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2018 Minerals Yearbook

TITANIUM [ADVANCE RELEASE]

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Titanium

By Joseph Gambogi

Domestic survey data and tables were prepared by Joseph J. Kohler, statistical assistant.

In 2018, two companies produced titanium mineral concentrates from surface mining operations near Offerman, GA, and Starke, FL, and a third company processed existing mineral sands tailings in Florida. The United States was net import reliant (as a percentage of apparent consumption) with respect to titanium mineral concentrates and titanium sponge, at 91% and 73% respectively. The leading sources of imported titanium mineral concentrates were Australia and South Africa (table 11). U.S. consumption of titanium used in steel and other alloys decreased by 2% from that in 2017 (table 7). The United States continued to be a net exporter of titanium dioxide (TiO_2) pigment and wrought titanium metal products. Based on TiO_2 content estimated from gross weight data, world production of titanium mineral concentrates in 2018 was about 8.3 million metric tons (Mt), nearly unchanged compared with that in 2017 (table 14).

Titanium is the ninth most abundant element in the earth's crust and can be found in nearly all rocks and sediments. Titanium has 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 ($TiCl_4$) with magnesium to produce titanium metal.

Production

Titanium industry data for this report were collected by the U.S. Geological Survey (USGS) from annual and quarterly surveys of domestic titanium operations. In 2018, the USGS annual surveys canvassed titanium mineral and pigment producers. All three producers of titanium mineral concentrates responded. Of the five domestic TiO_2 pigment operations, two responded. Production data for the nonrespondents were estimated based on prior year production levels and industry trends. Production data for titanium ingot and mill products were aggregated from a quarterly survey of producers.

Metal.—In commercial production of titanium metal, titanium-containing mineral concentrates are chlorinated to produce $TiCl_4$, which is then reduced with magnesium (the Kroll process) or sodium (the 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, scull, and vacuum-arc remelting are the commercial methods used to produce ingot and slab. Titanium mill products are formed by drawing, forging, and rolling of titanium 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 2018, U.S. producers of titanium sponge were Honeywell Electronic Materials Inc. (Salt Lake City, UT) and Titanium Metals Corp. (Timet), a subsidiary of Precision Castparts Corp. (Portland, OR) (table 2). Timet's Henderson, NV, plant produced titanium sponge using the Kroll process. Honeywell Electronic Materials used the Hunter process to produce titanium sponge as feed for the company's production of electronic-grade titanium. A second plant that produced titanium sponge by the Kroll process, in Rowley, UT, was idled by Allegheny Technologies Inc. (ATI) in 2016. The facility was idled so that it could be restarted if supported by market conditions (Allegheny Technologies Inc., 2016). Data on domestic production of titanium sponge were withheld to avoid disclosing company proprietary data. In 2018, U.S. production of titanium ingot increased by 3% and production of mill products was essentially unchanged from that in 2017 (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% and 70% titanium. U.S. producers of ferrotitanium were Arconic, Inc. (Canton, OH) with a capacity of 7,250 metric tons per year (t/yr) and Global Titanium Inc. (Detroit, MI) with a capacity of more than 10,000 t/yr. Data on production of ferrotitanium was withheld to avoid disclosing company proprietary data.

Mineral Concentrates.—Titanium minerals of economic importance include ilmenite, leucoxene, and rutile. Mining of titanium minerals usually is 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 is the most abundant titanium mineral with a contained TiO_2 content ranging from 35% to 65%. Rutile, naturally occurring TiO_2, has the highest TiO_2 content but is less abundant. Ilmenite is often processed to produce a synthetic rutile or titanium 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 The Chemours Co. (Wilmington, DE) and Southern Ionics Minerals, LLC (Offerman, GA). Chemours' mining operations near Starke, FL, produced a mixed product containing ilmenite, leucoxene, and rutile that was used as a feedstock in Chemours' TiO_2 pigment plants. Southern Ionics' operations included the Mission Mine and a mineral-sands processor in Charlton County, in southern Georgia.

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, synthetic rutile, chloride-grade ilmenite, or titanium slag is converted

to $TiCl_4$ by chlorination in the presence of petroleum coke. Titanium tetrachloride is oxidized with air or oxygen at about 1,000 degrees Celsius (°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 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. Either process may be used to produce pigment; the decision of which process to use is based on numerous factors, including raw material availability, freight costs, and waste disposal costs. In finishing operations, the crude form of the pigment is milled to produce a controlled particle-size distribution and 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 is the anatase pigment and is preferred for use in outdoor paints. Anatase pigment has a bluer tone than rutile, is somewhat softer, and is used mainly in indoor paints and in paper manufacturing. Depending on how 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 1.15 Mt in 2018, a 9% decrease compared with that in 2017 (tables 1, 5). U.S. producers of TiO_2 pigment using the chloride process were Cristal Global (a subsidiary of National Titanium Dioxide Co. Ltd.), The Chemours Co., Louisiana Pigment Co. L.P. (a joint venture of Kronos Worldwide, Inc. and Venator Materials Plc), and Tronox Ltd. (table 4). TOR Minerals International, Inc. produced a buff-color TiO_2 pigment from finely ground synthetic rutile.

