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2019 Minerals Yearbook

TITANIUM [ADVANCE RELEASE]

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Titanium

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In 2019, 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 an estimated 92% net import reliant (as a percentage of apparent consumption) with regard to titanium mineral concentrates and more than 50% import reliant (as a percentage of apparent consumption) with regard to titanium sponge (Gambogi, 2021a, b). 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 descending order of TiO_2 content, South Africa, Australia, Madagascar, and Mozambique (table 11). U.S. consumption of titanium used in steel and other alloys decreased by 3% from that in 2018 (table 7). Based on TiO_2 content estimated from gross weight data, world production of titanium mineral concentrates in 2019 was about 8.5 million metric tons (Mt), nearly unchanged compared with the revised amount in 2018 (table 14).

Titanium is the ninth most abundant element in the earth's crust and can be found in nearly all rocks and sediments. It 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 2019, the USGS annual survey canvassed titanium mineral and pigment producers.

Mineral Concentrates.—Titanium minerals of economic importance include ilmenite, leucoxene, and rutile. Dredging and dry surface mining techniques are usually used for the recovery of heavy minerals, including titanium 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 titanium minerals. Ilmenite is the most abundant titanium mineral with a TiO_2 content ranging from 35% to 65%. Rutile, which is naturally occurring TiO_2, has the greatest TiO_2 content, but is less abundant than ilmenite. Ilmenite often is 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.

In 2019, the U.S. producers of titanium mineral concentrates were The Chemours Co. (Wilmington, DE) and Southern Ionics Minerals, LLC (Jacksonville, FL). Chemours' mining operations near Starke, FL, produced a mixed product containing ilmenite, leucoxene, and rutile that was used as a captive feedstock in Chemours' TiO_2 pigment plants. In Starke, FL, Twin Pines Minerals LLC (Birmingham, AL) processed existing Chemours mine tailings to produce a zircon-rich concentrate that included minor amounts of rutile. In August, Chemours acquired Southern Ionics Minerals, LLC operations in southern Georgia. Southern Ionics operations in southern Georgia included the Mission Mine near Folkston and the Offerman mineral-processing operations near Nahunta.

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. $TiCl_4$ 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 is added to the $TiCl_4$ to ensure 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 then is 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 estimated to be 1.10 Mt in 2019, a 5% decrease compared with that in 2018 (tables 1, 5). U.S. producers of TiO_2 pigment using the chloride process were The Chemours Co., INEOS Pigments USA Inc., 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.

Metal.—In commercial production of titanium metal, titanium mineral concentrates are chlorinated to produce $TiCl_4$, which then is 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 2019, 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.

Ferrotitanium usually is 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, respectively. U.S. producers of ferrotitanium were Arconic, Inc. (Canton, OH) with an estimated capacity of 7,250 metric tons per year (t/yr) and AmeriTi Manufacturing Co. (formerly Global Titanium Inc.) (Detroit, MI) with a capacity of more than 10,000 t/yr. Data on production of ferrotitanium were not available.

Consumption

Mineral Concentrates.—Based on an estimate of the TiO_2 content of domestic production, imports, and exports, domestic consumption of titanium mineral concentrates was about 1.25 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.—Domestic production of TiO_2 pigment decreased by 5% and apparent domestic consumption (not accounting for changes in inventory) increased by 4% from that in 2018 (tables 1, 5). On a gross weight basis, leading uses of TiO_2 pigment, based on TiO_2 pigment shipments in the United States by domestic producers, were paint and coatings (which accounted for nearly 60% of shipments), followed by plastics and rubber (20%), and paper (5%). Other uses 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 (80%) was the leading end use for mill products. In general, production of titanium mill products precedes aircraft deliveries by about 12 months. 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, stainless, and high-strength low-alloy steels. Reported domestic consumption of titanium products in steel and other alloys was 11,100 metric tons (t), a 3% decrease from that in 2018 (table 7).

Stocks

Insufficient data were available to determine yearend consumer inventories of mineral concentrates and pigment. Titanium metal industry stocks were withheld to avoid disclosing company proprietary data.

Prices

Yearend titanium mineral concentrate prices are listed in table 9. In 2019, the yearend prices for ilmenite and rutile increased compared with those in 2018. Published prices for titanium slag were not available. Based on U.S. Census Bureau data, the value of slag imports from slag-producing countries in December 2018 was $700 to $790 per metric ton and ended 2019 at $805 to $955 per metric ton.

