



2010 Minerals Yearbook

ABRASIVES, MANUFACTURED

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In 2010, 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 131,000 t. U.S. silicon carbide production was estimated to be 35,000 t, with an estimated value of \$25.9 million. The U.S. apparent consumption of crude silicon carbide was estimated to be 116,000 t. U.S. production of metallic abrasives was 169,000 t valued at \$89.1 million. U.S. shipments of metallic abrasives were 187,000 t, with a value of \$117 million. The U.S. apparent consumption of metallic abrasives was estimated to be 199,000 t.

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

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 Abrasives operated a fused aluminum oxide plant in the United States, and Washington Mills Electro Minerals Corp. 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 by the producers, estimated, and rounded to the nearest 5,000 t.

Production of regular-grade fused aluminum oxide in 2010 was an amount rounded to 10,000 t, with a value rounded to \$1.7 million. The weight and value were essentially unchanged compared with 2009 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 2010 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 2010 U.S. apparent consumption of all forms of fused aluminum oxide was estimated to be 131,000 t, with a value of \$72.5 million, based on the average customs unit value for imports.

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 2010 was \$165 per metric ton at the point of production; the average value of high-purity fused aluminum oxide output was \$671 per ton at the point of production. Prices of abrasive grain produced from these materials and sold to consumers were significantly higher.

Average unit values of fused aluminum oxide traded by the United States in 2010 as reported in this publication are based on U.S. Census Bureau data. The average value for U.S. exports of crude fused aluminum oxide during the year was about \$3,400 per ton. The average customs value of crude fused

aluminum oxide imports during the year was \$555 per ton, but values ranged from \$210 per ton (Germany) to \$9,590 per ton (Republic of Korea), and those of fused aluminum oxide grain imports averaged \$1,300 per ton and ranged from \$481 per ton (United Kingdom) to \$6,700 per ton (Slovakia). The extremely high values represent small quantities of highly specialized materials.

Foreign Trade.—Compared with those of the previous year, crude fused aluminum oxide exports in 2010 increased by 62% to 20,000 t, and the value of those exports increased by 112% to \$67.9 million (table 5). Of the exports shipped to 39 countries, 78% went to Canada, Germany, Mexico, and the United Kingdom, in decreasing order by quantity.

During 2010, imports of crude fused aluminum oxide were received from 12 countries and increased by 268% to 141,000 t valued at \$78.1 million compared with those of 2009; imports of ground and refined fused aluminum oxide were received from 22 countries and increased by 71% to 44,600 t valued at \$58.0 million (table 6). Some of the imported crude fused aluminum oxide was refractory-grade material. China, Venezuela, and Canada supplied 77%, 15%, and 5%, respectively, of the crude imports. Compared with those of 2009, crude imports from Canada decreased to 7,180 t from 8,450 t, while imports from China increased to 108,000 t from 24,200 t, and those from Venezuela increased to 20,400 t from 5,090 t. Brazil, Germany, Austria, China, Hungary, and Italy provided 32%, 23%, 18%, 9%, 6%, and 4%, respectively, of the ground and refined material.

These relatively large increases in the quantities and values of aluminum oxide exports and imports are because of the improvement of global economic conditions during 2010 and its impact on industries that use aluminum oxide.

Silicon Carbide

Production.—One company produced abrasive-grade silicon carbide in the United States during 2010 (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 2010 to an estimated 35,000 t, and the value of production decreased slightly to \$25.9 million (table 2).

Consumption.—Abrasive-grade silicon carbide has many end uses. Specific applications in 2010 included antislip abrasives, blasting abrasives, bonded abrasives, coated abrasives, polishing/buffing compounds, tumbling media, and wiresawing abrasives. The total abrasive-grade silicon carbide consumed in the United States in 2010 was about 116,000 t with a value of \$92.0 million, based on the average customs unit value for imports.