Consumption

Metal.—Titanium metal alloys are used for their high strength-to-weight ratio and corrosion resistance. Based on USGS industry surveys, the aerospace industry (80%) was the leading end use for mill products. In general, production of titanium mill products preceded aircraft deliveries by about 12 months. Other uses of mill products included consumer goods and the marine, medical, oil and gas, pulp and paper, and specialty chemical industries. In 2018, mill product shipments increased by 3% from those in 2017 (table 3). 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, stainless, and high-strength low-alloy steels. Reported domestic consumption of titanium products in steel and other alloys was 11,400 metric tons (t), a slight decrease from that in 2017 (table 7).

Mineral Concentrates.—Based on an estimate of the TiO_2 content of domestic production, imports, and exports, domestic consumption of titanium mineral concentrates in 2018 was about 1.3 Mt (table 6). Consumption data for titanium mineral concentrates were estimated by the USGS owing to insufficient response by industry to the voluntary survey for consumption data.

TiO_2 Pigment.—Apparent domestic consumption of TiO_2 pigment (not accounting for changes in inventory) increased by 3% from that in 2017 (tables 1, 5). The leading uses of TiO_2 pigment, based on TiO_2 pigment shipments in the United States by domestic producers, were paint and coatings (59%), plastics and rubber (20%), and paper (5%). Other uses included agricultural, building materials, catalysts, ceramics, coated fabrics and textiles, cosmetics, floor coverings, food, printing ink, and roofing granules (table 8).

Stocks

Insufficient data were available to determine yearend consumer inventories of titanium mineral concentrates and TiO_2 pigment producer stocks. Reported yearend 2018 domestic stocks of sponge decreased by 19%; ingot and scrap stocks increased by 67% and 5%, respectively, compared with those in 2017 (table 3).

Prices

Yearend titanium mineral concentrate prices are listed in table 9. In 2018, yearend prices for ilmenite were relatively unchanged and rutile concentrates increased significantly compared with 2017. Published prices for titanium slag were not available. Based on U.S. Census Bureau data, the yearend range of unit values for titanium slag imports from slag-producing countries in 2017 was $600 to $690 per metric ton and in 2018 was $770 to $790 per metric ton.

The U.S. Department of Labor, Bureau of Labor Statistics Producer Price Index (PPI) for TiO_2 pigment (the baseline is June 1982 = 100) was 207 in January, peaked at 216 in March, and then ended at 205 in December 2018. The monthly PPI for titanium mill products began at 170 in January, peaked at 178 in September, and ended at 171 in December.

Foreign Trade

Metal.—Total imports of titanium metal, excluding ferrotitanium, were 62,600 t and were primarily in the form of waste and scrap (43%) and sponge (38%). Japan supplied 93% of imported titanium sponge, Russia supplied 99% of imported titanium ingot, and the United Kingdom, France, Japan, and Germany were, in descending order, the leading sources of imported scrap. Russia (44%) was the leading source of wrought products and castings (table 12). Exports of titanium metal were 57,500 t, excluding ferrotitanium, and were primarily in the form of unwrought (45%), waste and scrap (21%), and wrought products and castings (35%) (table 10).

Imports of ferrotitanium were 2,710 t, an increase of 6% from those in 2017 (table 12). Exports of ferrotitanium were 3,120 t, an increase of 29% compared with those in 2017 (table 10).

Mineral Concentrates.—U.S. imports of titanium mineral concentrates included ilmenite, rutile, synthetic rutile, and titanium 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 2018, the TiO_2 content of imports was estimated to be about 1.1 Mt, primarily in the form of ilmenite (39%), titanium slag (39%), and natural rutile (21%). South Africa and Australia were, in descending order of TiO_2 content, the leading import sources. The combined value for all forms of titanium mineral concentrate imports in 2018 was $713 million (table 11). Imports of titaniferous iron ore, containing less than 35% TiO_2, from Canada (classified as ilmenite by the U.S. Census Bureau), totaled 10,100 t in gross weight and were valued at $1.46 million. Exports of titanium mineral concentrates were minor relative to imports (tables 10, 11).

TiO_2 Pigment.—In 2018, the United States continued to be a net exporter of TiO_2 pigment, with exports exceeding imports by a ratio of about 2 to 1. Exports of TiO_2 pigment were 528,000 t valued at $1.55 billion, a 17% decrease in quantity compared with those in 2017. About 96% of TiO_2 pigment exports were in the form of finished pigment containing 80% or more TiO_2 content (table 10). During 2018, 269,000 t of TiO_2 pigment was imported, an increase of 12% from that in 2017. The leading import sources of TiO_2 pigment were Canada and China. About 80% of pigment imports were in the form of finished pigment containing more than 80% TiO_2 (table 13).

World Review

Global production of TiO_2 in mineral concentrates in 2018 was about 8.3 Mt, nearly unchanged from 2017. About 97% of production was from ilmenite and leucoxene with significant quantities upgraded to slag or synthetic rutile. The leading producers of titanium in mineral concentrates were, in descending order of TiO_2 content, China, Australia, Mozambique, and South Africa (table 14).

