2012 Minerals Yearbook

SILICON [ADVANCE RELEASE]

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Silicon

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Domestic statistics for silicon metal containing less than 99.9% silicon—silicon metal used as feedstocks for chemical, electronic, and metallurgical applications—were aggregated with those of ferrosilicon to avoid disclosing company proprietary data for both material categories. In 2012, total domestic ferrosilicon and silicon metal production was 383,000 metric tons (t) of contained silicon (table 1) and 499,000 t on a gross-weight basis (table 2), an increase of 17% and 10%, respectively, from those of 2011. On the basis of contained silicon, U.S. exports of silicon products decreased by 11% and imports decreased by 10%. Total U.S. apparent consumption of silicon materials was 601,000 t in 2012, up 7% from the revised amount of 564,000 t in 2011, owing to increased U.S. production. Year-average import prices for 50% and 75% ferrosilicon grades each decreased by 10% and those for silicon metal decreased by 19% compared with those in 2011. Combined world production of ferrosilicon and silicon metal increased by 6% to 10.6 million metric tons (Mt) on a gross-weight basis compared with the revised amount in 2011 (table 9). China was the leading producer of these silicon materials.

Silicon is a light chemical element with metallic and nonmetallic characteristics. Silicon is rarely found free in nature; it combines with oxygen and other elements to form silicates, which compose more than 25% of the Earth's crust. Silica (SiO_2) as quartz or quartzite is used to produce silicon ferroalloys for the iron and steel industries and silicon metal for the aluminum and chemical industries. Silicon metal may be further processed into ultra-high-purity semiconductor or solar grades; these contain 99.9% or greater silicon. Semiconductor-grade silicon metal used in making computer chips is crucial to modern technology, but the quantity is likely less than 5% of total silicon metal demand (Roskill's Letter from Japan, 2000). Silicon metal may also be refined into an upgraded metallurgical form or into wafers to power solar batteries. The U.S. Geological Survey (USGS) does not survey the ultra-high-purity silicon industry for production and related data; therefore, the only information in this report about these grades is from foreign trade statistics and published sources. Unless otherwise noted, silicon metal in this report refers to silicon metal containing less than 99.9% silicon.

Production

Silicon Ferroalloys.—Domestic gross production data for silicon ferroalloys were withheld to avoid disclosing company proprietary data; they were combined with U.S. silicon metal production statistics and reported as total silicon materials (tables 1–2). Ferrosilicon was produced in the United States by two companies—CC Metals and Alloys, Inc. and Globe Metallurgical, Inc. (GMI) (table 3).

In late January 2012, Globe Specialty Metals, Inc. (GSM), owner of U.S.-based silicon producer GMI, restarted production at its Bridgeport, AL, ferrosilicon plant that was closed in November 2011 because of a fire. The plant's production capacity was rated at 42,000 metric tons per year (t/yr). As a result of the fire, GSM lost about 4,000 t of output (American Metal Market, 2012; Globe Specialty Metals, Inc., 2012c).

Silicon Metal.—Production-related statistics for silicon metal were aggregated with domestic silicon ferroalloys to avoid disclosing company proprietary data. Two companies produced silicon metal in the United States—Dow Corning Corp. and GMI (table 3). Dow Corning's silicon metal production was used internally to manufacture silicones and other chemicals. GMI was the sole merchant silicon metal producer in the United States.

Total Silicon Materials.—Data for all silicon materials that were produced in the United States in 2012—ferrosilicon, miscellaneous silicon alloys, and silicon metal—were derived from monthly and annual voluntary surveys and estimates for nonrespondents by the USGS. The gross production-related data in table 2 were obtained from all operations listed in table 3 that were canvassed by means of the USGS "Silicon Alloys" survey. U.S. production reported in the world production table reflects net production of total silicon materials (table 9); that is, it includes adjustments in inventory and in-plant consumption of ferrosilicon and silicon metal to produce magnesium ferrosilicon, miscellaneous alloys, and different grades of silicon metal.

Upgraded-Metallurgical-Grade Silicon Metal.—Upgraded-metallurgical-grade silicon metal (UMG-Si) is used in silicon-based photovoltaic (solar) cells. UMG-Si does not require as much additional refinement as does polycrystalline silicon, which has been traditionally used in solar panel wafers. GSM did not produce UMG-Si commercially in 2012; rather, the company focused on research and development projects to improve UMG-Si production at its 360-t/yr Solsil, Inc. plant in Beverly, OH (Globe Specialty Metals, Inc., 2012a, p. 2, 15–16).

Semiconductor- and Solar-Battery-Grade Silicon.—U.S. polycrystalline silicon producer Hemlock Semiconductor Group had the third highest production capacity (40,000 t/yr) worldwide, following Hong Kong-based producer GCL Poly-Energy Holdings, Ltd. and German producer Wacker Chemie AG with production capacities of 65,000 t/yr and 52,000 t/yr, respectively (Roskill's Letters from Japan, 2013, p. 1).

Worldwide overcapacity of polycrystalline silicon metal delayed the startup of two new polycrystalline silicon plants in Tennessee—Hemlock Semiconductor's 10,000-t/yr plant in Clarksville, and Wacker Chemie's 15,000-t/yr plant in Cleveland. Startup at the $1.2 billion Hemlock Semiconductor

plant, scheduled for 2012, was delayed indefinitely. Production at the $1.6 billion Wacker Chemie plant was postponed until mid-2015 from late 2013. Production at both plants primarily would target solar cell applications. Investment bank B. Riley & Co. estimated that the new plants would supply an additional 36,000 t of silicon metal to the North American market (Metal-Pages, 2012a; Wacker Chemie AG, 2012; Chattanooga Times Free Press, 2013).

