SILICON

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Silicon is a light chemical element with metallic and nonmetallic characteristics. In nature, silicon combines with oxygen and other elements to form silicates. Silicon in the form of silicates constitutes more than 25% of the Earth's crust. Silica is a silicate consisting entirely of silicon and oxygen. 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. Ferrosilicon and silicon metal are referred to by the approximate percentage of silicon contained in the material and the maximum amount of trace impurities present.

Almost all ferrosilicon products are consumed by the iron and steel industries. In terms of their nominal silicon contents, the two standard grades of ferrosilicon are 50% ferrosilicon and 75% ferrosilicon.

Silicon metal is used by the primary and secondary aluminum industries and the chemical industry, which uses it principally for silicones. Specifications for silicon metal used by the primary aluminum and chemical industries generally are more stringent than those for metal used by the secondary aluminum industry. In addition, the chemical industry requires that the metal be ground into a fine powder rather than the lump form used by the aluminum industry. 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). This report contains no information about this highest purity silicon except as it appears in the foreign trade statistics.

For 2002, an overall domestic silicon production of 261,000 metric tons (t) of contained silicon was the least since 1991 and represented a decrease of 7% from that of 2001. Decreases in production were the most notable in the ferrosilicon category of 25% to 65% silicon content (nominal 50% ferrosilicon) and silicon metal, for which the declines were 7% and 18%, respectively, compared with those of 2001. Silicon metal and 50% ferrosilicon shipments decreased by 23% and 17%, respectively. On the basis of contained silicon, U.S. trade volumes of silicon products increased by 23% for imports and decreased by 5% for exports. Silicon in the trade category corresponding to nominal 75% ferrosilicon increased 22% compared with that imported in 2001 and accounted for 43% of silicon imports in 2002. The export decline was associated with the "other ferrosilicon" trade category. The combination of decreased domestic production with increased imports resulted in a decrease in the apparent consumption of silicon metal to 239,000 t of contained silicon in 2002 from 244,000 t in 2001. A 17% rise in ferrosilicon apparent consumption was a result of substantial decreases in industry stocks and net exports coupled with increases in domestic production and net imports. For silicon overall, apparent consumption increased by 8% to 540,000 t compared with 2001 levels. U.S. net import reliance for silicon materials increased 18% compared with 2001 levels, rising to 52% from 44%. Year-average dealer import prices for the standard grade of 75% ferrosilicon and silicon metal increased for the first time in 5 years by 3% for 75% ferrosilicon and 5% for metal. The year-average North American transaction price for 50% ferrosilicon declined for the sixth consecutive year, decreasing by 4% compared with that of 2001.

Production

In terms of gross weight and in comparison with those of 2001, overall domestic gross production, net shipments, and stocks of silicon products decreased by about 6%, 7%, and 40%, respectively. Silicon metal had the most pronounced year-to-year percentage declines, for which production and shipments fell by 18% and 23%, respectively. For the ferrosilicon category of 25% to 65% (nominal 50% ferrosilicon), production and shipments decreased by 7% and 17%, respectively. For the ferrosilicon category of 56% to 95% (nominal 75%), production and shipments increased by 11% and 41%, respectively, which were offset by declines in the other silicon product categories. These comparisons are exclusive of silvery pig iron, statistics for which were not published to avoid disclosing proprietary data. In terms of silicon content, excluding silvery pig iron, overall production of silicon materials was the least since 1991 and marks the fifth consecutive year of decline from a decade high of 430,000 t in 1997.

Domestic production data for silicon are derived from monthly and annual voluntary surveys and estimates for nonrespondents by the U.S. Geological Survey (USGS). The figures in table 2 represent 100% of the production and shipments from the operations listed in table 3 that are canvassed by means of the "Silicon Alloys" survey.

In July, Globe Metallurgical, Inc. reopened its two-furnace silicon smelter at Niagara Falls, NY, after closing it in December 2001 (Ryan's Notes, 2002c). Upon reopening, the company operated one furnace to produce silicon metal and one ferrosilicon.

As part of its efforts to reorganize, Globe sold some of its collateral in the form of inventory and accounts receivable at an auction on December 30 to Marco International, Inc. (Platts Metals Week, 2003b). Marco, a New York, NY-based metals trading company, paid more than $23 million for Globe's assets, which include all of the company's rights, titles, and interests in silicon metal produced by the company's Selma, AL, and Niagara Falls plants (American Metal Market, 2002c§[1]). Foundry alloys, including ferrosilicon and magnesium ferrosilicon, were also included in the auction. The companies

[1]References that include a section mark (§) are found in the Internet References Cited section.

also entered into a nonexclusive toll processing agreement covering the inventory purchased by Marco at the auction and certain materials that Marco may acquire in the future.

On April 2, 2003, Globe filed for Chapter 11 bankruptcy protection in the Southern District of New York (Ryan's Notes, 2003c). There are no plans for layoffs or plant closings, and the company's tolling agreement with Marco is expected to remain in place as the bankruptcy restructuring proceeds (Platts Metals Week, 2003a). The company hopes to emerge from Chapter 11 within the next year. Globe took the action primarily because of its nonproductive Norwegian assets (Ryan's Notes, 2003c).

