

Index

a

ab initio calculations 148
 additive elements 293
 adhesive/cohesive failure 280
 aerospace industry 118
 agglomeration process 189, 226
 – deagglomeration 225
 algebraic equations 197
 alkali metal contaminants 120
 – effect 120
 – schematic presentation 120
 Al-Li alloys 2, 6, 10, 19, 50, 52, 53, 116, 119, 121, 126, 139, 184, 185, 192, 311, 316, 358, 383, 413
 – acceptance 117
 – AlMg_3SiMn 2
 – extrusion 383
 – fundamentals 116
 – industrial thixocasting 2
 – mechanical properties 316
 – mix crystal 137
 – recycling 139
 – rheocasting 311
 – semi-solid forming 3
 Al-Li-Mg alloys 117, 118, 124, 127, 131, 137, 371
 – design 105
 – diagrammatic presentation 133
 – grain refinement 124
 – principle component 133
 – selection 118
 – thixocasting/thixomoulding 371
 Al-Li-Mg system 122, 128
 – alloy compositions 128
 Al-Li residues 139, 142
 – closed-loop recycling 142
 Al-Li thixoalloys 132, 322
 – adaptation 122

– flow diagram 122
 – matrix 117
 – rheocasting 134
 – systems 127
 – thixocasting 132, 314
 alloy systems 44, 61, 148
 – adaptation procedure 110
 – composition 110
 – elements 50, 61, 112, 290, 349, 423
 – modification 54
 alloying elements, *see* carbon
 Al_2O_3 insulating mats 352
 $\text{Al}_2\text{O}_3/\text{ZrO}_2$ -based ceramics 282
 Al-Si-based alloys 317
 alumina films 273–277, 279–281
 – bright-field TEM images 276, 277
 – coatings 269
 – crystallographic structure 274
 – matrix 277
 – optical micrograph 279
 – phase-formation diagram 273
 – plates 297
 – raw material 126
 – SEM images 275
 – tribiological tests 280
 aluminium 383
 – alloy A356 48, 169, 210
 – billets 9
 – dendrites 107
 – dendrites agglomerate 113
 – grain nucleation parameters 210
 – phase 115
 – production 9
 – rheometer 186
 – thixoforging/thixo lateral extrusion 383
 aluminium titanate (Al_2TiO_5) 282
 analogous quench tests 124

- arbitrary volume element 222
 argon atmosphere 290
 ASTM grain size 83
 austenite particles 71
 – carbon 89
 – chromium 89
 – grains 77
 – liquid phase boundary 75
 – martensitic matrix 96, 193
 – matrix 193
 – protuberances 81
 – stabilizing elements 89
 – transforms 87
 automated thixo cell 391
 automatic robot 344
 automotive applications 1
 – brake cylinders 1
 – chassis components 1
 – rims 1
 automotive/aerospace industries 311
 automotive industry 315
 axial/radial temperature measurements 320
 axisymmetric geometry 387
- b**
 ball-on-disk configuration 271
 billet 115
 – grain structure 115
 – material 431, 435
 – reheating 10
 – schematic drawing 322
 – stands 12
 – temperature 412
 – tray 320, 322
 bimodal distribution 225
 binary alloy 51
 – schematic phase diagram 51
 binary/ternary systems 130
 bipolar DC PECVD method 269
 body-centred components 76
 boron nitride (BN)-based side dams 282
 bright-field TEM images 276
 brittle scale layer 290
 BSE micrograph 38
 bulk ceramic forming tools 281
- c**
 Calphad method 148
 Calphad software 149
 capillary experiments 192, 193
 capillary Rheometer 171, 177–179, 189,
 191
 – horizontal 179
 – tool 190
 – vertical 178
 – viscometer 178
 carbide bands 63
 – accumulations 65
 – content 71
 – metallographic determination 71
 carbon 57
 – content changes 74
 carbon/chromium contents 90
 carbon pins 181
 – thermodynamic calculations 90
 Carousel-type machine 11, 12
 – induction coils 11
 – schematic diagram 12
 cartridge system 323
 casting process 40
 CCT diagram 88, 91, 92
 ceramic machining technologies 296
 ceramic materials 245, 281
 – mould 347
 – plates 331
 – sintering additives 293
 – spindle 176
 – tools 283, 298
 chemical vapour deposition (CVD) 248, 250
 – process 272
 chlorine bubbles 270
 chromium carbides 96, 193
 chromium/carbon-rich steel 64
 – 100Cr6 64
 chromium templates 269
 Clausius–Clapeyron equation 127
 closed-loop control 377
 – scheme 380
 CNC-controlled green machining 296
 coarsened silicon particles 10
 coated extrusion segment 268
 – SEM/EDS analysis 268
 coated tool 268
 – SEM/EDS analysis 268
 coating systems 248
 Cobapress method 317
 coefficient of thermal expansion (CTE)
 values 247
 coil geometry 375
 coil heating system 13
 – diagrammatic presentation 13
 components geometries 385
 – segregation 385
 compression test 182, 193
 – experimental setup 182
 computational fluid dynamics (CFD) 197
 – program 200
 – software FLUENT 6.3 208

