Index

AAS see atomic absorption spectroscopy
acid rain 240
adhesion
   surface forces 334, 350–2
   wetting of surfaces 203–4, 208
adsorption at interfaces
   approximate methods 160
   atomistic modelling 156–7
   blob model 160–1
   bound fraction 170–1
   configurational entropy 155
   copolymers 175–8, 179
   exact enumeration 157–9
   experimental considerations 166–74
   Flory surface parameter 155–6, 164–5
   hydrodynamic layer thickness 171–4, 179
   models/simulations for terminally attached
      chains 156–66
   physical adsorption 161–6
   polymers 151–80, 183, 186
   scaling theory 160–1, 165–6
   Scheutjens and Fleer model 161–5, 171–8
   small molecules 154–5
   surfactants 62, 66–73
   volume fraction profiles 162–5, 166–7, 178
adsorption isotherms 167–70, 183, 186
advanced surfactants 64, 87
aerodynamic particle sizers (APS) 227–8
aerosols 219–43
   composition 230–4
   deliquescent 234–5
   efflorescence 234–5
   equilibrium states 234–8
   generation methods 222–4
   heterogeneous chemistry 240–2
   hygroscopic growth 237–8
   Köhler theory 235–7
   mass concentration determination 225–7
   mass and heat transfer 239–40
   number concentration determination 225–6
   occurrence and properties 219–22
   off-line analysis 230–1
   particle size classification 220–1
   particle size determination 227–30
   phase behaviour 238
   real-time analysis 231–4
   sampling methods 224–5
   trace species uptake 240–2
   transformation kinetics 238–42
AES see atomic emission spectroscopy
AFM see atomic force microscopy
agglomeration 223
aggregation 4
   charge-stabilised colloids 45, 55
   electron microscopy 315
   emulsions 127–8
   polymers 181, 192–3
   rheology 249, 270
   stability 181, 192–3
   surfactants 62, 66–7, 75–82
   wetting of surfaces 206
see also coagulation; flocculation; micelles
Alexander–de Gennes theory 355, 359
alignment of anisotropic particles 289
alternating copolymers 137
amphiphilicity 61, 62
amphoteric surfactants 63, 65–6, 80
anionic surfactants
   aggregation 77–8
   classification and properties 63, 65
   emulsions 128
   microemulsions 92–3, 96, 100, 103, 109, 112
AO see Asakura–Oosawa
APS see aerodynamic particle sizers
Asakura–Oosawa (AO) model 189–92
association colloids 61
atomic absorption spectroscopy (AAS) 230–1
atomic emission spectroscopy (AES) 230–1
atomic force microscopy (AFM) 35, 335, 337–8, 340–1
atomistic modelling 156–7
average separation 12–14
axisymmetric drop shape analysis 214–16
back-scattered electrons (BSE) 312–13, 321, 326
Bancroft’s rule 96–7, 206
batch comminution 120–4
bcc see body-centred cubic
bending rigidity 103–7
BET isotherms 154–5
bicontinuous cubic liquid crystal phases 84–5
bicontinuous microemulsions 99–100, 104
binary phase diagrams 109–12
Bingham model 255
biodegradability of surfactants 64
biomimetic polymer brushes 358
blob model 143–4, 160–1, 354
block copolymers 137
adsorption at interfaces 175–8
emulsions 125
polymer solutions 150
rheology 268
stability 187, 192
body-centred cubic (bcc) packing 13
bolaform surfactants 64
bound fraction 170–1
boundary lubrication 358–60
bridging interactions 182, 192–3
Brownian motion 2–3
optical traps 306–7
stability 15, 17, 19
brushes 177–9
scaling models 160–1
surface forces 352–5, 358, 360
BSE see back-scattered electrons
bubble pressure techniques 214–15
capacitance, differential 27, 30–1, 33
capillary forces 350–2
capillary rise 214
cascade impactors 224–5, 227
Casson model 255
catanionic surfactants 64
cationic surfactants
aggregation 77–8
classification and properties 63, 65
emulsions 128
microemulsions 92–3, 96, 100, 103
surface forces 359
c.c.c. see critical coagulation concentration
CCNC see cloud condensation nuclei counters
chain–chain interactions 143
charge overcompensation 34
charge-stabilised colloids 45–59
attractive forces 46–7
counter-ion valency 52–4
critical coagulation concentration 53, 57–8
electrolyte concentration 51–2, 58
electrostatic repulsion 47–9
emulsions 127–8
kinetics of coagulation 55–8
pair potential 46–51
particle concentration 49–50
particle size 54–5
polymers 182
stability 51–5, 182
total potential 50–1
zeta potential 48, 54
see also surface charge
Chord theorem 336, 339
CIO see counter-ion only
clathrates 76
clays 270–1
cloud condensation nuclei counters (CCNC) 226
cloud point 74–5
clusters 14
CMC see critical micelle concentration
CNC see condensation nucleus counters
coagulation
aerosols 223
charge-stabilised colloids 55–8
critical coagulation concentration 53, 57–8
kinetics 55–8
measurement 57–8
coagulum, definition 14
coalescence
emulsions 126, 128–30
wetting of surfaces 206
cohesion 203–4, 208
colloidal domain
definition 1–2
materials and phases present 2–3
thermodynamic factors 2–4
comminution 118, 120–4
compressed air nebulisers 222–3
Index

