

TABLE OF CONTENTS

	PAGE
1 INTRODUCTION	1
2 SCOPE	6
3 TECHNOLOGY AND TECHNICAL TRENDS	8
3.1 Abrasive materials production	8
3.1.1 Fused aluminium oxide and related materials	8
3.1.1.1 Brown and white fused aluminium oxide.....	9
3.1.1.2 Aluminium oxide-zirconia.....	12
3.1.2 Microcrystalline aluminium oxide.....	13
3.1.3 Other aluminium oxide	16
3.1.3.1 Calcined bauxite.....	16
3.1.3.2 Calcined aluminium oxide.....	16
3.1.3.3 Ultra high-purity aluminium oxide powders	17
3.1.3.4 Pyrogenic aluminium oxide.....	17
3.1.3.5 Aluminium hydroxide	17
3.1.3.6 Abral.....	18
3.1.4 Silicon carbide.....	18
3.1.5 Diamond	19
3.1.5.1 High-pressure synthesis	20
3.1.5.2 Dynamic (shock wave) production methods.....	22
3.1.5.3 Diamond and similar materials produced by vapour deposition	22
3.1.6 Cubic boron nitride (CBN)	23
3.1.7 Cerium oxide.....	25
3.1.8 Natural mineral abrasives extraction	26
3.1.8.2 Garnet	27
3.1.8.3 Olivine	28
3.1.8.4 Pumice	29
3.1.8.5 Staurolite	30
3.1.8.6 Tripoli	30
3.1.8.7 Diatomite	31
3.1.9 Silica.....	31
3.1.10 Boron carbide	32
3.2 Abrasive materials properties and standards.....	32
3.2.1 Hardness	32
3.2.1.1 Alternative measures of hardness	33
3.2.1.2 The limits of hardness	34
3.2.2 Friability and strength.....	35
3.2.3 Other properties.....	37
3.2.3.1 Temperature effects	38
3.2.3.2 Shape.....	38
3.2.4 Fillers and additives	39
3.2.5 Grit size and standards	39
3.3 Recent developments in superhard materials	42
3.4 Bonded abrasives.....	45
3.4.1 Bond types.....	45
3.4.1.1 Resin and elastomeric bonds.....	45
3.4.1.2 Vitrified bonds.....	46
3.4.1.3 Metallic bonds	48
3.4.1.4 Other bonds.....	51
3.4.2 Nomenclature	52

3.4.2.1	Product marking system	52
3.4.2.2	Type of abrasive	52
3.4.2.3	Grit size	54
3.4.3	Properties of bonded abrasives	54
3.4.4	Dressing and truing	55
3.4.5	Applications of bonded abrasives	55
3.4.5.1	Pulpstone wheels	56
3.4.6	Coolants and lubricants	57
3.5	Coated abrasives	57
3.5.1	Backing materials and adhesives	57
3.5.2	Properties of coated abrasives	60
3.5.3	Structured or engineered coated abrasives	61
3.6	Loose abrasives	62
3.6.1	Metallic abrasives	62
3.6.1.2	Steel shot	62
3.6.1.3	Cast iron shot and grit	64
3.6.1.4	Cut wire and other metallic abrasives	64
3.6.1.4	Performance and properties	64
3.6.2	Other loose abrasives	65
3.6.2.1	Glass beads	65
3.6.2.2	Glass grit	66
3.6.2.3	Ceramic beads	66
3.6.2.4	Slag	67
3.6.2.5	Sodium bicarbonate blasting	68
3.6.2.6	Plastics	68
3.6.2.7	Natural organic materials	68
3.6.2.8	Dry ice	69
3.6.2.9	Calcium carbonate	69
3.7	Health and safety aspects	69
3.7.1	Airborne silica dust	69
3.7.2	Grinding wheel safety	71
3.7.2.1	Ring test	72
3.7.3.1	Coolants	72
3.7.3.2	Noise	72
3.7.3.3	Other areas	73
3.8	Recent developments in abrasive products	74
3.8.1	Research and development projects	75
3.9	Abrasive techniques and methods	77
3.9.1	Grinding methods	77
3.9.1.1	Standard grinding processes	77
3.9.1.2	Creep feed grinding	80
3.9.1.3	Centreless grinding	81
3.9.1.4	Grinding of ceramics	82
3.9.1.5	Other unusual grinding techniques	82
3.9.2	Abrasive blasting	82
3.9.2.1	Thermo blast technology	85
3.9.3	Shot peening	85
3.9.4	Water-jet cutting and cleaning	86
3.9.5	Coated abrasive methods	87
3.9.6	Tumbling, vibrating and other mass media finishing techniques	88
3.9.7	Polishing and lapping	90
3.9.7.1	Magnetorheological finishing (MRF)	91
3.9.7.2	Chemo-mechanical planarisation (CMP)	92
3.9.8	Wire sawing and stone cutting	96
3.9.9	Brushes	101