Silicon Chemicals.—In June, Bluestar Silicones USA Corp. [a subsidiary of China National Bluestar (Group) Co., Ltd.] opened a new silicone manufacturing plant and research and development center in York, SC. With the plant opening, the company consolidated its former U.S. manufacturing facilities in Ventura, CA, and Rock Hill, SC. The silicone materials that would be produced at the new York facility included antifoam, dispersions, fluids, high-consistency rubbers, liquid silicone rubbers, release coatings, resins, room-temperature vulcanized silicones, and specialty fluids (Bluestar Silicones USA Corp., 2012).

Consumption

Silicon Ferroalloys and Metal.—Most ferrosilicon (including miscellaneous silicon alloys) was used to produce steel (72%) (table 4). Silicon metal was used mainly to produce chemicals, such as silanes, silicones, and others (84%). Metallurgical-grade silicon carbide can substitute for ferrosilicon, especially in iron foundries. Data on North American production and U.S. imports of silicon carbide are reported in the Manufactured Abrasives chapter of the 2012 USGS Minerals Yearbook, volume I, Metals and Minerals.

In 2012, U.S. apparent consumption of silicon materials (ferrosilicon, miscellaneous silicon alloys, and silicon metal) was 601,000 t (table 1). Consumption of ferrosilicon and silicon metal in 2012 was estimated by CRU International Ltd. to have each decreased throughout most of the world, excluding China, Cuba, countries of the former Soviet Union, except Yugoslavia, and North Korea. (CRU International's world consumption coverage excluded China, Cuba, the former Soviet Union, and North Korea.) In terms of contained silicon, ferrosilicon consumption decreased to 1.87 Mt in 2012 from 2.01 Mt (revised) in 2011, and silicon metal consumption decreased to 1.43 Mt from 1.58 Mt (revised). The area with the largest year-over-year decrease in consumption of ferrosilicon, in terms of tonnage and as categorized by CRU International, was Europe. In decreasing order of consumption, Europe, other Asian countries (excluding China, Japan, and North Korea), and Japan accounted for 72% of the ferrosilicon consumption in 2012. Areas with the largest year-over-year decreases in silicon metal consumption, in terms of tonnage and as categorized by CRU International, were Japan, other Asian countries (excluding China, Japan, and North Korea), and the United States. Also in decreasing order of consumption, the European Union (EU), the United States, and other Asian countries (excluding China, Japan, and North Korea) accounted for 73% of the silicon metal consumed in 2012 (CRU Bulk Ferroalloys Monitor, 2013a, b).

Prices

Ferrosilicon and silicon metal prices tend to vary in response to changes in supply to, and consumption requirements by, the aluminum, chemical, ferrous foundry, and steel industries. Silicon material prices on average were lower in 2012 than those in 2011 because of lessening consumption in the United States toward yearend. The year-average spot prices given by Platts Metals Week were 91.7 cents per pound for 75% ferrosilicon and 127.3 cents per pound for silicon metal; these prices were 10% and 19% lower, respectively, than those in 2011. The year-average North American transaction price for 50% ferrosilicon, as calculated from Ryan's Notes listings, was 100.4 cents per pound, a 10% decrease from that in 2011. Average monthly ferrosilicon and silicon metal spot prices were at their highest during the first quarter of 2012 before generally trending downward until hitting lows in November and December—121.3 cents per pound for silicon metal, 96 cents per pound for 50% ferrosilicon, and 88.9 cents per pound for 75% ferrosilicon. The range for spot market prices, in cents per pound, ended the year as follows: silicon metal, 119 to 124; 50% ferrosilicon, 95 to 97; and 75% ferrosilicon, 88.5 to 90.

Foreign Trade

Trade volumes discussed are based on gross weight. U.S. ferrosilicon exports decreased by 39% to 20,600 t, and their value decreased by 15% to $34.4 million from those in 2011. In decreasing order of quantity, Canada, Japan, and Mexico accounted for 88% of the total 2012 ferrosilicon exports (table 5). Exports of silicon metal decreased by 4% to 76,200 t, and their value decreased by 28% to $1.9 billion from that in 2011. In decreasing order of quantity, China, Japan, and the Republic of Korea accounted for 74% of silicon metal exports. Shipments of ultra-high-purity silicon containing more than 99.99% silicon accounted for 73% of total silicon metal exported and 98% of the total value of combined ferrosilicon and silicon metal exports.

U.S. ferrosilicon imports increased by 7% to 250,000 t, but the value of those imports decreased slightly to $373 million compared with that in 2011. These imports increased because of an increase in standard 75% ferrosilicon imports (ferrosilicon trade category of "55% to 80% silicon, other"). Imports of 75% ferrosilicon accounted for 84% of total ferrosilicon imports, by gross weight, and 83% of total ferrosilicon value (table 6). Russia (45%) was the leading source of total ferrosilicon imports, followed by China (20%) and Canada (14%).

Silicon metal imports (137,000 t) decreased by 28% from those in 2011, and decreased by 37% in value to $552 million from $884 million in 2011. The decrease in silicon metal imports was attributable to decreases of 27,500 t and 23,000 t, respectively, in the "99.00% to 99.99% silicon" and "silicon, other" trade categories. Silicon metal in the "99.00% to 99.99% silicon" trade category accounted for 80% of the quantity, and 59% of the value, respectively, of all silicon metal imported in 2012. Brazil was the leading source of total silicon metal imports with 31%, followed by South Africa with 22%, and Canada with 20%.

The estimated U.S. net import reliance for ferrosilicon and silicon metal in 2012 as a percentage of apparent consumption was 36%. Net import reliance was defined as imports minus exports plus adjustments for industry stock changes.

Antidumping Duty Administrative Reviews.—Final antidumping duty rates assessed in 2012 on imports of silicon materials to the United States are listed in table 7. Results of appeals of import antidumping duty reviews made in 2012 are listed in table 8.

U.S.-World Trade Organization (WTO) Chinese Raw Material Export Dispute Settlement Proceedings.—In January 2012, the WTO Appellate Body affirmed the WTO Dispute Settlement Body decision in favor of the United States, which found that China's curbs placed on exports of various materials in 2009 were inconsistent with China's WTO obligations. As a result, the Chinese Government eliminated the 15% tax on silicon metal exports in December (Metal-Pages, 2012b; Office of the United States Trade Representative, 2012).

