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TITANIUM [ADVANCE RELEASE]

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Titanium

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There were two producers of titanium mineral concentrates in the United States in 2014. As a percentage of apparent consumption, the United States was 92% and 58% import reliant for titanium mineral concentrates and titanium sponge, respectively.

The United States continued to be a net exporter of titanium dioxide (TiO_2) pigment and wrought titanium metal products. The leading sources of imported titanium mineral concentrates were, in decreasing order, South Africa, Australia, Mozambique, and Canada (table 11). The leading sources of titanium sponge were, in decreasing order, Japan, Ukraine, China, and Kazakhstan (table 12). Domestic production of TiO_2 pigment decreased slightly compared with that of 2013 (table 5). U.S. consumption of titanium used in steel and other alloys was essentially unchanged from that in 2013 (table 7).

World production of titanium mineral concentrates in 2014 was 9.85 million metric tons (Mt) of gross production, a decrease of 8% from revised totals for 2013. The leading producers of titanium mineral concentrates, in terms of contained TiO_2 were, in descending order of production, China, Australia, South Africa, and Canada.

Titanium is the ninth most abundant element in the earth's crust and can be found in nearly all rocks and sediments. It is a lithophile element with a strong affinity for oxygen and is not found as a pure metal in nature. Titanium was first isolated as a pure metal in 1910, but it wasn't until 1948 that metal was produced commercially using the Kroll process (named after its developer, William Kroll) to reduce titanium tetrachloride with magnesium to produce titanium metal.

Production

Titanium industry data for this report were collected by the U.S. Geological Survey (USGS) from annual surveys of titanium mineral and pigment producers and quarterly surveys of titanium sponge, ingot, and mill producers. In 2014, the USGS annual survey canvassed titanium mineral producers. The two producers of titanium mineral concentrates responded. Of the six active domestic TiO_2 pigment operations, five responded. Production data for the operation that did not respond were estimated on the basis of prior year production levels and industry trends.

Mineral Concentrates.—Titanium minerals of economic importance include ilmenite, leucoxene, rutile, synthetic rutile, and titaniferous slag. Mining of titanium minerals is usually performed using dredging and dry surface mining techniques for the recovery of heavy minerals. Spiral separation by gravity is used to isolate the heavy-mineral suite, and magnetic and high-tension separation circuits are used to separate the heavy-mineral constituents. Ilmenite and rutile are the two principal minerals for titanium. Ilmenite is the most abundant titanium mineral with a contained TiO_2 content ranging from 35% to 65%. Rutile, naturally occurring TiO_2, is less abundant. Ilmenite is often processed to produce a synthetic rutile or titaniferous slag. Although numerous technologies are used to produce synthetic rutile, nearly all are based on either selective leaching or thermal reduction of iron and other impurities in ilmenite.

U.S. mineral concentrate producers were DuPont Titanium Technologies [a subsidiary of E.I. du Pont de Nemours and Co. (DuPont), Wilmington, DE] and Iluka Resources, Inc. (a subsidiary of Iluka Resources Ltd., Perth, Western Australia, Australia). DuPont's mining operations near Starke, FL, produced a mixed product containing ilmenite, leucoxene, and rutile that was used as a feedstock in DuPont's TiO_2 pigment plants. Iluka produced titanium mineral concentrates from its heavy-mineral operations near Stony Creek, VA. In December, Iluka announced its decision to mine out remaining reserves at its Brink and Concord deposits in Virginia and expected to cease mining and processing activities in the United States at the end of 2015. Iluka continued to hold mineral leases in resources located near Aurelian Springs, NC, and Hickory, VA (Iluka Resources Ltd., 2014).

Southern Ionics Inc. was developing heavy-mineral deposits at its Mission North Mine in Brantley County, GA, and its Mission South Mine in Charlton County, GA, and was constructing the Offerman mineral separation plant (MSP) in Pierce County, GA. The Mission South Mine was officially opened in May 2014, the Offerman MSP was expected to become operational in May 2015, and the Mission North Mine was expected to become operational in late 2015. The initial rate of production was expected to be 23,600 metric tons per year (t/yr) of titanium mineral concentrates and was expected to increase to about 62,000 t/yr after commissioning of the Mission North Mine (Southern Ionics Inc., 2013, p. 26; 2014; 2015).

Twin Pines Minerals LLC was developing a project to produce zircon and ilmenite concentrates by reprocessing tailings from former sand operations in New Jersey. A mineral sands wet concentration plant was being constructed with a feed capacity of 232 metric tons per hour. Production was expected to begin in the third quarter of 2015 (Mineral Sands Report, 2014, p. 5; Patel, 2015).

TiO_2 Pigment.—TiO_2 pigment is produced from titanium mineral concentrates by either the chloride process or the sulfate process. In the chloride process, natural rutile, chloride-grade ilmenite, or slag is converted to titanium tetrachloride ($TiCl_4$) by chlorination in the presence of petroleum coke. $TiCl_4$ is oxidized with air or oxygen at about 1,000 °C, and the resulting TiO_2 is calcined to remove residual chlorine and any hydrochloric acid that may have formed during the reaction. Aluminum chloride, added to the $TiCl_4$, ensures that virtually all of the titanium is oxidized into the rutile crystal structure, rather

than its polymorph anatase. In the sulfate process, ilmenite or titanium slag is reacted with sulfuric acid. Titanium hydroxide is then precipitated by hydrolysis, filtered, and calcined to produce TiO_2. Either process may be used to produce pigment; the decision of which process to use is based on numerous factors, including raw material availability and freight and waste-disposal costs. In finishing operations, the crude form of the pigment is milled to produce a controlled particle-size distribution and then surface treated or coated to improve its functional behavior in various media. Some typical surface treatments include alumina, organic compounds, and silica. The TiO_2 pigment produced is categorized by crystal form as either anatase or rutile. Rutile pigment is less reactive with the binders in paint when exposed to sunlight than anatase pigment and, thus, is preferred for use in outdoor paints. Anatase pigment has a bluer tone than rutile pigment, is somewhat softer, and is used mainly in indoor paints and in paper manufacturing. Depending on the manner in which it is produced and subsequently finished, TiO_2 pigment can have significantly different functional properties, including dispersion, durability, opacity, and tinting.

