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SILICON

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SILICON

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In 2006, domestic ferrosilicon production increased from that of 2005. At 146,000 metric tons (t) of contained silicon, production was about 17% higher than that of 2005 (table 1). On a gross-weight basis, ferrosilicon production increased by 21% from that in 2005 (table 2). Domestic statistics for silicon metal were concealed to avoid disclosing company proprietary data. On the basis of contained silicon, U.S. exports of silicon products increased by 4%, and imports increased by 6%. The increase in exports was associated with increases in all silicon metal trade categories (table 5). The increase in imports was primarily attributable to increases in the "55% to 80% silicon, other" ferrosilicon trade category, about one-half of which came from China (table 6). Apparent consumption for ferrosilicon increased by about 14% compared with that in 2005. Year-average import prices for the 50% and 75% ferrosilicon grades each increased by 14%, and those for silicon metal increased by 4% compared with that in 2005 (table 1).

Silicon is a light chemical element with metallic and nonmetallic characteristics. Silicon is not found free in nature. Silicon combines with oxygen and other elements to form silicates, which comprise 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 that is refined into semiconductor-grade metal for use in making computer chips is crucial to modern technology, but the quantity is less than 5% of total silicon metal demand (Roskill's Letter from Japan, 2000). Silicon metal may also be refined into wafers used to power solar batteries. The U.S. Geological Survey (USGS) does not survey the high-purity silicon industry for production and related data; therefore, the only information that this report contains about these high-purity grades is as it appears in the foreign trade statistics and from published sources.

Legislation and Government Programs

On November 17, the U.S. Food and Drug Administration (FDA) approved silicone gel-filled breast implants manufactured by Allergan Corp. (formerly Inamed Corporation) and Mentor Corporation for breast reconstruction in women of all ages and breast augmentation in women ages 22 years or older (U.S. Food and Drug Administration, 2006).

Production

Silicon Ferroalloys and Metal.—Domestic production data for silicon are derived from monthly and annual voluntary surveys and estimates for nonrespondents by the USGS. There are two standard grades of ferrosilicon—50% and 75%. A more detailed explanation of these grades is found in table 2. The data in table 2 were obtained from all operations listed in table 3 that are canvassed by means of the USGS "Silicon Alloys" survey. In terms of gross weight and compared with that of 2005, domestic ferrosilicon gross production, net shipments, and stocks increased by 21%, 16%, and 31% respectively. Data for ferrosilicon reflected adjustments in inventory and in-plant consumption of ferrosilicon to produce magnesium ferrosilicon and other miscellaneous alloys. Production-related statistics for silicon metal were concealed to avoid disclosing company proprietary data.

On November 13, Globe Specialty Metals Inc. (GSM), formerly International Metal Enterprises, Inc., acquired 100% ownership of silicon producer Globe Metallurgical Inc. for $83.9 million (London Stock Exchange, 2007). GMI owns three operating plants in the United States—Beverly, OH, Alloy, WV, and Selma, AL—and one idled plant in Niagara Falls, NY. Production capacities at the Beverly, OH, plant included 38,000 metric tons per year (t/yr) of magnesium ferrosilicon, 29,000 t/yr of silicon metal, and 10,000 t/yr of standard ferrosilicon. The Alloy, WV, plant could produce up to 77,000 t/yr of silicon metal and/or ferrosilicon. The Selma, AL, plant had a 28,500-t/yr silicon metal production capacity, as did the Niagara Falls, NY, facility (Ryan's Notes, 2006).

Semiconductor- and Solar-Battery-Grade Silicon.—U.S. production of polycrystalline silicon used in both semiconductor and solar cells was reported to be 18,500 t in 2006. Total domestic polycrystalline production by company was as follows: Hemlock Semiconductor Corporation, 9,500 t; REC Advanced Silicon Materials LLC, 3,200 t; MEMC Electronic Materials, 2,300 t; REC Solar Grade Silicon LLC, 2,300 t; and Mitsubishi Materials Group, 1,200 t (Roskill's Letters from Japan, 2007).

Consumption

Silicon Ferroalloys and Metal.—The majority of ferrosilicon (including miscellaneous silicon alloys) was used to produce steel (63%) and cast irons (36%) (table 4). Silicon metal was used mainly to produce chemicals—silanes, silicones, and others—and silica fume (78%). 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 2006 USGS Minerals Yearbook, volume I, Metals and Minerals.

In 2006, apparent consumption increased by 14% to 360,000 t for ferrosilicon and miscellaneous silicon alloys (table 1). Increases in net imports for consumption contributed to the rise in ferrosilicon apparent consumption. Silicon metal apparent consumption was withheld to avoid disclosing company proprietary data.

