

## Subject Index

### a

2-methylnaphthalene 452  
 4-chlorophenol 480  
 absorption 35 ff.  
 absorption heat pump 36, 408 ff.  
 accommodation coefficient 92 ff.  
 acetic acid 198, 452  
 acetone 395  
 acrylate polymerization 418, 427, 455  
 active area 5, 8, 32, 207, 213 ff.  
 actuator 276, 340, 344  
 adhesive bonding 337  
 adiabatic wall 66, 117 ff., 124 ff., 186, 197  
 AD-Merkblätter 270  
 adsorption 39, 393  
 alignment techniques 293  
 aluminum brazing 294  
 aluminum oxide 355  
 ammonia cracking 406  
 analogy of heat and mass transfer 77  
 analytical modeling 26, 235 ff.  
 anisotropic heat conduction 74, 88 ff.  
 annular flow 118 ff.  
 anodic bonding 338 ff.  
 Arrhenius law 175 ff.  
 aspect ratio 79, 120, 166 ff., 243, 275 ff.,  
 285, 297, 308, 356, 370, 400  
 assembling 292 ff.  
 atom transfer radical polymerization 455  
 automated microreaction system 423  
 axial dispersion 178 ff.  
 axial heat conduction 63, 93 ff., 242  
 axial mixing 178  
 azo pigment 425  
 azocoupling 492 ff.

### b

backmixing 177, 179  
 balance equations 10, 54, 95, 174, 206, 242  
 barium sulfate 41 ff.

basic engineering 208 ff., 226  
 batch operation 416, 444, 448, 456 ff.  
 bath reactor 456  
 Beer-Lambert law 480, 485, 488, 490  
 Bénard convection 32  
 benzaldehyde 376  
 Bernoulli equation 17, 60  
 bio fuel production 400  
 Biodisk 286  
 biological processes 106, 160, 396  
 Biot number 89  
 bisphenol F 453  
 blocking 5, 99 ff., 222 ff.  
 Bodenstein number 179, 195  
 boiling 115 ff.  
 boiling number 131  
 Boltzmann transport equation 10 ff., 93  
 Bond number 155  
 bond quality 339 ff.  
 Borofloat 369  
 borosilicate glass 338  
 boundary condition 48, 56, 89, 92  
 brainstorming 214 ff.  
 brazing 294  
 bubbly flow 37, 118  
 Buckingham theorem 23, 50  
 bulk technology 326  
 burr formation 274 ff., 293, 307 ff.  
 bypass switching 211

### c

CAD model 282, 357  
 calibration method 258 ff.  
 calorimetric monitoring 262 ff.  
 capacity 39  
 capillary force 72 ff., 223, 393  
 capillary number 155, 165  
 carbocationic polymerization 455  
 carbon black 102