U.S. production of TiO_2 pigment was 1.26 Mt in 2014, a slight decrease compared with that in 2013 (table 5). U.S. producers of TiO_2 pigment using the chloride process were Cristal (owned by the National Titanium Dioxide Company Ltd. and Gulf Investment Corp.), DuPont, Louisiana Pigment Co. L.P. (a joint venture of Kronos Worldwide, Inc. and Huntsman Corp.), and Tronox Ltd. (table 4). TOR Minerals International, Inc. produced a buff TiO_2 pigment from finely ground synthetic rutile.

Metal.—In commercial production of titanium metal, $TiCl_4$ is reduced with magnesium (Kroll process) or sodium (Hunter process) to produce a commercially pure titanium metal. The metal formed has a porous appearance and is referred to as sponge. Titanium ingot and slab are produced by melting titanium sponge and (or) scrap, usually with other alloying elements such as aluminum and vanadium. Electron beam, plasma arc melt, scull, and vacuum-arc remelting of sponge are the commercial methods used to produce ingot and slab. Titanium mill products are formed by drawing, forging, or rolling ingot or slabs into products of various sizes and shapes. These mill products include billet, pipe and tube, plate, rod and bar, sheet, strip, and wire. Titanium castings are produced by investment casting and rammed graphite mold casting.

In 2014, U.S. producers of titanium sponge were Allegheny Technologies Inc. (ATI), Honeywell Electronic Materials Inc., and Titanium Metals Corp. (Timet) (table 2). ATI's Rowley, UT, plant and Timet's Henderson, NV, plant produced titanium sponge using the Kroll process. Honeywell Electronic Material (Salt Lake City, UT) used the Hunter process to produce titanium sponge as feed for the company's production of electronic-grade titanium. Data on domestic production of titanium sponge were withheld to avoid disclosing company proprietary data. In 2014, U.S. production of titanium ingot decreased by 15% and mill shipments increased by 3% (table 3).

Ferrotitanium is usually produced by induction melting of titanium scrap with iron or steel, but may be produced through the aluminothermic reduction of ilmenite. The two grades of ferrotitanium that are normally produced contain 40% or 70% titanium. U.S. producers of ferrotitanium were RTI International Metals, Inc. (Canton, OH) with a capacity of 7,250 t/yr and Global Titanium Inc. (Detroit, MI) with a capacity of over 10,000 t/yr. Data on production of ferrotitanium were not available.

Consumption

Mineral Concentrates.—On a gross weight basis, 93% of domestic consumption of titanium mineral concentrates was used to produce TiO_2 pigment. The remaining 7% was used to produce metal and other miscellaneous products, including fluxes and welding rod coatings. Based on TiO_2 content, domestic consumption of titanium mineral concentrates was 1.43 Mt, a slight decrease compared with that of 2013 (table 6).

TiO_2 Pigment.—Domestic production of TiO_2 pigment decreased slightly and apparent domestic consumption (not accounting for changes in inventory) decreased by 3% from that of 2013 (table 5). The leading uses of TiO_2 pigment, based on TiO_2 pigment shipments in the United States by domestic producers, were paint, varnish, and lacquer (59.5%); plastics and rubber (19.6%); and paper (11.8%). Other uses (9.1%) included catalysts, ceramics, coated fabrics and textiles, floor coverings, printing ink, and roofing granules (table 8).

Metal.—Titanium metal alloys are used for their high strength-to-weight ratio and corrosion resistance. The aerospace industry (75%) was the leading end use for mill products. In general, production of titanium mill products precedes aircraft deliveries by about 1 year. In 2014, mill product shipments increased by 3% from those of 2013 (table 3). Other uses included consumer goods and the marine, medical, oil and gas, pulp and paper, and specialty chemical industries. A significant quantity of titanium in the form of ferrotitanium, scrap, and sponge was consumed in the steel and nonferrous alloy industries. In the steel industry, titanium is used for deoxidation, grain-size control, and control and stabilization of carbon and nitrogen content. Titanium-intensive steels include interstitial, free-machining, stainless, and high-strength low-alloy steels. Reported domestic consumption of titanium products in steel and other alloys was 11,900 metric tons (t), essentially unchanged from that of 2013 (table 7).

Stocks

Insufficient data were available to determine yearend consumer inventories of titanium mineral concentrates and TiO_2 pigment producer stocks. Yearend domestic stocks of sponge and ingot decreased by 9% and increased by 3%, respectively, from yearend 2013 levels (table 3). Yearend stocks of scrap increased by 8% from those of 2013.

Prices

Yearend titanium mineral concentrate prices are listed in table 9. Prices for bulk ilmenite and rutile concentrates continued to decline throughout 2014 owing to reduced demand and overcapacity. Published prices for titanium slag were not available. Based on U.S. Census Bureau data, the average value of slag imports from slag-producing countries (Canada and

South Africa) in 2014 increased to $720 per metric ton from $642 per metric ton in December 2013.

The U.S. Department of Labor, Bureau of Labor Statistics, producer price index (PPI) for TiO_2 pigment (June 1982 = 100), which was 236 in December 2013, trended downward during 2014 to 224 in December. The monthly PPI for titanium mill products, which was 181 in December 2013, decreased to 163 in January 2014, and then gradually rose to 180 in December.

Foreign Trade

Mineral Concentrates.—U.S. imports of titanium mineral concentrates included ilmenite, natural rutile, synthetic rutile, and titaniferous slag. The United States was heavily reliant on imports of titanium mineral concentrates because domestic consumption of titanium minerals greatly exceeded domestic production and capacity. In 2014, the TiO_2 content of imports was estimated to be 1.11 Mt, primarily in the form of titaniferous slag (52%), rutile (22%), and ilmenite (19%). South Africa, Australia, Mozambique, and Canada, in descending order of gross weight, were the leading import sources. The combined value for all forms of titanium concentrate imports in 2014 was $784 million (table 11). Imports of titaniferous iron ore from Canada decreased to 138 t in 2014 from 13,800 t in 2013. Although classified as ilmenite by the U.S. Census Bureau, the imports are used in ironmaking and are not processed for TiO_2 recovery. Exports of titanium concentrates were minor relative to imports (tables 10, 11).