Other domestic producers curtailed production in 2002. In July, Elkem Metals Co. restarted its No. 14 silicon furnace at its Alloy, WV, plant, which had been closed since September 2001. At the same time, Elkem closed its No. 6 silicon metal furnace at the Alloy plant to install new electrodes (Ryan's Notes, 2002d). The furnace was expected to remain closed through yearend 2002. Simcala Inc. continued to operate only two of its three silicon furnaces at its Mount Meigs, AL, plant in 2002. The company restarted the closed furnace in February 2003; the unit had been closed since August 2001 (Ryan's Notes, 200d).

Consumption

Ferrosilicon was used primarily as a deoxidizing and alloying agent in the production of iron and steel products. Silicon metal, which can be classified into metallurgical and chemical grades, was used by the aluminum industry in the production of cast and wrought products. It also served as the basic raw material in the manufacture of many chemical products and intermediates, such as silicones and silanes. Small quantities of silicon were processed into high-purity silicon for use in the semiconductor industry.

For 2002, total U.S. apparent consumption of silicon-containing ferroalloys and silicon metal was estimated to have increased by 8% to 540,000 t of contained silicon compared with that of 2001. Also in terms of contained silicon, apparent consumption increased by 17% to 301,000 t for ferrosilicon and miscellaneous silicon alloys and decreased slightly, by 2%, to 239,000 t for silicon metal. Decreases in exports and stocks and increases in imports and domestic production contributed to the rise in ferrosilicon apparent consumption. Increases in net imports, exports, and stocks and a decrease in production led to a decline in silicon metal apparent consumption. On the basis of silicon content, the share of total demand accounted for by ferrosilicon and miscellaneous silicon alloys rose to 56%. Table 4 presents data on U.S. reported consumption and stocks of silicon materials in 2002.

Particularly in iron foundries, metallurgical-grade silicon carbide can substitute for ferrosilicon. Data on North American production and U.S. imports of silicon carbide are reported in the Manufactured Abrasives chapter of the 2002 USGS Minerals Yearbook.

Consumption of ferrosilicon and silicon metal was estimated by CRU International Ltd. to have increased in 2002 throughout the Western World. In terms of contained silicon, ferrosilicon consumption increased to 1.77 million metric tons (Mt) in 2002 from 1.70 Mt in 2001, and silicon metal consumption increased to 1.02 Mt from 981,000 t. The United States had the largest year-to-year increase in ferrosilicon consumption in the Western World. Ferrosilicon consumption by rose 11% to 253,000 t in 2002 from 227,000 t in 2001 owing to an increase in steel production. Silicon metal demand decreased by 2% to 242,000 t in 2002 from 248,000 t in 2001 as a result of a sharp drop in shipments by producers as imports reached an alltime high. In decreasing order of consumption, Western Europe, Japan, and other Asian countries accounted for 71% of the ferrosilicon consumption in 2002. Also in decreasing order of consumption, Western Europe, the United States, and Japan accounted for 81% of the silicon metal consumed in 2002 (CRU Bulk Ferroalloys Monitor, 2003b, c).

As a rough indicator of global demand for silicon wafers made from polycrystalline silicon, world production of polycrystalline silicon increased by 14% to 20,350 t in 2002 (Roskill's Letter from Japan, 2003).

Microsilica (silica fume) is a byproduct from furnaces making silicon metal or ferrosilicon with a silicon content of at least 75%. It is obtained by capturing furnace offgases and fines to use as binder and filler in cements. The global market for fumed silica is estimated to exceed 230,000 tons per year (t/yr) (Interfax Mining & Metals Report, 2002b).

Prices

Demand for silicon ferroalloys and metal is determined in the short term less by their prices than by the level of activity in the steel, ferrous foundry, aluminum, and chemical industries. As a result, prices tend to vary widely with changes in demand and supply. The basis for U.S. prices of silicon materials was cents per pound of contained silicon.

Year-average import prices, as calculated from Platts Metals Week listings, were 32.8 cents per pound for 75% ferrosilicon and 53.2 cents per pound for silicon metal; these prices were 3% and 5% higher, respectively, than those of 2001. The year-average North American transaction price for 50% ferrosilicon as given by Ryan's Notes was 41.1 cents per pound, a 4% reduction from that of 2001 and the lowest since 1993. The decline in year-average prices for 50% ferrosilicon continued for the seventh consecutive year. Increases in year-average prices for silicon metal and 75% ferrosilicon occurred for the first time since 1996. The price range for silicon metal began the year unchanged from yearend 2001 at 48.5 to 50.5 cents per pound, gradually rising to 58 to 60 at yearend. The price range for 75% ferrosilicon began the year unchanged from yearend 2001 at 30 to 31 cents per pound, decreased to 29 to 30 cents per pound in late February where it remained for 9 weeks, and then progressively rose to end the year at 38 to 40 cents per pound. The price range for 50% ferrosilicon began the year at 36 to 38 cents per pound, declined to 34 to 36 cents per pound for 7 weeks starting in late March, and then trended upward to end the year at 47 to 50 cents per pound.

Increased 50% ferrosilicon prices in the last quarter of 2002, and 75% ferrosilicon prices throughout the year, were caused primarily by a reduction in domestic supply and disrupted shipments from Venezuela's Ferroven plant, owing to general strike conditions in the country (CRU Bulk Ferroalloys Monitor, 2003a). Prices for both grades of ferrosilicon continued to rise in December on the announced production cutbacks by several

Norwegian ferrosilicon producers (CRU Bulk Ferroalloys Monitor, 2002). Higher silicon metal prices were caused by the assessment of preliminary antidumping margins on Russian silicon metal imports in September (CRU Bulk Ferroalloys Monitor, 2003d).