- carbon monoxide 33, 365, 403 ff.
  - casting 356
  - catalyst carrier plates 360
  - catalyst efficiency 401
  - catalyst screening 185, 260
  - catalytic layer 191, 362
  - catalytic partial oxidation 186
  - catalytic reaction 479
  - cathodic reduction 488
  - caustic soda plants 429
  - cemented carbide 277
  - centrifugal force 79
  - centrifugal separation 28, 393
  - ceramic injection molding 359 ff.
  - ceramic joining 363 ff.
  - ceramic powder 358, 360
  - ceramic soldering 364
  - ceramic tape casting 403
  - ceramic-metall connection 363
  - ceramics microfabrication 354 ff.
  - CFD simulation 236 ff.
  - cGMP 399 ff.
  - chaotic advection 81, 347
  - characteristic cooling time 197
  - characteristic length 25
  - characteristic time 25, 31 ff.
  - characterization, geometric 307
  - chemical reaction
    - balance 15, 174 ff.
    - classification 9, 195 ff.
  - chemical reactor 160
  - chemical resistance 354, 363
  - chemical synthesis 492 ff.
  - chemical vapor deposition CVD 329
  - chemistry education 482
  - chip devices 465
  - chlorination 378
  - chromatographic separation 39, 251 ff.
  - churn flow 119 ff.
  - clamping 304
  - Clausius-Clapeyron equation 483
  - cleaning procedure 430
  - cleanroom 323
  - clogging 218, 445 ff.
  - Clusius-Dickel column 107
  - CO methanation 404
  - CO<sub>2</sub> laser 291, 302
  - coating 362
  - COC 302
  - co-current flow 97, 221
  - collision integral 12
  - combustion 29, 392, 406
  - commodity chemicals 398
  - compartment model 242, 244
  - compensation structure 336
  - compressible flow 56 ff., 62
  - condensation 115 ff.
  - conduction 20
  - consecutive alkylation 453
  - contact angle 129, 154
  - contacting element 80
  - continuity equation 14, 55
  - continuous flow reactors CFR 177 ff.
  - continuous operation 222, 250, 416, 457, 460, 467
  - continuously operated stirred tank CSTR 177
  - continuum approach 48
  - convection number 131
  - conversion 178, 194, 476, 480
  - COP 284
  - copper 141, 276
  - corrosion 223, 271, 315
  - cosmetic emulsion 420
  - cost calculation 225
  - cost consideration 410
  - cost management 228 ff.
  - counter-current flow 97
  - coupled transport processes 30, 35, 103
  - cracking 402
  - creativity techniques 214 ff.
  - critical heat flux 132 ff.
  - cured layer 361
  - Curie symmetry principle 105
  - CVD process 362
  - cycloaddition 377
  - cyclohexanol 451
  - cyclone 27 ff., 109, 376, 393
- d**
- Damköhler number 83, 191, 194
  - Danckwerts segregation intensity 77
  - dead volume 261, 306
  - Dean number 29, 66
  - Dean flow 78 ff.
  - deep reactive ion etching DRIE 331 ff., 344, 347
  - dehydration 394
  - DEMiS project 424 ff.
  - demonstrator 217, 436
  - density 56
  - density measurement 262
  - deposition rate 329 ff.
  - design methodology 213 ff., 435
  - design principles 218, 432
  - design process 205 ff., 217, 241

design rules 218ff., 359, 416  
 desorption 35ff., 393, 409, 479  
 desulfurization 402, 407  
 detail engineering 209, 226  
 dialkyl-substituted urea 256  
 diamond tools 274  
 diazonium salt 492  
 Diels-Alder reaction 254  
 diesel 401, 405, 407  
 differential element 13ff., 20, 89, 95  
 diffusion bonding 294ff., 363, 366, 374, 428  
 diffusion coefficient 74, 178, 220  
 diffusion length 376, 445  
 diffusion time 393, 400  
 diffusive mass transport 74ff.  
 dimensional analysis 22ff., 49ff.  
 dimensionless group 22, 50  
 dimensionless number 22ff., 213  
 dimerization 478  
 dimethyl sulfoxide 450  
 dispenser 341ff.  
 dispersion  
   – axial 181, 183  
   – radial 181  
 disposable device 286  
 dissipation function 18, 104  
 distillation 34, 394  
 distributed production 409  
 divinylbenzene 443  
 doctor-blade process 360ff.  
 dosing 464  
 driving force 32  
 droplet agglomeration 397  
 droplet breakup 158ff.  
 droplet diameter (Sauter) 151, 475  
 droplet generation process 168  
 droplet size distribution 397, 420, 444  
 dry plasma etching 336  
 dry-out mechanism 132  
 Dufour effect 107

**e**

ebullition cycle 119  
 Eckert number 52ff.  
 economizer 391  
 education concept 466  
 effective heat removal 418ff., 456  
 Einstein-Smoluchowski equation 31, 485  
 electrochemistry 465, 486  
 electrokinetic pumping 106ff.  
 electronic chip cooling 115  
 electro-osmotic flow 106ff.  
 elliptic point 80