TiO_2 Pigment.—In 2014, the United States continued to be a net exporter of TiO_2 pigment, with exports exceeding imports by a ratio of 3.1 to 1. Exports of TiO_2 pigment were 685,000 t, a slight increase compared with those of 2013. About 96% of TiO_2 pigment exports was in the form of finished pigment containing 80% or more TiO_2 (table 10). During 2014, 224,000 t of TiO_2 pigment was imported, an increase of 5% compared with that of 2013. The leading import sources of TiO_2 pigment were Canada (31%), China (24%), and Germany (12%). Seventy-six percent of pigment imports was in the form of finished pigment containing 80% or more TiO_2 (table 13).

Metal.—Total imports of titanium metal, excluding ferrotitanium, increased by 11% from those in 2013 (table 12). Imports of titanium metal were primarily in the form of waste and scrap (42%), sponge (40%), and wrought products and castings (14%). In descending order of tonnage, Japan, Ukraine, and China were the leading sources of imported titanium sponge, and Germany, the United Kingdom, Japan, and the Republic of Korea were, in descending order of tonnage, the leading sources of imported scrap. Japan and Russia supplied all of the imported titanium ingot, and China was the major source of titanium powder. Russia was the leading source of wrought products and castings. Imports of wrought products and castings were 6,280 t, a decrease of 4% from the revised 2013 total.

Imports of ferrotitanium were 2,210 t, a 31% increase compared with those of 2013 (table 12). Exports of ferrotitanium were 2,990 t, a 27% decrease compared with those of 2013 (table 10).

World Review

During 2014, world production of titanium mineral concentrates decreased by about 8% from that of 2013 while consumption increased by 5% over the same period. The deficit in production relative to consumption was met by a drawdown in mineral sand and pigment inventories. Sulfate feedstocks accounted for 75% of the consumption growth in 2014 (Griffin, 2014, p. 3). Global consumption of TiO2 pigments in 2014 was estimated at 5.74 Mt with China as the leading consumer at 1.90 Mt. The major end-use sectors were, in decreasing order, paints, plastics, paper, ink, and other (Adams, 2015, p. 13, 14).

Australia.—Iluka Resources Ltd. produced 177,000 t of rutile and 271,000 t of ilmenite from its operations in Australia, an increase of 40% and a decrease of 31%, respectively, compared with those of 2013. All of Iluka's synthetic rutile kilns were idled in 2014 in response to reduced market demand (Iluka Resources Ltd., 2015, p. 14, 18).

MZI Resources Ltd. continued the development of the Keysbrook project in Western Australia and expected to begin production in the fourth quarter of 2015. MZI expected to produce more than 95,000 t/yr of leucoxene and zircon (MZI Resources Ltd., 2015).

Image Resources' Atlas and Boonanarring deposits in the Perth Basin, Western Australia, were expected to produce 89,000 t/yr of ilmenite, 9,000 t/yr of rutile, and 5,400 t/yr of leucoxene over a 10-year mine life. The Boonanarring deposit was expected to become operational in late 2016 (Image Resources, 2014; 2015, p. 10).

China.—Imports of titanium mineral concentrates totaled 2.02 Mt in 2014, a decrease of 11% from those of 2013. The leading import sources, in decreasing order, were Australia, India, and Vietnam (Metal-Pages, 2015a).

China exported 5,691 t of titanium sponge in 2014, an increase of 41% from that of 2013 based on increased demand for lower grade sponge from South Korean steelmakers (Metal-Pages, 2015b).

India.—The National Aluminum Co. Ltd. signed a memorandum of understanding with Indian Rare Earths Ltd. to construct a titanium slag plant. The plant was to be located in the State of Odisha with a capacity of 100,000 t/yr of titanium slag. No timetable was given for planned completion of the plant (Darabshaw, 2014).

Japan.—In 2014, Japan produced 30,900 t of titanium sponge, a decrease of 27% from that of 2013. Exports of titanium sponge were about 15,800 t in 2014, a decrease of 9% from those of 2013 owing to lower demand from the global aircraft industry for titanium sponge; manufacturers were using larger quantities of scrap in lieu of sponge. Domestic shipments were 19,100 t, an increase of 11% from those of 2013, and were attributed to demand in plate heat exchanger and tubing in electric generation plants (Roskill's Letter from Japan, 2015).

Kazakhstan.—In 2014, the Ust-Kamenogorsk Titanium Magnesium Plant produced about 9,000 t of titanium sponge, a 25% decrease from that of 2013. The cutback in production, which began in 2013, was a deliberate company response to overstocking and inventory oversupply in the global titanium sponge market (Metal-Pages, 2015c).

Kenya.—In February 2014, Base Resources Ltd. made the first shipment of ilmenite from its Kwale heavy-mineral sands project. By yearend, Base Resources had produced 374,000 t of ilmenite and 59,500 t of rutile during the 18-month period since startup. Base Resources expected to produce 360,000 t/yr of ilmenite and 80,000 t/yr of rutile during the first 6 years of operations (Base Resources Ltd., 2014, p. 7, 20; 2015, p. 5)

Madagascar.—World Titanium Resources Ltd. (WTR) estimated ore reserves at its Ranobe deposit in the Toliara Sands Project in southwest Madagascar to be 161 Mt containing 8.2% heavy minerals. WTR expected to produce 407,000 t/yr of ilmenite and 44,000 t/yr of zircon-rutile concentrate over a mine life of 21 years. No timetable was given for start of production (World Titanium Resources, 2014, p. 8, 17).

Mozambique.—In 2014, Kenmare Resources plc's Moma Mine produced 854,600 t of ilmenite and 6,100 t of rutile, an increase of 19% and 53%, respectively, from that of 2013. In the second half of 2014, in response to market conditions, output of sulfate-grade ilmenite (ilmenite used in the sulfate process to produce TiO_2 pigment) was reduced whereas production of rutile and zircon were maximized (Kenmare Resources plc, 2015, p. 33).