Foreign Trade

Compared with those of 2001, total ferrosilicon and silicon metal exports, on a content basis, decreased by 6% to 21,600 t. Combined imports of ferrosilicon and silicon metal increased by 23% on a content basis. The biggest year-to-year changes were for exports of ferrosilicon and imports of silicon metal. Ferrosilicon exports at 6,620 t (contained silicon) were at their lowest since 1986. Silicon metal imports at 145,000 t were at their highest level in history.

U.S. ferrosilicon exports, on a gross weight basis, decreased by 45% from those of 2001, and their value decreased by 63%. In decreasing order of shipments, Canada, the Republic of Korea, Mexico, and Australia accounted for 92% of the total 2002 ferrosilicon exports (table 5). Exports of silicon metal increased by 20% in gross weight and 16% in value from those of 2001. Shipments of high-purity silicon containing more than 99.99% silicon accounted for about 95% of the total value for silicon metal exports. Exports in the category of "ferrosilicon, other" fell sharply (60%) from those in 2001. Combined shipments to Canada, Japan, the Republic of Korea, Mexico, and Germany accounted for 76% of the total silicon exports. Shipments to Germany in 2002 were only 3% of total silicon exports, falling by almost 65% from those in 2001.

U.S. imports of silicon ferroalloys increased by 18% in gross weight and 9% in value compared with those in 2001. Imports increased for all significant categories, with the exception of imports in the "silicon metal, other" category, which declined by 4% from those in 2001. On a gross weight basis, the imports of nominally 75% ferrosilicon (ferrosilicon category of "55% to 80% silicon, other") accounted for 80% of total ferrosilicon imports and 76% of total ferrosilicon value, respectively (table 6). No ferrosilicon in the category of "80% to 90% silicon" was imported in 2002 as it was in 2001. A minor amount (44 t, gross weight) of ferrosilicon in the category of "more than 90% silicon" was imported in 2002. Ferrosilicon imports in the category "55% to 80% silicon, more than 3% calcium," were more than 5 times those of 2001. Venezuela was the leading source of ferrosilicon imports at 24%.

Silicon metal imports, in gross weight, rose by 22% to 146,000 t from 120,000 t in 2001 and by 19% in value to $237 million from $200 million in 2001. On a gross weight basis, imports increased in all silicon metal categories except for "other silicon," which decreased by 4% from those in 2001. The "99.00% to 99.99% silicon" category accounted for 53% of the total value for silicon metal imports, an increase of 40% from those in 2001. The value of this category accounted for 35% of the total value of combined ferrosilicon and silicon imports. Brazil provided the largest volume of the "99.00% to 99.99% silicon" import category, at 37%, gross weight, followed by South Africa at 19%. For the category of "silicon, other," imports from Russia were 41% of the total, a decrease of 17% from those of 2001.

For 2002, U.S. net import reliance for ferrosilicon was estimated to have increased to 50% from 43% for ferrosilicon and to 54% from 45% for silicon metal. The overall import reliance for silicon was estimated to have risen to 52% in 2002 from 44% in 2001.

The general rates of duty that applied to U.S. imports during 2002 were the same as in 2001. On an ad valorem basis, these were 1.5% for standard 75% ferrosilicon, 1.1% for nominal 75% ferrosilicon containing more than 3% calcium, 1.9% for ferrosilicon containing 80% to 90% silicon, 5.8% for ferrosilicon containing more than 90% silicon, free for magnesium ferrosilicon and other ferrosilicon, and 5.3% or 5.5% for metal exclusive of the high-purity grade, which is free (U.S. International Trade Commission, 2003a).

Ferrosilicon Imports from Brazil, China, Kazakhstan, Russia, Ukraine, and Venezuela.—On June 6, the U.S. International Trade Commission (ITC) conducted a hearing to determine whether countervailing and antidumping duties should be reimposed on ferrosilicon imports from Brazil, China, Kazakhstan, Russia, Ukraine, and Venezuela. In 1999, the ITC ruled to eliminate all penalty duties on ferrosilicon imports from these countries imposed in 1994. In February 2002, the U.S. Court of International Trade (CIT) remanded the 1999 ruling back to the ITC because the ITC had not accorded domestic ferrosilicon producers an opportunity to participate in a hearing on the matter (Elkem Metals Co. v. United States, No. 99-10-00628, CIT Slip Opinion 2002-18).

On August 6, the five commissioners of the ITC unanimously determined that the U.S. ferrosilicon industry was not materially injured or threatened with material injury by reasons of the subject imports (U.S. International Trade Commission, 2002§). The ITC transmitted its determination on remand to the CIT, after which time all parties in the case were allowed to brief the Court. On June 18, 2003, the CIT remanded the 2002 determination back to the ITC so the ITC could provide additional evidence supporting the determination (Elkem Metals Co. v. United States, No. 99-10-00628, CIT Slip Opinion 2003-66).