Australia.—Iluka Resources Ltd. was Australia's leading producer of titanium mineral concentrates with operations in the Eucla basin, the Murray basin, and Western Australia. In 2018, Iluka's Australian operations produced 341,000 t of ilmenite and 41,700 t of natural rutile, compared with 391,000 t of ilmenite and 135,000 t of natural rutile produced in 2017. Using a portion of its own ilmenite as feedstock, the company produced 220,000 t of synthetic rutile compared with 211,000 t in 2017 (Iluka Resources Ltd., 2018, p. 134; 2019, p. 142).

In Queensland, Melior Resources Inc. was recommissioning its Goondicum ilmenite-apatite mining operation. The mine was placed on care-and-maintenance status in 2015. Indicated mineral resources were 66 Mt containing ilmenite (3.4 Mt) and apatite (1.2 Mt). Average annual production was expected to be 160,000 t of ilmenite and 40,000 t of apatite over a mine life of 9 years (Melior Resources Inc., 2018a, b).

Sheffield Resources Ltd. continued work on the development of its Thunderbird heavy-mineral-sands project in Western Australia targeting production of titanium and zirconium mineral concentrates. In 2018, the company projected that initial production of ilmenite products would be about 200,000 t/yr and reserves of ilmenite and leucoxene were 25 Mt, as of October 2018 (Sheffield Resources Ltd., 2018a, p. 15; 2018b, p. 2).

Image Resources NL continued development of its Atlas and Boonanarring heavy-mineral-sands projects in the North Perth basin in Western Australia. In December, Image Resources began commissioning production of heavy-mineral concentrate from Boonanarring. Production from the Boonanarring operation was expected to reach 220,000 t/yr of heavy-mineral concentrate containing ilmenite (59%), leucoxene (14%), and rutile (23%). Reserves from Atlas and Boonanarring in 2017 were reported to be about 29 Mt containing 2.2 Mt of heavy minerals including ilmenite, (50.5%); leucoxene, (2.7%); and rutile, (4.2%) (Image Resources NL, 2019, p. 1, 15).

A definitive feasibility study was underway at Strandline Resources Ltd.'s Coburn project in Western Australia. In November, measured and indicated resources were reported to be 726 Mt containing 1.3% heavy minerals. Ilmenite, rutile, and leucoxene were 48%, 7%, and 5%, respectively, of the total heavy-mineral resources (Strandline Resources Ltd., 2018, p. 4).

Canada.—In Quebec, Rio Tinto Fer et Titane Inc (RTFT) produced titanium slag at its Lac Tio mining operations and Sorel titanium slag operations. Sorel supplemented Lac Tio mineral concentrates with feedstock from its QIT Madagascar Minerals operations. In 2018, a furnace accident resulted in a temporary suspension of operations at Sorel and contributed to a 15% decrease in the company's combined titanium slag production of 1.12 Mt from Canada and South Africa (Rio Tinto plc, 2019, p. 49, 270).

China.—China was a leading producer and the leading consumer of titanium mineral concentrates, producing 4.2 Mt of ilmenite (table 14). Imports of titanium mineral concentrates under the Harmonized System (HS) code 261400 totaled 3.1 Mt in 2018, a slight increase from 2017. China imported titanium mineral concentrates from, in descending order of quantity, Mozambique, 31%; Kenya, 14%; and Australia, 13%. Exports of titanium mineral concentrates (HS code 261400) totaled 29,200 t in 2018, an increase of 32% from 2017 (IHS Markit Ltd., 2021).

According to China's National Chemical Industry Productivity Promotion Center, China's TiO_2 pigment production in 2018 was 2.95 Mt, an increase from 2.87 Mt in 2017 (Focus on Pigments, 2020). Imports of titanium-based pigments (HS codes 282300, 320611, and 320619) totaled 229,000 t in 2018, a decrease of 8% from those in 2017. Exports of titanium-based pigments (HS codes 282300, 320611, and 320619) totaled 909,000 t in 2018, an increase of 9% from exports in 2017 (IHS Markit Ltd., 2021).

Lomon Billions Group Co. Ltd. was China's leading TiO_2 pigment producer with about 700,000 t/yr of TiO_2 pigment production capacity. Lomon Billions produced almost 629,000 t of TiO_2 pigment in 2018, about 90% of which was made using the sulfate process. Lomon Billions was increasing its TiO_2 pigment production capacity in 2018 and expected capacity to reach 900,000 t/yr by 2020 (Griffin, 2019, p. 3, 16).

China also was the leading producer and consumer of titanium metal. In 2018, production of titanium sponge was 75,000 t. Imports of titanium metal and articles thereof (HS code 8108) totaled 14,200 t, and exports were 20,700 t. China's titanium sponge production capacity increased to 107,000 t/yr from 93,000 t/yr in 2017. New sponge production capacity was added by Chaoyang Baisheng Co. Ltd. and Xinjiang New Material Co. Ltd. (Argus Media group—Argus Metals International, 2019a; IHS Markit Ltd., 2021).