World Industry Structure

In 2012, the leading producers of ferrosilicon and silicon metal, combined, were China (7 Mt), Russia (1.1 Mt), Norway (420,000 t), and the United States (357,000 t, net production). Excluding the United States, world production of ferrosilicon, on a gross-weight basis, was estimated to have been 7.93 Mt in 2012 compared with 7.82 Mt (revised) in 2011. The major ferrosilicon producers in 2012 were, in decreasing order, China, Russia, Norway, and Brazil; together they accounted for 87% of total world production (table 9).

World production of silicon metal, excluding that from the United States, was estimated to have been 2.28 Mt in 2012 compared with 1.76 Mt (revised) in 2011 (table 9). China was, by far, the leading producer of silicon metal in the world in 2012 with an estimated 1.5 Mt; this was 66% of the world total. Other major producers of silicon metal in 2012 were, in decreasing order, Norway, Brazil, and France; they accounted for 20% of total world production.

New ferrosilicon and silicon metal projects scheduled for completion around the world from 2012–16 are listed in table 10.

World Review

Canada.—GSM acquired Becancour Silicon Metals Inc.'s 51% ownership in Quebec Silicon Limited Partnership's (QSLP) (formerly Timminco Ltd.) 47,000-t/yr silicon metal plant in Becancour, Quebec Province. Dow Corning retained 49% ownership in the plant. With this acquisition, GSM became the sole merchant silicon metal producer in North America. Grupo Ferroatlántica S.L. acquired QSLP's solar-grade silicon business (Globe Specialty Metals, Inc., 2012b; Ryan's Notes, 2012).

China.—China's exports of silicon materials in 2012 were significantly lower than those in 2011 because of lower global consumption requirements, particularly from the EU steel industry and the polycrystalline silicon industry in other parts of Asia. China's exports of ferrosilicon in 2012 decreased by 27% to about 454,000 t from 622,000 t exported in 2011. Ferrosilicon containing more than 55% silicon comprised the bulk of China's 2012 ferrosilicon exports at 411,000 t. The leading countries of destination for this category of Chinese ferrosilicon were Japan (54%), the Republic of Korea (19%), the United States (5%), and India (2%). Chinese export tariffs in 2012 for ferrosilicon remained at 25% (Metal-Pages, 2012b). China's exports of silicon metal also were significantly lower in 2012 compared with those in 2011; they decreased by 18% to 480,000 t from 584,000 t. The leading countries of destination for Chinese silicon metal were Japan (25%), the Republic of Korea (19%), and Thailand (7%) (TEX Report, The, 2012a–c).

One goal of China's 12th 5-year plan introduced in 2011 was the elimination of 7.4 Mt of outdated ferroalloys production capacity, which included ferrosilicon and silicon metal production in small electric arc furnaces (EAFs). Ferrosilicon and silicon metal production in EAFs of 6,300 kilovoltampere capacity would be phased out from 2011 to 2015 (Ferro-alloys.com, 2012a, b).

Metal-Pages (2012c) reported that 10 ferroalloy producers in Ledu County, Qinghai Province, had incorporated into one group, Qinghai Jiutong Group, to jointly manage all operations. The combined operating capacity of the group was about 600,000 t, mostly barium silicon, ferrosilicon, and silicon metal.

Norway.—During April, Finnfjord AS shut down two furnaces at its 100,000-t/yr ferrosilicon plant in Finnsnes as part of a $132 million project to improve energy efficiency by about 40%. The company estimated that about 6,000 t of ferrosilicon production was lost because of the project (Metal Bulletin, 2012; Finnfjord, AS, 2013).

South Africa.—In June, Silicon Technology (Pty.) Ltd. (Siltech), announced that it would indefinitely close its 55,000-t/yr ferrosilicon plant in Ballengeich, Kwazulu Natal Province at yearend, owing to poor economic conditions and high electricity costs (Looklocal, 2012).

Ukraine.—JS Company Privat Intertrading stopped ferroalloys production at its Stakhanov Ferroalloy Works and Zaporozhye Ferroalloy Works in December and November, respectively, owing to high energy tariffs that accounted for more than one-half of their operating costs (Metal-Pages, 2012d, e). According to Roskill Information Services Ltd. (2011, p. 26, 35), ferrosilicon production capacity was 200,000 t/yr at Stakhanov and 120,000 t/yr at Zaporozhye.

Uzbekistan.—In 2012, Uzbekistan began producing silicon metal. Uz-Kor Silicon LLC constructed a 12,000-t/yr silicon metal plant in the Navoi region at a cost of about $20.5 million. The company was a joint venture among the Republic of Korea's JS Neoplant Co., Ltd. (50%), the Uzbek State Committee of Geology and Mineral Resources (25%), and OJSC Navoiazot, Uzebkistan's leading chemical company (25%) (UzDaily.com, 2012).

Outlook

Domestic and global consumption of ferrosilicon was expected to follow closely the trend in steel production, for which the annual growth rate has been typically in the range of 1% to 2% in the United States. Details of the outlook for the steel industry are discussed in the Outlook section of the Iron and Steel chapter of the 2012 USGS Minerals Yearbook, volume I, Metals and Minerals. According to the World Steel

Association (2013a), raw steel production in 2012, compared with that in 2011, increased by 2.5% to 88.6 Mt in the United States and by 1.2% worldwide to 1.55 billion metric tons (Gt). Raw steel production in China, the world's leading producer of raw steel, increased by 3.1% to about 717 Mt.

World apparent consumption of finished steel products increased slightly to 1.4 Gt in 2012 from that in 2011. This was the smallest increase since 2009, when consumption decreased by 6.5%, and was caused mainly by decreased consumption in the EU. Even in China, the leading world consumer of steel products, apparent steel consumption slowed, increasing slightly to 646 Mt in 2012 from that in 2011. The combined steel consumption in the BRIC countries—Brazil, Russia, India, and China—also only increased slightly to 785 Mt; these countries accounted for about 55% of the world total. World steel apparent consumption was projected to increase slightly to 1.45 Gt in 2013 from that in 2012, and to 1.5 Gt in 2014 (World Steel Association, 2013b).