The ratio of reported to apparent consumption on a content basis was 38:62 for ferrosilicon, which includes miscellaneous

silicon alloys. This ratio was derived based on the typical silicon content of these materials noted in table 4.

Consumption of ferrosilicon and silicon metal was estimated by CRU International Ltd. to have decreased in 2006 throughout the Western World. In terms of contained silicon, ferrosilicon consumption increased to 2.08 million metric tons (Mt) from 1.92 Mt (revised) in 2005, and silicon metal consumption increased to 1.35 Mt from 1.29 Mt. Areas with the largest year-to-year increase in consumption of ferrosilicon and silicon metal were Japan and other Asian countries (excluding China and North Korea). In decreasing order of consumption, Europe, Japan, and other Asian countries accounted for 70% of the ferrosilicon consumption in 2006. Also in decreasing order of consumption, the European Union, the United States, and Japan accounted for 75% of the silicon metal consumed in 2006 (CRU Bulk Ferroalloys Monitor, 2007a, b).

Prices

Ferrosilicon and silicon metal prices (excluding those of high-purity silicon) tend to vary in response to changes in demand and supply by the steel, ferrous foundry, aluminum, and chemical industries. Year-average import prices given by Platts Metals Week were 54.9 cents per pound for 75% ferrosilicon and 79.3 cents per pound for silicon metal; these prices were 14% and 4% higher, respectively, than those of 2005. The year-average North American transaction price for 50% ferrosilicon as calculated from Ryan's Notes listings was 62.9 cents per pound, a 14% increase from that of 2005. Prices for both standard grades of ferrosilicon rose because of higher demand and increased costs associated with importing ferrosilicon from China after the Chinese government imposed a 5% export tax in mid-2005 (Metal Bulletin Ferro-Alloys Monthly, 2006a). Higher silicon metal prices in the United States were attributed to a decrease in supply that resulted from a decline in imports compared with those in 2005. This decline in imports was partially caused by Brazilian producer Rima Industrial S.A.'s decision to shift exports to Europe from the United States (Metal Bulletin Ferro-Alloys Monthly, 2006b).

Foreign Trade

Trade volumes discussed are based on gross weight. U.S. ferrosilicon exports decreased by 30% to 9,330 t, and their value decreased by 22% to $10.4 million from those of 2005. In decreasing order of quantity, Canada and Mexico accounted for 95% of the total 2006 ferrosilicon exports (table 5). Exports of silicon metal increased by 16%, and their value increased by 50% to $1,270 million from that of 2005. In decreasing order of quantity, Japan, China, and the Republic of Korea accounted for 69% of silicon metal exports. Shipments of high-purity silicon containing more than 99.99% silicon accounted for 62% of total silicon metal exported and 97% of the total value of combined ferrosilicon and silicon metal exports.

U.S. ferrosilicon imports increased by 13% to 327,000 t, as did the value of those imports ($244 million) compared with that in 2005. The rise in ferrosilicon imports was primarily attributable to an increase in the "55% to 80%, other" ferrosilicon trade category. Imports of standard 75% ferrosilicon (ferrosilicon category of "55% to 80% silicon, other") accounted for 82% of total ferrosilicon imports by gross weight and value (table 6). China was the leading source of ferrosilicon imports at 46%, followed by Russia at 18%.

Silicon metal imports decreased by 5% to 149,000 t from 157,000 t in 2005, but increased by 7% in value to $394 million from $366 million. These imports fell primarily because of a decrease in the "other silicon" trade category. Canada was the leading source of this import category at 41%, followed by Brazil at 37% and Ukraine at 9%. Silicon metal in the "99.00% to 99.99% silicon" trade category accounted for 84% of the amount of, and 50% of the value for, respectively, all silicon metal imported in 2006. The quantity of silicon metal imports in this trade category increased by 5% compared with that of 2005.

The estimated U.S. net import reliance for ferrosilicon in 2006 decreased slightly to 60% from 61% in 2005. Silicon metal import reliance was withheld to avoid disclosing company proprietary data.

The general rates of duty that applied to U.S. imports during 2006 were the same as in 2005. These were, on an ad valorem basis, 5.8% for ferrosilicon containing more than 90% silicon; 5.3% or 5.5% for metal exclusive of the high-purity grade, which is free; 1.9% for ferrosilicon containing 80% to 90% silicon; 1.5% for standard 75% ferrosilicon; 1.1% for nominal 75% ferrosilicon that contains more than 3% calcium; and free for magnesium ferrosilicon and other ferrosilicon (U.S. International Trade Commission, 2006b).