constant temperature process (CTP) 342, 355
 constitutive equation 173, 174
 continuous-cast/extruded billets 105
 continuous-pressed profiles 116
 continuous rheoconversion process (CRP) 15
 converter system voltage 321, 373
 cooling channel 208
 – device 352
 – process 211, 342, 344, 345, 347, 355
 – simulation 208, 211
 – variable parameters 345
 cooling/heating experiments 46
 cooling slope method 15
 cooling tube 434
 copper-based material 333
 copper-beryllium alloy 389, 390, 432
 copper bronze CDA905 317
 corrosion test 249, 287
 – experiments 286
 – schematic diagram 287
 corrosive effects 293
 cost-effective casting technique 117
 cost-effective fully liquid casting process 1
 Couette Rheometers 175
 – high-temperature 175
 CPR reactor 15
 Creep experiments 186
 – tests 187
 CSM Instrument tribometer 271
 CuCrZr based alloy segment 248
 Curie temperature 321

d

Darcy's law 199
 dark matrix 71
 DC sputtering technology 255
 deagglomeration process 225
 deformation mechanisms 232
 dendritic primary material 54
 – microstructure 52, 58, 347, 353
 – reheating 58
 – solid-phase particles 43
 dense/porous ceramic 295
 deposited coatings 248, 259
 – X-ray diffraction pattern 259
 depositing technology 248
 deposition parameters 252, 260, 265
 – deposition pressure 260
 – development 254
 – oxygen flow rate 260
 – process 263
 die-casting machine 319
 die-casting tool 178, 324

differential/integro-differential equations 197
 differential scanning calorimetry (DSC) 55
 differential thermal analysis (DTA) 55, 114, 147
 – curves 128
 – high-pressure 128
 – measurements 82
 – signal 153
 – system 128
 – testing 127, 132, 138
 diffusion-controlled process (DICTRA) 67, 150
 – curve 160
 – diffusion simulations 150
 – simulation 151, 152, 158, 159
 diffusion process 31, 47, 67
 dilatometer experiments 92
 – metallographic images 92
 direct chill casting 9
 – mould 9
 direct metal laser sintering (DMLS) 335
 discretization methods 199
 – numerical solution techniques 199
 discretized/discretization equation 200
 diving knife 339
 2D-MICRESS simulation 351
 double scale transition 228
 – schematic representation 228
 draft angles 370
 drop forging process 369
 dynamic mechanical component 86
 dynamic yield stress 186

e

EBSD measurements 76, 77, 80
 EDS graph 267
 elastic modulus 277
 – values 277
 electric heating cartridges 179, 324
 electric parameters 13
 electromagnetic/active mechanical stirring 9
 electromagnetic qualities 321
 electromagnetic stirring methods 1
 – stirred material 57
 electronic products 8
 – laptop housings 8
 element-distribution images 73
 Elotherm reheating unit 320
 energy-dispersive spectroscopy (EDS) 253
 enthalpy/heat capacity 155
 – bar graph 155
 equilibrium flow curve, *see* Herschel–Bulkley Law

- equilibrium tests 141
- equilibrium viscosity curves 184
- equivalent stress 174
- etching process 263
- eutectic structure 113
 - involvement 113
- extrusion channel 415, 432
- extrusion experiments 414
 - diameter 414
 - forces 420
 - forming process 411
 - load/displacement curves 420
- extrusion process 369, 415, 416, 437
 - model 437
 - simulation 437, 439
 - temperature development 437
- extrusion tool 428, 429
- schematic diagram 429