Demand for silicon metal comes primarily from the aluminum and chemical industries. Consumption of silicon metal by the U.S. aluminum castings industry was expected to mirror the short-term annual growth rate of 4% from 2012 through 2015 in aluminum casting sales, and the long-term annual growth rate of 3% from 2012 through 2021 (Modern Casting, 2013). GSM estimated that silicones account for 50% of the silicon metal consumption in the world, excluding China, Cuba, the former Soviet Union, and North Korea (Globe Specialty Metals, Inc., 2013, p. 7). From 2011–16, the value of U.S. consumption for silicones was forecast to increase 5.6% annually to $4.1 billion. The tonnage of U.S. silicone consumption was projected to increase 4.8% annually during the same time period (Freedonia Group, Inc., The, 2012).

World polycrystalline silicon capacity increased by 17% from that in 2011 to 280,000 t in 2012. In 2012, consumption of global polycrystalline silicon was estimated to be about 200,000 t. Of that amount, the solar cell market accounted for about 93% and the semiconductor market, 7%. World production capacity for polycrystalline silicon was forecast to increase to about 491,000 t by 2015. However, in 2013 and early 2014, surplus capacity was expected to lead to further suspension of output in China and elsewhere in Asia (Roskill's Letter from Japan, 2012; 2013).

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TABLE 1
SALIENT SILICON STATISTICS[1]

(Contained silicon, unless otherwise noted)

		2008	2009	2010	2011	2012
United States:						
Production:						
Ferrosilicon	thousand metric tons	180	139	176	W	W
Silicon metal[2]	do.	W	W	W	W	W
Total silicon materials[3]	do.	W	W	W	326	383
Exports:						
Ferrosilicon	do.	10	9	15	20	12
Silicon metal	do.	35	38	65	79	75
Imports for consumption:						
Ferrosilicon	do.	190	70	157	156	173
Silicon metal	do.	168	113	171	187	136
Apparent consumption:						
Ferrosilicon	do.	352	207	312	W	W
Silicon metal[2]	do.	W	W	W	W	W
Total silicon materials[3]	do.	W	W	W	564 r	601
Price, average:						
Ferrosilicon, 50% Si[4]	cents per pound	115.86	76.93	109.33	111.30	100.38
Ferrosilicon, 75% Si[5]	do.	108.71	68.91	97.18	102.20	91.66
Silicon metal[5]	do.	162.29	116.37	140.05	157.57	127.34
World production, gross weight:						
Ferrosilicon	thousand metric tons	7,320 r	7,280 r	7,890 r	7,820 r, 6	7,930 6
Silicon metal[7]	do.	1,770 r	1,550 r	1,800 r	1,760 r, 7	2,280 7*
Total silicon materials[3]	do.	9,090 r,7	8,830 r, 7	9,690 r, 7	9,950 r, 8	10,600 8

[e]Estimated. [r]Revised. do. Ditto. W Withheld to avoid disclosing company proprietary data.
[1]Data are rounded to no more than three significant digits, except prices; may not add to totals shown.
[2]Excludes semiconductor- and solar-grades of silicon metals.
[3]Includes ferrosilicon, miscellaneous silicon alloys, and silicon metal, excluding semiconductor and solar grades.
[4]Ryan's Notes North American transaction prices based on weekly averages.
[5]Platts Metals Week mean import prices based on monthly averages.
[6]Excludes net production of ferrosilicon in the United States.
[7]Excludes net production of silicon metal in the United States.
[8]Includes total net production of ferrosilicon and silicon metal in the United States.
*Correction posted December 7, 2015.

TABLE 2
PRODUCTION, SHIPMENTS, AND STOCKS OF SILICON ALLOYS AND METAL IN THE UNITED STATES[1, 2]

(Metric tons, gross weight)

	Gross production[3]	Net shipments	Producers' stocks, December 31
2011:			
Ferrosilicon	W	W	W
Silicon metal	W	W	W
Total silicon materials[4]	455,000 r	359,000	42,600
2012:			
Ferrosilicon	W	W	W
Silicon metal	W	W	W
Total silicon materials	499,000	351,000	48,600

[r]Revised. W Withheld to avoid disclosing company proprietary data.
[1]Data are rounded to no more than three significant digits.
[2]Includes ferrosilicon, miscellaneous silicon alloys, and silicon metal, excluding semiconductor and solar grades, unless otherwise noted.
[3]Ferrosilicon production includes material consumed in the production of miscellaneous silicon alloys.
[4]January 2011 data included ferrosilicon and miscellaneous silicon alloys only.

TABLE 3
PRINCIPAL PRODUCERS OF SILICON ALLOYS AND (OR) SILICON METAL IN THE UNITED STATES IN 2012[1]

Producer	Plant location	Product
CC Metals and Alloys, Inc.	Calvert City, KY	Ferrosilicon.
Globe Metallurgical, Inc.[2]	Alloy, WV	Ferrosilicon and silicon metal.
Do.	Beverly, OH	Do.
Do.	Bridgeport, AL	Ferrosilicon.
Do.	Niagara Falls, NY	Silicon metal.
Do.	Selma, AL	Do.
Dow Corning Corp.	Mt. Meigs, AL	Do.

Do. Ditto.
[1]Silicon metal producers exclude semiconductor- and solar-grade silicon manufacturers.
[2]Owned by Globe Specialty Metals, Inc.