Finland.—In September, Venator Materials Plc (United Kingdom) announced plans to close its TiO_2 pigment operation at Pori. In 2017, a fire significantly damaged the plant that was reported to have a design capacity of 130,000 t/yr and represented 17% of the company's global capacity. The plant was expected to operate at reduced production rates through 2022 (Venator Materials Plc, 2019, p. 6).

Japan.—According to the Japan Titanium Society, Japan produced 49,300 t of titanium sponge and 22,800 t of ingot in 2018. Owing to increased demand led by the global aerospace sector, titanium sponge exports increased to 26,800 t from 24,100 t in 2017 (Roskill's Letter from Japan, 2020).

According to the Ministry of Economy, Trade and Industry, Japan's production of TiO_2 pigments totaled 192,000 t in 2018, nearly unchanged from that in 2017. About 82% of this production was rutile pigment and the remainder anatase pigment. Japan's TiO_2 production capacity increased slightly during 2018 to 308,000 t/yr in December from 307,000 t/yr in March (Roskill's Letter from Japan, 2019).

Norway.—At yearend, Nordic Mining ASA neared completion of a definitive feasibility study of its Engebø rutile-garnet project in southwestern Norway. Following the completion of a drilling program in 2018, measured and indicated resources were increased to 98 Mt containing 3.87% TiO_2 using a 3% TiO_2 cutoff (Nordic Mining ASA, 2019, p. 7).

Russia.—Production of titanium sponge and ingots totaled 44,400 t and 60,000 t, respectively, and consumption was about 10,000 t in 2018. Sponge and ingot production capacities were about 46,400 t/yr and 80,500 t/yr, respectively. The primary end uses for the consumption of titanium metal were engines, 34%; aircraft, 27%; and industrial, 16% (Metz, 2019).

Saudi Arabia.—In August, Advanced Metal Industries Co. conducted a trial at its titanium sponge plant in Yanbu, but commercial production was delayed pending the construction of distillation operations. The company expected the operation to be fully commissioned with 15,600 t/yr of capacity within 18 months. Japan's Toho Titanium owned 35% interest in the project (Argus Media group—Argus Metals International, 2019b).

Sierra Leone.—Sierra Rutile, a subsidiary of Iluka, produced 54,500 t of ilmenite and 121,500 t of rutile in 2018, significantly less than production in 2017. In 2018, production was hampered by mechanical issues and labor strikes. Iluka was proceeding with plans to double mine and wet concentration capacity at the Gangama and Lanti mining operations. In March, Iluka began a definitive feasibility study to develop the Sembehun deposit and increase its mineral separation capacity in Sierra Leone (Iluka Resources Ltd., 2019, p. 28, 37).

South Africa.—Rio Tinto plc continued feasibility studies for the Zulti South Mine expansion that would support the Richards Bay Minerals mining and slag operations. In 2018, labor disputes in South Africa contributed to a 15% decrease in the company's combined titanium slag production from Canada and South Africa (Rio Tinto plc, 2019, p. 49).

Tanzania.—Strandline Resources announced that the Tanzanian Mining Commission approved a mining license for the Fungoni mineral sands project. Fungoni's ore reserves were reported to be about 12 Mt containing 3.9% total heavy minerals, as of October 2017 (Strandline Resources Ltd., 2019, p. 4, 7).

Ukraine.—Ukraine was the leading source of mineral concentrates in the Commonwealth of Independent States and a significant producer of titanium sponge. Titanium mineral concentrates were produced in the Dnipropetrovsk region by the Vilnohirsk mining operations and in the Zhytomyr region by the Irshansk, Mezhdurechensk, and Valki mining operations. Ukraine produced about 850,000 t and exported about 600,000 t of titanium mineral concentrates in 2018 (IHS Markit Ltd., 2021).

Ukraine produced 7,170 t of titanium sponge and 2,460 t of titanium ingot, nearly unchanged from production in 2017 (Metz, 2019). Ownership of the only titanium sponge producer, Zaporozhye Titanium and Magnesium Combine, was in legal dispute between the Government of Ukraine and Group DF through its subsidiary Tolexis Trading Ltd. (Group DF, 2018).

Outlook

Subject to disruptions in the global economy, global consumption of TiO_2 pigments is forecast to increase by about 4% annually. Global production capacity of TiO_2 pigments is expected to increase to meet increased demand. The distribution of chloride-process versus sulfate-process TiO_2 pigment capacity is expected to reach parity and is expected to be driven mainly by the expansion of chloride-process capacity in China (Adams, 2018a, p. 27; 2018b, p. 25, 26).

Future demand for titanium metal is primarily dependent on demand from the aircraft and engines industries supplemented by other uses such as chemical processing, desalination, power generation, and specialty steels.