Prices.—Based on information from industry sources and publications, the average value of abrasive-grade silicon carbide at the point of manufacture was \$739 per ton in 2010, which was unchanged compared with that of 2009. The average value for U.S. crude silicon carbide exports in 2010 was \$1,460 per ton, a 5% decrease compared with that of 2009. The average

value for U.S. ground silicon carbide exports was \$5,970 per ton, a 95% increase compared with that of 2009.

Crude silicon carbide imports from China had an average value of \$801 per ton. The average value of crude silicon carbide imports from other countries was \$778 per ton. Silicon carbide grain imports from China had an average customs value of \$1,260 per ton. The average customs value of silicon carbide grain imports from other countries was \$2,520 per ton (table 6).

Global prices for silicon carbide steadily increased throughout 2008 despite poor global economic conditions (Kennedy, 2008); then during 2009, the poor global economic conditions caused average prices to drop each quarter of that year. This trend reversed during 2010, as silicon carbide prices steadily increased throughout the year, reflecting improvement in global economic conditions. This price trend was demonstrated by the quarterly average unit values for imports of both types of silicon carbide. Crude silicon carbide import unit values increased from \$544 per ton in the first quarter to \$1,010 per ton in the fourth quarter, and silicon carbide grain unit values increased from \$2,110 per ton in the first quarter to \$2,200 per ton in the fourth quarter of 2010.

Foreign Trade.—In 2010, the United States exported crude silicon carbide to 23 countries and refined and ground silicon carbide to 39 countries. The total crude silicon carbide exports for 2010 increased by 7% compared with those of the previous year to 18,200 t valued at \$26.6 million (table 5). Of the exported crude silicon carbide material, 71% was shipped to Norway. Compared with those of 2009, exports of refined or ground silicon carbide increased by 31% to 4,920 t valued at \$29.4 million. Of the exported refined and ground material, 37% was shipped to Canada.

In 2010, the United States imported crude silicon carbide from 15 countries and imported ground and refined silicon carbide from 19 countries. Imports of crude silicon carbide increased by 66% during the year to 99,300 t valued at \$78.7 million (table 6). Imports of silicon carbide in ground or refined form increased by 140% to 43,400 t valued at \$85.9 million. China accounted for 65% of the crude silicon carbide imports and 43% of the ground and refined silicon carbide imports. A large part of the imports from China reportedly included metallurgical-grade material. During 2010, China doubled its silicon carbide production and was the world's leading producer of silicon carbide. With all grades and end uses of silicon carbide added together, China held a 70% global market share during 2010 (O'Driscoll and Watts, 2011).

These relatively large increases in the quantities and values of silicon carbide exports and imports were owing to the improvement of global economic conditions during 2010 and its impact on industries that use silicon carbide.

Aluminum-Zirconium Oxide

During 2010, fused aluminum-zirconium oxide for abrasive applications, such as resin-bonded grinding wheels, was produced at one plant in the United States, belonging to Saint-Gobain Abrasives, and one plant in Canada, belonging to Saint-Gobain Ceramic Materials Canada Inc., but production data from these plants are withheld to avoid disclosing company proprietary information.

Boron Carbide

Washington Mills Electro Minerals was the only commercial producer of boron carbide in the United States during 2010. Boron carbide was used as an abrasive for lapping and ultrasonic cutting operations previously possible only with diamond dust; it was also molded to form highly wear-resistant products, such as armor, powdered metal and ceramic forming dies, pressure blasting nozzles, thread guides, and wire-drawing dies. Boron carbide was also used in nuclear applications, such as neutron-absorbing shielding and reactor control rods (Washington Mills Electro Minerals Corp., 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 2010 increased by 21% compared with that of 2009. Six companies reported production of cut wire shot in 2010, 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 those of 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 2010, total sales of all steel shot and grit by U.S. producers increased by 23% to 185,000 t, compared with shipments in 2009.