TABLE 4
REPORTED CONSUMPTION, BY END USE, AND STOCKS OF SILICON FERROALLOYS AND METAL IN THE UNITED STATES IN 2012[1, 2]

(Metric tons, gross weight)

End use	Silvery pig iron[3]	Ferrosilicon, 50%[4]	Ferrosilicon, 75%[5]	Silicon metal[6]	Miscellaneous silicon alloys[7]	Silicon carbide[8]
Steel:						
Carbon and high-strength, low-alloy	(9)	42,900	30,400	(10)	1,650	(10)
Stainless and heat-resisting	--	(10)	45,000	286	(10)	(10)
Full alloy	--	8,340	10,600	(10)	(10)	--
Electric and tool	--	--	(10)	--	--	(10)
Unspecified	--	689	32,000	1,250	225	5,140
Total	--	52,000	118,000	1,540	1,870	5,140
Cast irons	12,500	25,700	21,200	(11)	15,900	16,700
Superalloys	--	(11)	749	169	--	--
Alloys, excluding superalloys and alloy steel	(9)	(11)	(11)	27,700 [12]	--	(11)
Miscellaneous and unspecified	--	1,970	198	160,000 [13]	(9)	(9)
Grand total	12,500	79,600	140,000	189,000	17,700	21,800
Consumers' stocks, December 31	366	1,180	8,040	3,240	534	878

-- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes U.S. Geological Survey estimates.
[3]Typically 18% silicon content but ranges between 5% to 24% silicon content.
[4]Typically 48% silicon content but ranges between 25% to 55% silicon content; includes briquets.
[5]Typically 76% silicon content but ranges between 56% to 95% silicon content; includes briquets.
[6]Typically 98% silicon content but ranges between 96% to 99% silicon content.
[7]Typically 48% silicon content. Primarily magnesium-ferrosilicon but also includes other silicon alloys.
[8]Typically 64% silicon content but ranges between 63% to 70% silicon content. Does not include silicon carbide for abrasive or refractory uses.
[9]Included with "Cast irons," to avoid disclosing company proprietary data.
[10]Included with "Steel: Unspecified," to avoid disclosing company proprietary data.
[11]Included with "Miscellaneous and unspecified," to avoid disclosing company proprietary data.
[12]Primarily aluminum alloys.
[13]Primarily silicones and other chemicals.

TABLE 5
U.S. EXPORTS OF FERROSILICON AND SILICON METAL IN 2012[1, 2]

(Metric tons, unless otherwise specified)

Country	Gross weight	Contained weight	Value
Ferrosilicon:			
More than 55% silicon:			
Brazil	99	59	$163,000
Canada	9,310	5,580	10,300,000
Colombia	35	26	90,700
Germany	20	15	16,500
Hong Kong	5	3	7,580
Japan	3,560	2,690	7,140,000
Malaysia	5	3	7,620
Mexico	2,090	1,270	4,750,000
Spain	120	97	297,000
Turkey	5	4	14,300
Other (2 countries)	6	3	15,200
Total	15,200	9,750	22,800,000
Other ferrosilicon:			
Brazil	116	58	280,000
Canada	1,520	760	3,210,000
Colombia	79	36	238,000
Japan	218	107	536,000
Korea, Republic of	576	257	741,000
Mexico	1,490	629	3,720,000
Taiwan	42	21	60,200
Thailand	78	36	214,000
Turkey	915	423	1,940,000
United Kingdom	175	85	348,000
Other (8 countries)	155	58	315,000
Total	5,370	2,470	11,600,000
Total ferrosilicon	20,600	12,200	34,400,000
Metal:			
More than 99.99% silicon:			
China	27,900	27,900	653,000,000
Germany	3,100	3,100	92,100,000
Hong Kong	186	186	3,930,000
Italy	248	248	15,800,000
Japan	13,600	13,600	625,000,000
Korea, Republic of	2,900	2,900	145,000,000
Malaysia	750	750	60,400,000
Norway	423	423	17,600,000
Singapore	1,650	1,650	37,600,000
Taiwan	4,650	4,650	159,000,000
Other (45 countries)	265	265	28,800,000
Total	55,600	55,600	1,840,000,000
99.00–99.99% silicon:			
China	752	752	808,000
Japan	1,870	1,550	5,380,000
Korea, Republic of	5,760	5,700	18,600,000
Malaysia	504	499	438,000
Netherlands	20	20	26,500
Nicaragua	21	21	29,600
Norway	36	36	98,100
Taiwan	58	57	96,200
United Arab Emirates	20	20	52,000
United Kingdom	538	535	1,240,000
Other (12 countries)	118	117	215,000
Total	9,700	9,300	27,000,000
Other silicon:			
Canada	4,460	4,330	14,000,000

See footnotes at end of table.

TABLE 5—Continued

U.S. EXPORTS OF FERROSILICON AND SILICON METAL IN 2012[1, 2]

(Metric tons, unless otherwise specified)

Country	Gross weight	Contained weight	Value
Other silicon—Continued:			
China	2,450	2,200	9,320,000
Germany	77	75	109,000
Hong Kong	75	73	390,000
Japan	958	808	7,680,000
Korea, Republic of	208	202	512,000
Malaysia	1,280	1,240	1,700,000
Mexico	866	841	2,430,000
Netherlands	104	101	102,000
Taiwan	169	164	488,000
Other (21 countries)	208	201	541,000
Total	10,900	10,200	37,300,000
Total silicon metal	76,200	75,200	1,900,000,000

[1]Countries listed are the leading importers in terms of quantities (gross weight).