Silicon Metal Imports from Brazil (July 1, 1999, through June 30, 2000).—On October 27, the U.S. Court of Appeals for the Federal Circuit (CAFC) reversed and remanded the judgment issued by the United States Court of International Trade (CIT) in 2004. The CIT had ordered the International Trade Administration of the U.S. Department of Commerce (ITA) to revise the duty based on the value-added taxes (VAT) paid by Rima (*Elkem Metals Co.* v. *United States*, Consol. Court No. 02-00232, CIT Slip Opinion 04-145). The CAFC agreed with the ITA's original decision to exclude the amount of VAT paid by Rima because the company's VAT costs were fully offset by its VAT credits [*Elkem Metals Co.* v. *United States*, 468 F.3d 794 (Fed. Cir. 2006)]. On December 22, the CIT ordered ITA to recalculate Rima's dumping margin excluding the VAT taxes, by March 21, 2007 (*Elkem Metals Co.* v. *United States*, Consol. Court No. 02-00232, CIT Slip Opinion 06-189).

Ferrosilicon Imports from Brazil, China, Kazakhstan, Russia, Ukraine, and Venezuela (1989 through 1993).—On July 21, the CIT remanded for the fourth time the U.S. International Trade Commission's (ITC) determination that U.S. ferrosilicon producers were not materially injured by these imports (*Elkem Metals Co.* v. *United States*, Consol. Court No. 99-00628, CIT Slip Opinion 06-108). The fourth remand required the ITC to provide additional evidence supporting the negative determination it made on August 18, 2003 (U.S. International Trade Commission, 2003). In response to the fourth CIT remand, the ITC again found that U.S. producers were neither materially injured nor threatened with material injury from these imports with or without price fixing by the U.S. producers (U.S. International Trade Commission, 2006a,

p. 5). As of mid-October 2007, the CIT had yet to decide on the ITC determination.

Silicon Metal Imports from Russia (July 2001 through December 2001).—On February 16, the ITA issued an amended final determination to reflect the results of two CIT cases involving the subject imports. A summary of the CIT cases is described in the Silicon chapter of the 2005 Minerals Yearbook, volume I, Metals and Minerals. The final antidumping duty rates were 87.08% for Bratsk Aluminum Smelter and 61.61% for ZAO Kremny/Sual-Kremny-Ural Ltd. (ZAO Kremny) (International Trade Administration, 2006h).

In a related matter, the ITC found that the U.S. silicon industry was injured by silicon imports from Russia in its remand determination in September 2004 (U.S. International Trade Commission, 2004). In December 2004, the CIT affirmed the ITC's remand determination and dismissed the case (*Bratsk Aluminum Smelter* v. *United States*, Consol. Court No. 03-00200, CIT Slip Opinion 04-153). In April 2006, the CAFC vacated the CIT's decision and ordered the CIT to issue a second remand to the ITC to address whether imports from non-subject countries (those countries not charged with dumping) were similarly priced as the Russian imports. In its second remand determination of March 2007, the ITC once again found that the U.S. silicon industry was injured by silicon imports from Russia (U.S. International Trade Commission, 2007).

Pending U.S.-Southern African Customs Union Free Trade Agreement.—Representatives from the Office of the United States Trade Representative (USTR) and member nations of the Southern African Customs Union (Botswana, Lesotho, Namibia, South Africa, and Swaziland) continued negotiations on the pending U.S.-Southern African Customs Union Free Trade Agreement (FTA). In April 2006, the parties agreed to establish a framework for pursuing the FTA over the longer term (Office of the United States Trade Representative, 2006). The USTR launched negotiations for the FTA in June 2003 (Office of the United States Trade Representative, 2003). The FTA could result in the elimination of the 5.5% ad valorem duty on imports of less than 99.00% silicon metal from South Africa.

Antidumping Duty Administrative Reviews.—On January 3, both the ITA and the ITC instituted 5-year reviews of the antidumping duty orders on silicon metal from Brazil and China to determine whether revocation of the orders would likely lead to continuation or recurrence of material injury (U.S. International Trade Commission, 2006c). In April, the ITC announced it would conduct full reviews of the antidumping duty orders (U.S. International Trade Commission, 2006d). On May 4, the ITA determined to continue the antidumping duties on Chinese silicon metal imports at a rate of 139.49%, and on silicon imports from Brazil at a rate of 91.06%, except for Camargo Correa Metais, S.A. (CCM) (93.2%); the antidumping duties for Companhia Brasileira Carbureto de Calcio and Rima were revoked (International Trade Administration, 2006f). In December, the ITC decided to revoke the antidumping duty order on imports of silicon metal from Brazil, while extending the order on Chinese silicon metal imports (U.S. International Trade Commission, 2006e). As a result of the ITC decision, the ITA announced it would continue to collect antidumping duties on silicon metal imports from China (International Trade Administration, 2006e).