The U.S. Department of Labor, Bureau of Labor Statistics Producer Price Index (PPI) for TiO_2 pigment (June 1982 = 100) was 216 in January and then decreased to 208 in February, which was the last month for which it was reported in 2019. The monthly PPI for titanium mill products began at 175 in January, ranged between 172 and 174 from February through October, peaked at 180 in November, and ended at 172 in December.

Foreign Trade

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 2019, the TiO_2 content of imports was estimated to be about 1.2 Mt, primarily in the form of ilmenite (37%), titanium slag (35%), and natural rutile (26%). South Africa, Australia, Madagascar, and Mozambique were, in descending order of TiO_2 content, the leading import sources, accounting for 80% of mineral concentrate imports. The combined value for all forms of titanium mineral concentrate imports in 2019 was $797 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 41 t in gross weight and were valued at $29,000. Exports of titanium mineral concentrates were minor relative to imports (tables 10, 11).

TiO_2 Pigment.—In 2019, 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 401,000 t valued at $1.18 billion dollars, a 24% decrease in quantity compared with those in 2018 (table 10). About 95% of TiO_2 pigment exports was in the form of finished pigment

containing 80% or more TiO_2 content. During 2019, 226,000 t of TiO_2 pigment was imported, a decrease of 16% from that in 2018. The leading import sources of TiO_2 pigment were Canada and China. About 82% of pigment imports was in the form of finished pigment containing more than 80% TiO_2 (table 13).

Metal.—Total imports of titanium metal, excluding ferrotitanium, were 73,400 t and were primarily in the form of waste and scrap (41%) and sponge (41%) (table 12). Japan supplied 88% of imported titanium sponge, Russia supplied 73% of imported titanium ingot, and the United Kingdom (19%), Germany (17%), Japan (16%), and France (12%) were the leading sources of imported scrap. Russia (43%) was the leading source of wrought products and castings. Exports of titanium metal were 46,400 t, excluding ferrotitanium, and were primarily in the form of wrought products and castings (45%), waste and scrap (32%), and ingot (16%) (table 10).

Imports of ferrotitanium were 3,390 t, an increase of 25% from those in 2018 (table 12). Exports of ferrotitanium were 1,520 t, a decrease of 51% compared with those in 2018 (table 10).

World Review

Based on TiO_2 content estimated from gross weight data, global production of TiO_2 in mineral concentrates in 2019 was about 8.5 Mt, essentially unchanged from that in 2018. The leading producers of titanium in mineral concentrates were, in descending order of TiO_2 content, China, Australia, South Africa, Canada, and Mozambique (table 14).

Australia.—Iluka Resources Ltd. was Australia's leading producer of titanium mineral concentrates with operations in the Eucla basin, Murray basin, and Western Australia. In 2019, Iluka's Australian operations produced 259,300 t of ilmenite and 46,900 t of natural rutile, compared with 340,600 t of ilmenite and 41,700 t of natural rutile produced in 2018. Using a portion of its own ilmenite as feedstock, the company produced 196,200 t of synthetic rutile compared with 219,900 t in 2018. In April, Iluka commissioned its Cataby mineral sands project in Western Australia, and by December, the mine was operating near its full production rate of about 370,000 t/yr of ilmenite and 30,000 t/yr of natural rutile. The ilmenite would be processed at Iluka's operation at Capel, Western Australia, to produce about 200,000 t/yr of synthetic rutile. Cataby's initial mine life was expected to extend by 8.5 years to 2027 (Iluka Resources Ltd., 2019, p. 142; 2020, p. 26, 146; 2021).

Melior Resources Inc. recommissioned its Goondicum ilmenite-apatite mining operation in November 2018, and the mine produced 45,200 t of ilmenite and 4,460 t of apatite in 2019. The company reported that the slime content in the feed material was higher than planned, which limited production during the year. Melior ceased operations at Goondicum in September (Melior Resources Inc., 2020).

