Titanium metal: Impact assessment for supply security

HIGHLIGHTS

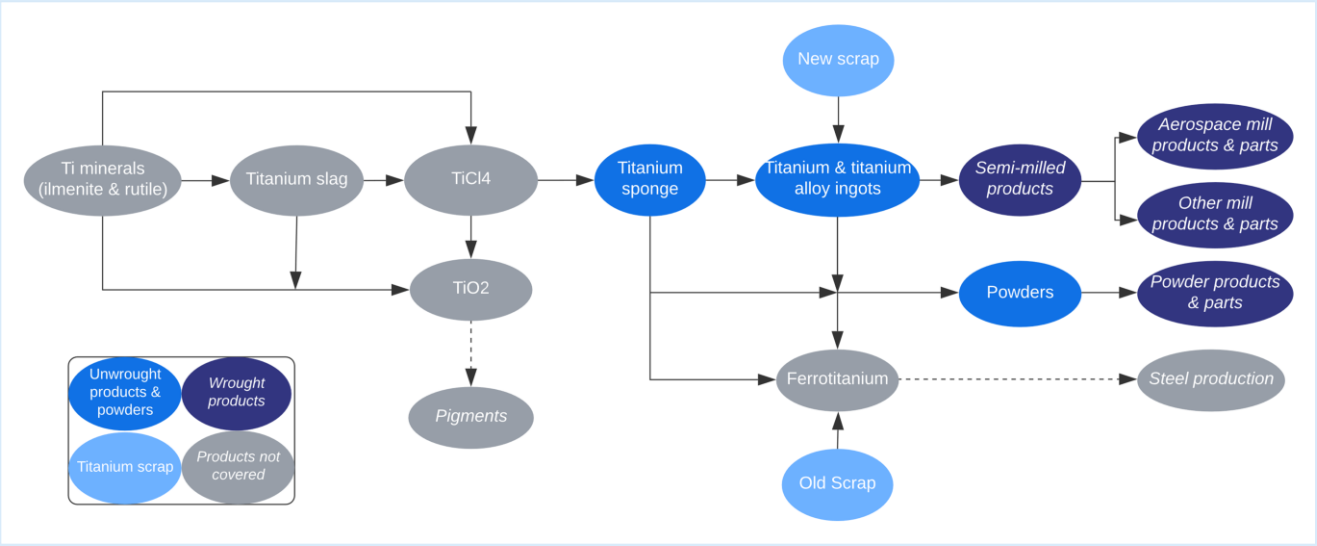
- → The EU does not produce titanium sponge (primary metal feedstock for wrought titanium) and relies fully on imports. Dependence on imports of wrought titanium products is significant. Imports cover at least 60% of EU's consumption of wrought titanium.
- → Imports of titanium metal in the EU are mostly in the form of wrought products (85% by value in 2020). The EU is the world's top importer of wrought titanium (mill products & articles).
- → The EU is particularly exposed to imports of wrought titanium from Russia (16% of import value in 2020). The EU imports unwrought titanium and powders from both Russia (9% of 2020 import value) and Ukraine (8% of 2020 import value).
- → Russia is a substantial source country of titanium for the aerospace industry globally, making supply chains vulnerable to disruption. Two-thirds of titanium metal in Europe is consumed by the aerospace sector.
- → An imminent shortage of titanium is not expected worldwide. High inventory levels and lower titanium demand in the post-pandemic period can mitigate impacts in the short term. Spare capacity in Japan and Kazakhstan, and emerging capacity in Saudi Arabia, are able to fill supply gaps for unwrought titanium.
- → The most plausible sources for the EU in order to shift supply from Russia in the medium term are its existing trade partners; Kazakhstan and Japan for unwrought titanium, and the US and the UK for wrought products.

QUICK GUIDE – This briefing is one of a series of overviews about potential supply disruption of non-food, non-energy raw materials due to Russia's war against Ukraine.

Joint Research Centre

Titanium metal is widely used in the aerospace industry because of its high strength-to-weight ratio, corrosion resistance and thermal stability. Titanium is also essential in the defence sector and critical infrastructures such as the chemical industry and power generation. Titanium is traded at different stages of processing. Wrought titanium, e.g. mill products, is the principal form in which titanium metal is marketed. Titanium was added to the EC's list of Critical Raw Materials in 2020.

