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ABRASIVES [ADVANCE RELEASE]

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ABRASIVES, MANUFACTURED

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In 2007, estimated Canadian and United States combined production of regular-grade fused aluminum oxide was 10,000 metric tons (t) with a value estimated to be $1.7 million. The U.S. apparent consumption of fused aluminum oxide was estimated to be 230,000 t with an estimated value of $78 million. U.S. silicon carbide production was estimated to be 35,000 t with an estimated value of $26 million. The U.S. apparent consumption of silicon carbide was estimated to be 180,000 t with an estimated value of $120 million. U.S. production of metallic abrasives was 203,000 t valued at $97 million. U.S. shipments of metallic abrasives sold or used was 220,000 t, with a value of $115 million. The U.S. apparent consumption of metallic abrasives was estimated to be 215,000 t with an estimated value of $92 million.

This report includes information on the following abrasives manufactured in the United States: aluminum-zirconium oxide, boron carbide, fused aluminum oxide, metallic shot and grit, and silicon carbide. In some cases, United States production data were combined with Canadian output to avoid disclosing company proprietary data and still provide useful data on the overall Canadian-United States market. Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using the unrounded data.

Abrasives play an important role in the fashioning and finishing of many products with a wide range of uses. Abrasives are natural or manufactured substances that are used to abrade, clean, etch, grind, polish, scour, or otherwise remove solid material by rubbing action (as in a grinding wheel) or impact (as in pressure blasting). The most important physical properties for abrasives are character of fracture (cleavage), friability, grain shape and size, hardness (scratch hardness), purity (uniformity), and toughness (rigidity). Additional considerations include availability, bonding characteristics, cost, and thermal stability. Manufactured abrasives are made from metals or minerals by heating or chemically treating them to enhance or give them abrasive properties. No single property is paramount for any use (Wellborn, 1996, p. 31, 43).

Manufactured abrasives generally dominate high-grade abrasives markets as opposed to natural abrasives because they have superior physical properties, more uniform quality, and can be tailored to meet users' needs. Consequently, manufactured abrasives typically are characterized by premium prices relative to natural abrasive minerals. Even though manufactured abrasives are usually more expensive, their durability and efficiency have proven to be more cost effective. They are preferred in many industrial applications, such as metal finishing, cutting, and polishing. In the United States, large volumes of abrasives also are used in cutting and finishing wallboard and timber. The abrasives market is mature, and the use of various manufactured abrasive materials is fairly well defined by application (Kendall, 2001, p. 55).

Fused Aluminum Oxide

Legislation and Government Programs.—During 2007, the Department of Defense (DOD) reported sales of 4,095 t of the National Defense Stockpile (NDS) aluminum oxide abrasive grain for $1.73 million. This depleted all remaining inventory of fused aluminum oxide abrasive grain. All the NDS crude fused aluminum oxide had been sold during 2000. Under Federal legislation authorizing the disposal of all NDS aluminum oxide, the DOD planned to continue such sales until all the stockpiled aluminum oxide was sold (Janet Rollins, market analyst, Defense National Stockpile Center, oral commun., November 6, 2007).

Production.—Production data for regular and high-purity fused aluminum oxide in this report were obtained by the U.S. Geological Survey (USGS) from producers in Canada and the United States. The data were collected from two companies that operated three plants and represented the entire Canadian and United States fused aluminum oxide industry (table 1). Saint-Gobain Grains & Powders operated a fused aluminum oxide plant in the United States, and Washington Mills Electro Minerals Co. operated fused aluminum oxide plants in Canada and the United States. Quantity data from the two countries were combined to avoid disclosing company proprietary data and are reported estimated and rounded to the nearest 5,000 t.

Production of regular-grade fused aluminum oxide in 2007 was an amount rounded to 10,000 t with a value rounded to $1.7 million. This represented a slight decrease in weight and a 5% increase in value compared with 2006 regular-grade fused aluminum oxide production (table 2). Reporting on the output of high-purity fused aluminum oxide has been discontinued to avoid disclosing company proprietary data.

Consumption.— Abrasive-grade fused aluminum oxide has many end uses. Specific applications in 2007 included antislip additives, bonded abrasives (such as abrasive grains that are made to adhere to each other and then are pressed or molded into abrasive tools), buffing/polishing compounds, coated abrasives (such as abrasive grains glued to a backing of paper or cloth), dry or wet blasting media, and tumbling media. Fused aluminum oxide in a micropowder form was used for industrial and electronic applications that require fine surface finishing. Fused aluminum oxide does not face any significant substitution threats at present as it is generally a very cost-effective abrasive. The total U.S. apparent consumption of all forms of fused aluminum oxide was estimated to be 230,000 t, with a value of $74.5 million in 2007.