Sheffield Resources Ltd. continued work on the development of its fully permitted Thunderbird heavy-mineral-sands project in Western Australia that would produce titanium and zirconium mineral concentrates. The company projected that the mine would produce about 470,000 t of ilmenite during its first year of production; production would then increase to more than 700,000 t/yr in the third and fourth years of production. Ore reserves were 750 Mt grading 3.1% ilmenite as of June 30, 2019 (Sheffield Resources Ltd., 2019, p. 5, 7).

Image Resources NL's Boonanarring heavy-mineral-sands project in the North Perth basin in Western Australia produced 270,000 t of heavy-mineral concentrate in 2019, its first full year of production. Annual production was more than initially forecast owing to higher-than-expected ore grades and the company forecast the mine would produce between 300,000 and 330,000 t of heavy-mineral concentrate in 2020 and 2021 (Image Resources NL, 2020, p. 9).

In mid-2019, a definitive feasibility study was completed for Strandline Resources Ltd.'s Coburn Project in Western Australia. Coburn would produce an average of 110,000 t/yr of ilmenite and 24,000 t/yr of rutile over an initial 22.5-year mine life, based on current reserves. At yearend, Strandline was securing offtake agreements and selecting construction contracts and a project financing option for Coburn (Strandline Resources Ltd., 2020, p. 2–4).

Canada.—In Quebec, Rio Tinto Fer et Titane Inc (RTFT), a subsidiary of Rio Tinto plc, produced titanium slag at its Lac Tio mining operations and Sorel titanium slag operations. RTFT Sorel supplemented Lac Tio mineral concentrates with feedstock from its QIT Madagascar Minerals operations. In 2019, combined titanium slag production from Rio Tinto's operations in Canada and South Africa increased by 8% to 1.21 Mt from 1.12 Mt in 2018. All nine of Sorel's slag furnaces were operating in 2019, contributing to the year-on-year production increase. In 2018, three of the nine furnaces were idle, and a furnace accident resulted in a temporary suspension of operations at Sorel (Rio Tinto plc, 2019a, p. 48–49; 2020, p. 55, 272).

China.—China was a leading producer and the leading consumer of titanium mineral concentrates, producing an estimated 4.7 Mt of ilmenite in 2019 (table 14). Imports of titanium mineral concentrates under the Harmonized System (HS) code 261400 were 2.6 Mt in 2019, a 16% decrease from those in 2018. The leading sources, in descending order of quantity, were Mozambique, 35%; Australia, 13%; Kenya, 13%; the Republic of Korea, 11%, and Vietnam, 11%. Exports of titanium mineral concentrates (HS code 261400) were 25,300 t in 2019, a decrease of 13% from those in 2018 (IHS Markit Ltd., 2021).

China's TiO_2 pigment production in 2019 was 3.1 Mt, an increase from 3.0 Mt in 2018. Imports of titanium-based pigments (HS codes 282300, 320611, and 320619) were 197,000 t in 2019, a decrease of 14% from those in 2018. Exports of titanium-based pigments (HS codes 282300, 320611, and 320619) totaled 1.08 Mt in 2019, an increase of 10% from exports in 2018 (Artikol, 2020; IHS Markit Ltd., 2021).

Lomon Billions Group Co., Ltd. was China's leading TiO_2 pigment producer with 1.01 million metric tons per year (Mt/yr) of TiO_2 pigment production capacity. Lomon Billions produced 630,000 t of TiO_2 pigment in 2019, about 90% of which was made using the sulfate process. During 2019, the company commenced production at a new 200,000-t/yr chloride-process TiO_2 plant (Lomon Billions Group Co., Ltd., 2020, p. 11, 21).

China also was the leading producer and consumer of titanium metal. In 2019, production of titanium sponge was about 85,000 t, an increase from 75,000 t in 2018. Imports of titanium metal and articles thereof (HS 8108) were 16,800 t, and exports were 22,400 t (Argus Media group—Argus Metals International, 2019a, 2021; IHS Markit Ltd., 2021).

Finland.—In 2018, 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 58,200 t of titanium sponge, 18% more than that in 2018. Titanium sponge exports increased by 24% to 33,400 t from 26,800 in 2018 (Roskill's Letter from Japan, 2020b).

According to the Ministry of Economy, Trade and Industry, Japan's production of TiO_2 pigments totaled 189,000 t in 2019, slightly less than that in 2018. About 83% of production was rutile pigment, and the remainder was anatase pigment. Japan's TiO_2 production capacity of 308,000 t/yr remained essentially unchanged at yearend 2019 compared with yearend 2018 (Roskill's Letter from Japan, 2020a).

