## Index

### a
- acylation 44, 45
- affinity chromatography 78
- affinity materials 78
- aliphatic/aromatic, separation 42
- alkali flame ionization detector (AFID) 30
- alkylation 44, 46
- alumina 65, 107, 170
- amperometric detection 98, 99
- antigen–antibody interaction 79
- APPI, see atmospheric pressure photoionization (APPI)
- atmospheric pressure chemical ionization (APCI) 85, 86, 88, 89
- atmospheric pressure photoionization (APPI) 85, 86, 89
- atomic emission detector (AED) 36
- autoinjectors 20, 47, 50, 51

### b
- band broadening 5, 6, 14, 22, 51, 53, 59, 61, 63, 106, 114, 129, 130, 137, 145
  - in column 8
  - diffusion coefficient 9
  - diffusion velocity of macromolecules 58
  - eddy diffusion 6
  - effective plate number 11
  - Gaussian distribution 5
  - Golay equation 8
  - large molecules 133
  - longitudinal diffusion 6, 7
  - outside column 9
  - particle size and layer thickness 106
  - physical processes 5
  - plate height 10, 11
  - resistance to mass transfer 7, 8
  - size of flow cell 82
  - benzoylbenzoic acid 113
  - bioluminescence 113

### c
- calcium sulfate 106
- calibration methods 192. See also quantitation
  - external standard 192, 193
  - internal standard 193–195
  - normalizing peak areas 192
  - standard addition 194, 195
- capillary columns 2, 11, 37, 54, 60, 62, 121, 122, 124, 146
  - open 11, 37
  - packed 37
  - split/splitless injector for 21
- capillary electrophoresis (CE) 127, 135, 136, 185
  - capillaries 136, 137
  - CE zone electrophoresis 140, 141
  - detection 139, 140
  - high-voltage supply 136
  - instrumentation 136
  - sample introduction 137–139
- capillary forces 2, 108–111
- carboxymethyl cellulose 106
- carrier gases 3, 17, 19, 20, 21, 27, 28, 31, 32, 39
  - van Deemter plot 19
- CE applications 134
  - protein separations 134, 135
  - separation of DNA/RNA 135
- cellulose 78, 107
- chemical ionization (CI) 33
- chemiluminescent detector 35
- chemiluminescent nitrogen detector 103
- chip device
  - chromatography on 150
  - columns and stationary phases 151
  - COMOSS 152, 153
  - detection 153, 154
  - sample introduction in 150
- chirality detection 103
- chiral separations in GC 38
<table>
<thead>
<tr>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>chiral separations in HPLC 77, 78</td>
</tr>
<tr>
<td>chromatofocusing 74, 75</td>
</tr>
<tr>
<td>chromatogram 3, 4</td>
</tr>
<tr>
<td>– milk proteins 75</td>
</tr>
<tr>
<td>– partially resolved peaks 12</td>
</tr>
<tr>
<td>– polymeric amines 4</td>
</tr>
<tr>
<td>– for quantification 114</td>
</tr>
<tr>
<td>– yeast proteins 56</td>
</tr>
<tr>
<td>chromatographic peak</td>
</tr>
<tr>
<td>– asymmetry measurement 12</td>
</tr>
<tr>
<td>– widths between tangents at baseline 10</td>
</tr>
<tr>
<td>chromatographic techniques, overview 2</td>
</tr>
<tr>
<td>chromophores 82</td>
</tr>
<tr>
<td>coeluting 13</td>
</tr>
<tr>
<td>column efficiency, measurement 9</td>
</tr>
<tr>
<td>– asymmetry 11</td>
</tr>
<tr>
<td>– coupling columns 10</td>
</tr>
<tr>
<td>– plate height 10, 11</td>
</tr>
<tr>
<td>columns 54–64, 122</td>
</tr>
<tr>
<td>– capillary 41, 42, 54, 62, 122, 146</td>
</tr>
<tr>
<td>– chiral 103</td>
</tr>
<tr>
<td>flash chromatography 63, 64</td>
</tr>
<tr>
<td>GC 180</td>
</tr>
<tr>
<td>microchip 60, 61</td>
</tr>
<tr>
<td>– monolithic 59, 60</td>
</tr>
<tr>
<td>– nanoflow 54</td>
</tr>
<tr>
<td>– narrow-bore 88</td>
</tr>
<tr>
<td>– open channel 152</td>
</tr>
<tr>
<td>– open tubular 1, 6, 7, 8, 11, 25, 37, 61, 121, 122, 146</td>
</tr>
<tr>
<td>– packed 6, 7, 14, 18, 25, 36, 37, 40, 54–59, 122–124, 146, 152</td>
</tr>
<tr>
<td>– temperature control 61–63</td>
</tr>
<tr>
<td>densitometers 113</td>
</tr>
<tr>
<td>detectors 26–28, 35, 49, 55, 59, 80, 81, 124, 125</td>
</tr>
<tr>
<td>– atomic emission 36</td>
</tr>
