



2011 Minerals Yearbook

ABRASIVES, MANUFACTURED [ADVANCE RELEASE]

ABRASIVES, MANUFACTURED

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In 2011, 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 167,000 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 91,000 t. U.S. production of metallic abrasives was 202,000 t valued at \$110 million. U.S. shipments of metallic abrasives were 206,000 t, with a value of \$122 million. The U.S. apparent consumption of all forms of metallic abrasives was estimated to be 212,000 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.

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 2011 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 2010 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 2011 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 2011 U.S. apparent consumption of all forms of fused aluminum oxide was estimated to be 167,000 t, with a value of \$105 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 2011 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 2011 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 \$3,750 per ton. The average customs value of crude fused aluminum oxide imports during the year was \$627 per ton, but values ranged from \$64 per ton (Brazil) to \$3,170 per ton (France), and those of fused aluminum oxide grain imports averaged \$1,360 per ton and ranged from \$887 per ton (China) to \$9,590 per ton (Slovak Republic). 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 2011 decreased slightly to 19,900 t, and the value of those exports increased by 10% to \$74.7 million (table 5). Of the exports shipped to 42 countries, 85% went to Canada, Germany, Mexico, the United Kingdom, and Japan, in decreasing order by quantity.

During 2011, imports of crude fused aluminum oxide were received from 11 countries and increased by 26% to 177,000 t valued at \$111 million compared with those of 2010; imports of ground and refined fused aluminum oxide were received from 20 countries and increased by 4% to 46,400 t valued at \$62.9 million (table 6). Some of the imported crude fused aluminum oxide was refractory-grade material. China, Venezuela, and Canada supplied 79%, 16%, and 4%, respectively, of the crude imports. Compared with those of 2010, crude imports from Canada increased slightly to 7,210 t from 7,180 t, while imports from China increased by 30% to 141,000 t from 108,000 t, and those from Venezuela increased by 38% to 28,200 t from 20,400 t. Germany, Austria, Brazil, Canada, China, Hungary, Italy, and France provided 24%, 19%, 18%, 15%, 8%, 4%, 4%, and 4%, respectively, of the ground and refined material.

These increases in the quantities and values of aluminum oxide exports and imports are because of the continued improvement of global economic conditions during 2011 and its impact on industries that use aluminum oxide.

Silicon Carbide

Production.—One company produced abrasive-grade silicon carbide in the United States during 2011 (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 2011 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 2011 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 2011 was about 91,000 t with a value of \$115 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 2011, which was unchanged compared with that of 2010. The average value for U.S. crude silicon carbide exports in 2011 was \$1,460 per ton, a slight decrease compared with that of 2010. The average value

for U.S. ground silicon carbide exports was \$4,100 per ton, a 31% decrease compared with that of 2010.

Crude silicon carbide imports from China had an average value of \$1,250 per ton. The average value of crude silicon carbide imports from other countries was \$1,280 per ton. Silicon carbide grain imports from China had an average customs value of \$1,420 per ton. The average customs value of silicon carbide grain imports from other countries was \$2,490 per ton (table 6).

Global prices for silicon carbide steadily increased throughout 2008 despite poor global economic conditions (Kennedy, 2008); during 2009, the poor global economic conditions caused average prices to drop each quarter of that year. This trend reversed during 2010, and silicon carbide prices steadily increased throughout 2010 and 2011, reflecting improvement in global economic conditions. This price trend was demonstrated by the quarterly average unit values for exports and imports of both types of silicon carbide, which generally increased throughout 2011. Crude silicon carbide import unit values increased from \$1,010 per ton in the fourth quarter of 2010 to \$1,330 per ton in the fourth quarter of 2011, and silicon carbide grain unit values increased from \$2,200 per ton in the fourth quarter of 2010 to \$2,610 per ton in the third quarter of 2011 and then dropped to \$1,670 in fourth quarter of 2011.