compression interactions  184–6
concentrated dispersions  289–90
concentration
  charge-stabilised colloids  49–50
  definitions  5–10
  effective  11–12
  size polydispersity  7–10
  volume fraction  5–7, 11–12
condensation nucleus counters (CNC)  226
condensation particle counters (CPC)  226, 230, 238
condensation polymerisation  136
configurational entropy  155
connectivity rule  164
contact angles  199–202, 205, 211, 213–14
continuous comminution  124
convex curvature  102
copolymers  137
  adsorption at interfaces  175–8, 179
  emulsions  125
  polymer solutions  150
  rheology  268
  stability  187, 192
core/shell particles  316–17
c-0-surfactants  92, 93
coulomb forces  330
counter-ion only (CIO) interactions  357–8
counter-ions
  charge-stabilised colloids  49–50, 52–4
  stability  182
  surface forces  344
  surfactants  77–8, 79
counter-propagating optical traps  300–2, 306–7
CPC see condensation particle counters
creams  2
  emulsions  126–7
  rheology  257–8
  stability  16
creep tests  254, 258–61
critical coagulation concentration (c.c.c.)  53, 57–8
critical micelle concentration (CMC)
  adsorption at interfaces  66–7, 69, 71
  emulsions  118, 128, 130
  micellisation  75, 77–80
  microemulsions  93
  solubility of surfactants  73–4
critical packing parameter  81–2, 83
critical supersaturation  237
critical surface tension  210
Cross model  256
cryo-transmission electron microscopy
  (TEM)  274, 317
crystalline colloids  318–19
cubic liquid crystal phases  83–6
cubic packing  12–13
cumulative size distributions  8–9
cyclosporin  113
cylindrical curvature  102
de Broglie relationship  280
Deborah number  256–7
Debye energy  330
Debye length  28–9, 48–50
deliquescence  234–5
deposition interactions  128, 182, 189–92
Derjaguin approximation  335–9
detergency process  207–8
dewetting  205
dialysis  1
differential capacitance  27, 30–1, 33
differential mobility analysers (DMA)  227–9, 237–8
differential mobility particle sizers (DMPS)  227–9
diffuse layers  26–30, 52
diffusion denuders  225
diffusion-related rapid coagulation  55–6
digital video microscopy  339
dimeric surfactants  64
dispersion density  5–6
dispersions
  charge-stabilised colloids  46
  concentrated  289–90
  electron microscopy  321–322
  reflection techniques  294
  rheology  263
  scattering techniques  284–5, 289–90
  stability  18–20
dispersive materials  210–12
dissolution of ionic solids  24–5
DLVO theory  4, 15–16, 19, 50, 345–52, 357–8
DMA see differential mobility analysers
DMPS see differential mobility particle sizers
double-chain surfactants
  aggregation  82
  applications and development  64–5
  microemulsions  102–3
  surface forces  359
doughs 250
drop shape analysis 214–16
dropping mercury electrodes 30–4
drug delivery 113
Du Nouy ring method 214
dynamic light scattering (DLS) 173, 278–9
dynamic surface tension 67
dynamical complexity 307–8

EDS see energy-dispersive spectrometry
EE see exact enumeration
effective concentration 11–12
effective volume fraction 11–12
efficiency of adsorption 71–2
efflorescence 234–5
elastic light scattering 233
elastic stretching energy 354
electroacoustics 42
electrochemical double layers 26–36
electrodynamic balances 233
electrokinetic properties 36–42
electro-osmotic pressure 38–9
entanglements 138, 140, 189, 253–4, 266–7
equilibrium brush thickness 354
environmental scanning electron microscopy (ESEM) 231, 325
equivalent thickness and electrolyte concentration 48
electrochemical impedance spectroscopy 32
excluded volume 142–3

FECO see fringes of equal chromatic order
FEG see field emission guns
ferritins 317
FID see flame ionisation detectors
FEG see field emission guns (FEG) 324–5
film bending rigidity 103–7
flame ionisation detectors (FID) 231
flat-for-curved approximation 336, 339
flocculants 192–4
flocculation
average separation 14
film bending rigidity 103–7
Florey surface parameter 155–6, 164–5, 183–5
Florey–Huggins lattice model 146–50, 154, 155, 185
flow cups 248
fluorescence spectroscopy 232–4
Index 367

fluxes 206
foams
rheology 250
stability 18
Fourier transform infrared (FTIR)
spectroscopy 171, 357
fractal surfaces 14, 293–4
fracture 250
free energy per chain 354
free radical polymerisation 136
friction 358–60
fringes of equal chromatic order (FECO) 341
FTIR see Fourier transform infrared
functionalisation 267
gas chromatography (GC) 231
gel-like particles 2
gels
colloidal particles 2
dynamical complexity 307–8
electron microscopy 323, 324
historical development 1
optical manipulation 307–8
polymers 192
stability 192
gemini surfactants 64
gyration radius 139–43