Norway.—Nordic Mining ASA completed a definitive feasibility study (published in January 28, 2020) of its Engebø rutile-garnet project in southwestern Norway. Under the mine plan, Engebø was projected to operate for 42 years, processing an average of 1.5 Mt/yr of ore. Proven and probable ore reserves were estimated to be 63.1 Mt containing 3.34% TiO_2 (Nordic Mining ASA, 2020, p. 4, 7–8).

Russia.—Production of titanium sponge and ingot was about 46,000 t and 65,000 t, respectively, in 2019. Sponge and ingot production capacities were about 46,500 t/yr and 81,000 t/yr, respectively. The primary end uses for the consumption of titanium metal in Russia were, in descending order, engines, aircraft manufacturing, and other industrial sectors excluding aerospace (Tirus International SA, 2020).

Saudi Arabia.—Advanced Metal Industries Co. began commercial production of titanium sponge at its plant in Yanbu in 2019. The company expected the operation to be fully commissioned and producing at its full 15,600-t/yr capacity within 18 months. Yanbu processed $TiCl_4$ sourced from a nearby TiO_2 plant, owned by Tronox. Toho Titanium Co., Ltd. (Japan) owned a 35% interest in the project (Argus Media group—Argus Metals International, 2019b).

Sierra Leone.—Sierra Rutile Ltd., a subsidiary of Iluka, produced 59,200 t of ilmenite and 137,200 t of rutile in 2019 compared with 54,500 t of ilmenite and 121,500 t of rutile in 2018. During 2019, Iluka completed expansion projects that doubled mine and wet concentration capacity at the Gangama and Lanti mining operations and continued to evaluate the Sembehun deposits, 20 to 30 kilometers north of the Sierra Rutile operations, to identify development options (Iluka Resources Ltd., 2019, p. 142; 2020, p. 26, 35, 146).

South Africa.—In early December, Rio Tinto curtailed its Richards Bay Minerals (RBM) mining and slag operations after an escalation of security incidents. Rio Tinto also suspended its Zulti South mine expansion project, which was approved in April and would extend the life of RBM. By the end of December, the company announced that it had begun a phased restart of mining operations after discussions with community and government representatives and other stakeholders. Construction of the Zulti South deposit remained suspended at yearend and would resume once operations at RBM were normalized. Despite the curtailment, the company's combined titanium slag production from its operations in Canada and South Africa increased by 8% to 1.21 Mt in 2019 from 1.12 Mt in 2018. Labor disputes in South Africa affected the company's titanium slag production in 2018 (Rio Tinto plc, 2019a, p. 49; 2019b, c; 2020, p. 272).

Tanzania.—Strandline continued to advance its Fungoni mineral sands project, near the port of Dar es Salaam. In the fourth quarter, Strandline announced that it was close to securing financing for most of the project's costs. The estimated capital cost of the project was $35 million (Strandline Resources Ltd., 2020, p. 4–5).

Ukraine.—Ukraine was the leading source of titanium 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 920,000 t (table 14) and exported 621,000 t of titanium minerals concentrates in 2019 (IHS Markit Ltd., 2021).

Ukraine produced about 6,900 t of titanium sponge and 3,200 t of titanium ingot, 5% less and 27% more, respectively, compared with production in 2019. Ownership of the only titanium sponge producer, Zaporozhye Titanium and Magnesium Combine Ltd., was in legal dispute between the Government of Ukraine and Group DF through its subsidiary Tolexis Trading Ltd. (Group DF, 2018; Tirus International SA, 2020).

Outlook

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 for aircraft and engines supplemented by other uses such as chemical processing, desalination, power generation, and specialty steels.