- f**
- FACTSAGE program 139
- fast-diffusing element 151
- Fe-Cr-W-C system 62, 66
 - pseudo-binary phase diagram 62, 66
- feed-forward control 394
- feedstock billets 20
- feedstock magazine 391, 393
- feedstock material 31, 35, 348
 - extruded/rolled 35
 - hot deformed/homogenized 35
- ferritic/homogenization phase 321
- ferritic/martensitic/austenitic state 156
- ferrous oxides 290
- filling/cutting sequence 396
 - scheme 396
- filling process 205
 - two-phase simulation 205
- fine-grained globular microstructure 7, 9
- fine particles 339
- finite difference method (FDM) 199, 377
 - inductive heating 377
- finite element-method (FEM) 175, 200, 221
 - analysis 300
 - concepts 222
 - simulations 195, 221, 428
- finite volume method 199
- firebricks 296
- flat bar tension specimens 360
- flatness-based control 378, 381
 - introduction 378
 - flatness-based control 382
- Flir ThermaCam P640 thermographic camera 348
- flow behaviour 172
 - mathematical modelling 172
 - flow length capabilities 328
 - determination 328
 - flow pressure 180
 - fluid mechanics 172
 - approach 172
 - suspension 44
 - fluid/solid phase distribution 131
 - Al-Li phase diagram 131
 - Fondarex system 323
 - forging process 394
 - control 394
 - micrographs positions 397
 - schematic view 397
 - steps 397
- fourfold plate sample 331

- g**
- gas bubbles technique 16
- gas inclusion 369
- gas pressure sintered silicon nitride (GPSN) 287
- gaseous nitrogen 285
- gating system 325
- Gaussian curve 210
- geometric probability computation 54
- Gibbs energy 148
- glassy grain boundary phase 287
- globular-equiaxed transition 350
- globular grains 346
- globular microstructure 342, 348, 349, 356
- globular solid particles 4, 5, 7, 43, 172, 223
- globulitic metal suspensions 45
- globulitic microstructure 123
 - formation 123
 - globulitic primary phase 422
 - globulitic solid phase 108
- grain boundary areas 80
 - segregation 80
- grain-density model 209, 214
- grain nucleation model 209
 - determination 209
 - parameters 209
- grain refinement 106, 108, 111
 - element 114
 - material 114, 115
 - modifying agents 111
 - grain size distribution 56
 - influence 56
 - rheological properties 56
- granular crystals nucleate 15
- grey-value thresholds 70
 - structural evaluation 70