emerging properties 10, 213, 433  
 emulsification 152, 156ff., 396ff., 420  
 emulsion stability 397  
 endothermic reaction 404  
 energy balance 13, 16ff., 55, 174  
 energy dispersive X-ray EDX 308  
 energy dissipation 17, 55, 87  
 energy input, specific 421  
 engineering design 214  
 engulfment theory 77, 87  
 enthalpy 17, 176, 483  
 entrance flow, heat transfer 91  
 entrance length 61, 190  
 entropy production 18, 55, 67, 104  
 epichlorohydrin 398  
 epoxy resin 453  
 equal-up 5, 206ff., 250, 312  
 equation of state 18, 54  
 equilibrium constant 175  
 equipment  
   – effectiveness 216  
   – arrangement 210  
   – equipment design 5, 217ff.  
 error function 75, 89  
 etching  
   – anisotropic dry 331  
   – anisotropic wet 333ff.  
   – isotropic 336ff.  
 etching mask 280  
 etching rates 369  
 ethane 396, 398  
 ethanol 197ff., 394, 405, 482  
 ethanol/water mixture 483  
 ethyl acetate 474, 476  
 ethylene 396, 398  
 ethylene glycol 420  
 ethylene oxide 419, 429  
 Euler equation 16  
 Euler number 84  
 European Pressure Equipment Direc-  
   tive 270  
 eutectic bonding 338  
 evaporation 115ff., 328, 374  
 excimer laser 288ff.  
 exothermic reaction 184, 306, 397, 447ff.  
 explosion limit 29  
 extraction 37, 81, 210, 407

**f**

fabrication technology 410  
 failure tolerant system 219  
 Fanno flow 62  
 Faraday law 486ff.

fast organic reactions 460  
 fast reaction 191, 197, 245, 445  
 Fe (III) ion 488, 490  
 ferric rhodanide 485  
 Fick's law 74, 178, 485  
 fictitious boiling 119  
 film condensation 140  
 filter 222  
 final product quality 251  
 fine chemistry 437, 449 ff., 464  
 fine particle synthesis 445, 460  
 finite difference method 26, 236  
 finite element method 26, 236  
 finite volume method 26, 236, 246  
 first law of thermodynamics 16, 55  
 first order reaction 187  
 Fischer-Tropsch process 398  
 fixed bed 182 ff., 193, 401  
 flow distribution 101, 240, 244, 256, 310, 360, 367  
 flow instability 79  
 flow oscillations 40, 134 ff.  
 flow patterns  
 – boiling 119 ff.  
 – condensation 121 ff.  
 flow regime map 119  
 flow visualization 80  
 flow-focussing 160 ff.  
 fluid design 243  
 fluid lamellae 76, 80, 156  
 fluidic connections 211, 252, 324  
 foam 8, 33, 362 ff.  
 force balance 15 ff.  
 FOTURAN 355, 370 ff., 374  
 fouling 101 ff., 223, 281, 424, 430  
 fouling mitigation 102  
 Fourier law 17, 103  
 Fourier number 89  
 free convection 32  
 free molecular flow 94  
 free radical polymerization 456  
 friction factor 61, 220, 243  
 Friedel-Crafts alkylation reaction 452  
 FTIR spectroscopic monitoring 254, 257  
 fuel cell  
 – PEM 403, 406  
 – solid oxide SOFC 404  
 fuel processing 389, 401 ff., 407  
 fully developed flow 65 ff.  
 functional elements 212  
 fusion bonding 339  
 fusion welding 363

**g**

gas chromatography 39  
 gas slug flow 118  
 gasket 294, 306  
 gas-liquid mixing 376 ff.  
 gas-phase epoxidation 424  
 gas-phase etching 336  
 gas-phase process 260, 366, 460  
 gas-to-liquid processing 398  
 gel-particle fabrication 442 ff.  
 glass 99, 244, 430, 474  
 glass bonding 374  
 glass crystallization 370  
 glass microfabrication 369 ff.  
 glass soldering 374  
 glass transition temperature 284  
 glass-ceramic structures 364, 371  
 gluing 299 ff., 374  
 glycerin 476  
 Grashoff number 32, 53  
 green part 358  
 green sustainable chemistry 460  
 green tape 361  
 Gregorig effect 137  
 Grignard exchange process 446 ff.