Prices.—The USGS canvassed fused aluminum oxide producers to determine the total value of their production for the year. The survey indicated that the average unit value of regular fused aluminum oxide produced in Canada during 2007 was $165 per metric ton at the point of production; the average

value of high-purity fused aluminum oxide output was $671 per metric ton at the point of production. Prices of abrasive grain produced from these materials and sold to consumers were significantly higher. The average price of NDS fused aluminum oxide grain sold in 2007 was $423 per ton.

Average unit values of fused aluminum oxide traded by the United States in 2007 as reported here are based on U.S. Census Bureau customs value data. The average value for U.S. exports of fused aluminum oxide during the year was about $2,600 per ton. Average unit values of crude fused aluminum oxide imports during the year ranged from $172 per ton (Guyana) to $1,470 per ton (Germany), and those of fused aluminum oxide grain imports ranged from $512 per ton (China) to $4,400 per ton (Singapore).

Foreign Trade.—Compared with those of the previous year, crude fused aluminum oxide exports in 2007 increased by 19% to 18,200 t, and the value of those exports increased by 14% to $47.2 million (table 5). Of the exports shipped to 33 countries, 77% went to Canada, Germany, Japan, and Mexico.

During 2007, imports of crude fused aluminum oxide were received from 11 countries and increased by 15% to 193,000 t valued at $69.6 million compared with those of 2006; imports of ground and refined fused aluminum oxide were received from 24 countries and increased by 8% to 44,000 t valued at $48.8 million (table 6). Some of the imported crude fused aluminum oxide was refractory-grade material. China, Venezuela, and Canada supplied 84%, 10%, and 3%, respectively, of the crude imports. Compared with those of 2006, crude imports from Canada increased by 46%, and from China, by 36%, while imports from Venezuela decreased by 51%. Brazil, Germany, Austria, Italy, China, and Hungary provided 25%, 24%, 17%, 9%, 8%, and 4%, respectively, of the ground and refined material.

Silicon Carbide

Production.—One company produced abrasive-grade silicon carbide in the United States during 2007 (table 1). This company also produced similar amounts of metallurgical-grade silicon carbide. A second company, in Hopkinsville, KY, produced a small quantity of silicon carbide, primarily intended for use in heat-resistant products rather than abrasives. U.S. silicon carbide production decreased slightly during 2007 to an estimated 35,000 t, and the value of production increased by 5% to about $26.0 million (table 2).

Consumption.—Abrasive-grade silicon carbide has many end uses. Specific applications in 2007 included antislip abrasives, blasting abrasives, bonded abrasives, coated abrasives, polishing/buffing compounds, tumbling media, and wiresawing abrasives. The total silicon carbide consumed in the United States was about 180,000 t, valued at more than $121 million in 2007.

Prices.—Based on information from industry sources and publications, the average value of abrasive-grade silicon carbide at the point of manufacture was estimated to be $673 per ton in 2007. The average value of total U.S. ground silicon carbide exports in 2007 was $1,810 per ton.

During 2007, imports from China accounted for about 88% of total U.S. crude silicon carbide imports. This Chinese material had an average value of $555 per ton. The average value of the remaining 12% of U.S. crude silicon carbide imports was $511 per ton. The average value of silicon carbide grain imports was $1,590 per ton; China accounted for 40% of such imports (table 6).

Foreign Trade.—During 2007, the United States exported crude silicon carbide to 29 countries and refined and ground silicon carbide to 35 countries. The total crude silicon carbide exports for 2007 increased by 7% compared with those of the previous year to 10,300 t valued at $18.7 million (table 5). Compared with those of 2006, exports of refined or ground silicon carbide decreased by 15% to 9,020 t valued at $21.5 million. Of the refined and ground material, 74% was shipped to Canada.

In 2007, the United States imported crude silicon carbide from 11 countries and ground and refined silicon carbide from 24 countries. Imports of crude silicon carbide decreased by 16% during the year to 121,000 t valued at $66.6 million (table 6). Imports of silicon carbide in ground or refined form increased by 6% to 43,000 t valued at $68.4 million. China accounted for 88% of the crude silicon carbide imports and 40% of the ground and refined silicon carbide. A large part of the imports from China reportedly included metallurgical-grade material.