3.9.10 Non-woven abrasives	101
3.9.11 Abrasive foams	101
3.9.12 Grinding media for mills	102
3.9.12.1 Ball milling	102
3.9.12.2 Vibration milling	102
3.9.12.3 Attrition milling	103
3.9.13 Grinding and chemical reactions	104
4 MARKETS AND TRADE FOR ABRASIVE GRAINS AND PRODUCTS	106
4.1 Aluminium oxide	106
4.1.1 Abrasive grade bauxite	106
4.1.2 Fused aluminium oxide	108
4.1.3 Microcrystalline aluminium oxide	113
4.1.4 Other aluminium oxide-based abrasives	114
4.2 Silicon carbide	125
4.3 Superabrasives	138
4.3.1 Industrial diamond	138
4.3.1.1 Diamond pellets	147
4.3.2 Cubic boron nitride (CBN)	148
4.3.3 Superabrasive products – consumption and future growth	149
4.4 Natural abrasives	150
4.4.1 Silica sand	150
4.4.2 Emery	150
4.4.3 Pumice	150
4.4.4 Garnet	151
4.4.5 Olivine	152
4.5 Bonded abrasives markets	153
4.6 Coated abrasives markets	154
4.7 Blasting media markets	154
4.7.1 Metallic abrasives	156
4.8 Other abrasive products	157
4.8.1 Ceramic proppants and beads	158
5 MARKETS, PRODUCTION AND TRADE BY COUNTRY AND REGION	160
5.1 General economic indicators and comparisons	160
5.2 Growth trends in various user sectors	163
5.2.1 Construction Industry	163
5.2.2 Mechanical engineering	165
5.2.3 Woodworking	167
5.2.4 Semiconductors	168
5.3 Abrasive products in Western Europe	169
5.4 Germany	192
5.5 France	198
5.6 Italy	201
5.7 United Kingdom	205
5.8 Spain	209
5.9 Scandinavia	212
5.10 Benelux	221
5.11 Other West European Countries	226
5.12 Turkey	237
5.13 East European countries	240
5.14 Japan	253
5.15 India	256

5.16	Brazil.....	259
5.17	South Africa	261
6	NORTH AMERICA	263
6.1	Introduction	263
6.1.1	Trade balances.....	263
6.1.1.1	International trade in abrasive products.....	263
6.1.2	Industry concentration	267
6.1.3	Market analysis.....	267
6.1.4	Industry segments	270
6.1.5	Key trends	273
6.1.6	Key US players.....	274
6.1.7	Trends in research.....	275
6.1.8	Environmental issues.....	277
6.1.9	Classification and definition	278
6.2	Synthetic minerals.....	279
6.2.1	Aluminium oxide	279
6.2.1.1	World capacity of aluminium oxide	281
6.2.1.2	Sol gel aluminium oxide abrasives	282
6.2.1.3	Chinese issues.....	282
6.2.2	Silicon carbide	283
6.2.3	Trends	288
6.2.4	US stockpile of synthetic minerals	289
6.2.5	Patents	292
6.2.6	Leading US companies – Synthetic minerals.....	293
6.2.7	Synthetic minerals – superabrasives	298
6.2.7.1	Diamond	299
6.2.7.1.1	US defence stockpile of diamonds.....	300
6.2.7.1.2	Industrial diamond – technology trends.....	304
6.2.7.2	Cubic boron nitride (CBN).....	304
6.2.7.2.1	Cubic boron nitride – technology trends.....	305
6.2.7.3	Leading US companies – superabrasives	305
6.3	Natural minerals.....	307
6.3.1	Corundum.....	307
6.3.2	Natural industrial diamond	307
6.3.2.1	Import and export of natural industrial diamond.....	307
6.3.3	Garnet	311
6.3.3.1	Markets for garnet	312
6.3.3.2	Leading US companies – garnet	313
6.3.4	Silica.....	313
6.3.4.1	Quartz.....	313
6.3.4.2	Soft siliceous powder abrasives	313
6.3.4.3	Novaculite	314
6.3.4.4	Sand	314
6.3.4.5	Leading US companies – silica	315
6.3.5	Tripoli	316
6.3.5.1	Production of tripoli	316
6.3.5.2	Leading US companies – tripoli.....	317
6.4	Bonded abrasive products.....	318
6.4.1	Export and import of bonded abrasives	320
6.4.2	Conventional grinding wheels	324
6.4.3	Diamond and CBN grinding wheels	326
6.4.4	Leading US companies – bonded products	330
6.4.4.1	Leading US companies - superabrasive bonded products.....	333
6.4.5	Business trends.....	335

6.4.6 Research	335
6.4.7 Patents	336
6.5 Coated abrasive products.....	338
6.5.1 Markets for coated abrasive.....	340
6.5.2 Exports and imports of coated abrasives.....	341
6.5.2.1 Fabric backed abrasive belts	341
6.5.3 Leading US companies – Coated abrasives.....	349
6.5.4 Recent innovations	353
6.5.5 Patents	353
6.6 Loose abrasives	355
6.6.1 Abrasive blasting.....	355
6.6.1.1 Microblasting	356
6.6.2 Silica	356
6.6.3 Coal slag.....	356
6.6.4 Boron carbide	357
6.6.5 Metal abrasives.....	357
6.6.5.1 Production of metal abrasives.....	358
6.6.5.2 Price	359
6.6.5.3 International trade in metal abrasives	359
6.6.6 Trends in loose abrasives	361
6.6.8 Leading US companies – loose abrasives.....	362
6.7 Wholesalers and distributors	367
6.7.1 Market status	367
6.8 Market forecasts for the US abrasives industry.....	370
6.9 Canadian abrasives industry	373
6.9.1 Leading Canadian companies.....	377
6.10 Mexico.....	380
6.10.1 Imports and exports	380
6.10.2 Leading Mexican companies.....	384
6.11 China.....	384
6.11.1 Recent changes.....	386
6.11.2 Leading Chinese companies.....	391
7 COMPANY PROFILES	403
8 SUMMARY AND CONCLUSIONS	442
9 APPENDICES	447
9.1 Currency exchange rates.....	447
9.2 Subsidiaries cross reference	448
9.3 Company addresses.....	452
9.4 National associations.....	464
9.5 Literature references	466
9.6 Glossary	469
9.7 Multilingual listing of abrasives terms.....	472
9.8 Abbreviations.....	475