h

hardness/coating thickness 256

hardness curves 97

hardness measurements 88

– carbide bands 88

heat conduction coefficient 376

heat exchangers 285

heat-influenced zone 403

heat transfer coefficient 376, 400

heat transfer equations 375

heat transfer experiment 401

– scheme 401

heat transfer problems 378

– flatness-based control 378

heat transmission 404

heat treatment 2, 362, 413

– evaluation 98

– strategies 98, 99

heating control scheme 380

heating/forming operations 373

heating process 13, 53

– structural development 53

heating system 373

Herschel–Bulkley law 173

Herschel–Bulkley model 198

heterogeneous material 221, 222

heterogeneous nucleation 314

high-alloyed steels 33, 318

high-angle grain boundaries 60

high-carbon steels 45

– semi-solid steel billet 321

high-chromium content steels 93

high corrosion resistance 108

high electromagnetic forces 11

high melting point alloys 282, 300

– material 326

– metals 357

– point 317

– rheocasting 357

– steel alloys 371

high-performance/weight-optimized steel components 318

high-pressure die casting (HPDC) 241

– machine 312–314, 336, 343, 349, 359, 363

– process 312

high-purity raw material 138

high-quality steel components 339

high-rigidity materials 117

high-solution scanning electron microscope image 95

high-speed steel 163, 318

– calculations 163

– components 386

– HS6-5-2 163

– HS6-5-3 386

high-strength aluminium alloys 2

high-temperature capillary viscometer 181

– insulation wool 296

– tribiological/thermal shock

evaluations 301

high thermal conductivity 248

– copper/molybdenum-based materials 248

homogeneous microstructure 9, 398, 399

homogeneous phase distribution 414

homogeneous temperature distribution 298, 374

horizontal capillary viscometer 180

hybrid tool 246

hydraulic forging press 311

hydraulic press 288, 392

hydrodynamic/viscous forces 170

hydrostatic pressure 18, 193

hypereutectic silicon alloys 20

– AlSi17Cu₄Mg (A390) 20

hypo-eutectic steel 100Cr6 98

– properties 98

– structural changes 98

hypo-eutectic/ledeburitic steels 61

i

immobile liquid phase 46

impeller geometry 335

– schematic drawing 335

indirect force measurement system 180

– schematic illustration 180

induction furnace 374, 393

– schematic drawings 374

inductive heating 377, 378

– control 377

– flatness-based control 378

inductive heating process 373

– disturbances 373

industrial coating unit 258

industrial mass production 7

industrial-scale isothermal thixoextrusion

experiments 426

industrial thixoforming 232

inert gas overpressure method 127

innovative materials 311

Institute of metal forming 391

INSTRON laboratory testing machine 424

INSTRON universal testing machine 418

intra-/inter-globular liquid phase 57, 58

– micrograph 58

– schematic influence 58

– volume fraction 57

ion bombardment 273

- importance 273
- ion flux 273, 301
- isothermal experiment 92, 204, 205
 - bar graph 205
 - graphical presentation 206
 - two-phase simulation 204
 - vs. two-phase isothermal simulation 206
- isothermal halt 47
- isothermal laboratory thixoextrusion
 - tests 419
 - tool dimensions 419
- isothermal/non-isothermal experiment 206
 - compression tests 232
 - flow patterns 206
 - parameters 232
- isothermal/stationary viscosity
 - measurements 46
- isothermal steady-state behaviour 229
- isothermal thixoextrusion 418, 424
- isothermal thixoforming 226
- isothermal tool 416
 - concept 416
 - schematic diagram 417
- ITT-TEVES 1

- j**
- jet-spray/float systems 117
- jet-spraying process 116

- k**
- KCl-LiCl salt mixture 142
- kitchen/diving knives 337
- knife geometry 337, 339

- l**
- laboratory-scale isothermal thixoextrusion test 418, 420
- Lagrange–Galerkin approach 201
- Lagrangian/arbitrary Lagrangian-Eulerian (ALE) techniques 197
- LARSTRAN/SHAPE 401
- light metal/high-melting alloys 371
- light metal thixoforming 282
- light weight components 370
 - requirements 370
 - line-scan measurements 73
- liquid aluminium processing 314
 - history 314
- liquid-based slurry-making process 16
- liquid electrolysed aluminium 16
- liquid-enriched material 191
- liquid matrix 45
- liquid metallic suspensions 44, 45
- liquid Newtonian matrix 172
- liquid-phase content 58, 69, 80
 - boundary 80
- liquid-phase fractions 50, 58, 370, 385
 - determination 81
- liquid-phase interval size 49
- liquid-phase progression 50
- liquid phase form 44, 70
- liquid-solid spatial distribution 231
- load-displacement diagram 430
- long-term heat resistance 96
- low-carbon steels 342
- low-melting alloy AlSi7Mg (A356) 383
- low-melting tin-lead alloy 172
- low-segregation components 86
- low superheat pouring with a shear field (LSPSF) 16
 - advantages 16
- low-temperature casting 14
- low-viscosity slag 289
- lubricant-free antifriction 294

- m**
- MAGMASOFT 201
 - simulation program 340, 360, 361
 - validation 340
- magnesium chips 8
 - alloyed variant 133
 - aluminium-lithium alloys 355
- magnetic material parameters 375
- magnetic permeability 55
- magnetohydro dynamic (MHD) 9
 - process 105
 - stirring 9
- magnetron sputtering 249
 - methods 250
- magnetron sputtering PVD process 250
 - schematic drawing 250
- martensite needles 78
- matrix 88
- martensitic microstructure 64
- martensitically hardened components 65
- master process controller 392
- material dwell time 432
 - estimation 432
- material flow/segregation 384
- material variable analysis 234
- mathematical model 124, 198
- maximum punch speed 386
- Maxwell equations 374, 375
- Meander experiments 329
 - tool 329
- MELEC pulse power supply (SPIK 2000 A) 257, 263
- melt-based metallurgical synthesis 121