Norway.—In 2014, titanium slag production at the TiZir Ltd. facility at Tyssedal was 183,700 t, a decrease of 3% from that of 2013, owing to a maintenance shutdown of the pre-reduction rotary kiln in March (TiZir Ltd., 2015, p. 3).

Russia.—In 2014, the leading end uses of titanium in Russia were engine manufacturing (29%), aircraft manufacturing (28%), and shipbuilding (25%) (Metz, 2015, p. 2).

In 2014, IRC Ltd. produced 178,426 t of ilmenite at its Kuranakh Mine, an increase of 19% from that of 2013. The Kuranakh Mine, located in the Amur region in the Russian Far East, was expected to produce 160,000 t/yr of ilmenite over a remaining mine life of more than 14 years (IRC Ltd., 2015, p. 9, 10).

In July, VSMPO-Avisma extended a long-term contract to supply the Boeing Co. with titanium rolled products until 2022. The rolled products were to meet Boeing's titanium demand for the manufacture of civilian aircraft. In recent years, VSMPO has supplied about 40% of Boeing's titanium requirements (Metal-Pages, 2014a).

Saudi Arabia.—In January, the National Industrialization Co. (Tasnee) and The National Titanium Dioxide Company Ltd. (Cristal) announced the establishment of a joint venture with the Toho Titanium Company Ltd. (Japan), to construct a titanium sponge production facility in Yanbu. The sponge facility would be built adjacent to Cristal's existing TiO_2 plant. The planned plant capacity was to be 15,600 t/yr, and production was expected to begin in the second quarter of 2017 (Cristal, 2014).

Senegal.—In the first year of production, Mineral Deposits Ltd. produced 100,590 t of ilmenite and 663 t of rutile and leucoxene at its Grand Côte operation. Mineral Deposits expected to produce 575,000 t/yr of ilmenite over a 25-year mine life (Mineral Deposits Ltd., 2015, p. 3, 6).

Sierra Leone.—Sierra Rutile Ltd. produced 114,163 t of rutile in 2014, a decrease of 5% from 2013 production owing to Ebola-virus-related challenges experienced during the year. Development at the Gangama Mine continued, with first production expected to begin in the second quarter of 2016. Once construction was completed, Gangama was expected to produce 90,000 t/yr of rutile (Sierra Rutile Ltd., 2015, p. 1, 4, 5).

South Africa.—Tronox Ltd. received the required permits and began full-scale development of its Fairbreeze Mine with production expected to begin in late 2015. During a 12-year mine life, the Fairbreeze Mine was expected to produce 220,000 t/yr of titanium slag and 30,000 t/yr of rutile. Production from the Fairbreeze Mine was expected replace feedstock from the Hillendale Mine, which ceased operations in 2014 (Turgeon, 2014, p. 3, 5).

Mineral Commodities Ltd. began production at their Tormin project on the west coast of South Africa in January and, by yearend, had produced 42,668 t of nonmagnetic zircon-rutile concentrate and 100,437 t of ilmenite concentrate. The Tormin project was expected to produce more than 100,000 t/yr of ilmenite and 45,000 to 50,000 t/yr of zircon-rutile concentrate grading up to 81% zircon and 11% rutile over an initial 3- to 5-year mine life (Mineral Commodities Ltd., 2015a, p. 7; 2015b).

Ukraine.—In July, after increasing capacity to 1,000 t/yr, the Zaporozhye Titanium Magnesium Plant (ZTMP) resumed production of titanium ingots. In 2014, ZTMP produced 207 t of ingot, a threefold increase from that of 2013. Production of titanium slag was 32,600 t and titanium sponge was 7,200 t, a decrease of 8% and 23%, respectively, compared with that of 2013. The cutbacks in production were attributed to planned reductions and emergency power blackouts (Metal-Pages, 2015d). ZTMP was considering future expansion of ingot production to 12,000 t/yr (Metal-Pages, 2014c). ZTMP is part of a vertically integrated chain of titanium companies owned by Group DF (Kiev) (Group DF, 2016).

Vietnam.—In 2014, about 90% of titanium mineral producers in Vietnam halted production, owing to stagnant market conditions, limited trading, and high producer inventories (Metal-Pages, 2014b).

Outlook

Consumption of titanium mineral concentrates is estimated to increase 5% per year through 2018. China is expected to remain the leading consumer (Griffin, 2014, p. 4). Global consumption of TiO_2 pigment is expected to rise by 4% per year from 2015 through 2020 and is expected to be the highest in China at 6.2% per year. The excess of TiO_2 pigment production capacity relative to consumption was estimated to be 32% in 2014 but is expected to decrease to 10% by 2020, owing to plant closures and curtailment of planned expansions (Adams, 2015, p. 19, 29). Outside of China and Russia, aerospace applications are expected to continue to lead demand for titanium metal as airframe and jet engine build rates increase as older aircraft are retired from service. Aerospace airframe titanium consumption is expected to almost double to about 58,000 t/yr in 2020, from an estimated 31,000 t consumed in 2014 (Seiner, 2015, p. 31). Growth of commercial aerospace engine manufacturing is expected to be 3.2% per year through 2022 (Leach, 2015, p. 7). Consumption of titanium metal in industrial uses is expected to increase slightly from 26,000 t/yr in 2015 to about 30,000 t/yr in 2020. Industrial end-use sectors, in decreasing order of consumption, are expected to be chemical processing, power generation, and the oil and gas industry (Cain, 2015, p. 29).