Hamaker constants
charge-stabilised colloids 46–7, 53
wetting forces 333, 343
wetting of surfaces 210–12
Hamaker pair-wise addition 343
Helmholtz–Gouy–Chapman model 344–5
Helmholtz layers 26–9
Hercel-Bulkley model 255
hexagonal liquid crystal phases 83–5
HFC see hydrofluorocarbon
high internal phase emulsions (HIPEs) 131
high performance liquid chromatography (HPLC) 231
high resolution transmission electron microscopy (HRTEM) 319, 320
HIPEs see high internal phase emulsions
historical development
colloidal systems 1–5
microemulsions 91–2
HLB see hydrophilic–lipophilic balance
holographic optical tweezers (HOT) 304–5
homogeneous nucleation 223
homogenisers 121
HOT see holographic optical tweezers
HPLC see high performance liquid chromatography
HRTEM see high resolution transmission electron microscopy
HTDMA see humidified tandem DMA
Huckel equation 42
humidified tandem DMA (HTDMA) 237–8
hydration forces 348–50
hydrodynamic drag 19
hydrodynamic layer thickness 171–4, 179
hydrodynamic radius 279
hydrodynamics
light scattering 279
polymers 171–4, 179
rheology 250
stability 19
hydrofluorocarbon (HFC) solvents 113
hydrophilic–lipophilic balance (HLB) 99–100, 124
hydrophobic effect 76
hydrophobic forces 350
hydrophobic modifications 268–9
hygroscopic growth 237–8
ICP-MS see inductively coupled plasma MS
IHP see inner Helmholtz plane
impactors 224–5
inductively coupled plasma MS (ICP-MS) 230–1
infrared (IR) spectroscopy 231, 234
inner Helmholtz plane (IHP) 26–7, 34
interaction free energy 332, 334–5, 355
interaction-limited coagulation 56–7
interfacial area 10, 67–9
interfacial layers 11–12
interfacial tension
- emulsions 118–20, 126, 129
- measurement methods 214
- microemulsions 93–5, 96, 101, 105
- surface forces 352
- ultra-low 101
- wetting of surfaces 198, 209, 214
- interferometry 341
- interparticle forces 36
- interpenetration 184–5
- inverse hexagonal liquid crystal phases 84–5
- ion adsorption 24–5
- ionic polymerisation 137
- ionic surfactants see anionic surfactants; cationic surfactants
- ionisation of surface groups 24
- isomorphous substitution 24–5

Keesom energy 330
Kelvin effect 236–7
Kelvin radius 351
Knudsen numbers 239, 241
Köhler theory 235–7
Krafft temperature 73–4
Kreiger model 256
Kuhn lengths 142

L-J see Lennard-Jones
- lamellar liquid crystal phases 83–5
- lamina flow 36–7
- Langmuir isotherms 154–5
- Laplace pressure 19, 351
- Laponite clays 270–1
- laser Doppler electrophoresis (LDE) 39–41
- laser-induced breakdown spectroscopy (LIBS) 231
- laser-induced fluorescence analysers 231
- laser microprobe mass spectrometry (LMMS) 231
- layer thickness 171–4, 179
- LCST see lower critical solution temperature
- LDE see laser Doppler electrophoresis
- Lennard-Jones (L-J) potential 330, 331–2
- LIBS see laser-induced breakdown spectroscopy
- Lifshitz approach 343
- light lever instrument for force evaluation (LLIFE) 341
- light scattering
  - advantages and disadvantages 274
  - electrophoresis 39, 41–2

interfacial area 10
- polymers 173
- principles 276–9
- radiation properties 275–6
- surface forces 357
- linearity 257–8
- liquid crystal spatial light modulators 304–5
- liquid crystalline mesophases 82–7
  - alignment of anisotropic particles 289
  - classification 82–3
  - definition 82–3
  - phase diagrams 86–7
  - structures 83–6
- liquid spreading 202–3, 207–9
- LLIFE see light lever instrument for force evaluation
- LMMS see laser microprobe mass spectrometry
- log/normal distributions 7–9
- London dispersion 46–7, 330
- lower critical solution temperature (LCST) 148–9
- lubrication 358–60
- lyotropic liquid crystals 83