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

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF FERROSILICON AND SILICON METAL
IN 2012[1, 2]

(Metric tons, unless otherwise specified)

Country	Gross weight	Contained weight	Value
Ferrosilicon:			
55%–80% silicon, more than 3% Ca:			
Brazil	1,230	918	$2,170,000
China	1,750	1,300	2,800,000
France	224	142	611,000
Germany	31	19	78,400
India	52	39	125,000
South Africa	43	34	34,800
Vietnam	100	75	110,000
Total	3,440	2,520	5,930,000
55%–80% silicon, other:			
Brazil	1,920	1,440	2,890,000
Canada	12,500	9,200	33,200,000
China	35,800	27,000	49,200,000
Egypt	1,430	1,060	2,010,000
France	2,260	1,600	5,940,000
Iceland	5,880	4,420	8,170,000
Norway	4,530	3,470	6,130,000
Russia	112,000	85,200	153,000,000
South Africa	3,550	2,630	5,840,000
Venezuela	27,900	21,100	39,500,000
Other (5 countries)	1,240	899	4,780,000
Total	209,000	158,000	311,000,000
80%–90% ferrosilicon, Germany	255	211	256,000
More than 90% ferrosilicon, Denmark	44	41	17,300
Magnesium ferrosilicon:			
Argentina	1,110	500	1,840,000
Brazil	456	208	1,070,000
Canada	12,600	5,660	26,600,000
China	2,080	957	4,280,000
France	504	242	771,000
Germany	35	14	56,900
Hong Kong	60	26	130,000
Iceland	7	4	45,300
India	457	219	751,000
Norway	128	60	200,000
Total	17,500	7,890	35,800,000
Other ferrosilicon:			
Brazil	44	22	205,000
Canada	9,340	2,760	12,200,000
China	9,460	1,440	7,110,000
France	29	14	88,300
Germany	247	107	454,000
India	45	20	47,900
Poland	19	9	29,500
Total	19,200	4,370	20,100,000
Total ferrosilicon	250,000	173,000	373,000,000
Metal:			
More than 99.99% silicon:			
Canada	171	171	554,000
China	183	183	4,800,000
Finland	19	19	1,460,000
Germany	1,460	1,460	98,000,000
Italy	11	11	923,000
Japan	275	275	19,600,000
Korea, Republic of	340	340	22,400,000

See footnotes at end of table.

TABLE 6—Continued
U.S. IMPORTS FOR CONSUMPTION OF FERROSILICON AND SILICON METAL
IN 2012[1, 2]

(Metric tons, unless otherwise specified)

Country	Gross weight	Contained weight	Value
Metal—Continued:			
More than 99.99% silicon—Continued:			
Malaysia	37	37	4,020,000
Spain	8	8	54,700
Taiwan	56	56	2,670,000
Other (14 countries)	20	20	2,290,000
Total	2,580	2,580	157,000,000
99.00%–99.99% silicon:			
Australia	12,900	12,800	37,100,000
Brazil	35,800	35,600	97,200,000
Canada	13,500	13,400	37,500,000
France	546	541	1,470,000
Kazakhstan	720	715	1,740,000
Netherlands	360	358	1,700,000
Norway	7,180	7,130	33,000,000
South Africa	30,500	30,200	97,500,000
Spain	1,140	1,130	3,690,000
Thailand	6,590	6,550	16,800,000
Other (5 countries)	137	87	504,000
Total	109,000	109,000	328,000,000
Other silicon:			
Australia	1,870	1,840	5,910,000
Belgium	180	173	385,000
Brazil	6,760	6,680	19,800,000
Canada	14,400	14,200	37,000,000
China	163	133	339,000
France	559	551	1,420,000
Germany	265	254	302,000
Japan	441	349	910,000
Norway	614	594	1,040,000
United Kingdom	68	67	159,000
Other (4 countries)	78	66	223,000
Total	25,400	24,900	67,500,000
Total silicon metal	137,000	136,000	552,000,000

[1]Countries listed are the leading exporters in terms of quantities.
[2]Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 7

SILICON MATERIALS: FINAL ANTIDUMPING DUTY RATES ASSESSED IN 2012[1]

(Listed in order of date assessed)

Date	Imported material	Country of origin	Period of investigation	Producer and duty rate
April 20	Silicon metal[2]	China	5-year review[3]	All imports (139.49%)
September 5	Do.	do.	6/1/10–5/31/11	Shanghai Jinneng International Trade Co., Ltd. (14.36%)
September 20	Do.	do.	6/1/07–5/31/08[4]	Jiangxi Gangyuan Silicon Industry Co., Ltd. (48.64%)

Do. do. Ditto.

[1]Antidumping duties are assessed by the U.S International Trade Commission (ITC).

[2]Excludes ultrahigh-purity silicon metal (greater than 99.99% silicon).

[3]Conducted on existing antidumping duty order by the International Trade Administration (ITA) of the U.S. Department of Commerce and the ITC.

[4]Amended final results of an antidumping duty administrative review by the ITA pursuant to the U.S. Court of International Trade's final decision of September 5, 2012, as summarized on table 8.

Source: Federal Register.

TABLE 8

SILICON MATERIALS: APPEALS OF IMPORT ANTIDUMPING DUTY ADMINISTRATIVE REVIEWS IN 2012, BY DECISION DATE

Imported material	Country of origin	Period of investigation	U.S. court	Decision	Decision date	Source
Silicon metal	China	6/1/07–5/31/08	CIT	The CIT upheld the ITC's decision to exclude the sale of a surplus captive powerplant (a fixed asset) by Indian silicon metal producer Ferro Alloys Corp. Ltd. (FACOR) in the company's Selling General and Administrative (SGA) expense ratio. FACOR was one of four nonmarket economy companies used by the ITC as surrogates to evaluate antidumping duties on the subject imports. As a result, the CIT upheld the ITC decision to change the antidumping duty margins for Jiangxi Gangyuan Silicon Industry Co., Ltd. to 48.64% from 50.02% and for Shanghai Jinneng International Trade Co., Ltd. To 21.97% from 23.16%.	September 5	Globe Metallurgical Inc. v. United States, Court No. 10–00032, CIT Slip Opinion 12–114.

CIT, Court of International Trade. ITC, International Trade Commission.