**h**

Hagen-Poiseuille flow 68  
 Hall sensor 105  
 halogen-lithium exchange 448  
 Hamel-Oseen vortex 28  
 Hastelloy 198, 430  
 hazardous chemicals 39, 208, 216, 399, 435, 460, 467  
 header 101, 136, 454  
 health care 410  
 heat and mass transfer 77, 400, 464  
 heat capacity flow 98  
 heat conduction 17, 88, 378  
 heat conductivity tensor 88, 89  
 heat engine, regenerative 31  
 heat exchange effectiveness 408  
 heat exchanger efficiency 97 ff., 378  
 heat production potential 186  
 heat pump 392  
 heat transfer 16 ff., 63 ff., 219, 465 ff., 469 ff.  
 – condensation 137 ff.  
 – conjugate 63  
 – convective 91 ff.  
 – unsteady 31  
 heat transfer area 95  
 heat transfer coefficient 91, 96, 469 ff.

heat transfer enhancement 66  
 heat wave 74  
 heating elements 367  
 hemodializer 396  
 Henry's law 20, 35 ff.  
 heterogeneous catalysis 194, 196, 465, 478  
 heuristic rules 211 ff.  
 high throughput screening 39, 260  
 HNA etching 336  
 hold-up 252, 261  
 hollow-fibre bundle 396  
 homogeneous reaction 195  
 hot embossing 287, 314, 356  
 hot spot 184, 189, 221, 223, 246  
 housing 303  
 HPLC 252, 259  
 HPLC fittings 306, 379  
 hydraulic diameter 123  
 hydrocarbon systems 404  
 hydrofluoric acid HF 369  
 hydrogen peroxide 197, 397 ff., 424, 451  
 hydrogen production 401  
 hydrolysis 419  
 hydrophilic surface affinity 153  
 hydroxyethyl cellulose 476  
 hyperbolic point 80

**i**

impinging jet micromixer 102  
 IMPULSE project 435  
 IMRET 416, 440  
 Inconel 403  
 infrared camera 256, 258  
 injection molding 285 ff., 314  
 inner energy 18  
 insulation  
 – electrical 222, 339  
 – thermal 30 ff., 95, 221 ff.  
 integrated sensors 433  
 integrated systems 405, 407  
 interconnection 303  
 interdiffusion 484  
 interfacial tension 154  
 intermediates 255 ff., 399, 447 ff., 460  
 iodide-iodine reaction 486 ff.  
 isobutene 478  
 iso-octane 405  
 isothermal processing 185, 252  
 isotropic etching 281, 369

**j**

jet fuel 404

**k**

Kelvin-Helmholtz double layer 72  
 Knudsen number 11, 21, 48, 54, 92 ff.  
 Knudsen pump 108  
 KOH etching 334, 343 ff.  
 Kolmogorov length scale 87

**l**

lab on a chip 253, 465  
 laboratory device 434  
 lab-scale application 253  
 laminar flow 61, 195, 470, 484  
 Langmuir-Hinshelwood mechanism 480  
 Laplace pressure 150  
 laser ablation 277, 372  
 laser microcaving 277 ff.  
 laser processing 372  
 laser pulse 290, 298  
 lattice Boltzmann method 26  
 leaching 37  
 leak tightness 309, 315  
 leak-tight seal 294, 306  
 length scales 4  
 Lewis number 77  
 life-science research 428  
 LIGA technology 110, 285, 356  
 LiO<sub>2</sub>/SiO<sub>2</sub> glass 369  
 liquefied natural gas LNG 391, 429  
 liquid cooling 430  
 liquid droplet flow 118  
 liquid jet 341  
 liquid lumped flow 118  
 liquid-ring flow pattern 118  
 lithium aluminum silicate 370 ff.  
 lithography 330  
 loading 37  
 local process control 434  
 Lockhart-Martinelli parameter 124 ff.  
 logarithmic temperature difference 96  
 logarithmic temperature difference 469  
 long-term experience 416  
 long-term stability 250, 315  
 low pressure CVD 329  
 lumped element modeling 26

**m**

Mach number 53, 56  
 macrokinetics 474 ff.  
 macroprocess 5 ff.  
 malachite green 485  
 manifold 101, 240  
 manufacturing pathway 269  
 market pull 43, 214, 431