Foreign Trade.—In 2011, the United States exported crude silicon carbide to 28 countries and refined and ground silicon carbide to 47 countries. The total crude silicon carbide exports for 2011 increased by 14% compared with those of the previous year to 20,800 t valued at \$30.4 million (table 5). Of the exported crude silicon carbide material, 79% was shipped to Norway. Compared with those of 2010, exports of refined or ground silicon carbide increased by 42% to 6,980 t valued at \$28.6 million. Of the exported refined and ground material, 32% was shipped to Germany.

In 2011, the United States imported crude silicon carbide from 17 countries and imported ground and refined silicon carbide from 21 countries. Imports of crude silicon carbide decreased by 23% during the year to 76,800 t valued at \$97.1 million (table 6). Imports of silicon carbide in ground or refined form increased by 20% to 52,200 t valued at \$104 million. China accounted for 44% of the crude silicon carbide imports and 47% of the ground and refined silicon carbide imports. Part of the imports from China reportedly included metallurgical-grade material. In 2010, China doubled its silicon carbide production and continued increasing production in 2011. In 2011, China again was the world's leading producer of silicon carbide. With all grades and end uses of silicon carbide added together, China held more than a two-thirds share of the global market (O'Driscoll and Watts, 2011).

Aluminum-Zirconium Oxide

During 2011, 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. 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 2011. 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., 2012). 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 2011 increased by 20% to 200,000 t compared with that of 2010. Six companies reported production of cut wire shot in 2011, 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 2011, total sales of all steel shot and grit by U.S. producers increased 10% to 204,000 t, compared with shipments in 2010. Total sales of all cut wire steel shot and grit by U.S. producers decreased 3% to 1,940 t, compared with shipments in 2010. The apparent consumption of all forms of metallic abrasives increased 17% to 212,000 t, compared with that of 2010.

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 2011 are listed in table 4. Average unit values of steel shot and grit ranged from \$0.30 to \$1.17 per kilogram. Average unit values of cut wire shot ranged from \$1.72 to \$6.39 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 2011 was \$0.52 per kilogram, and the average unit value for total sales of all steel shot and grit by U.S. producers was \$0.56 per kilogram. The average unit value for total U.S. production of cut wire shot in 2011 was \$3.64 per kilogram, and the average unit value for total sales of cut wire shot by U.S. producers was \$4.23 per kilogram. Average

unit values for metallic abrasives traded by the United States during 2011 were \$1.39 per kilogram for exports and \$0.70 per kilogram for imports.

Foreign Trade.—During 2011, the United States exported metallic abrasives to 42 countries and imported metallic abrasives from 16 countries. U.S. exports of metallic abrasives increased by 28% during the year to 39,500 t valued at \$55.0 million (table 5). Canada, China, Mexico, and the United Kingdom received 90% of the U.S. exports of metallic abrasives in 2011. U.S. imports increased by 14% during 2011 to 49,600 t valued at \$34.7 million (table 6). About 89% of the imports came from Canada, Germany, the Republic of Korea, and Sweden.

These increases in the quantities and values of metallic abrasives exports and imports were owing to the improvement of global economic conditions during 2011 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 2011, 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 2011

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	2010		2011	
	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 2011

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 (formerly Marwas Steel Co.)	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 OF METALLIC ABRASIVES IN THE
UNITED STATES, BY PRODUCT¹

Product	Production		Shipments ²	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
2010:				
Steel shot and grit	166,000	\$81,300	185,000	\$109,000
Cut wire shot and other ^c	2,120	7,770	1,990	8,420
Total	169,000	89,100	187,000	117,000
2011:				
Steel shot and grit	200,000	103,000	204,000	113,000
Cut wire shot and other ^c	1,950	7,100	1,940	8,180
Total	202,000	110,000	206,000	122,000

^cEstimated.