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 2010 are listed in table 4. Average unit values of steel shot and grit ranged from \$0.33 to \$1.23 per kilogram. Average unit values of cut wire shot ranged from \$1.90 to \$6.30 per kilogram for carbon steel, stainless steel, and zinc wire shot. The average unit value for total U.S. production of steel shot and grit in 2010 was \$0.49 per kilogram, and the average unit value for total sales of all steel shot and grit by U.S. producers was \$0.59 per kilogram. Average unit values for metallic abrasives traded by the United States during 2010 were \$1.34 per kilogram for exports and \$0.58 per kilogram for imports.

Foreign Trade.—During 2010, the United States exported metallic abrasives to 37 countries and imported metallic abrasives from 16 countries. U.S. exports of metallic abrasives increased by 19% during the year to 30,800 t valued at \$41.3

million (table 5). Canada, China, and Mexico received 90% of the U.S. exports of metallic abrasives in 2010. U.S. imports increased by 175% during 2010 to 43,400 t valued at \$25.3 million (table 6). About 87% of the imports came from Canada, Germany, and Sweden.

These relatively large increases in the quantities and values of metallic abrasives exports and imports are owing to the improvement of global economic conditions during 2010 and its impact on industries that use metallic abrasives.

Outlook

Abrasives markets are greatly influenced by activity in the manufacturing sector in the United States and by economic trends. During 2010, increases in the U.S. manufacturing sector resulted from improvement in the global economy that caused increases in U.S. manufactured abrasives production and consumption. This was 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.

The U.S. abrasive markets also are influenced by technological trends. Improved technology in these manufacturing sectors has resulted in surface quality that requires fewer grinding and finishing operations that use abrasives (O'Driscoll, 2003). Less expensive imports coupled with higher domestic production costs and low domestic production capacity continue to challenge U.S. producers of fused aluminum oxide and silicon carbide to maintain market share. Competition from developing nations, especially China, probably will lead to further decreases in domestic output. China has become a dominant force in both fused aluminum oxide and silicon carbide production in recent years. This has changed the makeup of the manufactured abrasives market. Lower-priced Chinese exports have displaced and are expected to continue to displace manufactured abrasives 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 are likely to continue to increase their prominence in world markets. China is now the world's leading producer of silicon carbide and is expected to continue expanding silicon carbide output to meet increases in global market demand (O'Driscoll and Watts, 2011). 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 are expected to be the dominant factors influencing the competitive stance of these suppliers.

The aerospace and automotive manufacturing sectors are likely to continue to have significant indirect influences on demand for manufactured abrasives used by metalworking operations supporting those sectors. The housing construction

sector in North America is expected to continue to have an indirect influence on demand for manufactured abrasives because of the large volumes of manufactured abrasives used in cutting and finishing wallboard and timber.

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TABLE 1
CRUDE ARTIFICIAL ABRASIVES MANUFACTURERS IN 2010

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

TABLE 2
ESTIMATED PRODUCTION OF CRUDE SILICON CARBIDE AND FUSED ALUMINUM OXIDE IN THE UNITED STATES AND CANADA^{1,2}

Product	2009		2010	
	Quantity ^{3,4} (metric tons)	Value ³ (thousands)	Quantity ^{3,4} (metric tons)	Value ³ (thousands)
Aluminum oxide, regular, abrasives ⁵	10,000	\$1,700	10,000	\$1,700
Silicon carbide ⁶	35,000	25,900	35,000	25,900

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

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

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

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

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

⁶Approximately 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 2010

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.
MLP Steel, LLC	Scottsdale, 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 PRODUCT¹

Product	Production		Shipments ²	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
2009:				
Steel shot and grit	137,000	\$64,900	151,000	\$83,700
Cut wire shot and other ^e	1,470	5,390	1,490	5,800
Total	138,000	70,300	152,000	89,500
2010:				
Steel shot and grit	166,000	81,300	185,000	109,000
Cut wire shot and other ^e	2,120	7,770	1,990	8,420
Total	169,000	89,100	187,000	117,000

^eEstimated.

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

²Includes reported exports.