- mass balance 14 ff.
- mass conservation 12
- mass production 42, 283, 322, 359, 430
- mass spectrometric gas analysis 260
- mass transfer 76 ff., 190, 479
- mass transfer coefficient 77, 192, 474 ff.
- mass transfer limitation 192, 196
- master model 356
- material balance 174
- material choice 270
- Maxwell-Boltzmann transport equation 12
- Maxwell-Cattaneo equation 73
- McCabe-Thiele diagram 34, 36
- mean diffusion length 74
- mean free path 11, 54, 92
- mechanical micromachining 272
- mechanical separation process 27
- medical technology 314
- membrane
  - liquid 33
  - porous 283
- membrane emulsification 151
- membrane separation 33, 393, 407
- mesostructured devices 432
- metal bonding 293
- metal foil 274, 276
- metal powder 282
- metal-organic reaction 424
- methane 398, 405
- methane partial oxidation 404
- methane steam reforming 465
- methanization 365
- methanol reforming 401, 403 ff.
- methodological design 211 ff., 433
- methoxylation 364
- methyl methacrylate MMA 456 ff.
- micro chemical engineering 464
- micro heat exchanger
  - micro heat exchanger 95, 221, 298, 311, 362, 364, 368, 374 ff., 378 ff., 389 ff., 417, 421 ff.
  - cross-flow 292, 296, 304, 366, 404, 469
  - plate 364, 469
  - printed circuit 428
  - recuperating 406
  - tube 448
- micro process engineering 225
- micro reaction technology 250
- micro total analysis system  $\mu$ TAS 253, 440, 465
- micro-/macro integration 38, 407, 430 ff.
- microanalytical systems 464, 482, 493
- microbeads, polymeric 165
- microcalorimetry 483
- microcapsules 150
  - coacervate 165
- microchannel separators 409
- Microchemical Initiative MCI 442
- Microchemical Process Technology
  - MCPT 441
- microchemistry 3, 440
- MicroChemTec 29, 223, 417, 466
- microcolumn structure 281
- microdrill 274
- microfabrication
  - ceramics 353 ff.
  - glass 353 ff.
  - metals 267 ff.
  - polymers 267 ff.
  - silicon 321 ff.
- microfluidic connections 379
- microfluidic device 222 ff., 314, 325
- microkinetics 479
- micromachining, laser 276 ff.
- micromixer 221, 373, 376 ff., 417 ff., 474 ff.
  - active 346
  - caterpillar 427
  - convective 77 ff., 347
  - cyclone 378
  - herringbone 81, 237
  - hydrodynamic focussing 396
  - interdigital 152, 156 ff., 254, 424, 427
  - IPHT 488, 490, 492
  - K-M type 454
  - L-shaped 78, 81
  - multilamination 454
  - split and recombine SAR 76
  - superfocus 376
  - T-shaped 42, 79 ff., 158 ff., 238 ff., 346, 448, 454, 477
  - Y-shaped 302, 442, 477
- micromixing 87, 421, 453 ff.
- microparticles, polymeric 165
- micropatterning 356
- microprocess 5 ff.
- microprocessor cooling 430
- micropump, silicon 343 ff.
- microreaction technology 433
- microreactor 106, 182 ff., 221 ff., 360, 362 ff., 364 ff., 373 ff., 397 ff., 445, 456 ff., 478
  - biological 160
  - catalytic test 479
  - ceramic 403
  - falling-film 378, 480
  - one-channel foil 486, 488

- photo 377, 407
- plate-fin 240 ff.
- thin film 400
- tube 457
- microreactor design criteria 194
- microstructure mold 284 ff.
- microstructuring technique 269
- microsystem technology 3, 322
- migration path 83
- milestones 224 ff., 228
- military application 388, 410
- Miller indices 334
- millisecond reactors 401
- miniaturization 27 ff.
- minimal invasive surgery 276
- miniplant 206, 226, 399, 474
- minireactor 399
- misalignment 293, 335
- mixer effectiveness 84 ff.
- mixer-settler 34, 38
- mixing 7, 78, 465 ff., 474 ff.
  - interdigital 376
  - multiphase flow 81
- mixing channel 347
- mixing effectiveness 85 ff.
- mixing length 85
- mixing length theory 77
- mixing number 475
- mixing performance 348
- mixing quality 78 ff.
- mixing time 82 ff.
- mixing-sensitive reaction 417 ff., 427
- mobile application 402
- modular system 304, 368, 423
- modularization 208, 223
- molding 356
- molecular collision frequency 54
- molecular distillation 29
- molecular weight distribution 458
- momentum equation 12, 15 ff., 55 ff.
- monocrystalline silicon 323
- monodisperse emulsion 150
- Monte Carlo method 26
- multiphase processing 392 ff., 408
- multiproduct plant 428
- multiscale chemical devices 430

**n**

- nanocrystals 372
- nanoparticles 41, 446
- naphta reforming 429
- natural convection 32
- Navier-Stokes equation 12, 54 ff.