Silicon Metal Imports from Russia.—On April 22, the ITC announced its determination that the United States silicon-metal-producing industry was materially injured by Russian silicon metal imports allegedly sold at less than fair value (U.S. International Trade Commission, 2002a). The ITC initiated its investigation of Russian silicon metal imports during July 2001 through December 2001 based on the March 7, 2002, petition by Globe Metallurgical Inc.; SIMCALA, Inc.; the International Union of Electronic, Electrical, Salaried, Machine and Furniture Workers; the Paper, Allied-Industrial Chemical and Energy Workers International Union; and the United Steel Workers of America. As a result of the ITC determination, the International Trade Administration (ITA) of the U.S. Department of Commerce announced its preliminary determination that the subject imports were being or were likely to be sold in the United States at less than fair value. As a result, the ITA set preliminary antidumping margins for ZAO Kremny, SUAL-Kremny-Ural Ltd. (91.06%); Bratsk Aluminum Smelter (123.62%); and Russia-wide (123.62%) (International Trade Administration, 2002c).

On February 5, 2003, the ITC held a hearing in connection with the final phase of its antidumping investigation of the

silicon metal imports from Russia. On February 11, the ITA announced its final determination of sales at less than fair value of these imports. The ITA set the final antidumping margins for ZAO Kremny, SUAL-Kremny-Ural Ltd. (54.77%); Bratsk Aluminum Smelter (77.51%); and Russia-wide (77.51%) (International Trade Administration, 2003c).

On March 7, 2003, the ITC made a final determination that the U.S. silicon industry was injured by the subject silicon metal and transmitted its determination to the Secretary of the U.S. Department of Commerce on March 19 (U.S. International Trade Commission, 2003b). On March 13, the ITA amended the antidumping margins to correct ministerial errors it made in setting the final margins in February by increasing the margins for ZAO Kremny, SUAL-Kremny-Ural Ltd. to 56.11% from 54.77% and Bratsk Aluminum Smelter to 79.42% from 77.51% (International Trade Administration, 2003b). The ITA issued an antidumping duty order on these imports on March 26 (International Trade Administration, 2003a). The order also documented an increase in the final Russia-wide antidumping margin to 79.42% from 77.51%.

Several appeals of the ITC's final antidumping ruling on Russian silicon metal imports were filed in late April 2003. The following companies separately appealed the ITC decision that the imports had injured or threatened to injure U.S. silicon producers: General Electric Company and Russian silicon producers SUAL-Kremny-Ural, Ltd. and Bratsk Aluminum Smelter (Platts Metals Week, 2003c; Ryan's Notes, 2003b). The U.S. silicon producers who filed the antidumping complaint—Globe Metallurgical, Inc. and Simcala, Inc.—also appealed the antidumping margin rates on the basis that they were too low (Platts Metals Week, 2003c).

Russian Market Economy Status.—The ITA held a public hearing on March 27 to solicit views on the status of Russia as a nonmarket economy country under the antidumping and countervailing duty laws (International Trade Administration, 2002b). On June 6, the ITA announced that Russia had transitioned to market economy status. The decision only affects future duty determinations that concern time periods after April 1, 2002, with no immediate effect on existing antidumping orders or investigations (International Trade Administration, 2002a).

Proposed United States-Southern African Customs Union Free Trade Agreement.—On November 4, the U.S. Trade Representative (USTR) formally notified congressional leaders of the administration's intent to initiate negotiations for a free trade agreement (FTA) with the nations of the Southern African Customs Union—Botswana, Lesotho, Namibia, South Africa, and Swaziland (Office of the United States Trade Representative, 2002§). 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. The USTR convened a public hearing on the proposed FTA on December 16 (Office of the United States Trade Representative, 2002).

On November 7, the USTR requested the ITC to prepare a report on the probable economic effects of the FTA. On November 26, the ITC announced the start of its investigation and a public hearing scheduled for January 28, 2003 (U.S. International Trade Commission, 2002b). The ITC submitted its confidential probable economic effect report to the USTR in April 2003 (U.S. International Trade Commission, 2003§). A public version of the report had not been released at the time of this chapter.

Antidumping Duty Administrative Reviews.—The ITA initiated and conducted various antidumping duty administrative reviews on silicon metal during 2002. On April 1, the CIT consolidated complaints filed by Companhia Brasileira Carbuerto de Calcio (CBCC) and Electrosilex S.A. (CIT No. 01-00082) and Elkem Metals Company and Globe Metallurical Inc. (CIT No. 01-00098) in response to the ITA's issuance of final antidumping duty margins in 2001 for silicon metal, excluding semiconductor-grade silicon, from Brazil covering the period of July 1, 1998, through June 30, 1999 (Elkem Metals Company and Globe Metallurgical Inc. v. United States, No. 01-00098, Slip Opinion 2002-34). In its opinion, the CIT also denied the motion to dismiss Electrosilex as a foreign plaintiff because the company lacked standing on the matter.

On May 17, the ITA issued amended final results of antidumping administrative review of silicon imports from Brazil for the period of investigation July 1, 1994, through June 30, 1995. The revised duty margins were as follows: RIMA Industrial S/A, 81.61%; Camargo Correa Metais, 35.23%; Eletrosilex, 13.18%; and Companhia Ferroligas Minas Gerais-Minasligas, 9.68% (International Trade Administration, 2002d).

On October 17, the CIT remanded for the second time the antidumping duty margin of 93.2% on imports of silicon metal from Electrosilex issued by the ITA on January 29, 2001, for the July 1, 1996, to June 30, 1997, period of review (American Silicon Technologies v. United States, No. 99-03-00149, Slip Opinion 2002-123). As a result, the ITA issued a final antidumping margin of 67.93% for Electrosilex on January 22, 2003 (International Trade Administration, 2003§).