Aluminum-Zirconium Oxide

During 2007, fused aluminum-zirconium oxide for abrasive applications, such as resin-bonded grinding wheels, was produced at one plant in the United States and one plant in Canada, both belonging to Saint-Gobain Grains & Powders, but production data from the producing plants are withheld to avoid disclosing company proprietary information.

Boron Carbide

Washington Mills was the only commercial producer of boron carbide in the United States during 2007. Boron carbide was used as abrasives for lapping and ultrasonic cutting operations previously possible only with diamond dust; it was also molded to form highly wear-resistant products, such as pressure blasting nozzles, wire-drawing dies, powdered metal and ceramic forming dies, thread guides, and armor. Boron carbide was also used in nuclear applications, such as reactor control rods and neutron absorbing shielding (Washington Mills Electro Minerals Co., 2008). Domestic production data for boron carbide are withheld to avoid disclosing company proprietary data.

Metallic Abrasives

Production.—Data on U.S. production and shipments of metallic abrasives were based on a survey of domestic producers conducted by the USGS. Survey data were collected from 11 companies operating 12 plants in the United States and accounted for all domestic production (table 3).

Steel shot and grit accounted for almost all the metallic abrasives produced domestically (table 4). U.S. production of

steel shot and grit in 2007 increased slightly compared with that of 2006; the average value was $438 per ton. Six companies reported production of cut wire shot in 2007, and most of that was cut from carbon steel wire and stainless steel wire. Other products reported included shot cut from aluminum, copper, and zinc wire. One company reported production of steel nuggets, a wrought carbon steel blast medium with properties similar to steel shot.

Consumption.—Metal abrasives are used primarily as loose particles propelled at high velocities for blast cleaning or to improve the properties of metal surfaces; 75% of the abrasives is employed in cleaning operations. Principal consumers include foundries, machine tool industries, metalworking plants (particularly those supporting the automotive and aircraft industries), and steel manufacturers.

During 2007, total sales of all steel shot and grit by U.S. producers increased slightly compared with shipments in 2006 to 218,000 t with an average value of $484 per ton sold or used.

Prices.—The USGS compiles survey data on the value of production and shipments, but it does not collect price data. The values of production and shipments reported by metallic abrasive producers in 2007 are listed in table 4. Average values of steel shot and grit ranged from $0.38 to $5.74 per kilogram. Average values of cut wire shot ranged from $2.65 to $5.17 per kilogram for aluminum wire shot and from $3.09 to $6.30 per kilogram for stainless steel wire shot. Average unit values for metallic abrasives traded by the United States during 2007 were as follows: exports, $1.50 per kilogram, and imports, $0.77 per kilogram.

Foreign Trade.—During 2007, the United States exported metallic abrasives to 35 countries and imported metallic abrasives from 20 countries. U.S. exports of metallic abrasives increased by 20% during the year to 26,800 t valued at $40.1 million (table 5). Canada, China, and Mexico received 86% of the U.S. exports of metallic abrasives in 2007. U.S. imports increased by 15% in 2007 to 22,400 t valued at $17.4 million (table 6). About 62% of the imports came from Canada; most of the remaining imports, in descending order, were shipped from China, Germany, South Africa, Spain, Hong Kong, and Japan.

Outlook

Abrasives markets closely follow economic and technological trends and are greatly influenced by activity in the manufacturing sector in the United States. This is particularly true of manufacturing activities in the aerospace, automotive, furniture, housing, and steel industries. Even though abrasives markets are linked to these end-use manufacturing sectors, growth in these sectors may not necessarily lead to an increase in abrasives consumption. Improved technology in these manufacturing sectors is resulting in surface quality that requires less grinding and finishing operations that use abrasives (O'Driscoll, 2003). Less expensive imports and higher domestic costs will continue to challenge U.S. producers of fused aluminum oxide and silicon carbide to maintain market share. Competition from developing nations, especially China, will probably lead to further decreases in domestic output. China has become a dominant force in both fused aluminum oxide and silicon carbide in recent years. This has changed the makeup of the manufactured abrasives market. Lower-priced Chinese exports have displaced and will continue to displace manufactured abrasive produced in Europe and North America (Gasser, 2002). The traditional suppliers among the Western industrialized nations are expected to continue consolidating and contracting.