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TABLE 1
SALIENT TITANIUM STATISTICS[1]

		2015	2016	2017	2018	2019
United States:						
Mineral concentrates:						
Production[2]	metric tons	300,000 e	100,000	100,000	100,000	100,000
Imports for consumption[3]	do.	1,380,000 r	1,330,000 r	1,560,000 r	1,470,000 r	1,540,000
Consumption[e, 4]	do.	1,720,000	1,740,000	1,760,000	1,610,000	1,630,000
Sponge metal:						
Imports for consumption	do.	20,200 r	16,200	23,300	23,700	30,000
Consumption	do.	31,200	34,100	37,400	35,200	W
Price, yearend[5]	dollars per pound	7.31–11.81	11.08–11.94	6.88–11.26	9.50–10.81	10.61–11.71
Titanium dioxide pigment:						
Production	metric tons	1,220,000	1,240,000	1,260,000	1,150,000	1,100,000 e
Imports for consumption	do.	221,000	247,000	240,000	268,000 r	226,000
Consumption, apparent[6]	do.	792,000 r	840,000 r	870,000	893,000	926,000
Producer price index, yearend[7]	(June 1982=100)	176	175	205	205	XX
World, production:						
Ilmenite concentrate[8]	metric tons	9,440,000	9,800,000 r	10,000,000 r	10,800,000 r	10,700,000 e
Rutile concentrate, natural[9]	do.	751,000	784,000 r	836,000 r	688,000 r	689,000
Titaniferous slag[e]	do.	1,640,000	1,520,000	1,800,000	1,600,000	1,700,000

[e]Estimated. [r]Revised. do. Ditto. W Withheld to avoid disclosing company proprietary data. XX Not applicable.
[1]Table includes data available through February 17, 2021. 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]Excludes titaniferous iron ore imported from Canada that is classified as ilmenite under the Harmonized Tariff Schedule of the United States.
[4]Does not include consumption used to produce synthetic rutile.
[5]Landed duty-paid unit based on U.S. imports for consumption.
[6]Production plus imports minus exports. Does not include stock changes.
[7]Source: U.S. Department of Labor, Bureau of Labor Statistics.
[8]Includes U.S. production of ilmenite and rutile, which is rounded to the nearest 100,000 metric tons to avoid disclosing company proprietary data.
[9]U.S. production of rutile included with ilmenite to avoid disclosing company proprietary data.

TABLE 2
ESTIMATED U.S. TITANIUM METAL PRODUCTION CAPACITY IN 2019[1, 2]

(Metric tons per year)

Company	Plant location	Yearend capacity	
		Sponge	Ingot[3]
Allegheny Technologies Inc.	Albany, OR	--	10,900
Do.	Monroe, NC	--	23,200
Do.	Richland, WA	--	10,000
Alloy Works LLC[4]	Greensboro, NC	--	1,800
Honeywell Electronic Materials Inc.	Salt Lake City, UT	500	--
Howmet Aerospace	Canton, OH	--	9,600
Do.	Niles, OH	--	13,600
Do.	Whitehall, MI	--	3,200
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	138,000

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, and vacuum-arc-remelting capacity.

[4]A subsidiary of Precision Castparts Corp. (Berkshire Hathaway Inc.).

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

(Metric tons)

Component	2018	2019
Production:		
Ingot	85,000	W
Mill products	38,000	W
Exports:		
Waste and scrap	11,900	15,000
Sponge	533	869
Ingot	10,600	7,260
Other unwrought	2,770	2,350
Wrought products and castings	19,900	20,900
Total	45,600	46,400
Imports:		
Waste and scrap	26,700 r	30,100
Sponge	23,700	30,000
Ingot	1,950	2,100
Powder	191	189
Other unwrought	1,190	1,070
Wrought products and castings	8,540 r	9,920
Total	62,300 r	73,400
Stocks, industry, yearend:		
Sponge	10,700	W
Scrap	15,900	W
Ingot	8,530	W
Consumption, reported:		
Sponge	35,200	W
Scrap	52,100	W
Ingot	67,600	W
Shipments:		
Ingot	23,300	W
Mill products (net shipments):		
Forging and extrusion billet	25,800	W
Other	12,200	W
Total	38,000	W
Castings	W	W
Receipts, scrap:		
Home	23,200	W
Purchased	52,000	W
Total	75,200	W

rRevised. W Withheld to avoid disclosing company proprietary data.
[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.