macro-emulsions 117–18, 125–6, 132–3
- macromolecules
  - historical development 4
  - wetting of surfaces 197
- marginal solvents 187–9
- MASIF see measurement and analysis of surface interaction forces
- mass concentration determination 225–7
- mass spectrometry (MS) 230–1, 232
- maximum bubble pressure techniques 214–15
- maximum mean core radius 105
- MC see Monte Carlo
- MD see Monte Carlo
- mean field theory 188–9
- measurement and analysis of surface interaction forces (MASIF) 341
- measuring geometries 249, 250–1, 258
- meso-structured inorganic materials 318
- micelles
  - adsorption at interfaces 66–7, 69, 71
  - average separation 13
  - depletion interactions 192
  - formation 75–82
  - historical development 5
- microemulsions 93–4
- molecular packing 80–2, 83
<table>
<thead>
<tr>
<th>Term</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>rheology</td>
<td>269</td>
</tr>
<tr>
<td>solubility of surfactants</td>
<td>73–4</td>
</tr>
<tr>
<td>thermodynamic factors</td>
<td>75–8</td>
</tr>
<tr>
<td>microcalorimetry</td>
<td>171</td>
</tr>
<tr>
<td>microemulsions</td>
<td>91–115</td>
</tr>
<tr>
<td>applications</td>
<td>92–3, 110–14</td>
</tr>
<tr>
<td>definitions</td>
<td>91–2</td>
</tr>
<tr>
<td>drug delivery</td>
<td>113</td>
</tr>
<tr>
<td>film bending rigidity</td>
<td>103–7</td>
</tr>
<tr>
<td>formation</td>
<td>93–5, 118–19</td>
</tr>
<tr>
<td>green and novel solvents</td>
<td>110–13</td>
</tr>
<tr>
<td>historical development</td>
<td>91–2</td>
</tr>
<tr>
<td>hydrophilic–lipophilic balance</td>
<td>99–100</td>
</tr>
<tr>
<td>interfacial tension</td>
<td>93–5, 96, 101, 105</td>
</tr>
<tr>
<td>kinetic instability</td>
<td>95</td>
</tr>
<tr>
<td>packing parameters</td>
<td>99</td>
</tr>
<tr>
<td>phase behaviour</td>
<td>107–12</td>
</tr>
<tr>
<td>phase inversion temperature</td>
<td>100–1, 132</td>
</tr>
<tr>
<td>physicochemical properties</td>
<td>95–110</td>
</tr>
<tr>
<td>predicting type</td>
<td>95–101</td>
</tr>
<tr>
<td>R ratio</td>
<td>97–9</td>
</tr>
<tr>
<td>reaction media for nanoparticles</td>
<td>113–14</td>
</tr>
<tr>
<td>spontaneous curvature</td>
<td>101–3</td>
</tr>
<tr>
<td>stability</td>
<td>93–5</td>
</tr>
<tr>
<td>surfactant film properties</td>
<td>101–7</td>
</tr>
<tr>
<td>ultra-low interfacial tension</td>
<td>101</td>
</tr>
<tr>
<td>Winsor classification</td>
<td>95–6, 98–9, 101, 105–6, 108–9</td>
</tr>
<tr>
<td>microfluidics</td>
<td>124</td>
</tr>
<tr>
<td>microscopy</td>
<td>4</td>
</tr>
<tr>
<td>mini-emulsions</td>
<td>117–19</td>
</tr>
<tr>
<td>mixed micellisation</td>
<td>94</td>
</tr>
<tr>
<td>molecular dynamics (MD)</td>
<td>160</td>
</tr>
<tr>
<td>molecular weight measurement</td>
<td>144–6</td>
</tr>
<tr>
<td>Monte Carlo (MC) methods</td>
<td>160</td>
</tr>
<tr>
<td>MS see mass spectrometry</td>
<td></td>
</tr>
<tr>
<td>nano-cavities</td>
<td>333</td>
</tr>
<tr>
<td>nanofabrication</td>
<td>304–5</td>
</tr>
<tr>
<td>nano-medicine</td>
<td>113</td>
</tr>
<tr>
<td>nanometer displacements</td>
<td>305–6</td>
</tr>
<tr>
<td>nanoparticles</td>
<td></td>
</tr>
<tr>
<td>emulsions</td>
<td>121–3</td>
</tr>
<tr>
<td>microemulsions</td>
<td>113–14</td>
</tr>
<tr>
<td>polymer natural interactions</td>
<td>151–2</td>
</tr>
<tr>
<td>natural atmospheric aerosols</td>
<td>219</td>
</tr>
<tr>
<td>natural polymers</td>
<td>135</td>
</tr>
<tr>
<td>nebulisers</td>
<td>222–3</td>
</tr>
<tr>
<td>neutron reflection</td>
<td>71, 294–7</td>
</tr>
<tr>
<td>neutron scattering see small angle neutron scattering</td>
<td></td>
</tr>
<tr>
<td>NMR see nuclear magnetic resonance</td>
<td></td>
</tr>
<tr>
<td>non-ionic surfactants</td>
<td></td>
</tr>
<tr>
<td>aggregation</td>
<td>78, 80</td>
</tr>
<tr>
<td>classification and properties</td>
<td>63, 65–6</td>
</tr>
<tr>
<td>emulsions</td>
<td>127–8, 132</td>
</tr>
<tr>
<td>microemulsions</td>
<td>92–3, 96, 100–1, 103, 109–11</td>
</tr>
<tr>
<td>non-VOC solvents</td>
<td>110–13</td>
</tr>
<tr>
<td>non-wetting</td>
<td>200–1, 204, 205</td>
</tr>
<tr>
<td>nuclear magnetic resonance (NMR)</td>
<td>171</td>
</tr>
<tr>
<td>nucleation and growth</td>
<td>118, 124–6</td>
</tr>
<tr>
<td>nucleation mode particles</td>
<td>220</td>
</tr>
<tr>
<td>number concentration determination</td>
<td>225–6</td>
</tr>
<tr>
<td>OHP see outer Helmholtz plane</td>
<td></td>
</tr>
<tr>
<td>oil stains</td>
<td>197, 207</td>
</tr>
<tr>
<td>oil-wetting</td>
<td>122</td>
</tr>
<tr>
<td>OPC see optical particle counters</td>
<td></td>
</tr>
<tr>
<td>optical manipulation</td>
<td>299–309</td>
</tr>
<tr>
<td>Brownian fluctuations</td>
<td>306–7</td>
</tr>
<tr>
<td>counter-propagating optical traps</td>
<td>300–2, 306–7</td>
</tr>
<tr>
<td>dynamical complexity</td>
<td>307–8</td>
</tr>
<tr>
<td>force generation</td>
<td>302–4</td>
</tr>
<tr>
<td>gels</td>
<td>307–8</td>
</tr>
<tr>
<td>measuring nanometer displacements</td>
<td>305–6</td>
</tr>
<tr>
<td>nanofabrication</td>
<td>304–5</td>
</tr>
<tr>
<td>optical tweezers</td>
<td>233–4, 302–5, 307, 339</td>
</tr>
<tr>
<td>principles</td>
<td>299–302</td>
</tr>
<tr>
<td>single particle dynamics</td>
<td>305–8</td>
</tr>
<tr>
<td>soft matter science</td>
<td>299–309</td>
</tr>
<tr>
<td>optical particle counters (OPC)</td>
<td>226, 229–30</td>
</tr>
<tr>
<td>optical traps</td>
<td>300–2, 306–7</td>
</tr>
<tr>
<td>optical tweezers</td>
<td>233–4, 302–5, 307, 339</td>
</tr>
<tr>
<td>organophilic clays</td>
<td>270–1</td>
</tr>
<tr>
<td>oscillation</td>
<td>257–8</td>
</tr>
<tr>
<td>oscillatory structural forces</td>
<td>346–8</td>
</tr>
<tr>
<td>osmotic pressure</td>
<td>353</td>
</tr>
<tr>
<td>Ostwald-De Waele model</td>
<td>256</td>
</tr>
<tr>
<td>Ostwald ripening</td>
<td>18, 126, 130–1</td>
</tr>
<tr>
<td>outer Helmholtz plane (OHP)</td>
<td>26–9, 34, 36</td>
</tr>
<tr>
<td>Owens–Wendt model</td>
<td>212–13</td>
</tr>
<tr>
<td>PAHs see polycyclic aromatic hydrocarbons</td>
<td></td>
</tr>
<tr>
<td>pair potential</td>
<td>46–51</td>
</tr>
<tr>
<td>PALS see phase analysis light scattering</td>
<td></td>
</tr>
<tr>
<td>parabolic surface approximation</td>
<td>336, 339</td>
</tr>
<tr>
<td>partial wetting</td>
<td>200–1</td>
</tr>
<tr>
<td>neutron scattering see small angle neutron scattering</td>
<td></td>
</tr>
</tbody>
</table>
particle dynamics 305–8
particle interaction potential 182–3
particle shape determination 286–7
particle size distribution see reflection techniques; scattering techniques; size polydispersity
particle sizers 227–30
pastes 262–3
PCS see photon correlation spectroscopy
Peclet number 17, 269
perfect non-wetting 200–1, 204
perfect wetting 200–1, 203
phase analysis light scattering (PALS) 39, 41–2
phase behaviour
aerosols 238
eмуsions 124–6, 131–3
microemulsions 100–1, 107–12, 132
polymers 181, 192
rheology 262–3
surfactants 86–7, 107–12
phase inversion temperature (PIT) 100–1, 131–3
phase rule 107
photoacoustic soot sensors 231
photon correlation spectroscopy (PCS) 278
photosurfactants 87
Pickering emulsions 11, 122, 129, 206
PIT see phase inversion temperature
PIXE see proton-induced X-ray emission
plastic materials 254–5, 261–2
Poisson–Boltzmann equation 344–5
polar materials 210–12
polar plots 277
polarisation forces 330
polycrystalline colloids 20
polycyclic aromatic hydrocarbons (PAHs) 231
polydispersity see size polydispersity
polyelectrolytes 144, 192–3
polymer latex particles 315, 324, 326
polymer melts 150
polymer solutions 146–50
polymeric surfactants 64, 80
polymers 135–50
polymerisation techniques 135–7
adsorption at interfaces 151–80, 183, 186
adsorption isotherms 167–70, 183, 186
applications 138, 141
approximate methods 160