On November 23, the ITA announced it had extended the June 1, 2001, through November 30, 2001, period of review for the new shipper antidumping review of silicon metal from China to January 14, 2003 (International Trade Administration, 2002f). By doing so, the ITA conducted the new shipper review concurrently with the June 1, 2001, through May 31, 2002, administrative review of silicon metal from China as requested by China Shanxi Province Lin Fen Prefecture Foreign Trade and Export Corp. On March 7, 2003, the ITA rescinded these reviews after the company withdrew its requests (International Trade Administration, 2003d). As a result, imports from the company are subject to the China-wide antidumping margin rate of 139.49%.

In December, the ITA announced the final results of its antidumping duty administrative review of silicon metal from Brazil for the July 1, 2000, through June 30, 2001, period of review (International Trade Administration, 2002e). The ITA determined a margin of zero for two companies—Rima Industrial S.A. and CBCC—and 0.74% for Companhia Ferroligas Minas Gerais-Minasligas. The ITA also found that Rima met the requirements for revocation of the antidumping duty order on silicon metal from Brazil. This revocation applies to silicon metal imports produced by Rima on or after July 1, 2001.

World Review

Data on annual world production of ferrosilicon and silicon metal by country during 1998 to 2002 are given in the

Ferroalloys chapter of the 2002 USGS Minerals Yearbook. World production of ferrosilicon was estimated to have been 4.23 Mt in 2002 compared with a revised total of 4.08 Mt in 2001. The major ferrosilicon producers in 2002, in decreasing order, were China, Russia, Norway, Ukraine, the United States, Brazil, Kazakhstan, South Africa, and France; they accounted for 86% of total production as listed in table 1. World production of silicon metal, excluding that from China, was estimated to have been 610,000 t in 2002 compared with a revised total of 629,000 t in 2001. China's production of silicon metal is believed to have been the world's largest, but firm data are lacking. China's annual output of silicon metal in 2002 was estimated to be about 300,000 t based on estimated consumption levels. Other major producers of silicon metal in 2002, in decreasing order, were Brazil, the United States, Norway, France, Russia, South Africa, and Spain; they accounted for about 83% of total production as listed in table 1.

European Union.—On October 12, the European Commission announced its review of the antidumping duty of 49% currently imposed on Chinese silicon metal imports (Hong Kong Trade & Industry Department, 2002§). Also in October, the European Commission began investigating whether Russian silicon metal imports were being dumped in the European Union (American Metal Market, 2002b§). The Commission voted in late June 2003 to impose antidumping duties on silicon imports from Sual (25.2%) and Bratsk (24%). A formal announcement of the preliminary duties was expected in July 2003 (Ryan's Notes, 2003a).

Australia.—While Australian Silicon Limited received final approval from the New South Wales Government in May for the development of its Australian Silicon Project (ASP) in Lithgow, New South Wales, the company announced its abandonment of the project in March 2003 (Mining Journal, 2002; Australian Silicon Limited, 2003a§). The reasons were cited to be as follows: 1) the dampening effect on prices of low-cost Chinese production; 2) the slowdown in major Western economies during the past 3 years; and 3) the company's difficulties in gaining long-term, environmentally sustainable access to a wood resource for charcoal production. On May 7, 2003, the company lost its financial backing by Portman Limited (Australian Silicon Limited, 2003b§).

China.—In 2002, China's exports of ferrosilicon rose to an alltime high of 538,000 t from about 470,000 t in 2001 (TEX Report, 2002). Data for 2002 Chinese silicon metal exports were not available at the time of this report.

Plans for several new silicon production facilities were reported during the year. In February, Dow Corning announced it would build a silicon metal beneficiation plant with China's Dalian Kangnig Silicon Development Corp. The facility would have production capacity of up to 50,000 t/yr (Ryan's Notes, 2002b). On July 11, Crompton Corporation announced the formation of a joint venture with the Nanjing Shuguang General Chemical Company to produce organofunctional silanes for export and the Chinese market (Crompton Corporation, 2002§). Through its joint venture Nanjing Crompton Shuguang Organosilicon Specialties Co., Ltd., the company planned to accelerate the growth of silanes in China and throughout the Asian Pacific region. On August 20, China National Bluestar (Group) Corp. announced it would develop a silicon metal plant in Gansu Province. The plant, expected to be operational in early 2003, would have production capacity of 50,000 t/yr (American Metal Market, 2002a§).

Egypt.—Egyptian Ferro Alloys Co.'s silica fume production capacity was noted to be approximately 20,000 t/yr (Ibrahim, 2002).

France.—Silicon producer Invesil (a subsidiary of Pechiney Electrometallurgie) announced it would start providing certificates of origin with its products to help mitigate consumers' concerns regarding the source of the materials (American Metal Market, 2002d§). Rhodia reported the closure of 19 plants worldwide, including a silicone molding polymers plants in Troy, NY, and a silicone sealants unit in Nanchang, China (Chemical Week, 2002).

Iceland.—Elkem ASA purchased the Icelandic Government's shareholding in ferrosilicon producer Icelandic Alloys Ltd. on December 11, which raised Elkem's stake in the company to 83.11% (Elkem ASA, 2002a§). Elkem achieved a 97.2% ownership in Icelandic Alloys by offering all outstanding shares in the company in January 2003 (Elkem ASA, 2003§).

India.—In January, the Indian Ministry of Commerce imposed an import duty of not less than $740 per metric ton on imports of ferrosilicon from Ukraine (Indian Ministry of Commerce, 2002§). As a result, Ukraine suspended ferrosilicon exports to India (Interfax Mining & Metals Report, 2002d).