- n-butane 364
- Nd:YAG laser 277, 288 ff.
- Nernst distribution 37
- Newton number 475
- NIR spectroscopy 255
- nitinol 276
- nitration reaction 256, 263, 375
- nitroglycerin 427
- noncontinuum effect 48
- nuclear magnetic resonance 254
- nucleate boiling 120 ff., 137
- nucleation 41
- number of transfer units NTU 97 ff.
- numbering up 5, 206, 220, 250, 311 ff., 409, 432, 460
- numerical simulation 26
- Nußelt number 53, 77, 91, 184, 470

**o**

- offshore platform 428
- olefins 401
- on site production 409, 437
- online analysis 254
- Onsager reciprocal relation 104
- optical measurement 253
- order of magnitude 25, 51, 213
- organic process 450 ff.
- organometallic process 446 ff.
- O-ring 294, 306
- Ostwald ripening 150
- oxidation 329, 364, 398, 451
  - ethanol 197 ff.
  - liquid phase 197
- oxidative coupling 367
- oxygenates 401
- o-xylene 186

**p**

- PA 302
- packaging 303
- packed bed 193
- palladium 33
- parallel switching 211
- partial oxidation 401 ff.
- particle size distribution 446
- particle synthesis 442 ff.
- particulate fouling 102
- passive mixer 346
- PC 284, 290, 302
- PDMS 154, 160, 394
- Péclet number 51, 179, 195
- PEEK 30, 284, 288
- Peltier effect 105, 263

- peristaltic pump 344 ff.  
 pharmaceutical chemistry 399, 464  
 phase separation 392 ff.  
 phenol 398  
 phenomenological coefficient 19, 103  
 photochemical reaction 372, 465, 447,  
 480 ff.  
 photolithography 280, 369  
 photoreduction 490  
 photoresist 327, 330, 369 ff.  
 physical principles 42  
 physical vapor deposition PVD 328  
 PI 288, 290  
 picoliter 160  
 piezo actuator 345  
 piezo electric material 344 ff.  
 pilot plant 206, 467  
 pilot study 208 ff.  
 pipe & instrumentation diagram 21, 209 ff.  
 Pi-theorem 23, 50  
 planar technology 325  
 plant design 208 ff.  
 plasma enhanced CVD 329  
 plasma etching 369 ff.  
 plate heat exchanger 96  
 plug flow reactor PFR 177 ff., 186, 195,  
 479  
 plugging 418  
 PMMA 154, 158, 280, 284, 302, 337  
 pneumatic actuation 344  
 Poiseuille flow 190  
 poly(vinyl alcohol) 443  
 polyamide 459  
 polycarbonate film 283  
 polycondensation process 458  
 polycrystalline silicon 323  
 polymer bonding 299 ff.  
 polymer laser microprocessing 287 ff.  
 polymer molding 284 ff.  
 polymerization 418, 455 ff.  
 polyolefines 299  
 POM 299  
 porosity 181  
 portable devices 402, 409  
 potassium hydroxide 333 ff.  
 PP 302  
 practical training 467  
 Prandtl number 53, 471  
 precipitation 41, 223, 445  
 preferential oxidation 405  
 preheating 421  
 pressure diffusion 30, 109  
 pressure drop 123 ff., 193, 220, 243  
 pressure fluctuations 136 ff.  
 pressure loss 84  
 pressure resistance 271, 304 ff., 309  
 pressure sensor 143, 261  
 process actuator 253  
 process analytical techniques 251 ff.  
 process analytical technology PAT 399  
 process chart 326 ff., 342  
 process control 222, 250  
 process design 208 ff., 431, 435  
 process development 417 ff.  
 process engineering 3 ff.  
 process flow diagram 21, 206 ff., 212  
 process intensification 8, 231, 388 ff., 398,  
 416, 418, 432  
 process simulation 206 ff.  
 process slip 326  
 process space 5 ff.  
 process steps 6, 326  
 procurement 227  
 production on demand 435  
 project controlling 228 ff.  
 project management 224 ff.  
 propane 405  
 propylene oxide 398, 424  
 prototype fabrication 272, 280, 310  
 P-Spice 26  
 PSU 288  
 PTFE 299, 485, 490  
 pulsed flow 239  
 pumping principles 40, 345  
 pumps 40, 222, 345, 409, 471 ff., 477  
 purification efficiency 408  
 PVDF 302  
 Pyrex glass 338, 369
- q**
- quality control 315  
 quartz glass 373  
 quenching 29, 259
- r**
- R&D projects 225 ff.  
 radial heat conduction 99  
 radiation heat transfer 18  
 radical polymerization process 455 ff.  
 Raman spectroscopy 258 ff.  
 Raoult's law 20  
 rapid bubble growth 119  
 rapid manufacturing 302  
 rapid prototyping 282, 323, 360 ff., 372  
 rapid screening 367  
 rapid tooling 288