TABLE 4
U.S. PRODUCERS OF TITANIUM DIOXIDE PIGMENT IN 2019[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
INEOS Pigments USA Inc.	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 26,400 metric tons per year 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]

		2018		2019	
		Gross weight	TiO_2 content[e]	Gross weight	TiO_2 content[e]
Production[2]	metric tons	1,150,000	1,080,000	1,100,000 [e]	1,030,000
Shipments:[e]					
Quantity	do.	1,150,000	1,080,000	1,100,000	1,030,000
Value	thousands	$3,400,000 [r]	XX	$3,200,000	XX
Exports	metric tons	528,000	497,000	401,000	377,000
Imports for consumption	do.	268,000 [r]	252,000	226,000	213,000
Consumption, apparent[e, 3]	do.	893,000	839,000 [r]	926,000	870,000

[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 CONCENTRATES[1, 2]

(Metric tons)

	2018		2019	
	Gross weight	TiO_2 content	Gross weight	TiO_2 content
Pigment	1,520,000	NA	1,550,000	NA
Miscellaneous[3]	88,400	NA	81,500	NA
Total	1,610,000	1,290,000	1,630,000	1,250,000

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)

	2018	2019
Steel:		
Carbon steel	5,440	5,340
Stainless and heat-resisting steel	3,560	3,310
Other alloy steel[3]	707	413
Total steel	9,700	9,070
Cast irons	7	3
Superalloys	456	565
Alloys, other than above	1,150	1,410
Miscellaneous and unspecified	89	14
Grand total	11,400	11,100

[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	2018	2019
Paint, varnish, and lacquer	58.9	59.0
Paper	4.7	4.5
Plastics and rubber	20.0	20.0
Other[2]	16.4	16.5
Total	100.0	100.0

[1]Table includes data available through September 15, 2020. 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[1]

		2018	2019
Concentrate:			
Ilmenite, cost including freight, China[1]	dollars per metric ton	164–180	190–210
Rutile, bagged, free on board (f.o.b.) Australian ports[1]	do.	1,045–1,350	1,250–1,300
Rutile, bulk, f.o.b. Australian ports[1]	do.	1,000–1,050	1,100–1,200
Titaniferous slag, import, 80% to 95% TiO_2[2]	do.	770–790	805–955
Metal:			
Sponge import[2]	dollars per kilogram	9.50–10.81	10.61–11.71
Scrap, turnings, unprocessed[3]	dollars per pound	0.80–0.90	0.85–0.90
Ferrotitanium, 70% Ti[3]	do.	2.90–3.10	2.90–3.10
Mill products[4]	producer price index	171	172
Titanium dioxide pigment[4]	do.	205	NA

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]

		2018		2019	
Class	HTS[2] code	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Metal:					
Scrap	8108.30.0000	11,900	$33,500	15,000	$40,200
Unwrought:					
Sponge	8108.20.0010	533	4,510	869	5,660
Ingot	8108.20.0030	10,600	166,000	7,260	109,000
Other unwrought	8108.20.0090	2,770	81,300	2,350	72,900
Total		13,900 r	252,000 r	10,500	188,000
Wrought:					
Bloom, sheet bar, slab	8108.90.6020	2,600	73,800	1,330	32,900
Bar, rod, profile, wire	8108.90.6031	5,990 r	272,000	7,390	344,000
Other	8108.90.8000	11,300	1,180,000	12,100	1,280,000
Total		19,900	1,520,000	20,900	1,650,000
Ferrotitanium and ferrosilicon titanium	7202.91.0000	3,120	12,300	1,520	6,310
Ores and concentrates	2614.00.0000	51,400	26,900	12,200	20,300
Pigment:					
80% or more titanium dioxide pigment	3206.11.0000	508,000	1,440,000	382,000	1,080,000
Other titanium dioxide pigment	3206.19.0000	15,800	99,000	13,000	86,200
Unfinished titanium dioxide[3]	2823.00.0000	4,680	8,900	5,670	10,600
Total		528,000	1,550,000	401,000	1,180,000