In March, the Indian Ministry of Commerce reduced its import duty on silicon metal with 99.00% purity from 35% to 25% (American Metal Market, 2002a). Most of India's silicon imports come from China.

Norway.—On October 7, Elkem's board of directors rejected Alcoa's takeover attempt of the company, which was triggered by Norwegian securities law when Alcoa increased its share in Elkem to more than 40% in 2001 (Elkem ASA, 2002b§). Alcoa's takeover bid was thwarted later in October when Orkla, Elkem's second largest shareholder, increased its shares in the company to 38.3%, up 0.6% (Ryan's Notes, 2002e). Alcoa had no immediate plans to launch a new takeover attempt.

Norwegian ferroalloy producers reported shuttering production in response to high electricity prices caused by a power shortage due to drought conditions. Elkem suspended ferrosilicon production at its Salten and Thamshavn plants (American Metal Market, 2002b). Fesil ASA closed its Lilleby Metall ferrosilicon plant and stopped two furnaces in December and another in January 2003 at its Holla Metall silicon plant (Fesil ASA, 2003§).

Russia.—On March 19, the Russian Ministry of Economic Development and Trade announced the start of an investigation into growing imports of crystalline silicon (Interfax Mining & Metals Report, 2002c). In late April, the Ministry also launched an investigation into silicon metal shipments alleged falsely labeled as Russian and shipped into the United States and European markets. One of the largest Russian producers, SUAL-Kremny-Ural Ltd. Works at Shelekhov in the Irkutsk region began placing holographic marks on its shipments of silicon to certify their origin (Metal Bulletin, 2002).

In June, Kuznetsky Ferrosplavy completed the refurbishment of its No. 7 ferrosilicon furnace begun in May. The furnace was fitted with a modern automated system for managing the smelting process. As a result, the company expected to

reduce its electricity consumption in the manufacture of 75% ferrosilicon by 5% to 6% (Interfax Mining & Metals Report, 2002a). The company also began commercial production of microsilica in 2002 with production capacity of 30,000 t/yr (Interfax Mining & Metals Report, 2002b).

In July, Bratsk Aluminum Smelter converted one of its two silicon metal furnaces to ferrosilicon as a result of the preliminary antidumping duties imposed by the ITA on Russian silicon metal imports in September (Ryan's Notes, 2002a).

Current Research and Technology

Results of industrial trials conducted by researchers with Invesil indicated several advantages of using silicon granules [1 millimeter (mm) to 10 mm in size) versus lumpy silicon (10 mm to 100 mm in size) in the manufacture of aluminum alloys. The advantages included increased silicon dissolution rates, increased silicon chemical homogeneity, and possible pneumatic storage and transport of the silicon (Baluais, Brown, and Strydom, 2002§).

Outlook

Demand for ferrosilicon follows trends in the iron and steel industries, for which the combined annual growth rates (CAGRs) have been typically in the range of 1% to 2%. Details of the outlook for the steel industry are discussed in the "Outlook" section of the iron and steel chapter. Raw steel production in 2002 increased by 2% in the United States and 6.5% globally. Apparent consumption of finished steel products grew to 802 Mt in 2002 from 772 Mt in 2001, an increase of 3.9% (Sweeney, 2003). This increase was primarily attributed to steel consumption in China; steel consumption in the rest of the world rose to 607 Mt in 2002 from 602 Mt in 2001, a slight increase of 0.8%. Steel consumption in most regions of the world was flat. Globally, ferrosilicon consumption in the iron and steel industries in 2003 was expected to be roughly that of 2002 with a slight increase to 1.848 Mt in 2003 from 1.845 Mt in 2002 (Metal Bulletin Research Ferro-alloys Monthly, 2003a).

Demand for silicon metal comes primarily from the aluminum and chemical industries. The American Chemistry Council estimated an increase of 4% in domestic chemical shipments as a result of a strengthening recovery in 2003 (Swift and Gilchrist Moore, 2002§). On the basis of a forecast for the foundry industry, demand for silicon by the U.S. aluminum castings industry can be expected to increase by 2% in 2003 (Kirgin, 2003§). The growth may not translate directly into increased consumption of silicon metal because of an increase foreseen in recycling of automotive scrap. Total world silicon metal consumption was expected to increase by 2% to 972 Mt in 2003 from 950 Mt in 2002 (Metal Bulletin Research Ferro-alloys Monthly, 2003b).

As a rough indicator of demand, world production of polycrystalline silicon is forecast to increase by about 14% to 23,150 t in 2003, with 71% used in semiconductors and 29% used in solar battery manufacture (Roskill's Letter from Japan, 2003). Future demand for polycrystalline silicon in semiconductors is uncertain because of the downturn in the global personal computer, fears of a slowdown in the U.S. economy, and concerns over the level of demand for semiconductors in cellular phones, but future demand for solar batteries, centered in Europe and the United States, is predicted to increase (Roskill's Letter from Japan, 2002).

Demand for microsilica comes from the cement industry. Worldwide demand for cement was projected to rise by 4.1% per year through 2006 to 2.1 billion metric tons, although advances were expected to be less robust in more developed areas such as the United States, Japan, and Western Europe (Mining Engineering, 2002).