- melting alloys 179
 – aluminium 179
 – magnesium 179
 – modular design 179
 melting curve 157
 melting energy 380, 381
 melting point alloys 3
 MeSES code 208, 215
 metal alloys 411
 metal flow 314
 metal matrix composites (MMCs) 20,
 317
 metal solidification process 52
 metal velocity 341
 – simulation 341
 metallic alloys 169, 247
 – alloys 247
 – steel 247
 metallic melt 4
 metallic precipitations 290
 metallic suspensions 46, 169–171, 175,
 183, 186
 – rheological behaviour 175
 – structural changes 46
 – yield stress 186
 metallic tool 292
 – frames 296
 metallographic image 59, 84
 metallographic tests 115
 metallurgical raw material production 135
 MHD agitation 126
 MHD grain structures 114
 MICRESS simulation 353
 micro-macro model 229
 micromechanics/homogenization
 techniques 221, 222
 microprobe examination 72, 79
 microstructure analysis 87, 435
 microstructure parameter determination
 81
 – assessment 81
 model tests 290
 molybdenum-based alloy (TZM) 248, 332,
 400
 molybdenum disilicide 296
 momentum conservation equations 198
 monolithic steel 181
 mould filling behaviour 327
 multi-stage forging process 3
 multicomponent pins 181
 multilayer system W-ZrO₂ 261
 – deposition parameters 261
 multiphase areas 43
 multisectioinal tool 337
- n**
 near-isothermal steel thixoextrusion
 experiments 299
 needle-shaped pearlite 94
 – interference-contrast image 94
 Newtonian flow behaviour 184
 Newtonian fluid 45, 172, 226
 NIF values 279
 nitride/boride-based coatings 248
 nitrogen gas 289
 non-interacting particles 173
 non-isothermal compression tests 235
 – concept 416
 – filling experiment 207
 – non-isothermal effects 169
 – non-steady-state behaviour 234
 – schematic diagram 417
 – simulated load-displacement curves
 235
 – solid fraction distribution 169
 – thixoextrusion experiments 428
 – tool 416
 non-metallic contamination 130
 non-oxide ceramics 282
 non-porous body 277
 – elastic modulus 277
 non-returnable container 356
 nucleation/crystal growth process 52
 nucleation parameters 210
 numerical models 197
 numerical solution techniques 199
 – discretization methods 199
- o**
 oil pump 319
 one-dimensional cooling simulation 432
 – schematic diagram 432
 one-phase models 6
 open-loop control schemes 378
 oscillating circuit parameters 320
 oscillation experiments 188
 Ostwald ripening 58, 171, 188, 350
 oxide-free material 326
 oxide-resistant skin 326
 oxide ceramics 294
 – alumina 294
 – coating materials 249
 – zirconium oxide 294
 oxide restrainer 334
 – thermograph 334
 oxide systems 148
 oxygen flow rate 262
 – effect 262
 oxygen partial pressure 263, 294

- oxygen-sensitive elements 358
 - magnesium/lithium impede 358
- p**
 - parameter-independent fine globular microstructure 435
 - parameter determination/adjustment 204
 - procedure 204
 - partial differential equation 375
 - partial liquid bodies 45
 - partial liquid materials 67
 - holding experiments 67
 - partial liquid metallic suspensions 47
 - rheological characteristics 47
 - partial liquid metals 59
 - partial liquid state 51, 56, 67, 86
 - microstructure 51
 - particle-reinforced aluminium alloy 413
 - passive stirring 9
 - peak voltage 273
 - parameters 273
 - pearlite nose 92
 - performance-related tests 279–281
 - adhesion 281
 - high-temperature tribiological 281
 - thermal shock evaluations 281
 - phase boundary surface 77
 - phase diagram 147
 - phase fractions 55
 - physical vapour deposition (PVD) 246
 - coating 251, 267
 - compression plates 266
 - hot working steel 267, 301
 - machine 260
 - metallic mould 251
 - method 249
 - PECVD coating technologies 249
 - process technology 301
 - technology 254
 - PID controller 381, 394
 - piezoelectric pressure sensors 178
 - pilot experiments 337
 - planetary motion 263
 - plasma-assisted CVD process 250
 - plasma-based deposition technique 250
 - plasma-enhanced chemical vapour deposition (PECVD) 246
 - coating 251
 - collisions 251
 - deposition chamber 270
 - process 272
 - schematic presentation 251, 270
 - system 270
 - technology 301
 - plastic deformation 10, 253
 - pneumatic cylinder 391
 - porous structure 276
 - power density (PD) 272
 - influence 272
 - power generators 12
 - power input 12
 - power-time curve 13, 14
 - precursor material 349
 - preheated tool 405
 - pressure-tight components 19
 - fuel rails 19
 - pressure-time curves 181
 - primary/secondary austenite 77
 - process-adapted shot chamber system 323
 - process-adapted shot sleeve system 325
 - process parameters 169, 298, 336, 430, 434
 - holding time 169
 - piston velocity 169
 - pressure 169
 - variation 430, 433
 - process-relevant material data 63
 - heat transmission coefficients 63
 - process simulation 210
 - process-specific disadvantage 316
 - process temperature 349
 - process window 411
 - diagram 412
 - processing stages 370
 - forging 370
 - roll forging 370
 - upsetting 370
 - programmable logic controller (PLC) 392
 - proportional-integral-derivative (PID) controller 380
 - prototyping steel tools 335
 - pseudo-binary phase diagram 87
 - pump housings 387
 - pyramid diamond hardness 360
 - q**
 - quasi-ledeburitic carbides 65
 - development 65
 - quenching experiments 71, 80, 81, 83, 85, 188
 - microstructures 85
 - temperature-time curve 85
 - thermodynamic calculations 81
 - quotient pyrometer 381
 - r**
 - radial gradients 11
 - radiation experiment 399, 400
 - scheme 400
 - radiation pyrometer 380