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TABLE 1
SALIENT TITANIUM STATISTICS[1]

		2010	2011	2012	2013	2014
United States:						
Mineral concentrate:						
Imports for consumption	metric tons	1,200,000	1,270,000	1,380,000	1,480,000	1,380,000
Consumption[e, 2]	do.	1,850,000	1,830,000	1,940,000	1,820,000	1,790,000
Sponge metal:						
Imports for consumption	do.	20,500	33,800	33,600	19,900	17,700
Consumption	do.	34,900	48,400	35,100	26,500 [r]	26,400
Price, yearend[3]	dollars per pound	3.50–6.24	3.27–6.74	3.53–6.95	3.20–6.23	4.07–5.96
Titanium dioxide pigment:						
Production	metric tons	1,320,000	1,290,000	1,140,000	1,280,000	1,260,000
Imports for consumption	do.	204,000	200,000	203,000	213,000	224,000
Consumption, apparent[4]	do.	767,000	706,000	722,000	826,000	802,000
Producer price index, yearend[5]	(June 1982=100)	194	268	268	236	224
World, production:						
Ilmenite concentrate[6]	metric tons	7,760,000 [r]	7,610,000 [r]	7,560,000 [r]	8,040,000 [r]	7,500,000 [e]
Rutile concentrate, natural[7]	do.	729,000 [r]	801,000 [r]	790,000 [r]	632,000 [r]	527,000 [e]
Titaniferous slag[e]	do.	2,300,000 [r]	2,250,000 [r]	2,200,000 [r]	2,050,000 [r]	1,820,000

[e]Estimated. [r]Revised. do. Ditto.
[1]Data are rounded to no more than three significant digits, except prices.
[2]Does not include consumption used to produce synthetic rutile.
[3]Landed duty-paid unit based on U.S. imports for consumption.
[4]Production plus imports minus exports. Does not include stock changes.
[5]Source: U.S. Department of Labor, Bureau of Labor Statistics.
[6]Includes U.S. production of ilmenite, leucoxene, and rutile rounded to one significant digit to avoid disclosing company proprietary data.
[7]U.S. production of rutile included with ilmenite to avoid disclosing company proprietary data.

TABLE 2
U.S. TITANIUM METAL PRODUCTION CAPACITY IN 2014[1, 2]

(Metric tons per year)

Company	Plant location	Yearend capacity[e]	
		Sponge	Ingot[3]
Alcoa Howmet	Whitehall, MI	--	3,200
Allegheny Technologies Inc.	Albany, OR	--	10,900
Do.	Monroe, NC	--	23,200
Do.	Richland, WA	--	10,000
Do.	Rowley, UT	10,900	--
Alloy Works LLC	Greensboro, NC	--	1,800
Honeywell Electronic Materials Inc.	Salt Lake City, UT	500	--
Perryman Co.	Houston, PA	--	1,800
RTI International Metals, Inc.	Niles, OH	--	13,600
Titanium Metals Corp.	Henderson, NV	12,600	12,300
Do.	Morgantown, PA	--	40,700
Do.	Vallejo, CA	--	800
Total		24,000	118,000

[e]Estimated. Do. Ditto. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Estimated operating capacity based on 7-day-per-week full production.
[3]Includes electron-beam, plasma, and vacuum-arc-remelting capacity.

TABLE 3
COMPONENTS OF U.S. TITANIUM METAL SUPPLY AND DEMAND[1]

(Metric tons)

Component	2013	2014
Production:		
Ingot	65,900 r	55,800
Mill products	37,000 r	37,400
Exports:		
Waste and scrap	4,700	4,610
Sponge	1,860	2,220
Other unwrought	1,260 r	2,280
Wrought products and castings	21,600 r	19,400
Total	29,400 r	28,500
Imports:		
Waste and scrap	12,700	19,300
Sponge	19,900	17,700
Other unwrought	775 r	1,510
Wrought products and castings	6,570 r	6,280
Total	39,900 r	44,800
Stocks, industry, yearend:		
Sponge	25,200	22,900
Scrap	16,200	17,500
Ingot	6,140	6,350
Consumption, reported:		
Sponge	26,500 r	26,400
Scrap	39,100 r	44,300
Ingot	52,700 r	55,200
Shipments:		
Ingot	21,800 r	30,500
Mill products (net shipments):		
Forging and extrusion billet	24,300 r	25,100
Other	10,900 r	11,200
Total	35,300 r	36,300
Castings (shipments)	W	W
Receipts, scrap:		
Home	17,900 r	18,700
Purchased	30,700 r	34,800
Total	48,600 r	53,600

rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.

TABLE 4
U.S. PRODUCERS OF TITANIUM DIOXIDE PIGMENT IN 2014[1, 2, 3]

(Metric tons per year)

Company	Plant location	Yearend capacity[4]
Cristal	Ashtabula, OH	220,000
DuPont Titanium Technologies	De Lisle, MS	340,000
Do.	Edgemoor, DE	190,000
Do.	New Johnsonville, TN	400,000
Louisiana Pigment Co. L.P.	Lake Charles, LA	150,000
Tronox Ltd.	Hamilton, MS	230,000
Total		1,530,000

Do. Ditto.
[1]Estimated operating capacity based on 7-day-per-week full production.
[2]Does not include TOR Minerals International, Inc.'s Corpus Christi, TX, production capacity of about 26,400 metric tons per year (t/yr) of buff TiO_2 pigment that is produced by refining and fine grinding of synthetic rutile.
[3]Data are rounded to no more than three significant digits; may not add to total shown.
[4]All plants use the chloride process to manufacture TiO_2 pigment.

TABLE 5
COMPONENTS OF U.S. TITANIUM DIOXIDE PIGMENT SUPPLY AND DEMAND[1]

		2013		2014	
		Gross weight	TiO_2 content	Gross weight	TiO_2 content
Production[2]	metric tons	1,280,000	1,210,000	1,260,000	1,190,000
Shipments:[3]					
Quantity	do.	1,220,000	1,140,000	1,270,000	1,190,000
Value	thousands	$3,760,000	XX	$3,450,000	XX
Exports	metric tons	670,000	630,000 e	685,000	644,000
Imports for consumption	do.	213,000	201,000 r, e	224,000	210,000
Consumption, apparent[e, 4]	do.	826,000	777,000	802,000	754,000

eEstimated. rRevised. do. Ditto. XX Not applicable.
[1]Data are rounded to no more than three significant digits.
[2]Does not include production of buff pigment.
[3]Includes interplant transfers.
[4]Production plus imports minus exports. Does not include stock changes.