On February 13, the ITA decided against assessing a duty on silicon metal imports from Brazilian producer Camargo Correa Metais S.A. (CCM) during the period of July 1, 2003, through June 30, 2004 (International Trade Administration, 2006c).

On July 25, the ITA started new shipper reviews of the antidumping duty order on silicon metal imports from China during the period of June 1, 2005, through May 30, 2006, as requested by Shanghai Jinneng International Trade Co., Ltd. and Jiangxi Gangyuan Silicon Industry Co., Ltd. on June 23 (International Trade Administration, 2006g). On December 21, the ITA extended the new shipper reviews to May 14, 2007 (International Trade Administration, 2006b).

The ITA began an antidumping duty administrative review of silicon metal imports during the period of July 1, 2005, through June 30, 2006, from Brazilian producers CCM, Companhia Ferroligas de Minas Gerais-Minasligas (Minasligas), Italmagnesio Nordeste S.A., and Ligas de Aluminio S.A. (LIASA) on August 30 (International Trade Administration, 2006a). On December 1, the ITA rescinded the administrative review for the companies because none had sales or exports of the subject merchandise during the period of review (International Trade Administration, 2006d).

World Review

Data on annual world production of ferrosilicon and silicon metal by country during 2002 through 2006 are provided in the Ferroalloys chapter of the 2006 USGS Minerals Yearbook, volume I, Metals and Minerals. World production of ferrosilicon was estimated to have been 5.94 Mt in 2006 compared with 5.74 Mt (revised) in 2005. The major ferrosilicon producers in 2006 were, in decreasing order, China, Russia, the United States, Brazil, South Africa, Ukraine, Iceland, and Kazakhstan; they accounted for 87% of total production as listed in table 1. World production of silicon metal, excluding that from China and the United States, was estimated to have been 540,000 t in 2006 compared with 711,000 t (revised) in 2005. Firm data on China's production of silicon metal are lacking, although one source reported it to be about 520,000 t in 2004 (Ryan's Notes, 2004); this appears to be within about 10% of the country's 2006 net export data as calculated from United Nations commodity trade statistics. China was thus by far the leading producer of silicon metal in the world in 2006. Other major producers of silicon metal in 2006 were, excluding the United States and in decreasing order, Brazil, Norway, France, Russia, South Africa, and Australia; they accounted for 81% of total production as listed in table 1.

European Union.—On November 23, the Council of the European Union terminated its partial review of antidumping measures on silicon metal imported from Russia during the period of April 1, 2005, to March 31, 2006, after the petitioning companies—Sual-Kremny-Ural Ltd. and ZAO Kremny—withdrew their request. The 22.7% duty therefore remained in effect on Russian silicon imports (Official Journal of the European Union, 2006a).

On November 30, the European Commission's Directorate General for Trade began an antidumping investigation of ferrosilicon imported during the period of October 1, 2005,

to September 30, 2006, from China, Egypt, Kazakhstan, Macedonia, and Russia. The Commission began the investigation based on the complaint lodged on October 16 by Euroalliages, the European Union ferroalloy producers' association (Official Journal of the European Union, 2006b).

Argentina.—GSM acquired Stein Ferroaleaciones S.A., a leading producer of silicon-based specialty alloys headquartered in Buenos Aires, for $36.4 million on November 20. Stein was renamed Globe Metales S.A. The company operated two furnaces at its Mendoza plant capable of producing 29,400 t/yr of calcium silicide and 58,300 t/yr of magnesium ferrosilicon, as well as a 8,500-t/yr cored-wire plant in San Luis, and a 14,800-t/yr cored-wire facility in Poland (London Stock Exchange, 2007).

Brazil.—On February 8, Brazilian ferroalloy producer Companhia Vale do Rio Doce sold its 49% stake in Nova Era Silicon (NES) to JFE Steel Corporation (Japan) for $14 million. NES produces ferrosilicon in the State of Minas Gerais (Companhia Vale do Rio Doce, 2006). As a result of the sale, NES ownership was split between JFE Steel Corporation (74.5%) and Mitsubishi Corporation (25.5%) (TEX Report, 2006b).

On January 31, 2007, GSM acquired CCM, one of the country's largest producers of silicon metal and silica fume, for $38.42 million. CCM was renamed Globe Metais Industria e Comercio S.A. (London Stock Exchange, 2007).

China.—China's exports of ferrosilicon containing more than 55% silicon rose 43% from that of 2005 to an alltime high of 1.315 Mt, and those containing 55% or less silicon decreased by 36% to 15,429 t. China exported 614,020 t of silicon metal in 2006, an increase of 14.5% from 536,130 t in 2005 (TEX Report, 2007a, c).