Asakura–Oosawa model 189–92
atomicistic modelling 156–7
average separation 13
blob model 143–4, 160–1
bound fraction 170–1
bridging interactions 182, 192–3
brushes 160–1, 177–9, 352–5, 358, 360
chain–chain interactions 143
charge-stabilised colloids 182
condensation polymerisation 136
configurational entropy 155
depletion interactions 182, 189–92
effective concentration 11
emulsions 120, 125, 127
entanglements 138, 140, 189, 253–4, 266–7
exact enumeration 157–9
excluded volume 142–3
experimental considerations 166–74
Flory surface parameter 155–6, 164–5, 183–5
Flory–Huggins lattice model 146–50, 154, 155, 185
free radical polymerisation 136
historical development 4
hydrodynamic layer thickness 171–4, 179
hydrophobic modifications 268–9
ionic polymerisation 137
Langmuir/BET isotherms 154–5
marginal solvents 187–9
models/simulations for terminally attached chains 156–66
molecular weight measurement 144–6
networks 267, 269
particle interaction potential 182–3
physical adsorption 161–6
physical properties 138–40, 146
polyelectrolytes 144
polymer melts 150
polymer solutions 146–50
polymerisation techniques 135–7
radius of gyration 139–43
random walk model 138–9, 141
rheology 253–4, 263–9
scaling theory 143–4, 160–1, 165–6, 185
Scheutjens and Fleer model 161–5, 171–8, 184
shape and size in solution 152–4
size polydispersity 9–10, 145–6, 155
stability 14–15, 18, 152–3, 181–95
steric stability 152–3, 182, 183–9
structural models 138–44
surface forces 183, 329, 334, 342, 352–5, 358, 360–1
viscosity 146, 173
volume fraction profiles 162–5, 166–7, 178
worm-like chains 141–2
see also copolymers
Porod’s law 292–4
potential of zero charge (pzc) 29–30, 32–4
potential-determining ions 25
pour point 248
precipitation, definition 14
primary aerosols 219
protein limit 192
proton-induced X-ray emission (PIXE) 230
pseudo-binary phase diagrams 109, 111
pseudoplastic materials 254–6
pseudo-solutions 1
pzc see potential of zero charge
quadrant photosensors 305–6
quantum mechanical forces 330
quiescent systems 15–16
R ratio 97–9
radius of gyration 139–43, 277, 286
Raman spectroscopy 231, 234
random close-packed (rcp) structures 13
random copolymers 137
adsorption at interfaces 175–6, 179
polymer solutions 150
stability 187
random walk model 138–9, 141
range approximation 336–7
rcp see random close-packed
reaction media for nanoparticles 113–14
reflection techniques 294–7
relative deformation 246
relative humidity (RH) 234–8
Reynolds numbers 19, 36, 251
RH see relative humidity
rheology 245–72
copolymers 268
creep tests 254, 258–61
Deborah number 256–7
definitions 246–7
experiment design 248–50
functionalisation 267
geometries 249, 250–1, 258
linearity 257–8
liquid and solid behaviour 259–61
measurement methods 245–56
networks 267, 269
oscillation 257–8
particle additives 268–71
plastic materials 254–5, 261–2
polymers 253–4, 263–7
pseudoplastic materials 254–6
sedimentation 261–3
shape anisotropy 270–1
shear compliance 258–61
shear history 254
shear modulus 246, 257–8
shear thinning/thickening 254–6, 265, 268–70
shear viscosity 247, 250–4, 261–2, 264–7
soft materials 263–71
storage stability 261–3
syneresis 262–3
thixotropy 254
viscoelasticity 256–63
viscometry 252–4
wall slip and fracture 250
roll-up mechanism 207–8
room temperature ionic liquids (RTILs) 110–12
saddle-shaped curvature 102
sulf concentration see electrolyte concentration
SANS see small angle neutron scattering
Sauter mean value 8
SAXS see small angle X-ray scattering
scaling theory 143–4, 160–1, 165–6, 185
scanning electron microscopy (SEM) advantages and disadvantages 273–4
aerosols 231
conventional systems 321–6
electrochemical double layer 34–5
general features of optical imaging systems 311–13, 321–2
polymer latex particles 324, 326
practical aspects 321–6
types of signal 321
scanning mobility particle sizers (SMPS) 229
scattering length densities 283–4, 294, 295–6
scattering techniques
absorption by atoms 282–3
advantages and disadvantages 273–4
alignment of anisotropic particles 289
apparatus 280–2