<tr>
<td>– chemiluminescent 35</td>
</tr>
<tr>
<td>– chemiluminescent nitrogen 103</td>
</tr>
<tr>
<td>– chiral 103</td>
</tr>
<tr>
<td>– conductivity 80, 102</td>
</tr>
<tr>
<td>– corona discharge 80, 102</td>
</tr>
<tr>
<td>– coulometric 98–100, 99, 100</td>
</tr>
<tr>
<td>– diode array 83, 84</td>
</tr>
<tr>
<td>– electrochemical 80, 98</td>
</tr>
<tr>
<td>– electrolytic conductivity 35</td>
</tr>
<tr>
<td>– electron capture 18, 29, 31, 32, 45, 46</td>
</tr>
<tr>
<td>– evaporative light scattering 100</td>
</tr>
<tr>
<td>– filter photometric 83</td>
</tr>
<tr>
<td>– flame ionization 28–30, 118, 121, 122, 124, 190</td>
</tr>
<tr>
<td>– flame photometric 35</td>
</tr>
<tr>
<td>– fluorescence 80, 95, 140</td>
</tr>
<tr>
<td>– Fourier transform infrared 36</td>
</tr>
<tr>
<td>– GC 27, 35, 121, 125</td>
</tr>
<tr>
<td>– light scattering 100, 101</td>
</tr>
<tr>
<td>– nitrogen–phosphorus detector (NPD) 30</td>
</tr>
<tr>
<td>– photoionization 35</td>
</tr>
<tr>
<td>– radioactivity 102</td>
</tr>
<tr>
<td>– spectrophotometric 83</td>
</tr>
<tr>
<td>– thermal conductivity 28, 29</td>
</tr>
<tr>
<td>– UV detectors 81, 156</td>
</tr>
<tr>
<td>diode array detector (DAD) 83, 84</td>
</tr>
<tr>
<td>eddy diffusion 6</td>
</tr>
<tr>
<td>electrochemical detection 98</td>
</tr>
<tr>
<td>– amperometric detection 98, 99</td>
</tr>
<tr>
<td>– coulometric detector 99, 100</td>
</tr>
<tr>
<td>electrochromatography (EC) 2, 78, 127, 145</td>
</tr>
<tr>
<td>electrokinetic injection 149</td>
</tr>
<tr>
<td>electron capture detector (ECD) 18, 29, 31, 32, 45, 46</td>
</tr>
<tr>
<td>electron ionization (EI) 33</td>
</tr>
<tr>
<td>electroosmosis 129</td>
</tr>
<tr>
<td>electrophoresis 127</td>
</tr>
<tr>
<td>– migration velocity, factors influencing 128</td>
</tr>
<tr>
<td>– secondary effects 128, 129</td>
</tr>
<tr>
<td>electrophoretic separation, see electrophoresis</td>
</tr>
<tr>
<td>electrophoretic techniques 127</td>
</tr>
<tr>
<td>elution strength</td>
</tr>
<tr>
<td>– higher 52, 53</td>
</tr>
<tr>
<td>– lower 52, 53</td>
</tr>
<tr>
<td>– organic solvent 69</td>
</tr>
<tr>
<td>– relative elution strength 51</td>
</tr>
<tr>
<td>evaporation injector, see packed column injector</td>
</tr>
<tr>
<td>FID, see flame ionization detector (FID)</td>
</tr>
<tr>
<td>field-flow fractionation (FFF) 155–157</td>
</tr>
<tr>
<td>– applications 158, 159</td>
</tr>
<tr>
<td>– detector 156</td>
</tr>
<tr>
<td>– flow FFF 156, 157</td>
</tr>
<tr>
<td>– instrumentation 155</td>
</tr>
<tr>
<td>– retention time 155, 156</td>
</tr>
<tr>
<td>– sedimentation FFF 158</td>
</tr>
<tr>
<td>– thermal FFF (ThFFF) 157, 158</td>
</tr>
<tr>
<td>flame ionization detector (FID) 18, 28, 30, 31, 118, 121, 122, 124, 125, 125, 190</td>
</tr>
<tr>
<td>fluorescence detection 80, 95, 140</td>
</tr>
<tr>
<td>– chemiluminescence detection 97</td>
</tr>
<tr>
<td>– filter fluorimeters 97</td>
</tr>
<tr>
<td>– spectrofluorimeters 97</td>
</tr>
<tr>
<td>– fluorescence intensity 97</td>
</tr>
</tbody>
</table>
– optical fibers, fluorescence detection with 45
fluorinated derivatives
fluorinated hydrocarbons 118
Fourier transform infrared (FTIR) detector 36
gas adsorption chromatography
(GSC) 17, 26
gas chromatography (GC) 1, 3, 17, 18, 26, 33, 115
– atomic emission detector 35
– chemiluminescent detector 35
– columns 24
– dimensions 24
– open tubular 25, 26
– packed 25
derivatization 44–46
electrolytic conductivity detector 35
electron capture detector 31, 32
flame ionization detector 28–30
flame photometric detector 35
Fourier transform infrared (FTIR) detector 36
– injection systems 19–24
– mobile phase/carrier gas 17–19
– nitrogen–phosphorus detector (NPD) 30, 31
– photoionization detector (PID) 35
– qualitative/quantitative analyses 43, 44
– stationary phases
– adsorption chromatography 36