TABLE 9

FERROSILICON AND SILICON METAL: WORLD PRODUCTION, BY COUNTRY[1, 2, 3]

(Metric tons, gross weight)

Country and commodity[4]	2008	2009	2010	2011[e]	2012[e]
Argentina, ferrosilicon[e]	10,400	11,300	11,000	11,000	11,000
Australia, silicon metal[e]	35,000	30,000	30,000	30,000	30,000
Bhutan, ferrosilicon[5]	30,824	90,798	97,528	94,000	94,000
Bosnia and Herzegovina:[e, 6]					
Ferrosilicon	640	470	870	1,800	--
Silicon metal	12,400	11,000	17,300	17,500	15,900
Total	13,000	11,500	18,200	19,300	15,900
Brazil:[e]					
Ferrosilicon	144,832 [7]	145,000	145,000	145,000	145,000
Silicon metal	131,940 [7]	132,000	132,000	132,000 [r]	133,000
Total	276,772 [7]	277,000	277,000	277,000 [r]	278,000
Bulgaria, ferrosilicon[e]	6,000	3,000	--	--	--
Canada:[e]					
Ferrosilicon	35,000	25,820 [7]	36,786 [7]	31,039 [7]	31,979 [7]
Silicon metal	50,000	30,000	30,000	30,000	35,000
Total	85,000	55,800	66,800	61,000	67,000
China:[e]					
Ferrosilicon	4,900,000	5,100,000	5,300,000	5,400,000	5,500,000
Silicon metal	1,100,000 [r]	993,000 [r]	1,140,000 [r]	1,050,000 [r]	1,500,000
Total	6,000,000 [r]	6,090,000 [r]	6,440,000 [r]	6,450,000 [r]	7,000,000
Egypt, ferrosilicon[e]	59,000	78,000	78,000	78,000	78,000
France:[e]					
Ferrosilicon	30,000	18,300	27,000	59,000	71,000
Silicon metal	118,000	80,000	112,000	128,000	130,000
Total	148,000	98,000	139,000	187,000	201,000
Germany, silicon metal	29,092	27,620	30,105	30,134 [7]	30,000
Iceland, ferrosilicon	107,882 [r]	112,993	114,231	120,076 [7]	115,000
India, ferrosilicon[e]	92,000	101,337 [7]	101,000	105,000	108,000
Iran, ferrosilicon	NA [r]	NA [r]	NA [r]	NA [r]	NA
Kazakhstan:					
Ferrosilicon	54,964	33,100	4,813	1,683 [r, 7]	496 [7]
Silicon metal	--	--	1,500	8,000	18,000 [7]
Total	54,964	33,100	6,313	9,683 [r, 7]	18,496 [7]
Laos, silicon metal[e, 6]	3,020	7,350	7,770	3,001 [r, 7]	15,281 [7]
Macedonia, ferrosilicon	42,674	7,657	30,044	56,167 [7]	42,402 [7]
Norway:					
Ferrosilicon	185,344 [r]	233,974 [r]	225,000 [r]	170,102 [r, 7]	220,000
Silicon metal	155,000 [r]	150,000 [r]	170,000	175,000 [r, 7]	200,000
Total	340,344 [r]	383,974 [r]	395,000 [r]	345,102 [r, 7]	420,000
Peru, ferrosilicon[e]	600	600	600	600	600
Poland, ferrosilicon	56,031	9,685	53,206	72,668 [r, 7]	73,000
Russia:[e]					
Ferrosilicon	850,000	745,000	916,000	1,030,000 [r, 7]	1,050,000
Silicon metal	54,000	23,900	48,700	52,000 [r]	52,000
Total	904,000	769,000	965,000	1,080,000 [r]	1,100,000
Slovakia, ferrosilicon	10,844	8,622	37,034	38,771 [7]	24,658 [7]
South Africa:					
Ferrosilicon	134,500	110,400	127,500	124,300 [r, 7]	120,000
Silicon metal	51,800 [r]	38,600 [r]	46,400 [r]	58,800 [r, 7]	55,000
Total	186,300 [r]	149,000 [r]	173,900 [r]	183,100 [r, 7]	175,000
Spain:[e]					
Ferrosilicon	74,000	44,000	64,400	57,000	42,000
Silicon metal	33,000	23,000	32,500	43,000	62,000
Total	107,000	67,000	97,000	100,000	104,000
Sweden, ferrosilicon	-- [r]	-- [r]	-- [r]	-- [r]	--

See footnotes at end of table.

TABLE 9—Continued

FERROSILICON AND SILICON METAL: WORLD PRODUCTION, BY COUNTRY[1, 2, 3]

(Metric tons, gross weight)

Country and commodity[4]	2008	2009	2010	2011[e]	2012[e]
Turkey, ferrosilicon[e]	4,500	4,000	4,000	4,000	4,000
Ukraine, ferrosilicon	152,800	150,300	195,500	150,900 [7]	119,400 [7]
United States:					
Ferrosilicon	248,000	194,000	246,000 [r]	(8)	(8)
Silicon metal	W	W	W	(8)	(8)
Total	248,000	194,000	246,000 [r]	370,000 [r, 7, 9, 1]	357,000 [7, 9, 10]
Uruguay, ferrosilicon	NA [r]	NA [r]	NA [r]	NA [r]	NA [r]
Uzbekistan, silicon metal	--	--	--	--	1,700
Venezuela, ferrosilicon[e]	88,000	52,100	76,800	70,000	81,000
Grand total	9,090,000 [r]	8,830,000 [r]	9,690,000 [r]	9,950,000 [r, 11]	10,600,000 [11]
Of which:					
Ferrosilicon	7,320,000 [r]	7,280,000 [r]	7,890,000 [r]	7,820,000 [r, 12]	7,930,000 [12]
Silicon metal	1,770,000 [r]	1,550,000 [r]	1,800,000 [r]	1,760,000 [r, 13]	2,280,000 [13]
U.S. total silicon materials	-- [r]	-- [r]	-- [r]	370,000 [r, 7, 9, 1]	357,000 [7, 9, 10]

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data; not included in "Total." NA Not available. -- Zero.

[1]World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through August 8, 2013.

[3]Excludes semiconductor and solar grades of silicon metal.

[4]In addition to the countries listed, Iran and Uruguay are thought to have produced ferrosilicon, but production information is inadequate for the formulation of estimates of output levels.

[5]Exports.

[6]Net exports.

[7]Reported figure.

[8]Data withheld to avoid disclosing company proprietary information; data undifferentiated and included in "Total."