The Central Government of China, through the National Development and Reform Commission (NDRC), announced on April 11 its plan to reduce the ferroalloy production capacity in the country by 25% to 17.0 million metric tons per year (Mt/yr) by 2010 (TEX Report, 2006a). The NDRC estimated the number of ferroalloy producers in the country to be 1,570; total installed production capacity was about 22 Mt/yr (twice that of 2000). In 2005, 1.16 Mt of ferroalloy production capacity was under construction, with an additional 1.23 Mt planned. Ferroalloy production in 2006 and 2005 was 14.332 Mt (70% utilization rate) and 10.947 Mt, respectively. In 2005, China accounted for 40% of global ferroalloy production and 30% each of global consumption and exports (TEX Report, 2006c, d; TEX Report, 2007b).

The Central Government of China raised the duty on ferrosilicon exports to 10% effective November 1, 2006, an increase of 5% from that imposed on June 1, 2005 (TEX Report, 2007f).

Ferrosilicon production capacity of the Erdos Group's Qipanjing plant, Inner Mongolia Autonomous Region, was 338,000 t/yr (30 furnaces) at yearend 2006. The company planned to add 180,000 t/yr of ferrosilicon capacity by October 2007 (TEX Report, 2007d).

France.—FerroPem, a division of Ferroatlantica Group (Spain), ceased operating its eight silicon metal furnaces for 10 weeks at the end of December 2005. As a result, the company lost about 20,000 t (10,000 metric tons per month) of silicon metal production in early 2006 (American Metal Market, 2006). FerroPem's plants in France are located at Anglefort, Chateau-Feuillet, Les Clavaux, and Montricher.

Iceland.—Elkem AS (a subsidiary of Orkla ASA) committed NKr270 million ($40.1 million) to install a new ferrosilicon-magnesium production and finishing plant at its Icelandic Alloys operations. The new unit would have a production capacity of 60,000 t/yr; production was expected to start in February 2008 (Elkem AS, 2006b). The company planned to transfer ferrosilicon-magnesium production from its Bjolvefossen plant in Hardanger, Norway, to the new Icelandic plant (Orkla ASA, 2007).

Norway.—Elkem ASA permanently closed two of its Norwegian silicon metal plants in the first half of 2006; the Meraker plant in Koppera and the Fiskaa plant in Kristiansand (Elkem AS, 2006a). The company also shut down a 25,000-t/yr silicon metal furnace at its Salten plant in Straumen because of rising energy and raw material costs in December (Metal-Pages, 2006b). The Thamshaven plant in Orkanger, which produced ferrosilicon and silicon metal, operated at reduced levels after an explosion in April (Metal-Pages, 2006c). On October 27, company officials approved NKr 2.7 billion ($412 million) for the construction of a new solar-grade silicon production facility at the Fiskaa plant (Orkla ASA, 2007).

Russia.—Russian exports of ferrosilicon were 295,000 t in 2006, a 17% increase compared with that in 2005. Russia was the second leading exporter of ferrosilicon following China (TEX Report, 2007e).

Kuznetsk Ferroalloy Works (KFZ), a subsidiary of Urals-Siberian Mining and Metallurgical Company, forecast production of ferrosilicon containing 45% silicon to increase by 10% in 2006 from the 439,922 t produced in 2005 (Interfax Metals & Mining Weekly, 2006b; Metal-Pages, 2006a). KFZ started a new ferrosilicon furnace at the former Yurga abrasives plant in the Kemerovo region of Russia on July 11. The new furnace would be capable of producing up to 1,500 metric tons per month of 75% ferrosilicon. The company planned to build another four furnaces at the Yurga plant during the next 2 years at a cost of $10 million each (Interfax Metals & Mining Weekly, 2006a).

Ukraine.—At yearend 2005, Stakhanov Ferroalloy Plant Joint-Stock Company (JSC), the country's leading ferrosilicon producer, had invested about $15 million to convert three of its ferrosilicon furnaces to silicomanganese production. Stakhanov began converting a fourth furnace to silicomanganese production in December 2006. The company expected the furnace to restart by mid-May 2007 at a cost of $1.9 million. After this conversion, Stakhanov's production mix would be one-half ferrosilicon and one-half silicomanganese (Metal-Pages, 2005, 2007).

The JSC Zaporozhye Ferroalloys Plant had indefinitely curtailed three ferrosilicon furnaces by mid-March 2006 because of high electricity prices, cutting total production by three-quarters. As a result, the plant would produce less than 5,000 metric tons per month (Metal-Pages, 2006d).

Outlook

Consumption of ferrosilicon follows trends in the iron and steel industries, for which the combined annual growth rates have 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 2006 USGS Minerals Yearbook, volume I, Metals and Minerals. Raw steel production increased by 3.5% in the United States while increasing 6% globally from that in 2005.