rRevised.
[1]Table includes data available 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	2018 Quantity (metric tons)	2018 Value (thousands)	2019 Quantity (metric tons)	2019 Value (thousands)
Ilmenite:	2614.00.6020				
Australia		256,000	$70,900	113,000	$18,200
Madagascar		169,000	33,300	250,000	52,500
Mozambique		141,000	23,900	172,000	32,400
Senegal		66,200	10,600	131,000	23,300
Ukraine		68,600	11,900	60,300	8,590
Other		5,200	4,790	--	--
Total		706,000	155,000	726,000	135,000
Titaniferous slag:	2620.99.5000				
Canada		136,000	101,000	74,000	66,400
Norway		20,500	13,100	30,100	23,000
South Africa		343,000	240,000	369,000	274,000
Total		500,000	354,000	473,000	363,000
Rutile, natural:	2614.00.6040				
Australia		65,800	56,800	78,400	71,600
Kenya		--	--	37,600	37,900
South Africa		163,000	121,000	188,000	147,000
Other		15,600 r	14,300 r	20,200	17,700
Total		245,000	192,000	324,000	274,000
Rutile, synthetic:	2614.00.3000				
Australia		15,000	11,700	12,000	8,180
South Africa		--	--	5,000	2,190
Other		73	128	1,340	14,300
Total		15,100	11,800	18,300	24,700
Titaniferous iron ore, Canada[3]	2614.00.6020	10,100	1,460	41	29

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	2018 Quantity (metric tons)	2018 Value (thousands)	2019 Quantity (metric tons)	2019 Value (thousands)
Waste and scrap:	8108.30.0000				
Canada		1,520	$4,460	1,750	$3,800
France		3,490 r	14,500 r	3,640	15,200
Germany		3,340 r	18,400 r	5,120	29,200
Italy		2,140	7,860	2,210	8,170
Japan		3,780	17,200	4,810	21,500
Korea, Republic of		1,290	5,960 r	1,230	6,520
Mexico		1,190	3,890	1,650	5,260
Singapore		586	2,230	715	2,270
Spain		471	2,050	558	2,340
United Kingdom		6,200	31,000 r	5,800	25,900
Other		2,700 r	15,600 r	2,620	13,100
Total		26,700 r	123,000	30,100	133,000
Unwrought:					
Sponge:	8108.20.0010				
Japan		22,100	202,000	26,600	240,000
Kazakhstan		1,530 e	14,000	2,930 e	26,500
Poland		--	--	105	823
Russia		13	106	73	605
Ukraine		52	311	297	2,820
Other		22	277	53	609
Total		23,700	217,000	30,000	271,000
Ingot:	8108.20.0030				
Kazakhstan		--	--	391	6,890
Russia		1,940	29,200	1,530	23,800
Other		12	210	180	4,300
Total		1,950	29,500	2,100	35,000
Powder:	8108.20.0015				
Canada		57	8,970	70	11,900
China		109	2,060	99	1,520
Germany		18	4,260	14	4,870
Other		7 r	1,380 r	7	1,580
Total		191	16,700	189	19,900
Other:	8108.20.0095				
Russia		1,020	22,400	943	20,900
United Kingdom		94	7,950	42	2,780
Other		80	4,600	82	4,460
Total		1,190	35,000	1,070	28,100
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		1,340	60,900	1,210	63,700
France		779	38,100 r	729	45,900
Italy		349	11,700	231	9,030
Japan		644	18,200	408	13,100
Korea, Republic of		389	6,660	434	8,230
Russia		3,810 r	151,000 r	4,260	177,000
Ukraine		185	2,660	1,390	17,800
United Kingdom		311	30,200	243	26,500
Other		730 r	85,300 r	1,020	105,000
Total		8,540 r	404,000 r	9,920	466,000
Ferrotitanium and ferrosilicon titanium	7202.91.0000				
Canada		1,070	2,860	1,210	3,770
Poland		95	332	487	1,590
Russia		256	730	193	576
Ukraine		80	263	247	736
United Kingdom		995	3,770	1,050	4,000
Other		210 r	585 r	205	600
Total		2,710	8,550	3,390	11,300

eEstimated. 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 bar, billet, bloom, castings, foil, pipe, plate, profile, rod, sheet, sheet bar, slab, strip, tube, wire, and other.