[9]Includes undifferentiated ferrosilicon and silicon metal to avoid disclosing company proprietary data.

[10]For 2011 and 2012, data include ferrosilicon and silicon alloys.

[11]Includes total U.S. net production of ferrosilicon and silicon metal.

[12]Excludes total U.S. net production of ferrosilicon.

[13]Excludes total U.S. net production of silicon metal.

TABLE 10

SILICON MATERIALS: PROJECTS SCHEDULED FOR COMPLETION, BY YEAREND 2016[1, 2, 3]

(Metric tons, gross weight, unless otherwise specified)

Projected year of first production	Country	Project and company	Project type	Incremental annual production capacity	Total annual production capacity	Silicon product[4]
2012[r]	Australia	Simcoa Silicon Plant Simcoa Operations Pty., Ltd.	silicon plant expansion	16,000	48,000 [r]	Si.
2012	China	Ferroatlántica Sichuan Silicon Plant Ganzi Ferroatlántica Silicon Industry Co., Ltd.[5]	new silicon smelter	XX	42,000	Do.
2012	Do.	Jingcheng Silicon Plant Uyunnan Ruili Jingcheng Group	do.	XX	100,000	Do.
2012	Do.	Mangshi Silicon Plant Mangshi Sinice Silicon Industry Company Ltd.[6]	reconstructed silicon plant	30,000 [e]	50,000	Do.
2012	India	Amit Ferroalloys Plant[7] Amit Ferro-Alloys & Steel Pvt. Ltd.	new ferroalloys plant	XX	19,800	FeSi.
2012	Malaysia	Banting Silicon Plant Elpion Co., Ltd.	new silicon plant	XX	50,000	Si.
2012	Sweden	Vargön Alloys Ferroalloys Plant[8] Vargön Alloys AB	ferroalloys plant conversion	XX	25,000	FeSi.
2012	Uzbekistan	Navoi Silicon Plant Uz-Kor Silicon LLC[9]	new silicon plant	XX	12,000	Si.
2013	China	ERDOS Qipanjing Plant ERDOS Group	silicon plant expansion	50,000	650,000	FeSi.
2013	Do.	Ferroatlántica Sichuan Silicon Plant Ganzi Ferroatlántica Silicon Industry Co., Ltd.[5]	do.	42,000 [r, e]	84,000 [r, e]	Si.
2013	Malaysia	Pertama Ferroalloys Plant[10] Pertama Ferroalloy SDN BHD	new ferroalloys plant	XX	60,000 [r]	FeSi.
2013[r]	Russia	Bratsk Ferroalloy Plant Mechel OAO	ferroalloys plant expansion	34,800	122,000	Do.
2013	Do.	Chelyabinsk Electrometallurgical Integrated Plant OAO Chelyabinsk Group	do.	300,000	600,000 [e]	Do.
2013	Do.	Yurga Plant JSC[5] Kuznetsk Ferroalloys	do.	70,000	150,000	Do.
2013	Sweden	Elkem Salten Plant Elkem AS	ferroalloys plant conversion	XX	20,000	Si.
2013	Uzbekistan	Angren Silicon Plant Uz-Shingdong Silicon LLC[11]	new silicon plant	XX	5,000	Do.
2014	China	Ferroatlántica Sichuan Silicon Plant Ganzi Ferroatlántica Silicon Industry Co., Ltd.[5]	silicon plant expansion	44,000 [e]	128,000 [r, e]	Do.
2014[e]	Malaysia	Asia Cement Silicon Plant Asia Cement Co., Ltd.	new silicon plant	XX	33,000	Do.
2014	Do.	Banting Silicon Plant Elpion Co., Ltd.	silicon plant expansion	50,000	100,000	Do.
2014	Do.	Sarawak Ferroalloys Plant[12] OM Materials (S) Pte Ltd. (80%) and Cahya Mata Sarawak Berhard (20%)	new ferroalloys plant	XX	310,000 [e]	FeSi.
2015	Iceland	PCC[13] Silicon Plant PCC[13] BakkiSilicon	new silicon plant	XX	32,000	Si.
2015	Do.	Thorsil Silicon Plant Thorsil ehf	do.	XX	53,000	Do.

[e]Estimated. [r]Revised. Do., do. Ditto. XX Not applicable.

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

[2]Excludes silicon metal containing more than 99.99% silicon.

[3]Projects in feasibility or later stages of development in mid-2013. Actual startup dates may be postponed, owing to economic or other factors. Additional projects might produce silicon materials by 2016, but not enough information was available to include them.

[4]FeSi Ferrosilicon and Si Silicon metal (containing 99.99% or less Si).

TABLE 10—Continued

SILICON MATERIALS: PROJECTS SCHEDULED FOR COMPLETION, BY YEAREND 2016[1, 2, 3]

[5]Owned by Grupo Ferroatlántica, S.L.

[6]A joint-venture between Grupo Ferroatlántica, S.L. (75%) and Ganzi Perfecture Kangding Sunday Silicon Co., Ltd. (25%).

[7]The Amit ferroalloys plant will also have a ferromanganese production capacity of 55,400 metric tons per year (t/yr) and a silicomanganese production capacity of 39,600 t/yr.

[8]One 30,000-metric-ton-per-year ferrochromium furnace will be converted to ferrosilicon production.

[9]A joint-venture between JS Neoplant Co. Ltd. (50%), the Uzbek State Committee on Geology and Mineral Resources (25%), and OJSC Navoiazot (25%).

[10]The Pertama ferroalloys plant will have a 174,000-metric-ton-per-year capacity (revised) to produce medium- and low-carbon ferromanganese and silicomanganese.

[11]A joint-venture between Shindong Enercom, Inc. (50%) and the Uzbek State Committee on Geology and Mineral Resources (50%).

[12]The Sarawak ferroalloys plant will also have a silicomanganese production capacity of 300,000 t/yr.

[13]Petro Carbo Chem.

Sources: Company annual reports, presentations, and press releases; unpublished personal communications; and trade publications.