– partition chromatography 37–42
temperature control 41, 42
thermal conductivity detector 28
two-dimensional separations 42, 43
gas chromatography–mass spectrometry (GC–MS) interfacing 33, 34
– split interface 34
gas–liquid chromatography (GLC) 17, 25, 26, 36–39
– stationary phases, characterization 39, 40
gas-solid chromatography (GSC) 3, 17, 26, 36, 44
Gaussian distribution 5, 6, 9
Gaussian peaks 9, 12
GC capillary column (WCOT) 26
GC detector, characteristics 29
GC–MS jet separator 34
GC×GC system 43
gel electrophoresis (GE) 2, 14, 127, 130
– gels 130, 131
– instrumentation 131–133
GLC–partition chromatography 37
Golay equation 8
gradient elution 3, 4, 10, 13, 56, 65, 67, 73, 74, 100, 102, 111, 120, 121, 122
– in HPLC 4, 48
– in CEC 146
– in SFC 122
Grob test 41
headspace techniques
– GC injection system 24
– static, and dynamic 23
height equivalent to theoretical plate (HETP) 11
high-performance liquid chromatography (HPLC) 2
– automation 50
columns
– microchip columns 60
– monolithic columns 59, 60
– open tubular columns 61
– packed columns 54–59
detectors 81, 100
dilution 51–53
– carryover 52
– solid-phase extractors (SPEs) 52, 53
– solvent elution strength 51, 52
– timed injection 52
– stationary phases 64–80
high-performance TLC (HPTLC) 105, 106
high-pressure mixing 48, 49
hydrodynamic chromatography 156
hydrophilic bonded phases 107
hydrophilic interaction liquid chromatography (HILIC) 67, 68
hydrophobic interaction chromatography (HIC) 73
hydrophobic interactions 70, 74, 107, 135, 165, 166, 172
immunodetection 113
inductively coupled plasma ionization
– (ICP) 85
injection systems 17–19, 149, 180
– capillary columns 21–24
– headspace techniques 23, 24
– large-volume injectors 23
– on-column injection 22, 23
– packed column injector 20
– split injection 21, 22
– splitless injection 22
injection techniques 22, 139
– constant volume injection 50


packed columns in GC 25
– particle size 25
packed columns in HPLC
– backpressure 58
– column dimensions 54
  – in HPLC 55
– column efficiency 56
  – flat van Deemter curves 56, 57
– column lifetime 57
– column material 54
column efﬁciency 56
ﬂat van Deemter curves 56, 57
column lifetime 57
column efﬁciency 56
column efﬁciency 56
concentration-sensitive detectors in HPLC 55
– core-shell particles 58, 59
– peak shapes 57, 58
– porous particles, conventional HPLC 58
– solvent saving 55
– ultra-high pressure liquid chromatography
  (UPLC/UPHLC) 59
– particle size 6, 11, 54, 56–59, 65, 106, 122, 156
– PEEK tubing 47
photoionization detector (PID) 35
polyamide 107
polyimide 25, 26, 136, 140, 146, 151
polymers
– cyclic oleﬁn copolymer (COC) 151
– linear hydrophilic 142
– molecular imprinted 168, 175, 188
– organic polymer-based materials 72
– polymeric silica-based materials 69
– used in microdialysis 184
polysiloxanes 38
polystyrene–divinylbenzene (PS-DVB)
  materials 1, 72
polyvinyl alcohol 106
potential-driven chromatography 127, 145
  – columns and stationary phases 146
  – instrumentation 145
  – mobile phases 145, 146
  – in separation science 146, 147
programmed temperature vaporizing (PTV)
  injector 23
protein precipitation 182
  – organic modifier 183
  – salts 183
  – trichloroacetic acid (TCA) 183
quadrupole mass analyzers 91, 92
quantitation 44, 189–191
  – based on peak height/peak area measurements 190
calibration methods 192–195
method validation 196
validation parameters 196
  – accuracy 197
  – linearity 197
  – range 197
  – repeatabilities 197
  – robustness 197, 198
  – selectivity 197
  – stability 198
validation procedure 198, 199
radioactivity detectors 102
radio frequency (RF) 91, 92
refractive index detection 100–102
refractive index (RI) detectors 80, 100
resolution 11
  – eluting bands 12
  – mass transfer
  – in stagnant mobile phase 7
  – in stationary phase 7