TABLE OF TABLES

Table 1: Typical chemical analyses of abrasive-grade calcined bauxite (%).....	8
Table 2: Composition of typical commercial fused aluminium oxide grains (%).....	10
Table 3: Composition and properties of fused aluminium oxide abrasives	11
Table 4: Non-metallurgical aluminium oxide production by continent/region.....	12
Table 5: Composition and properties of fused aluminium oxide-zirconia abrasives	13
Table 6: Properties of microcrystalline aluminium oxide abrasive grains	14
Table 7: Description of various microcrystalline abrasives	15
Table 8: Properties of fine aluminium oxide lapping materials.....	17
Table 9: Characteristics of single crystal natural diamond.....	19
Table 10: Mechanical properties of three types of bond for diamond grinding wheels	20
Table 11: Cerium oxide use in the glass industry	26
Table 12: Emery specifications, by producer.....	27
Table 13: Garnet compositions and hardness	27
Table 14: Composition and physical properties of typical Norwegian olivine	28
Table 15: Abrasive applications of pumice	30
Table 16: Mohs hardness of synthetic and natural abrasive materials.....	33
Table 17: Knoop hardness of abrasive materials	33
Table 18: Hardness according to the Mohs-Wooddell scale.....	34
Table 19: Hardness and relative friability of aluminium oxide and silicon carbide abrasive grains	35
Table 20: Strength of individual abrasive particles	36
Table 21: Physical properties of different types of CBN	37
Table 22: Typical properties of the five main types of abrasives.....	37
Table 23: The fraction of heat going to the workpiece in different grinding regimes.....	38
Table 24: Fillers and their influence on the production or grinding process	39
Table 25: FEPA series of microgrit sizings: F series	40
Table 26: FEPA-standard 42-1984 R 1993: macrogrit sizes for grinding wheels and other bonded abrasives	40
Table 27: International abrasive standard size comparisons for coated abrasives	41
Table 28: Approximate relationship between FEPA and other national diamond and CBN grit size designations	42
Table 29: Compositions of <i>Diamix</i> powders for metallic bonds in superabrasives	49
Table 30: Approximate compositions of <i>Diabase</i> powders for metallic bonds.....	49
Table 31: Properties of <i>Diamix</i> powders for metallic bonds in superabrasives	49
Table 32: Properties of pre-alloyed powders for diamond segments	50
Table 33: Eurotungstène's metallic alloys for binding diamond abrasive powders.....	50
Table 34: Wheel and mounted point marking system - Lukas, Germany.....	52
Table 35: Wheel marking system – Saint-Gobain (formerly Universal), UK.....	53
Table 36: Dressability and wear resistance of various types of bonded CBN wheels	55
Table 37: Typical recommended grinding speeds (surface velocity) for a range of materials, using aluminium oxide or silicon carbide bonded abrasives	56
Table 38: Surface finish obtained by different grit sizes	56
Table 39: Properties of vulcanised fibre backing material.....	59
Table 40: Application ranges of various types of bond for coated abrasives.....	59
Table 41: Typical speeds for coated abrasive belts in finishing various metals	60
Table 42: Comparison of abrasive grains used in blast cleaning.....	63
Table 43: Composition and properties of <i>Chronital</i> stainless steel shot.....	64
Table 44: Example of steel shot specification.....	65
Table 45: Comparison of the performance and cost between quartz sand and cast iron blasting media.....	65
Table 46: Properties of glass	66
Table 47: Properties and specifications of <i>Zirblast</i> fused ceramic beads.....	67
Table 48: Properties of resin blast media	68