TABLE 5
 U.S. EXPORTS OF ALUMINUM OXIDE, SILICON CARBIDE, AND METALLIC
 ABRASIVES, BY COUNTRY AND TYPE¹

Country	2009		2010	
	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)
Aluminum oxide, crude:				
Brazil	141	\$650	314	\$1,480
Canada	5,470	7,210	7,280	11,200
China	143	959	211	2,380
Germany	1,680	6,020	3,690	15,300
India	189	878	342	1,840
Japan	724	4,450	1,030	12,400
Korea, Republic of	430	3,180	1,090	9,000
Mexico	2,060	3,430	2,910	4,630
United Kingdom	634	1,640	1,730	2,250
Other	854	3,620	1,370	7,350
Total	12,300	32,000	20,000	67,900
Silicon carbide:				
Crude:				
Germany	2,550	3,020	3,040	3,470
Japan	32	458	64	1,500
Mexico	759	1,310	1,440	2,250
Norway	13,400	19,500	13,000	17,800
Other	182	1,890	669	1,650
Total	16,900	26,200	18,200	26,600
Ground and refined:				
Canada	1,680	2,540	1,810	2,620
China	71	475	261	2,530
Germany	349	4,440	495	14,700
Japan	270	873	822	3,200
Mexico	996	1,570	1,070	1,670
Other	380 ^r	1,600 ^r	473	4,700
Total	3,750	11,500	4,920	29,400
Metallic abrasives:				
Canada	5,160	4,730	6,580	6,520
China	7,470	10,400	8,340	12,600
Germany	172	572	230	956
Indonesia	824	1,500	48	28
Japan	963	972	508	487
Mexico	8,750	9,390	12,900	16,000
Taiwan	458	447	273	483
United Kingdom	753	2,080	488	656
Other	1,370	2,170	1,390	3,530
Total	25,900	32,200	30,800	41,300

^rRevised.

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

²Customs value.

TABLE 6
U.S. IMPORTS OF ALUMINUM OXIDE, SILICON CARBIDE, AND METALLIC
ABRASIVES, BY COUNTRY AND TYPE¹

Country	2009		2010	
	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)
Aluminum oxide:				
Crude:				
Canada	8,450	\$6,530	7,180	\$4,780
China	24,200	12,900	108,000	59,700
Venezuela	5,090	3,610	20,400	11,400
Other	489	181	4,580	2,250
Total	38,200	23,200	141,000	78,100
Ground and refined:				
Austria	4,210	7,100	8,010	14,400
Brazil	9,240	7,280	14,200	14,200
China	3,710	2,920	4,230	3,710
Germany	5,020	7,390	10,100	14,100
Hungary	1,100	1,090	2,530	2,430
Italy	982	1,210	1,720	2,160
Other	1,760 ^r	3,500 ^r	3,810	7,080
Total	26,000	30,500	44,600	58,000
Silicon carbide:				
Crude:				
China	39,700	24,000	64,800	51,900
Netherlands	4,540	1,330	3,020	1,340
Romania	4,320	1,260	9,240	4,400
South Africa	5,920	3,570	10,500	10,900
Venezuela	4,500	2,000	6,240	3,460
Other	935 ^r	1,250 ^r	5,510	6,710
Total	59,900	33,400	99,300	78,700
Ground and refined:				
Brazil	4,000	5,760	9,260	13,400
China	6,660	9,200	18,600	23,500
Germany	1,570	6,800	2,570	7,620
Japan	1,070	7,330	1,910	15,500
Norway	1,660	8,120	3,170	15,500
Russia	1,280	1,410	3,030	3,410
Vietnam	1,120	1,080	1,280	1,250
Other	725	1,430	3,520	5,730
Total	18,100	41,100	43,400	85,900
Metallic abrasives:				
Canada	6,380	3,920	9,610	6,990
China	1,690	3,680	1,550	2,810
Germany	1,300	1,040	1,810	1,510
Sweden	3,400	1,100	26,500	10,200
Other	3,040	2,330	4,000	3,750
Total	15,800	12,100	43,400	25,300

^rRevised.

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

²Customs value.