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TABLE 1
SALIENT SILICON STATISTICS[1]

(Thousand metric tons of silicon content unless otherwise specified)

	1998	1999	2000	2001	2002
United States:					
Production	429	423	367	282	261
Exports:					
Ferrosilicon	24	24	22	10	7
Silicon metal	23	37	19	12	15
Imports for consumption:					
Ferrosilicon	142	173	231	115	140
Silicon metal	99	113	130	116	145
Apparent consumption:					
Ferrosilicon	349	374	397	258	301
Silicon metal	267	269	292	244	239
Price, average, cents per pound Si:[2]					
Ferrosilicon, 50% Si	52.10	49.10	45.00	42.80	41.10
Ferrosilicon, 75% Si	43.10	40.20	35.40	31.90	32.80
Silicon metal	70.50	58.10	54.80	50.50	53.20
World, production, gross weight:[e]					
Ferrosilicon	3,900	3,900 [r]	4,240 [r]	4,080 [r]	4,230
Silicon metal	686 [r]	681 [r]	729 [r]	629 [r]	610

[e]Estimated. [r]Revised.
[1]Data are rounded to no more than three significant digits.
[2]Platts Metals Week dealer import prices.

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

(Metric tons, gross weight, unless otherwise specified)

			2001	2002		
	Silicon content (percentage)		Producers' stocks			Producers' stocks
Material	Range	Typical	December 31	Gross production[3]	Net shipments	December 31
Ferrosilicon[4]	25-65 [5]	48	31,900	156,000	104,000	19,400
Do.	56-95	76	30,400	98,600	104,000	15,800
Silicon metal, excluding semiconductor grades	96-99	98	2,230	113,000	105,000	3,820

[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 formerly was listed separately.
[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 2002

Producer	Plant location	Product[1]
Applied Industrial Minerals Corp.	Bridgeport, AL	FeSi.
CC Metals and Alloys, Inc.	Calvert City, KY	Do.
Elkem Metals Co.	Alloy, WV	FeSi and Si.
Globe Metallurgical, Inc.	Beverly, OH	Do.
Do.	Niagara Falls, NY	Do.
Do.	Selma, AL	Si.
Keokuk Ferro-Sil Inc.[2]	Keokuk, IA	FeSi and silvery pig iron.
Simcala, Inc.	Mount Meigs, AL	Si.

[1]FeSi, ferrosilicon; Si, silicon metal.
[2]Company did not produce, they fulfilled the agreed upon contracts with remaining inventory.

TABLE 4
REPORTED CONSUMPTION, BY END USE, AND STOCKS OF SILICON FERROALLOYS AND METAL IN THE UNITED STATES IN 2002[1, 2]

(Mertic 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	W	(9)	10,700	810	(9)	(9)
Stainless and heat-resisting	--	(9)	44,000	398	(9)	(9)
Full alloy	--	(9)	6,730	176	(9)	--
Electric and tool	--	(9)	25,700	--	(9)	(9)
Unspecified	--	28,100	--	(10)	1,060	7,960
Total	W	28,100	87,100	1,380	1,060	7,960
Cast irons	5,300	38,000	57,500	(10)	18,900	24,200
Superalloys	--	(11)	(10)	110	--	--
Alloys, excluding superalloys and alloy steel	W	413	(10)	176,000 [12]	--	--
Miscellaneous and unspecified	--	(11)	474	53,100	(11)	--
Grand total	5,300	66,400	145,000	231,000	20,000	32,200
Consumers' stocks, December 31	362	3,660	10,400	1,700	1,150	1,360

W Withheld to avoid disclosing company proprietary data. -- 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 abrasives or refractory uses.
[9]Included with "Steel, unspecified."
[10]Included with "Miscellaneous and unspecified."
[11]Included with "Cast irons."
[12]Primarily silicones, silanes, fumed silica, and other chemicals, plus aluminum alloys.

TABLE 5
U.S. EXPORTS OF FERROSILICON AND SILICON METAL, BY GRADE AND COUNTRY, IN 2002[1]

(Metric tons)

Country	Gross weight	Contained weight	Value
Ferrosilicon:			
More than 55% silicon:			
Canada	4,820	2,890	$3,280,000
Malaysia	33	25	54,700
Mexico	662	411	648,000
Trinidad and Tobago	11	6	8,590
Total	5,530	3,340	3,990,000
Other ferrosilicon:			
Australia	527	166	570,000
Brazil	43	22	36,200
Canada	3,810	1,910	2,370,000
China	48	24	13,100
Italy	81	43	131,000
Japan	336	30	717,000
Korea, Republic of	1,370	687	1,730,000
Malaysia	261	67	307,000
Mexico	525	264	608,000
Venezuela	29	15	26,800
Other	116	56	152,000
Total	7,150	3,280	6,660,000
Grand total ferrosilicons	12,700	6,620	10,600,000
Metal:			
More than 99.99% silicon:			
China	561	XX	16,200,000
France	75	XX	2,080,000
Germany	356	XX	15,900,000
Italy	85	XX	7,860,000
Japan	3,360	XX	168,000,000
Korea, Republic of	482	XX	19,000,000
Norway	388	XX	10,000,000
Taiwan	131	XX	5,740,000
Ukraine	120	XX	3,030,000
United Kingdom	85	XX	13,900,000
Other	276	XX	26,900,000
Total	5,920	5,920 [e]	289,000,000
99.00% - 99.99% silicon:			
Belgium	26	26	36,300
Brazil	40	39	55,900
Denmark	164	162	268,000
Japan	286	284	814,000
Korea, Republic of	20	20	28,600
Mexico	269	267	449,000
Nauru	51	51	72,000
Netherlands Antilles	103	102	168,000
Norway	275	272	387,000
Singapore	21	20	39,400
Other	127	126	226,000
Total	1,380	1,370	2,540,000
Other silicon:			
Canada	2,170	2,100	2,490,000
Germany	329	319	437,000
Israel	638	619	841,000
Japan	1,110	1,080	1,610,000
Korea, Republic of	524	509	840,000
Malaysia	253	246	479,000
Mexico	833	808	1,460,000
Philippines	428	416	$1,190,000

See footnotes at end of table.