Index 371
scattering techniques (Continued)
  contrast variations 290–2
  dispersions 284–5, 289–90
  form factors 285, 286–7
  Guinier plots 286
  particle shape determination 286–7
  particle size determination 285–6
  Porod’s law 292–4
  principles 274–5, 276–9, 282–4, 286
  radiation sources 279–80
  radiation types and properties 275–6
  radius of gyration 277, 286
  scattering length densities 283–4
  size polydispersity 287–9
  see also individual techniques
Scheutjens and Fleer (SF) model 161–5, 171–8, 184–5
Schulman’s droplets 119
Schultz polydispersity 105–7
SDT see spinning drop tensiometry
secondary aerosols 219
sedimentation 4
  aerosols 221
  emulsions 126–7
  optical manipulation 300
  particle size determination 274
  rheology 261–3
  stability 16, 181–2
self-association 77, 80
self-avoiding walk model 157–8
SEM see scanning electron microscopy
separation, average 12–14
SF see Scheutjens and Fleer
SFA see surface force apparatus
shape anisotropy 270–1
shear compliance 258–61
shear history 254
shear modulus 246, 257–8
shear planes 36–7
shear thinning/thickening 254–6, 265, 268–70
shear viscosity 247, 250–4, 261–2, 264–7
shearing flows 17
Shultz–Hardy rule 53
SI-ATRP see surface-initiated atom transfer radical polymerisation
simple cubic packing 12–13
single particle dynamics 305–8
size polydispersity 7–10
  aerosols 221–3
  charge-stabilised colloids 54–5
electron microscopy 322
  microemulsions 105–7
  polymers 9–10, 145–6, 155
  rheology 263
  scattering techniques 287–9
SLS see surface light scattering
small angle neutron scattering (SANS)
  absorption by atoms 282–3
  advantages and disadvantages 274
  alignment of anisotropic particles 289
  apparatus 280–2
  contrast variations 290–2
  dispersions 284–5, 289–90
  Guinier plots 286
  microemulsions 93, 105–7, 113
  particle shape determination 286–7
  particle size determination 285–6
  polymers 166–7, 171, 173, 179
  Porod’s law 292–4
  principles 279, 282–4, 286
  radiation properties 275–6
  radiation sources 279–80
  size polydispersity 287–9
small angle X-ray scattering (SAXS)
  absorption by atoms 282–3
  advantages and disadvantages 274
  alignment of anisotropic particles 289
  apparatus 280–2
  contrast variations 290–2
  dispersions 284–5, 289–90
  Guinier plots 286
  microemulsions 104
  particle shape determination 286–7
  particle size determination 285–6
  Porod’s law 292–4
  principles 279, 282–4, 286
  radiation properties 275–6
  radiation sources 279–80
  size polydispersity 287–9
Smoluchowski equation 42
SMPS see scanning mobility particle sizers
soaps 64–5
soft materials 263–71
soft matter science 299–309
solid/liquid dispersions 120
sols, definition 1
solubility 73–5, 213–14
spatial light modulators 304–5
specific adsorption 34–5
specific surface area (SSA) 10
<table>
<thead>
<tr>
<th>Term</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>spinning drop tensiometry (SDT)</td>
<td>94, 101, 105</td>
</tr>
<tr>
<td>microemulsions</td>
<td>94, 101, 105</td>
</tr>
<tr>
<td>wetting of surfaces</td>
<td>214</td>
</tr>
<tr>
<td>spontaneous curvature</td>
<td>101–3</td>
</tr>
<tr>
<td>spreading coefficients</td>
<td>202–3, 207–9</td>
</tr>
<tr>
<td>SSA</td>
<td>see specific surface area</td>
</tr>
<tr>
<td>stabilisers</td>
<td>15, 186–7</td>
</tr>
<tr>
<td>stability</td>
<td></td>
</tr>
<tr>
<td>aggregation</td>
<td>181, 192–3</td>
</tr>
<tr>
<td>Asakura–Oosawa model</td>
<td>189–92</td>
</tr>
<tr>
<td>bridging interactions</td>
<td>182, 192–3</td>
</tr>
<tr>
<td>charge-stabilised colloids</td>
<td>45–59, 182</td>
</tr>
<tr>
<td>copolymers</td>
<td>187, 192</td>
</tr>
<tr>
<td>creaming</td>
<td>16</td>
</tr>
<tr>
<td>definitions</td>
<td>14–18</td>
</tr>
<tr>
<td>depletion interactions</td>
<td>182, 189–92</td>
</tr>
<tr>
<td>dispersion</td>
<td>18–20</td>
</tr>
<tr>
<td>emulsions</td>
<td>126–33</td>
</tr>
<tr>
<td>marginal solvents</td>
<td>187–9</td>
</tr>
<tr>
<td>microemulsions</td>
<td>93–5</td>
</tr>
<tr>
<td>Ostwald ripening</td>
<td>18</td>
</tr>
<tr>
<td>particle interaction potential</td>
<td>182–3</td>
</tr>
<tr>
<td>polymers</td>
<td>14–15, 18, 152–3, 181–95</td>
</tr>
<tr>
<td>quiescent systems</td>
<td>15–16</td>
</tr>
<tr>
<td>rheology</td>
<td>261–3</td>
</tr>
<tr>
<td>sedimentation</td>
<td>16, 181–2</td>
</tr>
<tr>
<td>shearing flows</td>
<td>17</td>
</tr>
<tr>
<td>steric</td>
<td>152–3, 182, 183–9</td>
</tr>
<tr>
<td>surface forces</td>
<td>183, 352</td>
</tr>
<tr>
<td>suspensions</td>
<td>194</td>
</tr>
<tr>
<td>steric stability</td>
<td>152–3, 182, 183–9</td>
</tr>
<tr>
<td>sterically-stabilised emulsions</td>
<td>128</td>
</tr>
<tr>
<td>Stern layers</td>
<td>48, 52</td>
</tr>
<tr>
<td>Stern–Gouy–Chapman (SGC) theory</td>
<td>23, 26–30</td>
</tr>
<tr>