Emerging suppliers of fused aluminum oxide and silicon carbide in China, Eastern Europe, India, the Republic of Korea, and South America will continue to increase their prominence in world markets. Further success for these suppliers, particularly in such major markets as Japan, the United States, and Western Europe, will depend on their ability to provide higher grades of material and levels of supply reliability while maintaining lower prices. Energy costs, furnace size, quality-control systems, and the availability of essential mineral inputs will be the dominant factors influencing the competitive stance of these suppliers (O'Driscoll, 1997; Zhilun, 1997; Lunghofer and Wolfe, 1998).

The housing construction sector in North America will continue to have a significant indirect influence on demand for manufactured abrasives because of the large volumes of manufactured abrasives used in cutting and finishing wallboard and timber. The aerospace and automotive manufacturing sectors also will continue to be significant indirect influences on demand for manufactured abrasives used by metalworking operations supporting those sectors.

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TABLE 1
CRUDE ARTIFICIAL ABRASIVES MANUFACTURERS IN 2007

Company	Plant location	Product
Washington Mills Hennepin, Inc.	Hennepin, IL	Silicon carbide.
Saint-Gobain Grains & Powders	Huntsville, AL	Fused aluminum oxide (high-purity) and aluminum-zirconium oxide.
Saint-Gobain Ceramic Materials Canada Inc.	Chippewa, Ontario, Canada	Aluminum-zirconium oxide.
Washington Mills Electro Minerals Corp.	Niagara Falls, Ontario, Canada	Fused aluminum oxide (regular).
Do.	Niagara Falls, NY	Fused aluminum oxide (high-purity) and boron carbide.

Do. Ditto.

TABLE 2
ESTIMATED PRODUCTION OF CRUDE SILICON CARBIDE AND FUSED ALUMINUM OXIDE IN THE UNITED STATES AND CANADA[1, 2]

	2006		2007	
Product	Quantity[3, 4] (metric tons)	Value[3] (thousands)	Quantity[3, 4] (metric tons)	Value[3] (thousands)
Aluminum oxide, regular, abrasives[5]	10,000	$1,500	10,000	$1,700
Silicon carbide[6]	35,000	24,300	35,000	26,000

[1]Data are rounded to no more than three significant digits.

[2]Yearend stock data are withheld to avoid disclosing company proprietary data.

[3]Owing to rounding, data do not match total quarterly Mineral Industry Surveys estimated data.

[4]Quantities are rounded to the nearest 5,000 metric tons to avoid disclosing company proprietary data.

[5]Regular grade accounts for about 62% of total output, and high-purity material accounts for the remainder.

[6]Approximately one-half of the quantity and value consists of material for metallurgical and other nonabrasive applications.

TABLE 3
U.S. PRODUCERS OF METALLIC ABRASIVES IN 2007

Company	Plant location	Product (shot and/or grit)
Abrasive Materials, LLC	Hillsdale, MI	Cut wire.
Chesapeake Specialty Products, Inc.	Baltimore, MD	Steel.
Ervin Industries, Inc.	Adrian, MI	Do.
Do.	Butler, PA	Do.
Frohn North America, Inc.	Austell, GA	Cut wire.
Marwas Steel Co.	Scottdale, PA	Do.
Metaltec Steel Abrasive Co.	Canton, MI	Steel.
Peerless Metal Powders & Abrasive Co., Inc.	Detroit, MI	Steel and steel nuggets.
Pellets, LLC	Tonawanda, NY	Cut wire.
Platt Brothers & Co., Inc., The	Waterbury, CT	Do.
Premier Shot Co.	Cleveland, OH	Do.
Wheelabrator Abrasives Inc.	Bedford, VA	Steel.

Do. Ditto.

TABLE 4
PRODUCTION AND SHIPMENTS FOR METALLIC ABRASIVES IN THE UNITED STATES, BY PRODUCT[1]

Product	Production		Shipments[2]	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
2006:				
Steel shot and grit	198,000	$92,300	215,000	$106,000
Cut wire shot and other[e]	2,530	9,530	2,460	10,000
Total	200,000	102,000	218,000	116,000
2007:				
Steel shot and grit	201,000	87,900	218,000	105,000
Cut wire shot and other[e]	2,180	9,350	2,120	9,750
Total	203,000	97,200	220,000	115,000

[e]Estimated.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes reported exports.