Table 49: USA: health and safety limits for crystalline silica	70
Table 50: Speeds, stresses and proof stresses for rotating grinding wheels.....	71
Table 51: Types of materials suitable for grinding with conventional abrasives and superabrasives.....	77
Table 52: Parameters for carbide grinding by diamond wheels.....	79
Table 53: Relative durability of blast media	84
Table 54: Relative costs and performance of blasting nozzles.....	84
Table 55: Water-jet cutting market by application area (%).....	86
Table 56: Properties of sapphire versus monocrystalline synthetic diamond for use as water jet abrasive nozzles	87
Table 57: Relative rates of material removal in coated belt grinding	88
Table 58: Mass finishing selection parameters	89
Table 59: Quantity of abrasive media recommended for mass media techniques.....	89
Table 60: Examples of abrasive slurries used in CMP of semiconductor integrated circuits	93
Table 61: Low dielectric constant (k) materials for circuit fabrication.....	96
Table 62: Comparison of stone cutting techniques	97
Table 63: Comparison between waste materials produced by two methods of sawing granites	97
Table 64: Main uses of natural stone worldwide	99
Table 65: Stone imports to the USA: major source countries, January 2006 (monthly totals)	100
Table 66: Comparative wear resistance of media in attrition mill grinding.....	104
Table 67: Production of bauxite by country, 2001-2005 (thousand tonnes).....	106
Table 68: Main producers of abrasive grade bauxite	108
Table 69: A comparison between Nanchuan and Henan abrasive bauxite	108
Table 70: Aluminium oxide production for non-metallurgical applications, 2001-2005 (thousands of tonnes).....	109
Table 71: World production capacity of fused aluminium oxide by country, 1998-2005 (tonnes).....	109
Table 72: Europe: fused aluminium oxide capacity, 2005 (tonnes)	110
Table 73: Fused aluminium oxide production, 2005 (tonnes).....	111
Table 74: China: leading producers of brown fused aluminium oxide (tonnes)112	
Table 75: Western Europe: market share of fused aluminium oxide abrasive grains by producer, 2005 (% by weight).....	113
Table 76: EU Countries: Imports of artificial corundum, 2005 (Euros) (Part 1).....	115
Table 77: EU Countries: Imports of artificial corundum, 2005 (Euros) (Part 2).....	116
Table 78: EU Countries: Imports of artificial corundum, 2005 (x 100 kg) (Part 1).....	117
Table 79: EU Countries: Imports of artificial corundum, 2005 (x 100 kg) (Part 2).....	118
Table 80: EU Countries: Exports of artificial corundum, 2005 (Euros) (Part 1).....	119
Table 81: EU Countries: Exports of artificial corundum, 2005 (Euros) (Part 2).....	121
Table 82: EU Countries: Exports of artificial corundum, 2005 (x 100 kg) (Part 1).....	122
Table 83: EU Countries: Exports of artificial corundum, 2005 (x 100 kg) (Part 2).....	124
Table 84: World production capacity of silicon carbide by country, 2001-2005 (tonnes).....	125
Table 85: Europe: silicon carbide capacity by producer, 2005 (tonnes)	125
Table 86: North and South America and Middle East: silicon carbide capacity by producer, 2005 (tonnes)	127
Table 87: Western Europe: price trends for silicon carbide abrasive grains, 1996-2006 (US\$).....	128
Table 88: Europe: market share of silicon carbide abrasive grain by producer, 2005	128
Table 89: EU Countries: Imports of silicon carbide, 2005 (Euros) (Part 1)	129
Table 90: EU Countries: Imports of silicon carbide, 2005 (Euros) (Part 2)	130
Table 91: EU Countries: Imports of silicon carbide, 2005 (x 100 kg) (Part 1)	131
Table 92: EU Countries: Imports of silicon carbide, 2005 (x 100 kg) (Part 2)	132
Table 93: EU Countries: Exports of silicon carbide, 2005 (Euros) (Part 1)	133
Table 94: EU Countries: Exports of silicon carbide, 2005 (Euros) (Part 2)	135

Table 95: EU Countries: Exports of silicon carbide, 2005 (x 100 kg) (Part 1)	136
Table 96: EU Countries: Exports of silicon carbide, 2005 (x 100 kg) (Part 2)	137
Table 97: USA: prices of diamond imports, 2000-2005 (\$ per carat)	138
Table 98: Synthetic diamond production and productive capacity by major country, 1997-2005 (million carats).....	139
Table 99: Production of natural industrial diamond by major country, 1998-2005 (thousand carats ¹).....	140
Table 100: EU Countries: Imports of industrial diamonds, 2005 (Euros) (Part 1).....	141
Table 101: EU Countries: Imports of industrial diamonds, 2005 (Euros) (Part 2).....	142
Table 102: EU Countries: Imports of industrial diamonds, 2005 (x 100 kg) (Part 1).....	143
Table 103: EU Countries: Imports of industrial diamonds, 2005 (x 100 kg) (Part 2).....	143
Table 104: EU Countries: Exports of industrial diamonds, 2005 (Euros) (Part 1)	144
Table 105: EU Countries: Exports of industrial diamonds, 2005 (Euros) (Part 2)	145
Table 106: EU Countries: Exports of industrial diamonds, 2005 (x 100 kg) (Part 1)	145
Table 107: Applications of diamond abrasives in the glass industry	146
Table 108: Europe: diamond saw tool market by country, 2004 (%).....	147
Table 109: Bond types used in CBN wheels in Europe, 2005 (%).....	148
Table 110: Europe: trends in the bond types used in CBN wheels, 1995-2005 (%).....	148
Table 111: Comparative cost/benefit profile for vitrified aluminium oxide and ceramic-bonded CBN grinding wheels	149
Table 112: World production of pumice, 2001-2005 (thousand tons).....	151
Table 113: Worldwide garnet production and reserves by geographical region, 2001-2005 (tonnes).....	151
Table 114: Garnet abrasive markets by geographical region, 2005 (tonnes).....	152
Table 115: Western Europe: market shares of suppliers of bonded abrasives (excluding superabrasives), 2005 (€ million and percentage).....	153
Table 116: Western Europe: market shares of suppliers of coated abrasives, 2005 (€ million and percentage).....	154
Table 117: Western Europe: consumption and prices of abrasive blasting media, 2005.....	155
Table 118: Europe: producers of steel shot and grit by production and capacity, 2005 (tonnes).....	157
Table 119: Main macro economic forecasts for the Eurozone	161
Table 120: GDP by country, 2005 (millions of US\$)	162
Table 121: Europe: total construction output 2001-2008 (billions of Euros at 2005 constant prices)	163
Table 122: Western Europe and Eastern Europe: construction output forecast by sector, 2003-2008 (%).....	164
Table 123: Concrete drilling and sawing by country, 2004 (US\$ million)	165
Table 124: Worldwide production ¹ of machine tools, 2001, 2004 and 2005 (€ million)	166
Table 125: Motor vehicle production in Europe by country, 2003-2005	167
Table 126: Total sawn-wood production by country, 1998, 2000 and 2003 (thousand m ³).....	168
Table 127: Worldwide semiconductor market growth by region, 2005-2008 (\$ million)	168
Table 128: Western Europe: overall trade patterns for abrasive products, 2005 (thousand tonnes)	169
Table 129: Western Europe: overall trade patterns for abrasive products, 2005 (\$ million)	170
Table 130: EU countries: Imports of bonded abrasives, 2005 (Euros) (Part 1)	171
Table 131: EU countries: Imports of bonded abrasives, 2005 (Euros) (Part 2)	172
Table 132: EU countries: Imports of bonded abrasives, 2005 (x 100 kg) (Part 1).....	173
Table 133: EU countries: Imports of bonded abrasives, 2005 (x 100 kg) (Part 2).....	174
Table 134: EU countries: Exports of bonded abrasives, 2005 (Euro) (Part 1).....	175
Table 135: EU countries: Exports of bonded abrasives, 2005 (Euro) (Part 2).....	177
Table 136: EU countries: Exports of bonded abrasives, 2005 (x 100 kg) (Part 1).....	178

