- sol-gel transition 181
 - 2D 379
- solvent quality 13, 137, 201
- spheroids 155, *see also* ellipsoids
 - oblate 155, 162
 - prolate 155, 162, 371
- square well, *see* potential of particle interaction
- squeeze flow 312
- stability
 - colloidal 7, 17–18, 122
 - electrostatic 123, 127–37, 273, 280
 - electrosteric 123, 147
 - kinetic 11, 122, 181
 - ratio 18
 - steric 122, 126, 137–47
 - thermodynamic 12, 126
- stabilization, *see* stability
- stabilizing layer, *see also* polymer: brush
 - thickness 145
- start-up experiment 232
- state diagram 17, 95, 158, 187, 198, 380
- Stefan-Reynolds equation 312
- step-strain experiments 341
- stepwise changes in stress or shear rate 230, 235
- steric stabilization, *see* potential
- Stern layer 8
- sticky parameter, *see* Baxter sticky parameter
- sticky sphere(s) 16, 187, *see also* potential of particle interaction
- Stokes 3
- Stokes-Einstein-Sutherland equation 4, 203
- Stokes flow, *see* flow: creeping
- Stokes number 68
- Stokesian Dynamics, *see* simulation: Stokesian dynamics
- storage modulus, *see* modulus
- strain hardening 275, 328, 341
- stress/stress contributions 22, *see also* force
 - Brownian 91, 108, 165
 - characteristic 5
 - critical 106, 141, 337
 - deviatoric 23
 - elastic, *see* thermodynamic
 - electrostatic 124
 - extra 23
 - extra surface 376
 - hydrodynamic 36, 47, 91, 98, 108, 165

Index**393**

- normal 22
- overshoot 232
- reduced 80
- shear 22
- surface 376
- thermodynamic 98
- yield, *see* yield stress
- stress-jump measurements 165, 282, 354
- stress relaxation 26, 230, 313
- string formation 54, 108, 275, 380, *see also*
 - chains/chaining
- structural heterogeneity 210
- structural hysteresis 238
- structure factor 67, 87
- structure kinetics models 239–43
- structure parameter 236
- superposition flows 355
 - orthogonal superposition moduli 356
 - parallel superposition moduli 355
- surface
 - charge 8, 9, 136, 172, 270
 - coverage 378
 - maximum 378
 - flocculation 379
- surfactant 182
- suspension balance model 66
- suspension temperature, *see* suspension balance model
- terminal zone 28
- thermal energy 2
- thixotropy 228
 - measurement 315–16
- transient gels 201
- transition, *see* phase: transition
- Trouton ratio 23, 166, 172, 275, 329, 343
- tubular pinch 67
- two-dimensional dispersions 373–81
- uniaxial extensional flow, *see* extensional flow
- vane 309
- viscoelasticity 25, 84, 125, 134, 135, 157, 230, 325
- viscosity (definition) 19
 - apparent 23, 24, 293
 - complex 28
 - dynamic 28, 103, 157
 - elongational, *see* viscosity: extensional
 - extensional 23, 94, 166, 168, 275, 328, 336
 - high frequency 29, 56, 91, 101, 124, 130, 134, 148, 166
 - high shear 82, 83, 91, 105, 140
 - hydrodynamic 56, 101, 261
 - intrinsic 44, 70, 96, 138, 173
 - low shear, *see* viscosity: zero shear
 - normal 65
 - relative 37
 - surface dilatational 376
 - surface shear 376
 - intrinsic 378
 - complex 378
 - zero shear 83, 91, 124, 126
 - electrostatically stabilized 131, 133
 - electrosterically stabilized 148
 - flocculated 184
 - hard sphere 98, 106, 109
 - nonspherical 163, 170, 172
 - sterically stabilized 139
- viscous resuspension 63
- volume fraction (definition) 15
- von Smoluchowski 17, 98, 113, 128, 174, 184, 363
- wall slip, *see* slip
- Weissenberg number 30, 330, 331, 339
- yield strain 143, 209, 310
 - absolute 209
 - perturbative 209
- yield stress 136, 143, 184–7, 207–11, 240, 241, 368–9, 372
 - absolute 310
 - apparent 307
 - Bingham 25, 143, 211, 241, 244, 307
 - Casson 307
 - compressive 187, 208, 211
 - dynamic 106, 184, 186, 235, 305, 366, 368–9
 - Herschel-Bulkley 307
 - ideal 185, 305
 - measurements 305–15
 - static 305, 308, 368
 - surface 373, 379
- zero frequency modulus, *see also* modulus/moduli
- zeta potential, *see* potential of particle interaction: zeta
- Zwanzig-Mountain 144