TABLE 5
U.S. EXPORTS OF ALUMINUM OXIDE, SILICON CARBIDE, AND METALLIC ABRASIVES, BY COUNTRY AND TYPE[1]

Country	2006 Quantity (metric tons)	2006 Value[2] (thousands)	2007 Quantity (metric tons)	2007 Value[2] (thousands)
Aluminum oxide, crude:				
Belgium	--	--	41	$41
Brazil	525	$2,270	485	2,070
Canada	5,120	5,430	5,670	5,870
China	137	1,020	266	1,780
Germany	3,010	6,870	4,330	15,600
India	222	864	406	1,650
Japan	1,570	7,340	1,430	5,740
Korea, Republic of	939	5,200	631	3,560
Mexico	1,840	3,170	2,530	3,370
Other	1,890	9,090	2,390	7,550
Total	15,300	41,200	18,200	47,200
Silicon carbide:				
Crude:				
Finland	222	712	--	--
Germany	55	362	11	1,170
Japan	6	46	438	2,180
Mexico	482	1,100	407	1,100
Norway	8,620	7,910	9,260	12,500
Other	271	2,620	198	1,790
Total	9,660	12,800	10,300	18,700
Ground and refined:				
Canada	8,800	7,100	6,650	5,760
China	8	173	10	115
Costa Rica	16	49	23	63
France	29	364	1	52
Germany	145	4,410	370	9,610
Italy	53	195	16	60
Japan	200	521	529	2,040
Korea, Republic of	15	122	41	201
Mexico	474	866	953	981
Norway	545	676	42	80
Spain	66	154	35	93
United Kingdom	101	124	147	229
Other	129	1,150	201	2,170
Total	10,600	15,900	9,020	21,500
Metallic abrasives:				
Australia	7	5	106	93
Canada	9,680	7,260	8,400	6,990
China	141	724	7,660	17,000
France	203	231	104	281
Italy	24	16	--	--
Japan	28	92	420	393
Mexico	9,020	9,810	6,970	9,130
Taiwan	239	239	98	179
United Kingdom	1,960	2,630	1,150	2,510
Other	1,000	3,370	1,890	3,580
Total	22,300	24,400	26,800	40,100

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS OF ALUMINUM OXIDE, SILICON CARBIDE, AND METALLIC ABRASIVES, BY COUNTRY AND TYPE[1]

Country	2006 Quantity (metric tons)	2006 Value[2] (thousands)	2007 Quantity (metric tons)	2007 Value[2] (thousands)
Aluminum oxide:				
Crude:				
Canada	4,390	$4,130	6,420	$5,220
China	119,000	34,100	161,000	50,300
Venezuela	40,400	11,900	19,800	12,400
Other	4,480	2,060	5,130	1,710
Total	168,000	52,100	193,000	69,600
Ground and refined:				
Austria	6,410	9,560	7,400	11,300
Brazil	11,600	9,630	11,100	8,550
Canada	938	1,390	715	1,320
China	2,010	784	3,450	1,770
France	1,260	1,900	1,410	2,500
Germany	9,900	14,400	10,700	14,400
Hungary	2,120	1,730	1,880	1,640
Italy	3,030	2,660	4,060	3,170
Korea, Republic of	780	919	231	255
South Africa	40	115	22	31
United Kingdom	831	2,030	364	891
Other	1,800	2,640	2,630	3,030
Total	40,700	47,700	44,000	48,800
Silicon carbide:				
Crude:				
Brazil	380	167	456	273
China	118,000	55,400	106,000	59,100
Netherlands	4,140	558	6,800	1,450
Romania	6,180	720	--	--
Russia	1,510	913	--	--
Venezuela	8,050	3,280	5,190	2,880
Other	6,210	7,910	2,270	2,910
Total	145,000	69,000	121,000	66,600
Ground and refined:				
Brazil	10,500	9,250	9,600	9,340
Canada	756	814	231	266
China	16,300	13,700	17,400	20,100
Japan	2,040	10,700	1,820	10,200
Norway	1,300	6,170	2,660	14,100
Russia	1,710	1,310	1,540	1,200
Venezuela	2,680	1,540	1,800	1,160
Vietnam	3,450	2,660	5,700	4,110
Other	1,810	5,730	2,220	7,850
Total	40,500	51,900	43,000	68,400
Metallic abrasives:				
Canada	12,300	6,980	13,800	8,370
China	2,820	1,890	2,970	2,640
Germany	2,320	3,320	2,740	3,830
Other	2,100	2,220	2,900	2,520
Total	19,600	14,400	22,400	17,400

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

Source: U.S. Census Bureau.