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TABLE 1
SALIENT TITANIUM STATISTICS[1]

		2014	2015	2016	2017	2018
United States:						
Mineral concentrate:						
Production[2]	metric tons	200,000 e	300,000 e	100,000	100,000	100,000
Imports for consumption	do.	1,380,000	1,440,000	1,340,000 r	1,570,000	1,480,000
Consumption[e, 3]	do.	1,790,000	1,720,000	1,740,000	1,760,000	1,610,000
Sponge metal:						
Imports for consumption	do.	17,700	20,700	16,200	23,300 r	23,700
Consumption	do.	26,400	31,200	34,100	37,400	35,200
Price, yearend[4]	dollars per kilogram	8.97–13.15	7.31–11.81	11.08–11.94	6.88–11.26	9.50–10.81
Titanium dioxide pigment:						
Production	metric tons	1,260,000	1,220,000	1,240,000	1,260,000	1,150,000
Imports for consumption	do.	224,000	221,000	247,000	240,000 r	269,000
Consumption, apparent[5]	do.	802,000	788,000	834,000 r	870,000	893,000
Producer price index, yearend[6]	(June 1982=100)	224	176	175	205	205
World, production:						
Ilmenite concentrate[7]	metric tons	10,400,000	9,440,000 r	9,830,000 r	10,100,000 r	10,500,000
Rutile concentrate, natural[8]	do.	637,000 r	751,000 r	786,000 r	838,000 r	691,000
Titanium slag[e]	do.	2,000,000 r	1,640,000 r	1,520,000 r	1,800,000 r	1,600,000

[e]Estimated. [r]Revised. do. Ditto.
[1]Table includes data available through September 15, 2020. Data are rounded to no more than three significant digits, except prices.
[2]U.S. production rounded to one significant digit to avoid disclosing company proprietary data.
[3]Does not include consumption used to produce synthetic rutile.
[4]Landed duty-paid unit based on U.S. imports for consumption.
[5]Production plus imports minus exports. Does not include stock changes.
[6]Source: U.S. Department of Labor, Bureau of Labor Statistics.
[7]Includes U.S. production of ilmenite and rutile rounded to one significant digit to avoid disclosing company proprietary data.
[8]U.S. production of rutile included with ilmenite to avoid disclosing company proprietary data.

TABLE 2
U.S. TITANIUM METAL PRODUCTION CAPACITY IN 2018[1, 2]

(Metric tons per year)

		Yearend capacity[e]	
Company	Plant location	Sponge	Ingot[3]
Allegheny Technologies Inc.	Albany, OR	--	10,900
Do.	Monroe, NC	--	23,200
Do.	Richland, WA	--	10,000
Alloy Works LLC	Greensboro, NC	--	1,800
Arconic Inc.	Niles, OH	--	13,600
Do.	Whitehall, MI	--	3,200
Honeywell Electronic Materials Inc.	Salt Lake City, UT	500	--
Perryman Co.	Houston, PA	--	11,500
Titanium Metals Corp.[4]	Henderson, NV	12,600	12,300
Do.	Morgantown, PA	--	40,700
Do.	Vallejo, CA	--	800
Total		13,100	128,000

[e]Estimated. Do. Ditto. -- Zero.
[1]Table includes data available through September 15, 2020. 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-arc, and vacuum-arc-remelting capacity.
[4]A subsidiary of Precision Castparts Corp. which is owned by Berkshire Hathaway Inc.

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

(Metric tons)

Component	2017	2018
Production:		
Ingot	82,100	85,000
Mill products	38,000	38,000
Exports:		
Waste and scrap	9,450	11,900
Sponge	3,090	533
Ingot	9,010	10,600
Other unwrought	2,730 r	2,770
Wrought products and castings	19,900	19,900
Total	44,200	45,600
Imports:		
Waste and scrap	25,100 r	27,100
Sponge	23,300 r	23,700
Ingot	1,550	1,950
Powder	157	191
Other unwrought	1,120 r	1,190
Wrought products and castings	8,700 r	8,450
Total	60,000 r	62,600
Stocks, industry, yearend:		
Sponge	13,200	10,700
Scrap	15,200	15,900
Ingot	5,120	8,530
Consumption, reported:		
Sponge	37,400	35,200
Scrap	62,400	52,100
Ingot	67,800	67,600
Shipments:		
Ingot	21,500	23,300
Mill products (net shipments):		
Forging and extrusion billet	26,000	25,800
Other	11,000	12,200
Total	37,000	38,000
Castings	W	W
Receipts, scrap:		
Home	22,100	23,200
Purchased	48,600	52,000
Total	70,700	75,200

rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Table includes data available September 15, 2020. 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 2018[1, 2, 3]

(Metric tons per year)

Company	Plant location	Yearend capacity[4]
The Chemours Co.	De Lisle, MS	340,000
Do.	New Johnsonville, TN	350,000
Cristal Global	Ashtabula, OH	245,000
Louisiana Pigment Co. L.P.	Lake Charles, LA	168,000
Tronox Ltd.	Hamilton, MS	225,000
Total		1,330,000

Do. Ditto.
[1]Table includes data available through September 15, 2020. Data are rounded to no more than three significant digits; may not add to total shown.
[2]Estimated operating capacity based on 7-day-per-week full production.
[3]Table 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.
[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]

