

Contents

Symbols and Abbreviations	XIII
1 Introduction	1
2 Principles of Cutting Edge Engagement.....	3
2.1 Cutting Edge Form.....	4
2.2 Cutting Edge Engagement	7
2.3 Distribution of Force and Energy in the Grinding Process	11
2.4 Grit and Bond Wear.....	14
3 Structure and Composition of Grinding Wheels	17
3.1 Grit Material	17
3.1.1 Natural Grit Materials	17
3.1.2 Synthetic Grit Materials	19
3.2 Bonds	37
3.2.1 Resin Bonds.....	38
3.2.2 Vitrified Bonds.....	39
3.2.3 Metallic Bonds	40
3.2.4 Other bonds	40
3.2.5 Fillers and Additives	41
3.3 Tool Structure and Designation	42
3.3.1 Composition of Conventional Grinding Wheels	43
3.3.2 The Designation of Conventional Tools.....	45
3.3.3 Composition of Superabrasive Grinding Wheels	50
3.3.4 The Designation of Superabrasive Grinding Wheels	51
3.4 Tool Manufacture	54
3.4.1 The Manufacture of Tools with Conventional Abrasives.....	54
3.4.2 The Manufacture of Superabrasive Grinding Wheels	58
3.5 Tool Testing.....	61
3.5.1 Hardness Testing	62
3.5.2 Investigations in Grit Break-out.....	64
3.6 Abrasive Belts (Coated Abrasives)	66
3.6.1 Composition of Abrasive Belts	66
3.6.2 The Manufacture and Structure of Abrasive Belts	66

4 The Machinability of Various Materials	73
4.1 The Concept of “Machinability” in the Grinding Process	73
4.2 Influencing the Material Properties of Steels.....	74
4.2.1 Material Properties as a Function of Carbon Content	74
4.2.2 The Influence of Alloying Elements on Material Properties	77
4.2.3 Material Properties as a Function of Heat Treatment.....	79
4.3 The Structure of Various Steel Materials.....	83
4.3.1 Case-Hardened Steels.....	83
4.3.2 Heat-Treated Steels	84
4.3.3 Nitrided Steels.....	86
4.3.4 Roller Bearing Steels.....	87
4.3.5 Tool Steels.....	88
4.3.6 Non-Corrosion, Fireproof and High-Temperature Steels.....	89
4.4 Grinding Various Structural Components in Steels	91
4.5 Grinding Iron-Casting Materials.....	92
4.6 Grinding Nickel-Based Materials	94
4.6.1 Construction and Structure.....	94
4.6.2 Properties and Uses	96
4.6.3 Grinding Behaviour – Influences on the Grinding Process	96
4.7 Grinding Titanium Materials	99
4.7.1 Construction and Structure.....	99
4.7.2 Properties and Uses	102
4.7.3 Grinding Behaviour – Influences on the Grinding Process	103
4.8. Grinding Brittle Materials.....	105
4.8.1 The Machining Behaviour of Brittle Materials	106
4.8.2 Machining High-Performance Ceramics.....	107
4.8.3 Glass Machining.....	108
4.8.4 Silicon	110
5 Cooling Lubricants.....	113
5.1 Principles of Cooling Lubricants in the Grinding Process.....	113
5.1.1 General Functions	113
5.1.2 The Tribological System of Grinding.....	114
5.1.3 Requirements of Cooling Lubricants in the Grinding Process	114
5.2 Classification, Structure and Properties	116
5.2.1 Oils.....	116
5.2.2 Emulsions.....	117
5.2.3 Aqueous Solutions	119
5.2.4 Use of Additives.....	119
5.3 The Influence of Cooling Lubrication on the Grinding Process	120
5.3.1 Cooling Lubricant Type	120
5.3.2 Cooling Lubricant Supply	123
5.4 Supervision, Maintenance and Disposal	129