TABLE 5--Continued
U.S. EXPORTS OF FERROSILICON AND SILICON METAL, BY GRADE AND COUNTRY, IN 2002[1]

(Metric tons)

Country	Gross weight	Contained weight	Value
Metal--Continued:			
Other silicon--Continued:			
Taiwan	493	478	1,150,000
United Kingdom	334	324	707,000
Other	834	809	2,890,000
Total	7,940	7,710	14,100,000
Grand total silicon metal	15,200	15,000	305,000,000

[e]Estimated. XX Not applicable.
[1]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, BY GRADE AND COUNTRY, IN 2002[1]

(Metric tons)

Country	Gross weight	Contained weight	Value
Ferrosilicon:			
55% to 80% silicon, more than 3% calcium:			
Argentina	158	96	$207,000
Brazil	1,270	793	1,020,000
Canada	202	134	65,800
China	161	145	79,900
France	142	93	193,000
Germany	40	12	40,500
Mexico	6	3	13,300
Norway	6	4	10,500
United Kingdom	11	7	58,100
Total	1,990	1,290	1,680,000
55% to 80% silicon, other:			
Brazil	3,590	2,690	2,110,000
Canada	8,940	6,840	5,740,000
China	7,070	5,360	3,530,000
France	3,480	2,300	6,450,000
Iceland	19,200	14,400	8,950,000
Kazakhstan	33,800	25,800	14,000,000
Norway	10,700	8,000	8,920,000
South Africa	6,550	4,750	3,020,000
Ukraine	21,500	16,000	9,070,000
Venezuela	49,100	36,900	26,900,000
Other	768	408	2,000,000
Total	165,000	123,000	90,600,000
More than 90% silicon, China	44	27 [2]	220,000
Magnesium ferrosilicon:			
Argentina	1,730	769	1,210,000
Brazil	3,730	1,690	2,420,000
Canada	1,840	882	1,180,000
China	3,410	1,720	2,580,000
France	20	9	22,200
Germany	5	2	12,000
Japan	243	108	429,000
Korea, Republic of	3,640	786	2,340,000
Norway	10,700	4,930	8,630,000
Slovenia	4	1	6,480
Ukraine	37	18	14,900
Total	25,300	10,900	18,800,000

See footnotes at end of table.

TABLE 6--Continued
U.S. IMPORTS FOR CONSUMPTION OF FERROSILICON AND SILICON METAL, BY GRADE AND COUNTRY, IN 2002[1]

(Metric tons)

Country	Gross weight	Contained weight	Value
Ferrosilicon--Continued:			
Other ferrosilicon:			
Brazil	228	117	199,000
Canada	10,500	3,590	7,410,000
China	40	20	66,100
France	30	13	56,300
Italy	94	41	28,600
Norway	23	4	18,100
Russia	2,560	472	717,000
Ukraine	1,020	471	327,000
United Kingdom	2	1	2,690
Total	14,500	4,730	8,830,000
Grand total ferrosilicon	207,000	140,000	120,000,000
Metal:			
More than 99.99% silicon:			
China	24	XX	$537,000
Cyprus	54	XX	80,000
Finland	12	XX	54,900
Germany	369	XX	44,500,000
Italy	306	XX	12,500,000
Japan	463	XX	14,700,000
Korea, Republic of	138	XX	1,780,000
Poland	7	XX	30,900
Spain	16	XX	65,600
United Kingdom	4	XX	243,000
Other	16	XX	1,410,000
Total	1,410	1,410 [e]	75,900,000
99.00% - 99.99% silicon:			
Argentina	6,920	6,690	6,590,000
Australia	568	564	619,000
Brazil	38,300	38,000	49,300,000
Canada	15,400	16,000	18,600,000
Germany	1,860	1,850	3,370,000
Norway	3,860	3,830	5,980,000
Russia	13,200	13,100	14,500,000
Saudi Arabia	757	751	671,000
South Africa	19,900	19,800	22,800,000
Spain	1,480	1,470	1,420,000
Other	1,730	1,690	1,770,000
Total	104,000	104,000	125,000,000
Other silicon:			
Arab Emirates	1,070	1,050	891,000
Argentina	280	277	264,000
Canada	1,880	1,840	2,230,000
China	4,590	4,420	3,570,000
Germany	220	216	188,000
Korea, Republic of	780	766	610,000
Norway	3,280	3,220	2,970,000
Russia	16,800	16,500	13,700,000
Saudi Arabia	338	330	243,000
South Africa	11,000	10,600	10,100,000
Other	807	635	783,000
Total	41,000	39,900	35,500,000
Grand total silicon metal	146,000	145,000	237,000,000

[e]Estimated. XX Not applicable.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Data was adjusted by the U.S. Geological Survey.