		2017		2018	
Component		Gross weight	TiO_2 content[e]	Gross weight	TiO_2 content[e]
Production[2]	metric tons	1,260,000	1,190,000	1,150,000	1,080,000
Shipments:[e]					
Quantity	do.	1,280,000	1,210,000	1,150,000	1,080,000
Value	thousands	$3,240,000	XX	$3,290,000	XX
Exports	metric tons	634,000	596,000	528,000	497,000
Imports for consumption	do.	240,000 [r]	225,000	269,000	252,000
Consumption, apparent[e, 3]	do.	870,000	818,000	893,000	840,000

[e]Estimated. [r]Revised. do. Ditto. XX Not applicable.
[1]Table includes data available through September 15, 2020. Data are rounded to no more than three significant digits.
[2]Does not include production of buff pigment.
[3]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 MINERAL CONCENTRATES[1, 2]

(Metric tons)

	2017		2018	
	Gross weight	TiO_2 content	Gross weight	TiO_2 content
Pigment	1,660,000	NA	1,520,000	NA
Miscellaneous[3]	92,100	NA	88,400	NA
Total	1,760,000	1,410,000	1,610,000	1,290,000

NA Not available.
[1]Table includes data available through September 15, 2020. 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)

	2017	2018
Steel:		
Carbon steel	5,410	5,440
Stainless and heat-resisting steel	3,640	3,560
Other alloy steel[3]	735	707
Total steel	9,790	9,700
Cast irons	5	7
Superalloys	595	456
Alloys, other than above	1,130	1,150
Miscellaneous and unspecified	81	89
Grand total	11,600	11,400

[1]Table includes data available through September 15, 2020. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes ferrotitanium, scrap, sponge, and other titanium additives.
[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	2017	2018
Paint, varnish, and lacquer	68.6 r	58.9
Paper	4.6 r	4.7
Plastics and rubber	24.7 r	20.0
Other[2]	2.1 r	16.4
Total	100.0	100.0

rRevised.
[1]Table includes data available through September 15, 2020. Does not include exports.
[2]Includes agricultural, building materials, catalysts, ceramics, coated fabrics and textiles, cosmetics, floor coverings, food, printing ink, and roofing granules. Also includes shipments to distributors.

TABLE 9
YEAREND PRICES OF TITANIUM PRODUCTS

		2017	2018
Concentrate:			
Ilmenite, free on board (f.o.b.) Australian ports[1]	dollars per metric ton	160–185	NA
Ilmenite, cost including freight, China[1]	do.	NA	164–180
Rutile, bagged, f.o.b. Australian ports[1]	do.	770–850	1,045–1,350
Rutile, bulk, f.o.b. Australian ports[1]	do.	710–770	1,000–1,050
Titanium slag, import[2]	do.	600–690 r	770–790
Metal:			
Sponge import[2]	dollars per kilogram	6.88–11.26	9.50–10.81
Scrap, turnings, unprocessed[3]	dollars per pound	0.55–0.65	0.80–0.90
Ferrotitanium, 70% Ti[3]	do.	2.10–2.20	2.90–3.10
Mill products[4]	producer price index	170	171
Titanium dioxide pigment[4]	do.	205	205

rRevised. do. Ditto. NA Not available.
[1]Source: Industrial Minerals.
[2]Landed duty-paid unit value based on U.S. imports for consumption from producing countries.
[3]Source: S&P Global 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	2017 Quantity (metric tons)	2017 Value (thousands)	2018 Quantity (metric tons)	2018 Value (thousands)
Metal:					
Scrap	8108.30.0000	9,450	$28,100	11,900	$33,500
Unwrought:					
Sponge	8108.20.0010	3,090	28,100	533	4,510
Ingot	8108.20.0030	9,010	127,000	10,600	166,000
Other	8108.20.0090	2,730	64,700	2,770	81,300
Total		24,300	248,000	25,800	285,000
Wrought:					
Bloom, sheet bar, slab	8108.90.6020	3,480	105,000	2,600	73,800
Bar, rod, profile, wire	8108.90.6031	5,560 r	254,000 r	5,980	272,000
Other	8108.90.8000	10,900	1,110,000	11,300	1,180,000
Total		19,900	1,470,000	19,900	1,520,000
Ferrotitanium and ferrosilicon titanium	7202.91.0000	2,420	8,560	3,120	12,300
Ores and concentrates	2614.00.0000	8,940	12,300	51,400	26,900
Pigment:					
80% or more titanium dioxide pigment	3206.11.0000	608,000	1,480,000	508,000	1,440,000
Other titanium dioxide pigment	3206.19.0000	22,000	111,000	15,800	99,000
Unfinished titanium dioxide[3]	2823.00.0000	4,210 r	8,460 r	4,680	8,900
Total		634,000	1,600,000	528,000	1,550,000

rRevised.
[1]Table includes data available through January 19, 2020. 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 OR LOCALITY[1]