Sources: U.S. Census Bureau and U.S. Geological Survey.

TABLE 6
ESTIMATED U.S. CONSUMPTION OF TITANIUM CONCENTRATE[1, 2]

(Metric tons)

	2013		2014	
	Gross weight	TiO_2 content	Gross weight	TiO_2 content
Pigment	1,690,000	NA	1,660,000	NA
Miscellaneous[3]	130,000	NA	128,000	NA
Total	1,820,000	1,460,000	1,790,000	1,430,000

NA Not available.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes a mixed product containing altered ilmenite, leucoxene, and rutile.
[3]Includes alloys, carbide, ceramics, chemicals, glass fibers, titanium metal, and welding-rod coatings and fluxes.

TABLE 7
U.S. CONSUMPTION OF TITANIUM IN STEEL AND OTHER ALLOYS[1, 2]

(Metric tons)

	2013	2014
Steel:		
Carbon steel	5,670	5,790
Stainless and heat-resisting steel	3,460	3,580
Other alloy steel[3]	808	838
Total steel	9,940	10,200
Cast irons	14	11
Superalloys	538	523
Alloys, other than above	1,340	1,120
Miscellaneous and unspecified	46	38
Grand total	11,900	11,900

[1]Includes ferrotitanium, scrap, sponge, and other titanium additives.
[2]Data are rounded to no more than three significant digits; may not add to totals shown.
[3]Includes high-strength low-alloy and tool steel.

TABLE 8
ESTIMATED U.S. DISTRIBUTION OF TITANIUM PIGMENT SHIPMENTS, TITANIUM DIOXIDE CONTENT, BY INDUSTRY[1]

(Percent)

Industry	2013	2014
Paint, varnish, and lacquer	61.5	59.5
Paper	10.7	11.8
Plastics and rubber	24.1	19.6
Other[2]	3.7	9.1
Total	100.0	100.0

[1]Does not include exports.
[2]Includes agricultural, building materials, ceramics, coated fabrics and textiles, cosmetics, food, and printing ink. Also includes shipments to distributors.

TABLE 9
YEAREND PRICES OF TITANIUM PRODUCTS

		2013	2014
Concentrate:			
Ilmenite, free on board (f.o.b.) Australian ports[1]	dollars per metric ton	230–300	150–165
Rutile, bagged, f.o.b. Australian ports[1]	do.	1,200–1,500 r	840–1,000
Rutile, bulk, f.o.b. Australian ports[1]	do.	1,100–1,400 r	820–950
Titaniferous slag, import, 80% to 95% TiO_2[2]	do.	405–455 r	690–835
Metal:			
Sponge import[2]	dollars per pound	3.20–6.23	4.07–5.96
Scrap, turnings, unprocessed[3]	do.	1.35–1.45	1.45–1.55
Ferrotitanium, 70% Ti[3]	do.	2.75–2.80	2.90–3.10
Mill products[4]	producer price index	181	180
Titanium dioxide pigment[4]	do.	236	224

[r]Revised. do. Ditto.
[1]Source: Industrial Minerals.
[2]Landed duty-paid unit value based on U.S. imports for consumption.
[3]Source: Platts Metals Week.
[4]June 1982 = 100. Source: U.S. Department of Labor, Bureau of Labor Statistics.

TABLE 10
U.S. EXPORTS OF TITANIUM BY CLASS[1]

Class	HTS[2] code	2013 Quantity (metric tons)	2013 Value (thousands)	2014 Quantity (metric tons)	2014 Value (thousands)
Metal:					
Scrap	8108.30.0000	4,700	$21,800	4,610	$18,200
Unwrought:					
Sponge	8108.20.0010	1,860	22,500	2,220	29,900
Ingot	8108.20.0030	5,460 r	87,200 r	4,980	78,000
Other	8108.20.0090, 8108.20.0095	1,260	11,600	2,280	66,600
Wrought:					
Billet	8108.90.6010	2,660 r	109,000 r	--	--
Bloom, sheet bar, slab	8108.90.6020	2,280	75,000 r	2,420	78,500
Bar, rod, profile, wire	8108.90.6031	4,150 r	214,000 r	5,460	251,000
Other	8108.90.8000	12,500	903,000	11,500	1,030,000
Total		21,600 r	1,300,000 r	19,400	1,360,000
Ferrotitanium and ferrosilicon titanium	7202.91.0000	4,110	17,100	2,990	12,400
Ores and concentrates	2614.00.0000	11,500	22,700	2,240	5,400
Pigment:					
80% or more titanium dioxide pigment	3206.11.0000	624,000	1,590,000 r	658,000	1,640,000
Other titanium dioxide pigment	3206.19.0000	43,600 r	210,000 r	22,500	136,000
Unfinished titanium dioxide[3]	2823.00.0000	3,180 r	8,390 r	4,160	9,840
Total		671,000 r	1,800,000	685,000	1,790,000

rRevised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Harmonized Tariff Schedule of the United States.
[3]Unmixed and not surface treated.

Source: U.S. Census Bureau.

TABLE 11
U.S. IMPORTS FOR CONSUMPTION OF TITANIUM CONCENTRATES, BY COUNTRY[1]