Table 137: EU countries: Exports of bonded abrasives, 2005 (x 100 kg) (Part 2)	179
Table 138: EU countries: Imports of coated abrasives, 2005 (Euros) (Part 1).....	180
Table 139: EU countries: Imports of coated abrasives, 2005 (Euros) (Part 2).....	181
Table 140: EU countries: Imports of coated abrasives, 2005 (x 100 kg) (Part 1)	182
Table 141: EU countries: Imports of coated abrasives, 2005 (x 100 kg) (Part 2)	183
Table 142: EU countries: Exports of coated abrasives, 2005 (Euros) (Part 1)	184
Table 143: EU countries: Exports of coated abrasives, 2005 (Euros) (Part 2)	186
Table 144: EU countries: Exports of coated abrasives, 2005 (x 100 kg) (Part 1)	188
Table 145: EU countries: Exports of coated abrasives, 2005 (x 100 kg) (Part 2)	190
Table 146: Germany: production of abrasive products by major categories, 1998-2005 (€ million).....	192
Table 147: Germany: production of abrasive products by major categories, 1998-2005 (thousand tonnes and m ² x '000).....	193
Table 148: Germany: manufacturing trends for the main categories of abrasive products, 1993-2005 (€ million).....	193
Table 149: Germany: number of companies involved in manufacture of abrasive products by major categories, 1995-2005	194
Table 150: Germany: Exports of bonded abrasives, 2005 (US\$ and kg)	196
Table 151: Germany: Imports of bonded abrasives, 2005 (US\$ and kg).....	196
Table 152: Germany: Exports of coated abrasives, 2005 (US\$ and kg).....	197
Table 153: Germany: Imports of coated abrasives, 2005 (US\$ and kg).....	197
Table 154: France: abrasives production, 2000 and 2004	198
Table 155: France: Export of bonded abrasives, 2005 (US\$ and kg).....	199
Table 156: France: Import of bonded abrasives, 2005 (US\$ and kg).....	199
Table 157: France: Export of coated abrasives, 2005 (US\$ and kg).....	200
Table 158: France: Import of coated abrasives, 2005 (US\$ and kg).....	200
Table 159: Italy: sales of porcelain stoneware tiles, 1982-2005 (millions of m ²).....	201
Table 160: Italy: Exports of bonded abrasives, 2005 (US\$ and kg)	203
Table 161: Italy: Imports of bonded abrasives, 2005 (US\$ and kg).....	203
Table 162: Italy: Exports of coated abrasives, 2005 (US\$ and kg).....	204
Table 163: Italy: Imports of coated abrasives, 2005 (US\$ and kg).....	204
Table 164: UK: manufacture of bonded and coated abrasive products by major categories, 1998-2005 (UK manufacturers' sales)	205
Table 165: UK: Exports of bonded abrasives, 2005 (US\$ and kg).....	207
Table 166: UK: Imports of bonded abrasives, 2005 (US\$ and kg)	207
Table 167: UK: Export of coated abrasives, 2005 (\$ and kg).....	208
Table 168: UK: Import of coated abrasives, 2005 (\$ and kg).....	208
Table 169: Spain: Exports of bonded abrasives, 2005 (US\$ and kg).....	210
Table 170: Spain: Exports of coated abrasives, 2005 (US\$ and kg).....	211
Table 171: Spain: Imports of coated abrasives, 2005 (US\$ and kg)	211
Table 172: Denmark: Export of bonded abrasives, 2005 (US\$ and kg)	213
Table 173: Denmark: Import of bonded abrasives, 2005 (US\$ and kg).....	213
Table 174: Denmark: Export of coated abrasives, 2005 (US\$ and kg).....	214
Table 175: Denmark: Import of coated abrasives, 2005 (US\$ and kg).....	214
Table 176: Finland: Exports of bonded abrasives, 2005 (US\$ and kg)	215
Table 177: Finland: Imports of bonded abrasives, 2005 (US\$ and kg).....	215
Table 178: Finland: Exports of coated abrasives, 2005 (US\$ and kg).....	216
Table 179: Finland: Import of coated abrasives, 2005 (US\$ and kg).....	216
Table 180: Norway: Exports of bonded abrasives, 2005 (US\$ and kg)	217
Table 181: Norway: Imports of bonded abrasives, 2005 (US\$ and kg)	217
Table 182: Norway: Exports of coated abrasives, 2005 (US\$ and kg)	218
Table 183: Sweden: Exports of bonded abrasives, 2005 (US\$ and kg)	219
Table 184: Sweden: Imports of bonded abrasives, 2005 (US\$ and kg)	219
Table 185: Sweden: Exports of coated abrasives, 2005 (US\$ and kg)	220
Table 186: Sweden: Imports of coated abrasives, 2005 (US\$ and kg).....	220