- rarefied gases 92 ff., 108  
 Rayleigh number 32  
 reaction  
   – exothermic 263  
   – fast 255  
   – isothermal 263  
 reaction conditions 417 ff., 465  
 reaction enthalpy 18, 175  
 reaction kinetics 83, 398  
 reaction rate constant 31, 83, 175 ff., 185, 476  
 reaction technology 466  
 reaction-rate limitation 420  
 reactor behavior, thermal 187  
 reactor dimensions 245  
 reactor housing 367  
 reactor operation, stable 189, 199  
 reactor performance 189  
 reactor safety 189 ff., 196, 199  
 reactor startup 404 ff.  
 recirculation 211  
 rectification column 34 ff., 409  
 refrigeration 390  
 relaxation time 21  
 research phase 204  
 residence time 101, 178 ff., 192, 245, 252, 399, 409, 446, 460  
   – distribution RTD 178 ff., 194 ff., 239  
   – mean 82, 179  
 resistor heating 364  
 reversible assembly 364  
 Reynolds number 22, 51, 78, 155, 179, 219, 470 ff.  
   – critical 58  
   – two-phase flow 131  
 Ru catalyst 406  
 runaway, reactor 184, 200, 398, 409
- S**  
 safety 216, 460  
 sampling device 259  
 sampling point 252  
 sandblasting 373  
 saponification 474 ff.  
 saturation 41  
 Sauter diameter 420  
 scale-out 433  
 scaling, scale-up 24, 50 ff., 206 ff., 311, 467  
 scanning electron microscopy SEM 308  
 Schmidt number 82, 179  
 screening 256  
 sealing 305 ff., 324, 367  
 secondary flow 78 ff., 81  
 Seebeck effect 105, 263  
 segregation index 80  
 selective laser melting 282  
 selective methanation reactor 404  
 selective oxidation 368  
 selectivity 31, 178 ff., 183 ff., 454, 460, 480  
 self-alignment 335  
 semi-infinite body 90  
 sensitivity coefficients 64  
 sensor  
   – capacitance 482  
   – Coriolis 261 ff.  
   – flow 254, 261  
   – incline 32  
   – mass flow 261 ff.  
 sensor integration 310, 423, 493  
 sensors 261 ff., 303  
 separation nozzle 109  
 separation operations 7  
 serial switching 211  
 series production 313 ff.  
 serpentine channel 37, 66  
 shape design 239 ff.  
 shape memory alloy 276  
 Sherwood number 77, 190  
 shrinkage 358  
 SiC foams 368  
 side reactions 451  
 silicon 40, 255, 261  
 silicon carbid 355, 366  
 silicon chip housing 324  
 silicon dioxide 328  
 silicon nitride 328 ff., 406  
 silicon properties 325  
 silicon reactor 403, 406  
 silicon structuring 330  
 silver chloride nanoparticles 446  
 similarity 24, 205 ff.  
 simultaneous engineering 424  
 sinusoidal microchannels 281  
 sizeable bubble 121  
 slender channels 57 ff.  
 slip flow 48, 92 ff.  
 small-scale series 272  
 soldering 294 ff., 305, 364, 430  
 sol-gel method 362  
 solid formation 416  
 solid freeform fabrication 357  
 Soret effect 107  
 soybean oil 164  
 space time 177, 182, 187, 194 ff.  
 space-time yield 418, 420 ff.  
 spatial resolution 256