Concentrate and country	HTS[2] code	2013 Quantity (metric tons)	2013 Value (thousands)	2014 Quantity (metric tons)	2014 Value (thousands)
Ilmenite:	2614.00.6020				
Australia		189,000	$51,700	118,000	$19,800
Mozambique		167,000	34,100	217,000	38,600
Senegal		--	--	20,100	2,610
Other		33,800	4,880	137	62
Total		389,000	90,600	355,000	61,100
Titaniferous slag:	2620.99.5000				
Australia		--	--	108,000	63,300
Canada		222,000	119,000	213,000	162,000
Madagascar		--	--	26,600	5,640
South Africa		459,000	342,000	331,000	225,000
Other		-- [r]	-- [r]	4	8
Total		681,000 [r]	461,000 [r]	678,000	455,000
Rutile, natural:	2614.00.6040				
Australia		94,800	66,100	64,100	47,300
Canada		12,000	15,600	--	--
Kenya		--	--	16,800	15,600
Sierra Leone		42,900	26,600	20,200	16,200
South Africa		118,000	145,000	144,000	109,000
Ukraine		11,300	14,800	10,200	7,710
Other[3]		121 [r]	320 [r]	295	378
Total		279,000	269,000	255,000	196,000
Rutile, synthetic:	2614.00.3000				
Australia		124,000	163,000	84,400	66,400
Malaysia		2,420	4,200	2,790	4,030
Other[3]		72 [r]	138 [r]	304	514
Total		127,000	167,000	87,500	71,000
Titaniferous iron ore, Canada[4]	2614.00.6020	13,800	1,460	138	62

[r]Revised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Harmonized Tariff Schedule of the United States.
[3]All or part of these data have been referred to the U.S. Census Bureau for verification.
[4]Includes materials consumed for purposes other than production of titanium commodities, principally heavy aggregate and steel-furnace flux. Titaniferous iron ore from Canada is classified as ilmenite under the HTS.

Source: U.S. Census Bureau; data adjusted by the U.S. Geological Survey.

TABLE 12
U.S. IMPORTS FOR CONSUMPTION OF TITANIUM METAL, BY CLASS AND COUNTRY[1]

Class and country	HTS[2] code	2013 Quantity (metric tons)	2013 Value (thousands)	2014 Quantity (metric tons)	2014 Value (thousands)
Waste and scrap:	8108.30.0000				
Canada		826	$3,230	970	$3,760
China		158	952	437	3,540
France		1,810	11,300 r	1,900	11,600
Germany		2,130	13,700	3,360	21,400
Israel		448	2,450	692	4,020
Italy		190	552	1,300	5,840
Japan		1,500 r	6,830 r	2,130	11,400
Korea, Republic of		607 r	3,350	1,950	10,500
Mexico		599	2,420	825	2,690
Sweden		222	1,360	359	1,490
Taiwan		298	1,430	563	2,890
United Kingdom		3,160	11,300	3,030	11,600
Other		729 r	4,760 r	1,740	9,850
Total		12,700	63,600 r	19,300	101,000
Unwrought:					
Sponge:	8108.20.0010				
China		3,130	29,500	1,530	11,800
Japan		13,400	166,000	13,300	155,000
Kazakhstan[e]		825	11,300	660	6,640
Ukraine		1,360	15,700	1,910	16,200
Other		1,190	8,070	298	2,810
Total		19,900	230,000	17,700	193,000
Ingot:	8108.20.0030				
Italy		4	79	--	--
Japan		--	--	35	3,390
Russia		879	14,000	665	12,200
Total		883	14,100	700	15,600
Powder:	8108.20.0015				
Canada		4	1,140	7	2,230
China		78	1,320	102	1,780
Japan		3	745	--	--
Other		4	1,210	11	2,670
Total		89 r	4,410	120	6,670
Other:	8108.20.0091, 8108.20.00095				
France		53	2,310	54	2,250
Germany		243	5,250	349	7,830
Russia		376	9,770	808	20,900
United Kingdom		89	5,820	288	12,800
Other		14 r	1,460 r	7	218
Total		775	24,600	1,510	44,000
Wrought products and castings:[3]	8108.90.3030, 8108.90.3060, 8108.90.6010, 8108.90.6020, 8108.90.6031, 8108.90.6045, 8108.90.6060, 8108.90.6075				
Canada		129	7,350	111	8,960
China		785 r	35,900	1,060	40,200
Germany		63 r	13,800 r	578	29,700
Japan		516	20,500	95	17,900
Russia		3,800	138,000	3,040	124,000
Taiwan		174	6,490 r	47	3,470
United Kingdom		381 r	38,700 r	373	42,700
Other		717 r	43,300 r	968	56,700
Total		6,570 r	304,000 r	6,280	324,000
Ferrotitanium and ferrosilicon titanium	7202.91.0000	1,680	7,260	2,210	9,290

[e]Estimated. [r]Revised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Harmonized Tariff Schedule of the United States.
[3]Includes bar, billet, bloom, castings, foil, pipe, plate, profile, rod, sheet, sheet bar, slab, strip, tube, wire, and other.

Source: U.S. Census Bureau.

TABLE 13
U.S. IMPORTS FOR CONSUMPTION OF TITANIUM PIGMENT, BY COUNTRY[1]

Country	HTS[2] code	2013 Quantity (metric tons)	2013 Value (thousands)	2014 Quantity (metric tons)	2014 Value (thousands)
80% or more titanium dioxide pigment:	3206.11.0000				
Australia		2,210	$6,850	6,850	$17,600
Belgium		3,680	10,600	2,540	7,350
Brazil		--	--	100	207
Canada		54,800	178,000	60,600	183,000
China		32,700	80,800	33,500	71,800
Czech Republic		2,310	5,670	2,150	5,230
Finland		7,010 r	16,300 r	6,810	17,400
France		3,370	9,930	2,350	6,350
Germany		19,900 r	59,600 r	22,500	63,400
India		662	1,460	786	1,620
Italy		1,390 r	3,960 r	1,850	4,790
Japan		7,200	30,900	5,330	25,100
Malaysia		--	--	242	441
Mexico		1,910	6,970	4,640	12,300
Netherlands		605	2,340	1,760	5,440
Norway		4,430	12,600	5,610	14,600
Saudi Arabia		500	1,320	--	--
Singapore		835	2,480	--	--
Slovenia		336	740	318	700
Spain		3,970	11,200	4,840	11,600
Taiwan		503	1,260	--	--
Ukraine		11,300	22,400	6,490	12,100
United kingdom		362	1,020	353	964
Other		286 r	811 r	155	518
Total		160,000	467,000 r	170,000	462,000
Other titanium dioxide:	3206.19.0000				
Canada		7,910 r	24,500 r	8,030	25,200
China		1,750	5,540	2,030	6,150
Colombia		181	577	201	663
France		66	603	12	190
Germany		1,370	5,900	1,140	6,750
India		139	830	525	2,190
Israel		4	730	--	36
Italy		241	1,060	377	1,580
Japan		266 r	5,670 r	245	5,460
Korea, Republic of		62	661	12	483
Mexico		103	787	233	932
Spain		--	--	13	277
United kingdom		48	1,750	59	2,160
Other		115 r	750 r	193	780
Total		12,300	49,300 r	13,100	52,900
Unfinished titanium dioxide:[3]	2823.00.0000				
China		11,500 r	28,200 r	17,100	37,400
Czech Republic		2,560 r	7,130 r	2,550	6,660
Finland		3,710 r	12,100 r	3,030	10,700
France		7,230 r	27,400 r	4,300	17,800
Germany		4,230 r	12,200 r	3,470	10,500
India		2,400 r	5,240 r	2,050	4,290
Italy		3,500 r	10,900 r	1,410	3,820
Japan		853	6,410 r	481	4,800
Korea, Republic of		3,980 r	8,740 r	4,730	9,040
Other		853 r	4,080 r	1,610	6,560
Total		40,800 r	122,000	40,800	112,000
Grand total		213,000	638,000	224,000	627,000