Table 187: Belgium: Exports of bonded abrasives, 2005 (US\$ and kg).....	222
Table 188: Belgium: Imports of bonded abrasives, 2005 (US\$ and kg).....	222
Table 189: Belgium: Exports of coated abrasives, 2005 (US\$ and kg).....	223
Table 190: Belgium: Imports of coated abrasives, 2005 (US\$ and kg).....	223
Table 191: Netherlands: Exports of bonded abrasives, 2005 (US\$ and kg).....	224
Table 192: Netherlands: Imports of bonded abrasives, 2005 (US\$ and kg).....	224
Table 193: Netherlands: Exports of coated abrasives, 2005 (US\$ and kg).....	225
Table 194: Netherlands: Imports of coated abrasives, 2005 (US\$ and kg).....	225
Table 195: Austria: Exports of bonded abrasives, 2005 (US\$ and kg).....	227
Table 196: Austria: Imports of bonded abrasives, 2005 (US\$ and kg).....	227
Table 197: Austria: Exports of coated abrasives, 2005 (US\$ and kg).....	228
Table 198: Austria: Imports of coated abrasives, 2005 (US\$ and kg).....	228
Table 199: Greece: Exports of bonded abrasives, 2005 (US\$ and kg).....	229
Table 200: Greece: Imports of bonded abrasives, 2005 (US\$ and kg).....	229
Table 201: Greece: Exports of coated abrasives, 2005 (US\$ and kg).....	230
Table 202: Greece: Imports of coated abrasives, 2005 (US\$ and kg).....	230
Table 203: Ireland: Exports of bonded abrasives, 2005 (US\$ and kg).....	231
Table 204: Ireland: Imports of bonded abrasives, 2005 (US\$ and kg).....	231
Table 205: Ireland: Exports coated abrasives, 2005 (US\$ and kg).....	232
Table 206: Ireland: Imports of coated abrasives, 2005 (US\$ and kg).....	232
Table 207: Portugal: Exports of bonded abrasives, 2005 (US\$ and kg).....	233
Table 208: Portugal: Imports of bonded abrasives, 2005 (US\$ and kg).....	233
Table 209: Portugal: Exports of coated abrasives, 2005 (US\$ and kg).....	234
Table 210: Portugal: Imports of coated abrasives, 2005 (US\$ and kg).....	234
Table 211: Switzerland: Exports of bonded abrasives, 2005 (US\$ and kg).....	235
Table 212: Switzerland: Imports of bonded abrasives, 2005 (US\$ and kg).....	235
Table 213: Switzerland: Exports of coated abrasives, 2005 (US\$ and kg).....	236
Table 214: Switzerland: Imports of coated abrasives, 2005 (US\$ and kg).....	236
Table 215: Turkey: Exports of bonded abrasives, 2005 (US\$ and kg).....	238
Table 216: Turkey: Imports of bonded abrasives, 2005 (US\$ and kg).....	238
Table 217: Turkey: Exports of coated abrasives, 2005 (US\$ and kg).....	239
Table 218: Turkey: Imports of coated abrasives, 2005 (US\$ and kg).....	239
Table 219: East European countries' population, 2005 (millions).....	240
Table 220: Poland: Exports of coated abrasives, 2005 (US\$ and kg).....	241
Table 221: Poland: Imports of coated abrasives, 2005 (US\$ and kg).....	241
Table 222: Poland: Exports of coated abrasives, 2005 (US\$ and kg).....	242
Table 223: Poland: Imports of coated abrasives, 2005 (US\$ and kg).....	242
Table 224: Russia: Exports of bonded abrasives, 2005 (US\$ and kg).....	243
Table 225: Russia: Imports of bonded abrasives, 2005 (US\$ and kg).....	243
Table 226: Russia: Exports of coated abrasives, 2005 (US\$ and kg).....	244
Table 227: Russia: Imports of coated abrasives, 2005 (US\$ and kg).....	244
Table 228: Hungary: Exports of bonded abrasives, 2005 (US\$ and kg).....	245
Table 229: Hungary: Imports of bonded abrasives, 2005 (US\$ and kg).....	245
Table 230: Hungary: Exports of coated abrasives, 2005 (US\$ and kg).....	246
Table 231: Hungary: Imports of coated abrasives, 2005 (US\$ and kg).....	246
Table 232: Czech Republic: Exports of bonded abrasives, 2005 (US\$ and kg).....	247
Table 233: Czech Republic: Imports of bonded abrasives, 2005 (US\$ and kg).....	247
Table 234: Czech Republic: Exports of coated abrasives, 2005 (US\$ and kg).....	248
Table 235: Czech Republic: Imports of coated abrasives, 2005 (US\$ and kg).....	248
Table 236: Slovakia: Exports of bonded abrasives, 2005 (US\$ and kg).....	249
Table 237: Slovakia: Imports of bonded abrasives, 2005 (US\$ and kg).....	249
Table 238: Slovakia: Exports of coated abrasives, 2005 (US\$ and kg).....	250
Table 239: Slovakia: Imports of coated abrasives, 2005 (US\$ and kg).....	250
Table 240: Slovenia: Exports of bonded abrasives, 2005 (US\$ and kg).....	251
Table 241: Slovenia: Imports of bonded abrasives, 2005 (US\$ and kg).....	251