6 Grinding	135
6.1 Preparation.....	135
6.1.1 Dressing Kinematics.....	136
6.1.2 Sharpening.....	142
6.1.3 Further Dressing Methods – Special Methods.....	146
6.1.4 Cleaning	152
6.1.5 Dressing Variables and Effective Mechanisms – The Influence of Tool Preparation on the Grinding Process	153
6.2 Parameters.....	161
6.3. Methodological Variants according to DIN 8589.....	177
6.3.1 Introduction	177
6.3.2 External Cylindrical Grinding	182
6.3.3 Internal Cylindrical Grinding	210
6.3.4 Surface Grinding	212
6.3.5 Coated Abrasives.....	215
6.4 Other Variants.....	227
6.4.1 Gear Grinding.....	227
6.4.2 Gear Honing	248
6.5 Process Design.....	251
6.5.1 The Influence of Variables and Parameters on the Result.....	251
6.5.2 The Influence of the Grinding Tool on the Output.....	269
6.5.3 Multistage Processes	273
6.5.4 Disturbances	280
6.6 Application Examples.....	287
6.6.1 External Cylindrical Peripheral Plunge Grinding.....	287
6.6.2 External Form Grinding	290
6.6.3 Internal Cylindrical Peripheral Plunge Grinding.....	293
6.6.4 Centreless Plunge Grinding.....	296
6.6.5 Surface Peripheral Plunge Grinding.....	299
7 Honing	302
7.1 Kinematic Principles.....	303
7.2 Honing Tools and their Preparation.....	309
7.2.1 Honing Stones with Corundum or Silicon Carbide	309
7.2.2 Honing Stones with Boron Nitride and Diamond.....	309
7.3 Influences on the Process and the Work Result	310
7.3.1 Input Variables	310
7.3.2 Tool Shape and Specifications	321
7.3.3 Workpiece Structure.....	329
7.3.4 Additives	331
7.4 Examples of Application.....	333
7.4.1 Plateau Honing	333

7.4.2 Gear Honing of Externally Toothed Spur Gears with an Internally Toothed Tool	334
7.4.3 Laser Honing	337
8 Lapping and Polishing	338
8.1 Lapping	338
8.1.1 Fundamentals	339
8.1.2 Composition of Tools and Operational Materials	347
8.1.3 Accessories	350
8.1.4 Parameters	351
8.1.5 Applications	354
8.2 Polishing	356
8.2.1 Principles	357
8.2.2 Tool Construction and Composition	364
8.2.3 Accessories	367
8.2.4 Parameters	368
9 Special Methods.....	370
9.1 Abrasive Blast Cutting	370
9.1.1 Operating Principle, Initial Process Parameters and Blast Parameters	370
9.1.2 Method Variations and Applications	371
9.2 Free Abrasive Grinding	375
9.2.1 Operating Principle	375
9.2.2 Method Variations and Applications	376
9.2.3 The Influence of Input Process Parameters on the Result	379
9.3 Cutting with Geometrically Undefined Cutting Edges	380
9.3.1 Abrasive Cutting	380
9.3.2 Multi-Wire Slicing (MWS)	383
9.3.3 Inner Diameter Slicing	387
10 Process Monitoring.....	390
10.1 The Necessity of Process Monitoring	390
10.2 Sensors for Process Monitoring	392
10.2.1 Force Sensors	392
10.2.2 Current Sensors	393
10.2.3 AE-Sensors	394
10.3 First Contact Control	397
10.4 Collision Monitoring	400
10.5 Dressing Monitoring	401
10.6 Service Life Monitoring while Grinding Using AE.....	403
10.6.1 Monitoring Grinding Wheel Wear with the AE Effective Value ...	403
10.6.2 Detecting Chattering	404
10.6.3 Process Step Recognition as an Element of Reliable Monitoring ..	405

10.7 Control of Workpiece Properties 406

10.8 Reliability of Process Monitoring 408

Literature 410

Index 431