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	2010		2011	
	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)
Aluminum oxide, crude:				
Brazil	314	\$1,480	340	\$1,610
Canada	7,280	11,200	8,830	11,100
China	211	2,380	361	3,710
Germany	3,690	15,300	3,280	17,900
India	342	1,840	347	1,770
Japan	1,030	12,400	1,040	13,300
Korea, Republic of	1,090	9,000	933	6,860
Mexico	2,910	4,630	2,610	4,760
United Kingdom	1,730	2,250	1,080	2,570
Other	1,370	7,350	1,090	11,100
Total	20,000	67,900	19,900	74,700
Silicon carbide:				
Crude:				
Germany	3,040	3,470	2,150	2,240
Japan	64	1,500	20	601
Mexico	1,440	2,250	455	1,180
Norway	13,000	17,800	16,500	22,300
Other	669	1,650	1,690	4,020
Total	18,200	26,600	20,800	30,400
Ground and refined:				
Canada	1,810	2,620	1,820	3,340
China	261	2,530	374	3,200
Germany	495	14,700	2,260	11,600
Japan	822	3,200	494	3,010
Mexico	1,070	1,670	519	1,190
Thailand	1	4	560	654
Other	472 ^f	4,700	958	5,620
Total	4,920	29,400	6,980	28,600
Metallic abrasives:				
Canada	6,580	6,520	7,990	8,310
China	8,340	12,600	9,440	19,000
Germany	230	956	181	796
Indonesia	48	28	234	155
Japan	508	487	658	734
Mexico	12,900	16,000	16,500	19,900
Taiwan	273	483	500	596
United Kingdom	488	656	1,550	1,550
Other	1,390	3,530	2,440	4,050
Total	30,800	41,300	39,500	55,000

^fRevised.

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

²Customs value.

Source: U.S. Census Bureau.

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

Country	2010		2011	
	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)
Aluminum oxide:				
Crude:				
Canada	7,180	\$4,780	7,210	\$5,390
China	108,000	59,700	141,000	87,500
Venezuela	20,400	11,400	28,200	17,500
Other	4,580	2,250	964	505
Total	141,000	78,100	177,000	111,000
Ground and refined:				
Austria	8,010	14,400	8,720	15,500
Brazil	14,200	14,200	8,550	9,020
Canada	941	1,840	6,850	7,960
China	4,230	3,710	3,760	3,340
France	1,080	2,130	1,650	3,380
Germany	10,100	14,100	11,000	15,600
Hungary	2,530	2,430	1,870	1,830
Italy	1,720	2,160	1,790	2,150
Other	1,790 ^r	3,120 ^r	2,240	4,150
Total	44,600	58,000	46,400	62,900
Silicon carbide:				
Crude:				
Brazil	4,500	3,960	6,170	9,870
China	64,800	51,900	33,700	42,100
Netherlands	3,020	1,340	10,500	10,700
Romania	9,240	4,400	4,630	5,610
South Africa	10,500	10,900	19,000	22,800
Venezuela	6,240	3,460	34	852
Other	1,010 ^r	2,750 ^r	2,860	5,080
Total	99,300	78,700	76,800	97,100
Ground and refined:				
Brazil	9,260	13,400	13,600	19,200
China	18,600	23,500	24,300	34,600
Germany	2,570	7,620	3,000	6,050
Japan	1,910	15,500	1,920	19,500
Norway	3,170	15,500	2,880	14,000
Russia	3,030	3,410	3,580	5,030
South Africa	2,610	3,430	1,410	2,930
Vietnam	1,280	1,250	408	399
Other	907 ^r	2,300 ^r	1,060	2,290
Total	43,400	85,900	52,200	104,000
Metallic abrasives:				
Canada	9,610	6,990	10,800	8,840
China	1,550	2,810	2,220	3,710
Germany	1,810	1,510	2,650	2,250
Japan	978	1,990	1,510	3,020
Korea, Republic of	1,650	659	2,660	1,140
Sweden	26,500	10,200	28,100	14,000
Other	1,370 ^r	1,100 ^r	1,630	1,730
Total	43,400	25,300	49,600	34,700

^rRevised.

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

²Customs value.

Source: U.S. Census Bureau.