  – variables 12
restricted access materials (RAM) 168
restrictors 124
retardation factor (Rf) 111, 112
retention factor 3, 5, 10, 12, 53, 69, 71, 112, 144
retention gap 22, 23, 25, 121, 122
retention time 2, 6, 9, 10, 11, 13, 34, 37, 44–46, 155, 156, 158, 193, 196
reversed-phase materials 68
  – hybrid materials and hydrosililated
    materials 72
  – organic polymer-based materials 72
  – retention 69, 70
  – separation principles 68, 69
  – silica-based reversed-phase materials 71
  – solvation parameter model 70, 71
rhodamine B 113
sample preparation method 162
  – enrichment factor, deﬁned 162, 164
  – property 162
  – recovery
  – calculation 163
  – equations, to describe 162
sample size 107, 161, 163, 164, 188
S-chamber 108, 109
silicones 20, 38–40, 42
silylation 44, 45
size exclusion chromatography (SEC) 1, 76, 77, 158
size exclusion materials 76
  – materials 76, 77
  – mobile phases 77
  – separation principles 76
Snyder’s solvent triangle 166
solid-phase extraction (SPE) 168–170
  – ion exchange 172–174
  – ion exchangers and chemical structure 174
  – mixed-mode 175
  – molecular imprinted polymers 175, 176
  – normal-phase extraction 170–172
  – restricted access materials 176
  – reversed-phase 172
  – SPE hardware 176–178
  – typical reversed-phase SPE steps 169
solid-phase extractors in HPLC 52, 53
  – analytical column, large-volume injection 53
solid-phase microextraction (SPME) 178
  – adsorption/extraction 178, 179
  – desorption/injection 179
  -- SPME-GC 180
  -- SPME-HPLC 180
  – fiber materials and extraction parameters 180
solubility 68, 77, 116, 118, 165, 181
  – delivery 47–49
  – gradients 68
  – nonpolar 165
  – organic 68, 69, 73, 167, 175, 182, 186
  – polar 169, 172
  – reservoirs 48, 49
  – Snyder’s solvent triangle 166
  – strength 13, 65
SPE, see solid-phase extraction (SPE) 83
spectrophotometric detectors 83
split injection 22
SPME, see solid-phase microextraction (SPME) 39
starch 106
Stokes’ radius 128
supercritical ammonia 118
supercritical fluid 115
supercritical fluid chromatography (SFC) 115
  – columns 122–124
  – detectors 124, 125
  – gradients in 120, 121
  – injection 121
  – instrument configurations 116, 117
  – mobile phases 118
  -- delivery 119, 120
  – restrictor 124
supercritical fluid extraction (SFE) 116
supercritical fluids
  – densities 116
  – diffusion coefficients 116
  – solubility 116
  – viscosities 116
support-coated open tubular (SCOT) columns 26, 37, 44
TCD, see thermal conductivity detector (TCD) 62
temperature gradients in HPLC 41
temperature-programmed separations 41
temperature programming in GC 41
thermal conductivity detector (TCD) 18, 28, 29
thermal field-flow fractionation (ThFFF) 157, 158
thin layer chromatography (TLC) 1, 105
  – chemically bonded phases 107
  – detection 112–114
  – elution and development 108–111
  – mobile phases 107, 108
  – overpressured layer chromatography 111
  – Rf value 111, 112
  – sample application 105, 106
  – stationary phases 106, 107
  – two-dimensional development 110
TMS derivatives 45
trimethylsilylimidazole (TMSIM) 45
two-dimensional (2D) chromatography 13
two-dimensional separations 14, 42–43, 134
U
ultra-high pressure liquid chromatography (UPLC/UPHLC) 48, 59
  – reduced analysis time/increased peak heights 59
  – vs. conventional HPLC 59
ultrathin TLC (UTLC) 107
UV detectors 81
  – choosing right wavelength 82
  – chromophores 82
  – detection limits 82
  – filter photometric detection 83
  – flow cells 82
V
validation parameters 196
  – accuracy 197
  – linearity 197
– range 197
– repeatabilities 197
– robustness 197, 198
– selectivity 197
– stability 198
van Deemter curve 14
van Deemter equation 8
van Deemter plot 19
video systems 114


w
wall-coated open tubular (WCOT) columns 26, 37, 39, 40

z
zone electrophoresis 133