World apparent consumption of finished steel products increased by 9% to 1.121 billion metric tons (Gt) in 2006 from that in 2005. This increase was primarily attributed to steel consumption in Asia, particularly in China. Asia accounted for 54% of steel consumed worldwide in 2006, up by 9.4% to 607.2 Mt from that in 2005. China alone consumed about 374 Mt, a 14.4% increase from 2005. Steel consumption in 2006 was also up in all other regions of the world; Brazil, China, India, and Russia accounted for about 41% of the total (International Iron and Steel Institute, 2006). Global steel apparent consumption was projected to increase by 6.8% in both 2007 and 2008. Brazil, China, India, and Russia were expected to lead this growth with a combined increase in steel consumption of 12.8% and 11.1% in 2007 and 2008, respectively. Steel consumption in North America was forecast to decrease by about 5% to 148.1 Mt in 2007 compared with that in 2006 because of a downturn in residential construction, but increase by 4% between 2007 and 2008 (International Iron and Steel Institute, 2007).

Demand for silicon metal comes primarily from the aluminum and chemical industries. The American Chemistry Council reported a 2.2% increase in domestic chemical output in 2006 compared with that in 2005. Production was nearly unchanged (up 0.7%) in the first 9 months of 2007 compared with that in 2006 (American Chemistry Council, 2007a, b). Consumption of silicon by the U.S. aluminum castings industry was expected to mirror the 2.2% (2.39 Mt) increase in aluminum casting shipments forecast for 2007 and to rise by 4.5% and 16.2% by 2008 and 2016, respectively (Kirgin, 2007).

World production of polycrystalline silicon can be used as a rough indicator of high-purity silicon consumption. Compared with that of 2006, world production of polycrystalline silicon was forecast to increase by 10% to 36,500 t in 2007, by 43% to 47,500 t in 2008, by 80% to 59,600 in 2009, by 237% to 74,500 in 2010, and by about 500% to 83,400 in 2011 (Roskill's Letters from Japan, 2007).

Demand for microsilica, a byproduct from furnaces making silicon metal or ferrosilicon with a silicon content of at least 75%, comes from the cement industry, where it is used as a binder and filler in cements. Domestic consumption of cement through 2009 was forecast to increase by 2.5% from 120 Mt in 2005 (International Cement Review, 2006). Worldwide consumption of cement was projected to rise by 4.1% per year through 2006 to 2.1 Gt, although advances were expected to be less robust in more developed areas such as Japan, the United States, and Western Europe (Mining Engineering, 2002).

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TABLE 1
SALIENT SILICON STATISTICS[1]

		2002	2003	2004	2005	2006
United States:						
Production, Si content:						
Ferrosilicon	thousand metric tons	150	116	128	125	146
Silicon metal	do.	111	137	147	145	139
Exports:						
Ferrosilicon	do.	7	6	6	8	5
Silicon metal	do.	15	20	18	23	27
Imports for consumption:						
Ferrosilicon	do.	140	189	173	197	223
Silicon metal	do.	145	126	165	152	146
Apparent consumption:						
Ferrosilicon	do.	301	304	297	317	363
Silicon metal	do.	240	240	291	275	W
Price, average:						
Ferrosilicon, 50% Si[2]	cents per pound	41.10	47.70	58.20	55.00	62.90
Ferrosilicon, 75% Si[3]	do.	32.90	45.30	55.40	48.00	54.90
Silicon metal[4]	do.	53.20	61.30	81.90	76.20	79.30
World, production, gross weight:						
Ferrosilicon	thousand metric tons	4,300 r	5,030 r	5,730 r	6,010 r	6,250
Silicon metal[5]	do.	618 r	650 r	667 r	669 r	502 [6]

rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Data are rounded to no more than three significant digits.
[2]Ryan's Notes North American transaction prices based on weekly averages.
[3]Platts Metals Week mean import prices based on monthly averages.
[4]Platts Metals Week dealer import prices based on monthly averages.
[5]Excluding China.
[6]Excluding the United States.

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

(Metric tons)

	Silicon content (percent)		2005 producers' stocks, December 31	2006		
Material	Range	Typical	gross weight	Gross production[3] gross weight	Net shipments gross weight	Producers' stocks, December 31 gross weight
Ferrosilicon[4]	25-65 [5]	48	9,130	164,000	114,000	14,000
Do.	56-95	76	10,800	88,700	89,400	12,100
Silicon metal, excluding semiconductor grades	96-99	98	6,380	W	W	W

W Withheld to avoid disclosing company proprietary data.
[1]Data are rounded to no more than three significant digits.
[2]Data for silvery pig iron (less than 25% silicon) withheld to avoid disclosing company proprietary data.
[3]Ferrosilicon production includes material consumed in the production of miscellaneous silicon alloys.
[4]Includes miscellaneous silicon alloys, which were listed separately prior to 1999.
[5]25% to 55% for ferrosilicon; 32% to 65% for miscellaneous silicon alloys.