- radiation trials 400
 ram speed 232
 raw material 114
 – characteristics 114
 raw material development programme 125
 – assessment 125
 reactive magnetron sputtering 251
 refractory reaction 293
 reheating/semi-solid casting 21
 reheating time 111, 112
 remnant metal 346
 resilient components 315
 resonant circuit 373
 restraining system 326
 rheo-cast tie rods 363
 – mechanical properties 363
 rheocasting process 1, 14, 107, 312, 395
 – scheme 395
 – route 15
 rheo-container process (RCP) 135, 313, 355
 – implementation 135
 rheo-process 52, 364
 rheoforming plants 316
 rheoforming process 396
 rheological experiments 190, 203
 Rheometer 9, 175
 – tests 9
 robot controller 393
 robust process 10
 Rockwell hardness (HRC) 339
 roller-bearing steel 100Cr6 64
 – components 64
 rotating rod sticks 176
 – advantages/disadvantages 175
 rotational Rheometer 183
 RVE boundaries 223
- s**
- salt systems 148
 scanning electron microscopy (SEM) 253
 – analysis 423
 – EDS substantiates 299
 – images 95
 Scheil–Gulliver calculations 149, 150
 scrap metal 16
 scratch test measurements 279
 secondary austenite 71
 secondary dendrite arm 150
 secondary electrons 273
 SEED process 14, 16
 SEED technology 16
 – heat extraction 16
 segmented test 252
 – schematic drawing 252
- segregation mechanism 385
 self-heating alumina 421
 self-heating ceramic 295
 – schematic tool 295
 – thixocasting moulds 297
 – thixoextrusion 297
 self-heating steel thixoforming 296
 – construction 296
 self-heating thixocasting mould 297
 semi-continuous feeding techniques 296
 semi-liquid state 47
 semi-solid alloy 203
 – processing 18
 semi-solid aluminium alloys 189
 – billets 16, 18, 320
 semi-solid bar extrusion 413, 415
 semi-solid bulk material 384
 semi-solid casting 19
 – capabilities 19
 semi-solid extrusion 412
 – material 413
 – process 412
 semi-solid forging process 370
 – schematic view 370
 semi-solid forging plant 388
 semi-solid impact steel extrusion 414
 semi-solid material 17, 182, 195, 202, 268,
 314, 315, 328, 368, 369, 373, 384, 390, 398
 – disadvantage 202
 – flow stress 195
 – processing 315
 – structure 6
 – suspensions 191
 semi-solid metal (SSM) 1, 2, 7, 221, 251, 299
 – advancement 7
 – Al-Li components 138
 – alloys 169, 313, 371
 – metallurgical aspects 31
 – microstructure 223, 224
 – modification 38
 – origins 1
 – process 19, 31, 41, 312, 313
 – Rheo/Thixo-routes 34
 – rheocasting/thixocasting 31
 – schematic representation 224
 – semi-solid behaviour 223
 – slurry-making process 6, 34
 – thixotropic behaviour 371
 – technology 38, 44, 314
 semi-solid process (SSP) 149, 154, 161, 169,
 283, 286, 395
 – industry-related/target-oriented
 enhancement 169
 – suitability 158, 161