<td>Stöber method</td>
<td>126</td>
</tr>
<tr>
<td>Stokes diameter</td>
<td>227</td>
</tr>
<tr>
<td>Stokes drag</td>
<td>19</td>
</tr>
<tr>
<td>Stokes–Einstein equation</td>
<td>279</td>
</tr>
<tr>
<td>storage stability</td>
<td>261–3</td>
</tr>
<tr>
<td>streaming potential/current</td>
<td>36, 37–8</td>
</tr>
<tr>
<td>stress overshoot</td>
<td>253–4</td>
</tr>
<tr>
<td>supercooled aerosols</td>
<td>238</td>
</tr>
<tr>
<td>supercritical carbon dioxide</td>
<td>110–13</td>
</tr>
<tr>
<td>supercritical fluid microemulsions</td>
<td>113–14</td>
</tr>
<tr>
<td>supersaturation</td>
<td>237, 238</td>
</tr>
<tr>
<td>surface activity</td>
<td>66–7</td>
</tr>
<tr>
<td>surface charge</td>
<td>23–43</td>
</tr>
<tr>
<td>dissolution of ionic solids</td>
<td>24–5</td>
</tr>
<tr>
<td>electro-osmotic pressure</td>
<td>38–9</td>
</tr>
<tr>
<td>electroacoustics</td>
<td>42</td>
</tr>
<tr>
<td>electrochemical double layer</td>
<td>23, 26–36</td>
</tr>
<tr>
<td>electrokinetic properties</td>
<td>36–42</td>
</tr>
<tr>
<td>electrolyte flow</td>
<td>36–7</td>
</tr>
<tr>
<td>electrophoresis</td>
<td>39–42</td>
</tr>
<tr>
<td>Hg/electrolyte interface</td>
<td>30–4</td>
</tr>
<tr>
<td>interparticle forces</td>
<td>36</td>
</tr>
<tr>
<td>ion adsorption</td>
<td>24–5</td>
</tr>
<tr>
<td>ionisation of surface groups</td>
<td>24</td>
</tr>
<tr>
<td>isomorphous substitution</td>
<td>24–5</td>
</tr>
<tr>
<td>origins</td>
<td>24–5</td>
</tr>
<tr>
<td>potential-determining ions</td>
<td>25</td>
</tr>
<tr>
<td>specific adsorption</td>
<td>34–5</td>
</tr>
<tr>
<td>Stern–Gouy–Chapman theory</td>
<td>23, 26–30</td>
</tr>
<tr>
<td>streaming potential/current</td>
<td>36, 37–8</td>
</tr>
<tr>
<td>surface energy</td>
<td>198, 199–201, 203–4, 210</td>
</tr>
<tr>
<td>surface excess</td>
<td>67–71, 94</td>
</tr>
<tr>
<td>surface force apparatus (SFA)</td>
<td>183, 335, 337–8, 341–2, 348–50, 355–6</td>
</tr>
<tr>
<td>surface forces</td>
<td>329–62</td>
</tr>
<tr>
<td>adhesion energy</td>
<td>334, 350–2</td>
</tr>
<tr>
<td>boundary lubrication under water</td>
<td>358–60</td>
</tr>
<tr>
<td>capillary forces</td>
<td>350–2</td>
</tr>
<tr>
<td>Derjaguin approximation</td>
<td>335–9</td>
</tr>
<tr>
<td>DLVO theory</td>
<td>345–52, 357–8</td>
</tr>
<tr>
<td>electrochemical double layer type</td>
<td>344–5, 357–8</td>
</tr>
<tr>
<td>future challenges</td>
<td>360–1</td>
</tr>
<tr>
<td>hydration forces</td>
<td>348–50</td>
</tr>
<tr>
<td>hydrophobic forces</td>
<td>350</td>
</tr>
<tr>
<td>interaction free energy</td>
<td>332, 334–5</td>
</tr>
<tr>
<td>intermolecular forces</td>
<td>329–33</td>
</tr>
<tr>
<td>measurement</td>
<td>333–4, 339–42, 356–60</td>
</tr>
<tr>
<td>oscillatory structural forces</td>
<td>346–8</td>
</tr>
<tr>
<td>polymer-mediated</td>
<td>329, 334, 342, 352–5, 358, 360–1</td>
</tr>
<tr>
<td>pressure, force and energy</td>
<td>334–5</td>
</tr>
<tr>
<td>size and shape</td>
<td>334–9</td>
</tr>
<tr>
<td>surface-grown biomimetic polymer brushes</td>
<td>358</td>
</tr>
<tr>
<td>surfactants</td>
<td>355–60</td>
</tr>
<tr>
<td>types</td>
<td>342–56</td>
</tr>
<tr>
<td>van der Waals type</td>
<td>343</td>
</tr>
<tr>
<td>surface free energy</td>
<td>17–18</td>
</tr>
<tr>
<td>surface-grown biomimetic polymer brushes</td>
<td>358</td>
</tr>
<tr>
<td>surface-initiated atom transfer radical polymerisation (SI-ATRP)</td>
<td>358</td>
</tr>
<tr>
<td>surface light scattering (SLS)</td>
<td>105</td>
</tr>
<tr>
<td>surface roughness</td>
<td>18–19</td>
</tr>
</tbody>
</table>
surface tension
adsorption at surfaces 66–7
electrochemical double layer 33
wetting of surfaces 198–200, 202–3, 207–15
surface wetting see wetting of surfaces
surfactants 61–89
adsorption at interfaces 62, 66–73
advanced surfactants 64, 87
aggregation 62, 66–7
 amphiphilicity 61, 62
applications 61, 64–6
average separation 13
biodegradability 64
characteristic features 61–2
classification 62–4
cloud point 74–5
counter-ions 77–8, 79
deployment interactions 192
effectiveness of adsorption 72–3
efficiency of adsorption 71–2
electrolyte concentration 69–70, 79–80
emulsions 121–4, 127–30, 132
factors affecting the CMC 78–80
film bending rigidity 103–7
film properties 101–7
historical development 4–5
hydrophilic group effects 79
hydrophobic group effects 79
Krafft temperature 73–4
liquid crystalline mesophases 82–7
micellisation 75–82
molecular packing 80–2, 83
phase behaviour 107–12
phase diagrams 86–7
reflection techniques 295–7
rheology 263
solubility 73–5
spontaneous curvature 101–3
stability 15, 20
surface excess 67–71
surface forces 355–60
surface tension/activity 66–7
temperature effects 80
thermodynamic factors 67–71, 75–8
ultra-low interfacial tension 101
wetting of surfaces 197, 207
see also microemulsions
suspsensions 194
syneresis 262–3