TABLE 3
PRINCIPAL PRODUCERS OF SILICON ALLOYS AND/OR SILICON METAL IN THE UNITED STATES IN 2006

Producer	Plant location	Product
CC Metals and Alloys, Inc.	Calvert City, KY	Ferrosilicon.
Globe Metallurgical, Inc.[1]	Alloy, WV	Ferrosilicon and silicon metal.
Do.	Beverly, OH	Do.
Do.	Selma, AL	Silicon metal.
Oxbow Carbon and Minerals LLC	Bridgeport, AL	Ferrosilicon.
Simcala, Inc.	Mt. Meigs, AL	Silicon metal.

[1]The Alloy, WV, plant was formerly owned by Elkem Metals Co.

TABLE 4
REPORTED CONSUMPTION, BY END USE, AND STOCKS OF SILICON FERROALLOYS AND METAL IN THE UNITED STATES IN 2006[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)	18,900	1,170	1,460	(9)
Stainless and heat-resisting	--	(9)	49,800	292	(9)	(9)
Full alloy	--	(9)	7,410	256	(9)	--
Electric and tool	--	--	(9)	--	(9)	(9)
Unspecified	--	32,800	30,600	(10)	703	7,500
Total	--	32,800	107,000	1,720	2,160	7,500
Cast irons	4,860	36,600	33,900	(10)	11,600	22,200
Superalloys	--	(11)	(10)	364	--	--
Alloys, excluding superalloys and alloy steel	(11)	540	(10)	48,400 [12]	--	--
Miscellaneous and unspecified	--	--	1,410	176,000 [13]	(11)	--
Grand total	4,860	69,900	142,000	227,000	13,800	29,700
Consumers' stocks, December 31	332	5,980	8,970	1,380	943	1,380

-- 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 "Steel: Unspecified," to avoid disclosing company proprietary data.

[10]Included with "Miscellaneous and unspecified," to avoid disclosing company proprietary data.

[11]Included with "Cast irons," to avoid disclosing company proprietary data.

[12]Primarily aluminum alloys.

[13]Primarily silicones, silanes, fumed silica, and other chemicals.

TABLE 5
U.S. EXPORTS OF FERROSILICON AND SILICON METAL, BY GRADE AND COUNTRY, IN 2006[1]

Country	Gross weight (metric tons)	Contained weight (metric tons)	Value
Ferrosilicon:			
More than 55% silicon:			
Canada	4,490	2,700	$4,770,000
Colombia	74	52	113,000
El Salvador	5	3	12,000
Malaysia	33	25	46,800
Mexico	1,290	775	1,670,000
Total	5,890	3,550	6,610,000
Other ferrosilicon:			
Brazil	178	89	223,000
Canada	2,360	1,180	2,460,000
Colombia	80	37	115,000
Finland	8	4	8,510
Indonesia	21	10	25,100
Korea, Republic of	2	1	11,400
Mexico	738	367	920,000
Spain	8	4	9,360
Switzerland	34	17	26,700
United Kingdom	3	1	4,200
Other	3	2	3,320
Total	3,430	1,710 [2]	3,810,000
Grand total ferrosilicon	9,320	5,260	10,400,000
Metal:			
More than 99.99% silicon:			
China	1,900	1,900	179,000,000
Finland	103	103	3,950,000
Germany	2,310	2,310	147,000,000
Italy	137	137	11,400,000
Japan	7,710	7,710	594,000,000
Korea, Republic of	1,060	1,060	90,600,000
Malaysia	147	147	21,000,000
Norway	2,300	2,300	107,000,000
Taiwan	575	575	43,900,000
United Kingdom	125	125	15,200,000
Other	360	360	24,900,000
Total	16,700	16,700	1,240,000,000
99.00%-99.99% silicon:			
Belarus	34	34	37,700
Brazil	995	986	2,560,000
China	763	756	2,150,000
Germany	321	318	887,000
India	52	51	150,000
Italy	143	142	420,000
Japan	37	36	45,300
Sweden	34	34	47,700
Taiwan	113	112	330,000
United Kingdom	30	30	42,000
Other	136	135	235,000
Total	2,660	2,630	6,900,000

See footnotes at end of table.