Concentrate and country or locality	HTS[2] code	2017 Quantity (metric tons)	2017 Value (thousands)	2018 Quantity (metric tons)	2018 Value (thousands)
Ilmenite:	2614.00.6020				
Australia		229,000	$35,700	256,000	$70,900
Madagascar		198,000	36,800	169,000	33,300
Mozambique		191,000	30,200	141,000	23,900
Senegal		65,100	10,200	66,200	10,600
Ukraine		65,900	9,730	68,600	11,900
Other		-- r	-- r	5,200	4,790
Total		748,000 r	123,000 r	706,000	155,000
Titaniferous slag:	2620.99.5000				
Australia		1,500	1,050	--	--
Canada		106,000	74,300	136,000	101,000
Norway		32,700	19,200	20,500	13,100
South Africa		339,000	210,000	343,000	240,000
Total		479,000	305,000	500,000	354,000
Rutile, natural:	2614.00.6040				
Australia		84,200	46,900	65,800	56,800
Kenya		30,500	22,000	--	--
Sierra Leone		10,200	7,710	10,000	10,300
South Africa		140,000	87,600	163,000	121,000
Ukraine		20,200	14,400	426	446
Other		3,530 r	2,220 r	5,100	3,580
Total		289,000	181,000	245,000	192,000
Rutile, synthetic:	2614.00.3000				
Australia		33,600	24,100	15,000	11,700
Kenya		10,000	7,450	--	--
Other		1,500 r	2,120 r	73	128
Total		45,100	33,600	15,100	11,800
Titaniferous iron ore, Canada[3]	2614.00.6020	11,900	8,330	10,100	1,460

rRevised. -- Zero.
[1]Table includes data available through January 19, 2020. 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 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 OR LOCALITY[1]

Class and country or locality	HTS[2] code	2017 Quantity (metric tons)	2017 Value (thousands)	2018 Quantity (metric tons)	2018 Value (thousands)
Waste and scrap:	8108.30.0000				
Canada		1,510	$4,190	1,520	$4,460
France		2,940	11,700	3,890	14,700
Germany		4,020	18,700	3,390	18,600
Italy		1,860	6,080	2,140	7,860
Japan		3,440 r	13,800	3,780	17,200
Korea, Republic of		1,150	5,030	1,290	5,970
Mexico		813	3,040	1,190	3,890
Singapore		654	1,930	586	2,230
Spain		667	2,850	471	2,050
United Kingdom		5,730	44,300	6,200	30,900
Other		2,340 r	10,600 r	2,650	15,100
Total		25,100 r	122,000	27,100	123,000
Unwrought:					
Sponge:	8108.20.0010				
Japan		19,400	178,000	22,100	202,000
Kazakhstan[e]		1,740 r	15,900	1,530	14,000
Russia		136	1,090	13	106
Ukraine		1,970	11,700	52	311
Other		126 r	1,160 r	22	277
Total		23,300 r	208,000	23,700	217,000
Ingot:	8108.20.0030				
Russia		1,490	22,600	1,940	29,200
Other		62	416 r	12	210
Total		1,550	23,000	1,950	29,500
Powder:	8108.20.0015				
Canada		39	7,400	57	8,970
China		102	1,870	109	2,060
Other		16 r	3,510 r	25	5,640
Total		157	12,800	191	16,700
Other:	8108.20.0095				
Russia		895	21,900	1,020	22,400
United Kingdom		95	3,760	94	7,950
Other		131 r	4,130 r	80	4,600
Total		1,120	29,700	1,190	35,000
Wrought products and castings:[3]	8108.90.3030, 8108.90.3060, 8108.90.6020, 8108.90.6031, 8108.90.6045, 8108.90.6060, 8108.90.6075				
China		1,170 r	43,700	1,340	60,900
France		779	42,300	779	38,200
Germany		278	17,100	150	11,400
Italy		99	5,700	349	11,700
Japan		720	19,300	644	18,200
Korea, Republic of		231	5,110	389	6,660
Russia		3,980	156,000	3,710	146,000
Ukraine		373	5,070	185	2,660
United Kingdom		423 r	38,400 r	311	30,200
Other		644 r	72,400 r	598	74,100
Total		8,700 r	405,000 r	8,450	400,000
Ferrotitanium and ferrosilicon titanium:	7202.91.0000				
Canada		930	2,340	1,070	2,860
Estonia		93	201	75	241
Russia		531	1,580	256	730
United Kingdom		856	2,960	995	3,770
Other		144	505	310	939
Total		2,560 r	7,580 r	2,710	8,550

[e]Estimated. [r]Revised.
[1]Table includes data available through January 19, 2020. 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 OR LOCALITY[1]