Box 1: Titanium's value chain and scope



1. Titanium "sponge" is the primary metal stage of titanium, an intermediate product between titanium ore and titanium ingot. The next processing stage involves the melting of sponge and/or scrap feedstock (mainly new scrap), usually with alloying elements such as vanadium and aluminium, to produce ingots and slabs, as well as titanium powders used in additive manufacturing. Generic mill products of several forms (rods and bars, tubes and pipes, wire, sheets, and plates) and other downstream articles (forgings, castings, finished parts and components) are subsequently fabricated from ingots (and slabs). Fabrication of titanium into finished products generates large amounts of scrap that is a valuable input for the production of unwrought titanium.
2. Titanium commodities examined are unwrought products, wrought products and titanium scrap. Titanium minerals, titanium slag, and titanium oxide for pigments are not in the spotlight. Ferrotitanium, used by the steel industry, will be presented with ferroalloys in a forthcoming note.
3. Unwrought titanium products comprise sponge and ingots. Wrought titanium products include mill products and titanium articles.

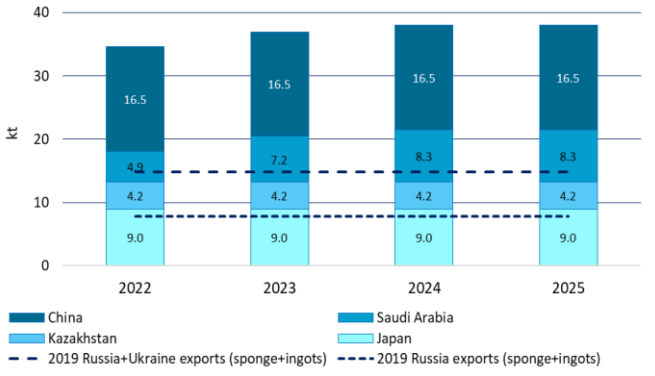
IMPACT ASSESSMENT

Short-term impacts and medium-term outlook globally

Exports from Russia and Ukraine amounted to 16.5 kt of sponge and ingots in 2019 (ITA, 2021), or 17% of global exports of unwrought titanium[1]. The unused production capacity of titanium sponge in Japan (primarily) and Kazakhstan, and the ramping up of the new Saudi plant can absorb a universal loss of Russian and Ukrainian unwrought metal supply. It is estimated that these sources can possibly provide by 2023 more than 20 kt of extra supply compared to the 2020 production levels (Figure 1). China's captive capacity may also contribute to expanding global output.

For supply suitable for aerospace applications, Russia's total exports of sponge and ingots equalled 9 kt in 2019 (ITA, 2021). The increased sponge output in Japan and Kazakhstan could potentially add around 13 kt to the market and, theoretically, fill a gap of Russian exports in terms of total volume. If the products of the new facility in Saudi Arabia are qualified for the aviation industry, the limited non-Russian supply base that is certified for aerospace will be extended.

Figure 1 – Potential for additional titanium sponge production compared to 2020 versus exports of unwrought titanium from Russia and Ukraine[2,3]



Source: JRC estimate based on data from USGS (2022), Louvigné (2021), UN Comtrade (2022), and historical production data shown in Figure 7.

[1] Data for HS 810820 'Titanium; unwrought, powders'.

[2] Exports from Russia and Ukraine are expressed in sponge 'equivalent' weight, i.e. ingot quantity is converted to sponge quantity required for its production.

[3] The extra production potential from China, Japan, and Kazakhstan is derived from the maximum capacity utilisation rate achieved in 2016-2020 per country.

By looking at past maximum export volumes from the world's major exporters for wrought titanium, it is concluded that there are also sources large enough to allow switching of import origins in the short term in case of a worldwide disruption in the supply chain (Figure 2). Moreover, stocks that may have formed due to the collapse in global demand in 2020-2021 could limit the short-term impacts. The forecast for a lower demand from 2022 to 2026 compared to 2019, which is anticipated to recover gradually to the pre-pandemic levels not earlier than 2027 as shown in Figure 6, could also mitigate market shortages, especially in the short term.

Box 2: The Russian and Ukrainian titanium industry

Russia is one of the few countries having a complete supply chain for titanium metal, from sponge to wrought products. In 2020, Russia accounted for 13% and 12% of the global output and exports of titanium sponge, respectively, and had a 9% export share by volume globally for unwrought titanium and powders. Furthermore, Russia is also among the leading manufacturers and exporters of titanium mill products worldwide. In 2020, it accounted for 19% by volume of global exports of mill products and titanium articles. Russia was also a substantial source of metal for aircraft manufacturing before the Russo-Ukrainian war. Russia's role in supplying titanium to the US and European aerospace industries is assessed as being crucial (Safirova et al., 2017).