Table 242: Slovenia: Exports of coated abrasives, 2005 (US\$ and kg).....	252
Table 243: Slovenia: Imports of coated abrasives, 2005 (US\$ and kg).....	252
Table 244: Japan: diamond and CBN tool production, 2001-2006 (million Yen)	253
Table 245: Japan: Exports of bonded abrasives, 2005 (US\$ and kg)	254
Table 246: Japan: Imports of bonded abrasives, 2005 (US\$ and kg).....	254
Table 247: Japan: Exports of coated abrasives, 2005 (US\$ and kg)	255
Table 248: Japan: Imports of coated abrasives, 2005 (US\$ and kg).....	255
Table 249: India: Exports of bonded abrasives, 2005 (US\$ and kg)	257
Table 250: India: Imports of bonded abrasives, 2005 (US\$ and kg)	257
Table 251: India: Exports of coated abrasives, 2005 (US\$ and kg)	258
Table 252: India: Imports of coated abrasives, 2005 (US\$ and kg).....	258
Table 253: Brazil: Exports of bonded abrasives, 2005 (US\$ and kg)	259
Table 254: Brazil: Imports of bonded abrasives, 2005 (US\$ and kg)	259
Table 255: Brazil: Exports of coated abrasives, 2005 (US\$ and kg)	260
Table 256: Brazil: Imports of coated abrasives, 2005 (US\$ and kg)	260
Table 257: South Africa: Exports of bonded abrasives, 2005 (US\$ and kg).....	261
Table 258: South Africa: Imports of bonded abrasives, 2005 (US\$ and kg)	261
Table 259: South Africa: Exports of coated abrasives, 2005 (US\$ and kg).....	262
Table 260: South Africa: Imports of coated abrasives, 2005 (US\$ and kg)	262
Table 261: USA: abrasives shipments by type, 1997-2006 (thousands of US\$)	263
Table 262: Trade balance in abrasive products by country (thousands of US\$)	264
Table 263: Change in international abrasives trade, 1997-2003 (millions of US\$)	267
Table 264: Number of employees in the US abrasives industry, 2001-2006	267
Table 265: Changes in US gross domestic product (GNP), 1998-2004 (billions of US\$)	268
Table 266: Annual output of selected manufacturing sectors (billions of US\$).....	268
Table 267: USA: Abrasives production and total manufacturing output (\$ billion)	268
Table 268: Sales of abrasives compared with total manufactured sales in the USA, 1992-2005 (billion \$)	269
Table 269: Number of abrasives companies in the USA, 2001-2005	271
Table 270: The size of the US abrasives industry by number of companies and value of production, 1997-2005	272
Table 271: USA: Production of fused aluminium oxide (regular and high purity), 2001-2005 (tonnes).....	279
Table 272: USA: Imports of fused aluminium oxide, 2001-2005 (tonnes)	280
Table 273: USA: Exports of fused aluminium oxide, 2001-2005 (tonnes)	280
Table 274: Price of fused aluminium oxide, USA and Canada (\$ per ton)	280
Table 275: USA: Imports of crude aluminium oxide, 2004-2005 (tonnes)	280
Table 276: USA: Imports of ground and refined aluminium oxide, 2004-2005	280
Table 277: USA: Exports of crude aluminium oxide, 2004-2005 (tonnes)	281
Table 278: World capacity for aluminium oxide, 2005 (tonnes).....	281
Table 279: USA: Production of silicon carbide, 2001-2005 (tonnes)	283
Table 280: USA: Imports of silicon carbide, 2001-2005 (tonnes)	284
Table 281: USA: Exports of silicon carbide, 2001-2005 (tonnes).....	284
Table 282: USA: Apparent consumption of silicon carbide, 2001-2005 (tonnes).....	284
Table 283: Price of silicon carbide, USA and Canada (\$ per ton), 2001-2005	284
Table 284: USA: Net import reliance as a percentage, 2001-2005	284
Table 285: Global silicon carbide production, 2005 (tonnes)	284
Table 286: USA: Exports of crude silicon carbide, 2004-2005	286
Table 287: USA: Exports of ground and refined silicon carbide, 2004-2005	286
Table 288: USA: Imports of crude silicon carbide, 2004-2005	287
Table 289: USA: Imports of ground and refined silicon carbide, 2004-2005.....	287
Table 290: USA: Prices for aluminium oxide and silicon carbide, 2003-2005 (US\$)	288
Table 291: US Government National Defense stock pile of fused aluminium oxide, 2005 (tons)	289
Table 292: USA: production, trade and consumption of synthetic diamond,	