- thixoforming 241
- semi-solid sample 152
- semi-solid slug 221
- semi-solid slurry 242, 243, 247, 292, 299, 356, 414
- semi-solid state 11, 243, 289, 371
- forging 371
- semi-solid steel 23, 288, 291, 294, 299
- temperature 415
- semi-solid viscosity 227, 230, 231
- evolution 230, 231
- sequenced thixoforming methods 411
- thixoforging/thixocasting 411
- sequential tool movement 390
- Shamrock-like thixoextrusion 419
- shear/pressure gradients 6
- shear rate jump experiments 183, 184
- shear stress 173
- shear-thinning thixotropic flow behaviour 196
- Sheil equation 234
- short-wave thermal image camera 332
- Si_3N_4 -based ceramics 283
 - aluminium titanate (Al_2TiO_5) 283
- silicon carbide 285
- silicon nitride 283, 285, 286, 288, 290, 292
- applicability 292
- simulated strain rate 233
- simulative analysis 399
- simultaneous heating process 413
- single-phase feedstock material 35
- single slug production method (SSP) 15
- sintering additives 286
- sintering shrinkage 296
- slurry production 10
- small-scale thixoforging series 288
- SMM process routes 8
 - diagram 8
- software packages 200
 - Flow-3D 200
 - FLUENT 200
 - MAGMASOFT 200
- solid bonds 225, 226, 227
- shear rate 226
- solid fraction distribution 205
 - analysis 205
- solid globules 45
 - shape 45
- solid particles 45, 46, 70, 223, 227, 328
 - fluid suspension 46
 - morphology 45
- solid/liquid phases 54
 - concentration 51
 - contents 69
- fraction 312
- volume fraction 54
- solid-liquid boundary surface 57, 59, 75
- solid-liquid fraction 32, 48
- solid-liquid interface 153, 342
 - interfacial energy 60
- solid-liquid phase 138
- boundary 79
- solid-liquid suspension 45
- solid-phase determination 55
- solid-phase fraction 43, 55
- solid-phase particles 43, 57, 58
- solid-phase protrusions 53
- dissolution 53
- solid-phase skeleton fractures 108
- solid/semi-solid metals 287
- solid-state mechanics 174
 - approach 174
- solidification process 53, 337
 - simulation 53
- stable phase diagram 147
- state-of-the-art tool solutions 243
- steady-state flow curves 183
- thixotropic effects 183
- steady-state measurements 193
- steady-state temperature 382
- steady-state values 177
- steel 21, 385
 - 100Cr6 77, 159
 - alloys 319, 372
 - billets 421
 - bulk ceramic characteristics 284
 - calculations 159
 - experimental assembly presentation 176
 - extrusion process 411
 - heat treatment scheme 63
 - material aspects 43
 - materials 319
 - multitude 319
 - phase diagram 159
 - profile 242
 - rheoforging 395
 - Rheometer 175, 176
 - schematic temperature evolution 243, 244, 245
 - sheet 352
 - structural parameters 77
 - temperature 361
 - thixo lateral extrusion 385
 - thixocasting 364
 - thixoextrusion 299, 420
 - thixoforming 43, 243–245, 267, 268, 282–284, 292–294, 300
 - tool 286

- X210CrW12 21, 63
- Stefan–Boltzmann constant 376
- step-shooting experiments 325, 338
- stirring modes 9
 - mechanical stirring 9
 - passive stirring 9
- strategy/tools and process parameters 418
- stress induced and melt activated (SIMA)
 - process 105
- stress/strain rate tensors 227
- strontium-refined/titanium grain-refined alloy 343
- substrate current/voltage 271
 - time-dependent evolution 271
- surface oxides 17
- suspension rheology, *see* oscillation experiments
- Swiss Federal Institute of Technology 360