TABLE 5—Continued
U.S. EXPORTS OF FERROSILICON AND SILICON METAL, BY GRADE AND COUNTRY, IN 2006[1]

Country	Gross weight (metric tons)	Contained weight (metric tons)	Value
Metal—Continued:			
Other silicon:			
Canada	694	674	$796,000
China	1,380	1,320	12,900,000
Germany	695	675	1,140,000
Hong Kong	105	101	925,000
Japan	1,460	1,400	5,710,000
Korea, Republic of	2,630	2,550	3,600,000
Mexico	116	113	370,000
Netherlands	298	288	2,390,000
United Kingdom	72	70	119,000
Venezuela	74	72	105,000
Other	224	216	790,000
Total	7,740	7,480	28,900,000
Grand total silicon metal	27,100	26,800	1,280,000,000

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Contained weight estimated from gross weight.

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF FERROSILICON AND SILICON METAL, BY GRADE AND COUNTRY, IN 2006[1]

Country	Gross weight (metric tons)	Contained weight (metric tons)	Value
Ferrosilicon:			
55%-80% silicon, more than 3% Ca:			
Brazil	20	13	$24,500
Canada	19	14	10,100
China	1,750	1,280	1,310,000
France	1,310	816	2,080,000
Total	3,100	2,120	3,430,000
55%-80% silicon, other:			
Brazil	3,950	2,950	3,270,000
Canada	12,700	9,590	12,100,000
China	128,000	96,100	87,700,000
France	3,820	2,640	6,860,000
Germany	522	389	2,380,000
Norway	7,230	5,360	9,150,000
Russia	56,600	42,400	40,400,000
South Africa	2,520	1,880	1,640,000
Ukraine	3,050	2,300	1,740,000
Venezuela	51,200	38,400	37,100,000
Other	787	570	1,080,000
Total	270,000	203,000	203,000,000
More than 90% silicon, China	21	19	6,300
Magnesium ferrosilicon:			
Argentina	2,380	1,060	2,230,000
Brazil	2,700	1,210	2,490,000
Canada	7,610	3,540	7,740,000
China	360	169	360,000
France	995	476	901,000
India	128	69	116,000
Netherlands	409	188	297,000
Norway	7,820	3,590	7,030,000
Russia	2,100	943	854,000
South Africa	123	59	145,000
Other	255	119	499,000
Total	24,900	11,400	22,700,000
Other ferrosilicon:			
Argentina	60	27	54,200
Brazil	155	26	143,000
Canada	8,900	2,350	7,660,000
China	20,000	4,110	6,140,000
France	151	84	201,000
India	71	31	59,700
Russia	27	14	20,800
United Kingdom	5	2	8,840
Total	29,400	6,650	14,300,000
Grand total ferrosilicon	327,000	223,000	244,000,000

See footnotes at end of table.

TABLE 6—Continued
U.S. IMPORTS FOR CONSUMPTION OF FERROSILICON AND SILICON METAL, BY GRADE AND COUNTRY, IN 2006[1]

Country	Gross weight (metric tons)	Contained weight (metric tons)	Value
Metal:			
More than 99.99% silicon:			
Canada	19	19	$33,400
China	81	81	3,990,000
France	32	32	2,770,000
Germany	881	881	74,000,000
Italy	350	350	38,700,000
Japan	344	344	29,800,000
Korea, Republic of	56	56	12,600,000
Poland	13	13	146,000
Russia	11	11	2,920,000
Spain	11	11	102,000
Other	57	57	3,160,000
Total	1,860	1,860 [2]	168,000,000
99.00%-99.99% silicon:			
Australia	12,700	12,600	19,200,000
Brazil	46,500	46,100	69,700,000
Canada	18,700	18,500	30,300,000
China	88	76 [3]	125,000
Japan	10	(4) [3]	12,800
Norway	7,300	7,230	13,900,000
Philippines	1,240	1,180 [3]	1,570,000
South Africa	38,400	38,100	59,800,000
Sweden	25	25	159,000
United Kingdom	467	30 [3]	755,000
Other	(4)	(4)	12,400
Total	125,000	124,000	196,000,000
Other silicon:			
Australia	240	235	371,000
Brazil	8,010	7,700	11,100,000
Canada	8,860	8,400	12,500,000
China	105	25	143,000
Japan	105	13	138,000
Norway	1,060	1,040	1,660,000
Philippines	383	344	505,000
Sweden	422	106	591,000
Ukraine	1,870	1,840	2,240,000
United Kingdom	552	538	792,000
Other	56	49	104,000
Total	21,700	20,300	30,100,000
Grand total silicon metal	149,000	146,000	394,000,000

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Contained weight estimated from gross weight.
[3]All or part of these data have been referred to the U.S. Census Bureau for verification.
[4]Less than ½ unit.

Source: U.S. Census Bureau.