Taylor instability 121
TEM see transmission electron microscopy
temperature-jump procedure 125
tensiometry 71
ternary phase diagrams 107–9
thermotropic liquid crystals 82–3
thixotropy 254
three of emulsions 119–20
time-of-flight MS (TOF-MS) 232
TIRM see total internal reflection microscopy
TOF-MS see time-of-flight MS
total internal reflection microscopy
(TIRM) 340
total potential 50–1
transmission electron microscopy (TEM) 231
advantages and disadvantages 273–4
conventional systems 313–19
core/shell particles 316–17
general features of optical imaging
systems 311–14
internal structure 317–21
polymer latex particles 315
practical aspects 314–15
resolution and contrast 313–14
sample preparation 314–15
Traube’s rule 72

UCST see upper critical solution temperature
ultracentrifuges 274
ultra-low interfacial tension 101
ultramicroscopy 4
ultrasonic nebulisers 222
unit area approximation 337
upper critical solution temperature
(UCST) 148–9

van der Waals forces
charge-stabilised colloids 46, 58
emulsions 128–9
optical manipulation 300
stability 181
surface charge 23
surface forces 329, 331–3, 343, 350
vibrating orifice aerosol generators
(VOAG) 222–3
viscoelasticity 256–63
viscometry 252–4
viscosity 3–4, 146, 173
viscous flow 248
VOAG see vibrating orifice aerosol generators
volatile organic compounds (VOCs) 110
volume fraction
  definition 5–7
  effective 11–12
profiles 162–5, 166–7, 178
rheology 265–6

wall slip 250
water-wetting 122
weighting factors 162–4
wettability envelopes 212–14
wetting of surfaces 197–217
  adhesion 203–4, 208
  characterisation of solid surfaces 210
  cohesion 203–4, 208
  contact angles 199–202, 205, 211, 213–14
  definitions 198
  degrees of wetting 200–1
  detergency process 207–8
  dispersive materials 210–12
  interfacial tension 198, 209, 214
  liquid on liquid spreading 207–9
  liquid spreading 202–3, 207–9
  measurement methods 214–16
  polar materials 210–12
  principles 197–8
  rheology 250
  spreading coefficients 202–3, 207–9
  surface energy 198, 199–201, 203–4, 210
  surface tension 198–200, 202–3, 207–15
  two immiscible liquids on a surface 204–6
  wettability envelopes 212–14
  Zisman plots 210
Winsor classification 95–6, 98–9, 101, 105–6, 108–9
worm-like chains 141–2
WOW double emulsions 119

X-ray fluorescence (XRF) spectroscopy 230
X-ray photoelectron spectroscopy (XPS) 230
X-ray reflection 104, 294–7
X-ray scattering see small angle X-ray scattering
XPS see X-ray photoelectron spectroscopy
XRF see X-ray fluorescence

Young’s equation 200, 202, 204, 207
zeolites 316, 318
zeta potentials 23–4
  charge-stabilised colloids 48, 54
  effective concentrations 12
  electrokinetic properties 36, 41–2
  Zisman plots 210
zwitterionic surfactants 63, 65–6, 80