- t**
- T-shaped die-filling experiment 203
- temperature distribution 402–404
 - heat conductivity 403
- temperature interval size 48
- temperature sensitivity 48
 - measurement module 177
- terminal freezing range (TFR) 32, 38
- testing tool plate 265
- tetragonal martensite 63
- tetragonal phase 261
- textile industry 294
- thermal boundary 244
- thermal gradients 296
- thermal insulation materials 295
 - thermal conductivity 295
- thermal process 242, 283
- thermal shock 244, 285, 298
 - resistance 244, 282, 283, 288, 294
 - sensitive materials 294
- thermal spray coatings 245
- Thermo-Calc software 148
- thermochemical calculations 121, 140
 - experimental validation 140
- thermochemical metal-salt equilibrium 139
- thermochemical modelling 121
- thermochemical simulation methods 147
 - equilibrium calculations 149
 - Thermo-Calc software 148
- thermodynamic calculations 55, 67, 69, 79, 82, 89
- thermodynamic data 55, 148
 - database 156
 - usage 55
- thermodynamic diffusion calculations 76
- thermodynamic equilibrium calculations 76
- thermomechanical stress 300
- thermomechanical treatment 10
- thermophysical/thermodynamic data 401
- thin-film analysis equipment 258
- thin-film deposition techniques 249
- thin-film PVD/PECVD coating 247
- thin-film techniques 256
 - nanoin-dentation 256
 - XRD 256
- thin-walled components 387
- thixo-cast step samples 116
 - grain structure 116
- thixo/rheoforging process 371
- thixo-steel component 339
- thixocast A356 357
 - elongation 357
 - model components 317
- thixocasting process 312, 317–319, 325, 330, 332, 337
 - layout 312
 - simulation 325
- thixocasting route 311
 - aspects 311
- thixocasting step samples 133
 - aluminium-lithium alloys 133
- thixocasting/thixoforging steels 415
- thixoextrusion experiments 430, 431, 439
- thixoextrusion process 436
 - numerical simulation 436
- thixoforging components 383, 401
 - simulation 401
- thixoforging experiments 392
- thixoforging operation 373
- thixoforging tools 296
- thixoforging/thixo lateral extrusion 18, 369
 - process 389
 - schematic view 369, 370
- thixoformed components 196
- thixoformed specimens 100
- thixoforming 44
 - background 44
- thixoforming experiments 293, 294, 298
- thixoforming feedstock formation 208
 - simulation 208
- thixoforming material(s) 108, 109, 111, 387
 - assessment 111
 - parameter 109
- thixoforming moulds 251, 269
- thixoforming process 14, 17, 52, 100, 105, 106, 131, 196, 241, 255, 265, 300, 391, 392, 399, 405
 - alloy decomposition 100

- high pressure 131
 - schematic presentation 106
 - simulation 399
 - tool concepts 241
 - thixojoining components 389
 - thixotropic effects 172
 - thixotropic fluids 172
 - thixotropic material 111
 - thixotropic metal suspensions 45
 - rheological behaviour 45
 - thixotropic model 198
 - Ti/Zr grain-refined alloys 126
 - AlLi₄Cu₄ 126
 - AlLi₄Mg₈ 126
 - TiAlZrN interlayer 263
 - time-dependent flow 169
 - time-dependent thixotropic behaviour 5
 - time-dependent viscosity 6, 179
 - time-temperature curve 190
 - tin-lead alloy 170, 186
 - TiN particles 84, 86
 - titanium-doped 100Cr₆ specimens 84
 - element distribution images 84
 - titanium nitride 82, 83
 - effect 82
 - solubility limit 83
 - titanium-zirconium-molybdenum (TZM) 330, 403
 - cores 341
 - mould 251
 - segments 253
 - substrate 253
 - tool 401
 - tool design/construction 296
 - tool geometry 137, 418
 - tool materials 24
 - rating matrix 24
 - tool steel X210CrW12 150
 - calculations 150
 - schematic presentation 150
 - tool surfaces 333
 - thermography 333
 - tool systems 247
 - trajectory planning tasks 378
 - transformation kinetics 96
 - transmission electron microscopy (TEM) 275
 - transport equations 209
 - tribochemical attack 283
 - triboindenter apparatus 271
 - tube-like oxide layer 355
 - twin-screw rheomoulding 107
 - two-phase network 87
 - two-phase system 223
- u**
- UDS200 Couette rheometer 186
 - upscaled extrusion tests 425
- v**
- vacuum arc-based deposition 249
 - vacuum-formed refractory fibre 296, 322
 - validation experiments 213, 353
 - vertical capillary viscometer 179
 - Vexocast process 107
 - vigorous agitation 5
 - schematic illustration 5
 - Viscometer 179
 - viscoplastic constitutive equations 174
 - viscoplastic material 226
 - volatile precursors 250
 - volume of fluid (VOF) model 200
 - technique 200
 - volume power density 374
- w**
- warm-working steel 98
 - water-cooled rack 179
 - water-cooled sample 354
 - welded fuel tanks 119
 - welding, *see* heat treatment
 - Widmanstätten carbides 94
- x**
- X-ray diffraction (XRD) 255
 - analysis 290
 - measurements 255
 - patterns 258
 - X-ray mapping 38
 - X-ray micro-tomography 56
 - X-rayed thixocast steel 336
- y**
- yield stress 187
 - schematic diagram 187
 - Young's modulus 251, 258, 263, 265, 423
- z**
- zirconium metal oxide 260, 294, 330
 - ZrO₂-based coatings 260
 - ZrO₂-coated plates 267
 - ZrO₂ hysteresis 264
 - Zr/Sc-microalloyed AA1420 359
 - microstructure 359