Pigment and country or locality	HTS[2] code	2017 Quantity (metric tons)	2017 Value (thousands)	2018 Quantity (metric tons)	2018 Value (thousands)
80% or more titanium dioxide pigment:	3206.11.0000				
Belgium		8,930	$20,200	13,000	$33,200
Canada		85,600	207,000	85,600	207,000
China		36,600	84,100	48,500	119,000
Czechia		3,440	8,510	5,630	15,900
Germany		17,400	45,000	21,500	62,800
Japan		6,600	24,100	5,640	25,300
Mexico		11,400	24,300	9,060	20,400
Spain		5,880	12,100	7,670	19,400
Other		15,300 r	38,300 r	18,800	48,100
Total		191,000	463,000	215,000	551,000
Other titanium dioxide:	3206.19.0000				
Canada		10,800	25,800	10,900	28,900
China		1,660 r	6,830 r	3,600	15,500
Colombia		317	793	335	984
France		216	1,030	772	4,010
Italy		807	2,260	794	3,230
Other		1,120 r	14,400 r	1,440	14,500
Total		15,000 r	51,100 r	17,800	67,200
Unfinished titanium dioxide:[3]	2823.00.0000				
China		14,400	34,200	21,900	53,900
Czechia		2,570	5,620	273	793
Finland		1,530	5,150	315	1,140
France		3,870	10,300	2,050	6,370
Germany		6,460	19,900	4,730	17,400
India		2,210	4,580	3,200	8,390
Other		2,460 r	8,440 r	2,970	12,300
Total		33,400	88,100	35,400	100,000
Grand total		240,000 r	602,000 r	269,000	719,000

rRevised.
[1]Table includes data available through January 19, 2020. 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 OR LOCALITY[1]

(Metric tons, gross weight)

Concentrate and country or locality	2014	2015	2016	2017	2018
Ilmenite and leucoxene:[2, 3]					
Australia	1,250,000	1,156,000	1,400,000 r	1,500,000 r	1,200,000 e
Brazil[e, 4]	136,000 r	133,000 r	130,000 r	130,000 r	110,000
China	4,240,000	3,910,000	3,800,000	3,830,000	4,200,000
India[e]	663,000 r	552,000 r	618,000 r	517,000 r	590,000
Indonesia	1,485	23,000 e	20,000 e	20,000 e	2,000 e
Kazakhstan[e]	10,000	8,000	14,000	9,400	10,000
Kenya	368,239	444,999	468,903	470,317	453,133
Madagascar	333,736	166,290 r	267,962 r	403,500 r	380,500
Malaysia	8,159	5,814	4,316 r	6,363 r	9,000 e
Mozambique	926,800	828,893	1,340,330	1,197,419 r	1,283,075
Norway[e]	864,000	630,000 r	590,000 r	670,000 r	590,000
Russia	178,426	193,236	18,900 r	3,300 r	3,600
Senegal	100,590	427,690	416,349 r	492,441	530,000 e
Sierra Leone	35,838	37,633	50,000 e	58,000 e	54,500
Sri Lanka	32,972	39,439	26,159 r	51,940 r	60,847
Ukraine	450,000 e	350,000 e	350,000 e	392,000	745,417
United States[4, 5]	200,000 e	300,000 e	100,000	100,000	100,000
Vietnam[6]	558,000	238,000 r	210,800 r	225,300 r	210,000 e
Total[7]	10,400,000	9,440,000 r	9,830,000 r	10,100,000 r	10,500,000
Rutile:[3]					
Australia	212,000	320,000	300,000 r	300,000	200,000 e
Brazil[e, 4]	3,100 r	3,300 r	4,500 r	4,500 r	2,000
India[e]	15,100 r	16,400 r	16,200 r	14,100 r	15,000
Kenya	59,348	78,947	88,288	91,456	95,715
Madagascar[e]	6,700 r	3,300 r	5,400 r	8,100 r	7,600
Malaysia	3,069	198	3,810 r	5,266 r	6,000 e
Mozambique	6,100 e	5,981	7,781	9,137 r	8,830
Senegal	663	5,311	9,664 r	9,975	9,980 e
Sierra Leone	114,163	126,022	143,000	168,000	121,500
South Africa[e]	100,000 r	95,000 r	100,000 r	120,000 r	110,000
Sri Lanka	2,111 r	1,808	2,237 r	2,174 r	2,319
Turkey[e]	5,000	5,000	5,000	5,000	5,000
Ukraine	110,000 e	90,000 e	100,000 e	100,000 e	106,858
United States	(8)	(8)	(8)	(8)	(8)
Total	637,000 r	751,000 r	786,000 r	838,000 r	691,000
Titanium slag:[e, 9]					
Canada	900,000	700,000	700,000 r	800,000 r	700,000
South Africa	1,100,000 r	940,000 r	820,000 r	1,000,000 r	900,000
Total	2,000,000 r	1,640,000 r	1,520,000 r	1,800,000 r	1,600,000

[e]Estimated. [r]Revised.

[1]Table includes data available through February 3, 2020. All data are reported unless otherwise noted. Totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]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 "Titanium slag," and the rest is used for purposes other than production of titanium commodities, principally steel-furnace flux and heavy aggregate.

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

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

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

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

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

[8]Included with ilmenite and leucoxene to avoid disclosing company proprietary data.

[9]Slag was also produced in China, India, Kazakhstan, Norway, Russia, and Vietnam, but this output was not included under "Titanium slag" to avoid duplicative reporting.