See footnotes at end of table.

TABLE 13—Continued
U.S. IMPORTS FOR CONSUMPTION OF TITANIUM PIGMENT, BY COUNTRY[1]

[r]Revised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Harmonized Tariff Schedule of the United States.
[3]Unmixed and not surface treated.

Source: U.S. Census Bureau.

TABLE 14
TITANIUM: WORLD PRODUCTION OF MINERAL CONCENTRATES, BY COUNTRY[1, 2]

(Metric tons)

Concentrate type and country	2010	2011	2012	2013	2014[e]
Ilmenite and leucoxene:[3, 4]					
Australia	1,651,000	1,501,000 [r]	1,572,000	1,342,000 [r, e]	1,200,000
Brazil[5]	166,000	166,000	166,000	166,000 [e]	166,000
China[e]	1,400,000	1,700,000	1,600,000	1,700,000	1,600,000
India[e]	729,000 [r]	550,000	340,000 [r]	436,000 [r]	320,000
Indonesia	60,000	18,000	20,000	23,000	23,000
Kazakhstan[e]	25,000	25,000	25,000	20,000 [r]	20,000
Kenya	--	--	--	5,539	165,000
Madagascar	287,000	464,000 [r]	529,790 [r]	560,000 [e]	498,000
Malaysia	19,036	28,782	22,275	16,000 [r, e]	17,000
Mozambique	678,400	636,800	574,500	720,100	854,600
Norway	864,000	870,000	831,000	830,000 [e]	740,000
Russia	--	63,490	125,095	150,458	178,000
Senegal	--	--	--	--	101,000
Sierra Leone	18,206	15,946	22,590	32,349 [r, e]	36,000
Sri Lanka[e]	52,263 [r, 6]	68,085 [r, 6]	44,700 [r]	42,700 [r]	42,000
Ukraine[e]	500,000	261,000 [6]	247,000 [6]	670,000 [r, 6]	411,000
United States[e, 5, 7]	400,000	400,000	300,000	300,000	200,000
Vietnam[8]	912,000	840,600	1,143,800	1,025,779 [r]	929,000
Total[9]	7,760,000 [r]	7,610,000 [r]	7,560,000 [r]	8,040,000 [r]	7,500,000
Rutile:[4]					
Australia	429,000	474,000	425,000	232,000 [r]	212,000
Brazil[5]	2,331	2,350	1,881	2,021 [r, p]	2,020
India[e]	19,100 [r]	18,800 [r]	24,000 [r]	26,000 [r]	19,100
Kenya	--	--	--	152	24,200
Madagascar[e]	5,700	9,300 [r]	11,000 [r]	12,000 [r]	10,700
Malaysia	7,567	10,810	20,008	5,983 [r]	6,000
Mozambique	4,700	6,455	4,000 [r]	5,100 [r]	8,210
Senegal	--	--	--	--	663
Sierra Leone	68,198	67,916	94,493	120,349 [r, e]	114,000
South Africa	130,000	149,000	150,000 [e]	65,000 [e]	58,500
Sri Lanka[e]	2,568 [6]	1,970 [r]	1,590 [r]	1,410 [r]	1,400
Ukraine[e]	60,000	60,000	58,000	162,000 [r, e]	70,000
United States	(10)	(10)	(10)	(10)	(10)
Total	729,000 [r]	801,000 [r]	790,000 [r]	632,000 [r]	527,000
Titaniferous slag:[e, 11]					
Canada	1,090,000	878,000	900,000	900,000	800,000
South Africa	1,210,000 [r, 6]	1,367,000 [r, 6]	1,300,000 [r]	1,150,000 [r]	1,020,000
Total	2,300,000 [r]	2,250,000 [r]	2,200,000 [r]	2,050,000 [r]	1,820,000

[e]Estimated. [p]Preliminary. [r]Revised. -- Zero.

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

[2]Includes data available through October 20, 2015.

[3]Ilmenite is also produced in Canada and South Africa, but this output is not included here because most of it is duplicative of output reported under "Titaniferous slag," and the rest is used for purposes other than production of titanium commodities, principally steel furnace flux and heavy aggregate.

[4]Small amounts of titanium minerals were reportedly produced in various countries, but information is inadequate to make reliable estimates of output levels.

[5]Does not include production of unbeneficiated anatase ore.

[6]Reported figure.

[7]Includes rutile to avoid disclosing company proprietary data. Rounded to one significant digit.

[8]Estimate based on import statistics from trading partners (primarily China and Japan).

[9]Includes U.S. production, rounded to one significant digit, of ilmenite, leucoxene, and rutile to avoid disclosing company proprietary data.

[10]Included with ilmenite to avoid disclosing company proprietary data.

[11]Slag is also produced in China, Norway, Kazakhstan, Russia, and Vietnam, but this output is not included under "Titaniferous slag" to avoid duplicative reporting.