- specialty chemistry 437
  - species balance 15
  - specification 212, 225
  - spectroscopic analysis 254
  - speed of sound 62
  - sputtering 328 ff., 362
  - stainless steel 295 ff., 313, 390, 403, 430, 471
  - standard protocol 466
  - static mixer 84, 360, 418
  - steam methane reforming 406
  - steam reformers 404
  - stents 276 ff.
  - stereolithography 291 ff., 357 ff., 361 ff.
  - stirring 474 ff.
  - stop-flow conditions 484
  - straight microchannels 275
  - stream tube approximation 59 ff.
  - stripping 36
  - Strouhal number 239
  - SU8 285
  - sulfuric acid 420, 429
  - superinsulation 30
  - surface characteristics 467 ff.
  - surface coating 328
  - surface modification 328
  - surface reactions 323
  - surface roughness 102, 127, 219, 272 ff., 279, 281, 290, 308, 336
  - surface tension 121 ff., 137
  - surface-to-volume ratio 194, 263
  - surfactants 153 ff., 397, 420
  - Swern oxidation 450 ff.
  - switching 211
  - syngas 401
  - system integration 433
- t**
- tantalum 33
  - tape casting 360
  - Taylor bubble 121
  - Taylor series expansion 26
  - technical chemistry 468 ff.
  - technical work
    - shaft 176
    - specific 60
  - technology push 43, 214, 431
  - Teflon tubes 379
  - temperature control 184
  - temperature jump coefficient 92
  - temperature profile, axial 185
  - terrace, slit-like 164
  - thermal boundary layer 129
  - thermal design 241 ff.
  - thermal expansion 32, 363
  - thermal material properties 270
  - thermal resistance 363
  - thermal transpiration 108
  - thermally developing pipe flow 65
  - thermocatalytic air purifier 408
  - thermodiffusion 30, 107 ff.
  - thermodynamic equilibrium 10
  - thermoelectric cooler 141
  - thermoelectric effect 30, 105 ff., 263
  - thermofluid design 244 ff.
  - thermoplastics 284
  - time resolution 255
  - titanium 430
    - nitride 367
    - silicate 424
  - transfer coefficient 20
  - transformation rate 174 ff.
  - transport phenomena 19 ff., 103, 196, 434
  - transport properties 72
  - TRIZ method 215
  - turbulent flow 61
  - two-film model 19
  - two-phase CFD 168
  - two-phase flow patterns 117 ff.
  - two-phase instabilities 136 ff.
- u**
- unit operations 6 ff., 42, 210, 397, 403, 406, 435, 465 ff.
  - unsteady heat transfer 89
  - UV oxidation 480
  - UV/Vis spectroscopy 255, 492
- v**
- van't Hoff equation 175
  - vapor pressure 73
  - vapor quality 138
  - vaporizer 403
  - velocity distribution 11
  - Villermoux-Dushman reaction 80, 478, 486 ff.
  - viscous dissipation, specific 60
  - viscous flow 16, 416
  - viscous heating 65 ff.
  - visualization 214, 256
  - vitamin K3 451
- w**
- wafer 323, 326
  - wall efficiency 95 ff.
  - wall roughness 53, 219

wall thickness 305  
washcoating 362 ff., 365  
water-ethanol mixture 34  
water-gas shift reaction 402, 404 ff.  
water-toluene mixture 36  
Weber number 155, 475  
welding  
– conduction 297  
– deep penetration 297  
– electron-beam 294  
– laser 294, 296, 301  
– polymers 300

– solution 300  
– ultrasonic 300 ff.  
– wolfram inert gas WIG 305  
wet chemical etching 280 ff., 313

**x**

xenon ions 283, 336

**y**

yield 19, 31, 84, 178, 184, 216, 241 ff., 250,  
377, 398, 418 ff., 424  
Young-Laplace equation 154, 163