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

Country or locality	HTS[2] code	2018 Quantity (metric tons)	2018 Value (thousands)	2019 Quantity (metric tons)	2019 Value (thousands)
80% or more titanium dioxide pigment:	3206.11.0000				
Australia		1,240	$3,200	7,480	$16,000
Belgium		13,000	33,200	13,700	35,800
Canada		85,600	207,000	81,600	199,000
China		48,400 r	119,000	13,300	29,500
Czechia		5,630	15,900	5,550	14,600
Germany		21,500	62,800	17,400	49,500
Japan		5,640	25,300	5,320	26,500
Mexico		9,060	20,400	4,100	8,890
Norway		3,250	8,160	4,170	9,920
Spain		7,670	19,400	12,600	33,800
Other		14,300 r	36,700 r	19,200	51,100
Total		215,000	551,000	184,000	475,000
Other titanium dioxide:	3206.19.0000				
Canada		10,900	28,900	11,600	30,700
China		2,900 r	11,200 r	1,260	4,780
France		772	4,010	369	1,860
Italy		794	3,230	476	1,810
Other		1,780 r	15,500 r	1,630	16,500
Total		17,100 r	62,900 r	15,300	55,600
Unfinished titanium dioxide:[3]	2823.00.0000				
Canada		277	708	5,620	19,000
China		21,900	54,000 r	9,230	20,600
France		2,050	6,370	2,020	5,890
Germany		4,730	17,400	3,300	14,900
India		3,190 r	8,390	2,280	5,500
Korea, Republic of		332	1,330	1,240	3,000
Other		2,940 r	12,200 r	2,780	12,600
Total		35,500 r	100,000	26,500	81,500
Grand total		268,000 r	714,000 r	226,000	612,000

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	2015	2016	2017	2018	2019
Ilmenite and leucoxene:[2, 3]					
Australia	1,156,000	1,400,000	1,500,000	1,400,000 r	1,400,000 e
Brazil[4]	133,000 e	106,400 r	67,000 r, e	110,000 e	41,000 e
China	3,910,000	3,800,000	3,830,000	4,200,000	4,700,000 e
India[e]	552,000	618,000	517,000	590,000	270,000
Indonesia[e]	23,000	20,000	20,000	2,000	4,000
Kazakhstan[e]	8,000	14,000	9,400	10,000	10,000
Kenya	444,999	468,903	470,317	453,133	341,182
Madagascar	166,290	267,962	403,500	380,500	461,800
Malaysia	5,814	4,316	6,363	14,158 r	2,334
Mozambique	828,893	1,340,330	1,197,419	1,283,075	990,000 e
Norway	630,000	590,000	670,000	590,000	660,000
Russia	193,236	18,900	3,300	3,600	4,000 e
Senegal	427,690	416,349	492,441	530,000 e	520,000 e
Sierra Leone	37,633	50,000	58,000	54,500	59,200
Sri Lanka	39,439	26,159	51,940	60,847	43,779
Ukraine	350,000 e	350,000 e	392,000	745,417	818,543
United States[4, 5]	300,000 e	100,000	100,000	100,000	100,000
Vietnam	238,000	210,800	225,300	235,100 r	271,100
Total[6]	9,440,000	9,800,000 r	10,000,000 r	10,800,000 r	10,700,000 e
Rutile:[3]					
Australia	320,000	300,000	300,000	200,000	200,000
Brazil[4]	3,300	2,700 r	1,000 r	2,000	600
India[e]	16,400	16,200	14,100	12,000 r	12,000
Kenya	78,947	88,288	91,456	95,715	78,961
Madagascar[e]	3,300	5,400	8,100	7,600	9,200
Malaysia	198	3,810	5,266	5,070 r	5,947
Mozambique	5,981	7,781	9,137	8,830	7,000 e
Senegal	5,311	9,664	9,975	9,980 e	10,000 e
Sierra Leone	126,022	143,000	168,000	121,500	137,200
South Africa[e]	95,000	100,000	120,000	110,000	120,000
Sri Lanka	1,808	2,237	2,174	2,319	1,959
Turkey	5,000 e	5,000 e	6,706 r	6,498 r	6,450 e
Ukraine	90,000 e	100,000 e	100,000 e	106,858	100,000 e
United States	(7)	(7)	(7)	(7)	(7)
Total	751,000	784,000 r	836,000 r	688,000 r	689,000
Titaniferous slag:[e, 8]					
Canada	700,000	700,000	800,000	700,000	800,000
South Africa	940,000	820,000	1,000,000	900,000	900,000
Total	1,640,000	1,520,000	1,800,000	1,600,000	1,700,000

[e]Estimated. [r]Revised.

[1]Table includes data available through February 17, 2021. 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 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]Includes U.S. production of ilmenite, leucoxene, and rutile, which is rounded to one significant digit to avoid disclosing company proprietary data.

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

[8]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.