2001-2005 (millions of carats).....	300
Table 293: USA: Imports of synthetic diamond dust, 2004-2005.....	301
Table 294: USA: Exports of synthetic diamond dust, 2004-2005.....	302
Table 295: USA: Exports of unworked industrial diamond, 2004-2005.....	303
Table 296: USA: Import, export and re-export of diamond, 2005.....	303
Table 297: Estimated world production of synthetic diamond, by country, 2001-2005 (thousands of carats)	303
Table 298: USA: Imports of natural industrial diamond stones by country, 2004-2005.....	308
Table 299: USA: Imports of natural diamond dust, grit and powder, by country, 2004-2005	309
Table 300: USA: Exports of natural industrial diamond, by country, 2004-2005	310
Table 301: USA: re-exports of natural industrial diamond, by country, 2004-2005	310
Table 302: USA: Garnet production, 2001-2005	311
Table 303: USA: Trends in garnet production, 2000-2005 (tonnes).....	312
Table 304: USA: Production of tripoli (tons)	316
Table 305: USA: Exports of bonded abrasives, 2005	321
Table 306: USA: Import of bonded abrasives, 2005	322
Table 307: USA: Re-exporting of bonded abrasives, 2005.....	323
Table 308: USA: Exports of grinding wheels containing conventional abrasives, 2005	324
Table 309: USA: Imports of grinding wheels containing conventional abrasives, 2005.....	325
Table 310: USA: Exports of diamond and CBN grinding wheels, 2005.....	327
Table 311: USA: Imports of diamond and CBN grinding wheels, 2005.....	328
Table 312: USA: Re-exports of superabrasives products, 2005	329
Table 313: Production of coated abrasives in the USA, 2005 (\$ x '000).....	338
Table 314: USA: Exports of cloth backed coated abrasive belts, 2005.....	341
Table 315: USA: Imports of fabric backed coated abrasive belts, 2005.....	342
Table 316: USA: Re-exports of fabric backed coated abrasive belts, 2005	343
Table 317: USA: Exports of paper backed coated abrasives, 2005.....	344
Table 318: USA: Imports of paper-backed coated abrasives, 2005.....	345
Table 319: USA: Re-exports of paper-backed coated abrasives, 2005	345
Table 320: USA: Exports of other coated abrasives products (nonwoven and other products), 2005.....	346
Table 321: USA: Imports of other coated abrasive products, 2005.....	348
Table 322: USA: Re-exports of other coated abrasive products, 2005	348
Table 323: USA: Coal slag production for abrasives, 1997-2004 (tons)	356
Table 324: USA: Boron carbide production, 1996-2001	357
Table 325: USA: shipments of metallic abrasives, 2004-2005.....	358
Table 326: USA: Imports of metal abrasives, 2004 and 2005.....	360
Table 327: USA: Exports of metal abrasives, 2004 and 2005	360
Table 328: US producers of metallic abrasives, 2005	361
Table 329: Canada: Exports of bonded abrasives, 2005.....	375
Table 330: Canada: Imports of bonded abrasives, 2005	375
Table 331: Canada: Exports of coated abrasives, 2005	376
Table 332: Canada: Imports of coated abrasives, 2005	376
Table 333: Mexico: Exports of natural abrasives (pumice stone, emery, other natural abrasives), 2005	380
Table 334: Mexico: Imports of natural abrasives (pumice stone; emery; other natural abrasives), 2005	381
Table 335: Mexico: Exports of bonded abrasives (US\$ and kg), 2005	382
Table 336: Mexico: Imports of bonded abrasives (US\$ and kg), 2005.....	382
Table 337: Mexico: Exports of coated abrasives (US\$ and kg), 2005.....	383
Table 338: Mexico: Imports of coated abrasives (US\$ and kg), 2005.....	383
Table 339: China: Exports of bonded abrasives, 2005	388
Table 340: China: Imports of bonded abrasives, 2005	389
Table 341: China: Exports of coated abrasives, 2005	389

Table 342: China: Imports of coated abrasives, 2005.....	390
Table 343: Western Europe: predicted growth prospects of abrasive products by different classes, 2005-2010 (€ million)	390
Table 343: Western Europe: predicted growth prospects of abrasive products by different classes, 2005-2010 (€ million)	446

FIGURES

Figure 1: Relative size of main abrasive categories.....	271
Figure 2: Price trends for silicon carbide (\$ per ton)	283
Figure 3: Imports of crude silicon carbide, 2004	284
Figure 4: Silicon carbide grain imports, 2004.....	285
Figure 5: Silicon carbide world capacity, 2005.....	285
Figure 6: Types of bonds / all abrasives	318
Figure 7: US coated abrasives production by type, 2005.....	338
Figure 8: USA: Metal abrasives production and consumption.....	359