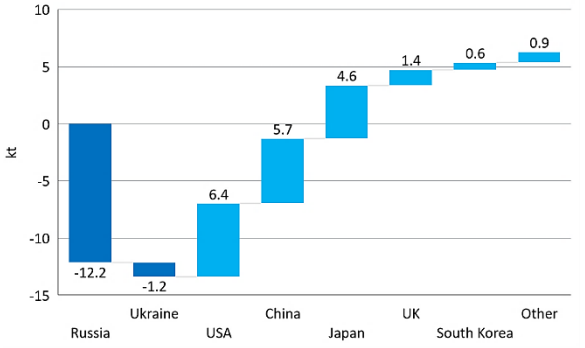
The Russian VSMPO-Avisma Corp. is the world's *largest* vertically integrated producer of titanium and titanium alloy products of all forms and shapes (Alexandrov, 2020). In 2019, the Russian company provided 21% of global titanium demand for wrought titanium products (JRC based on (ITA, 2021) and (Louvigné, 2021)).

At present, titanium remains exempt from restrictions on trade with Russia. Direct sanctions on imports of titanium and titanium products after Russia's invasion of Ukraine are not imposed so far (June 2022) by the EU, nor has an export embargo been imposed by Russia as a retaliation to western sanctions.

Ukraine is an important producer of titanium minerals (7% of the global output in 2019). In addition, the state-owned Zaporozhye Titanium & Magnesium Combine Ltd (ZTMC Ltd) produces titanium *sponge and ingots* of titanium and titanium alloys. The plant is located in Zaporizhia in southeastern Ukraine, which is currently (May 2022) under Ukraine's control but close to the *frontline*. It is not known whether or not the production line is still in operation. Ukraine produced 2% of the world's titanium sponge in 2020. Its share in global exports equalled 1% for titanium sponge, 7% for unwrought titanium and 2% for wrought titanium by volume in 2020.

Ukraine was by far the principal source of titanium mineral concentrate imports into Russia until 2021, with a share ranging from about 70% to 90% in the last years. Ukraine banned exports to Russia of titanium raw material (ilmenite), and the Russian titanium producer VSMPO-Avisma has *redirected* its purchases to other countries. Disruption in Ukraine's exports of titanium concentrates due to Russia's invasion will not directly affect the supply of titanium metal as they are destined to TiO_2 producers.

Figure 2 – Hypothetical losses of Russian and Ukrainian exports of wrought titanium products versus potential additional exports from elsewhere[4]



Source: JRC based on UN Comtrade (2022)

In the case of wrought products for the aerospace sector, supply chains are vulnerable to disruption if shipments are interrupted, given the scale of reliance on Russia (see Box 2 and Box 3). However, long production cycles combined with high industry stocks and hedging strategies may relieve the short- to medium-term pressure on supply chains.

Though, the outcome of cutting supply ties with Russia for aerospace products is challenging to predict. The impact assessment requires further research on manufacturing capacities of titanium mill products and articles for the aviation industry. Furthermore, the industry's buffer inventories are not disclosed, which adds to the uncertainty in assessing supply security. Finally, titanium products for the aerospace sector are highly specialised. Non-Russian companies cannot replace swiftly the fabrication of specific products if Russian supply is disrupted (Safirova *et al.*, 2017).

Short-term impacts and medium-term outlook in the EU

In case of a supply shock, the EU will need to replace total imports from Russia and Ukraine between 8-9 kt (expected in 2022) to 11-12 kt (expected in 2026)[5], of which around 40% corresponds to unwrought titanium and 60% to wrought titanium.

The EU has a strong partnership with the US in titanium trade. The US is the most significant origin for imports of all groups of titanium products to the EU, accounting for more than one-third of EU import value (see Figure 21). Moreover, the EU is

[4] Russian and Ukrainian exports refer to 2020. "Potential" from other countries listed is calculated as the difference between 2020 exports and peak exports recorded in 2017-2020. EU exports are excluded.

[5] JRC estimation based on historical data of imports and demand, and demand projections.

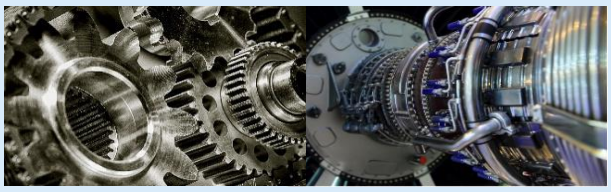
the top destination for US exports of wrought titanium products. Besides, the US holds the largest capacity in the world for titanium ingots after China, and it is the leading global exporter worldwide of wrought products. Thus, the US is a likely alternative source for imports of unwrought titanium (ingots) and the most plausible source to replace imports of wrought titanium products from Russia. Yet, a booming increase of defence spending in Western countries may boost titanium demand, e.g. from the US defence sector, and limit export availability to European civil aerospace industry of appropriate titanium grades.

Box 3: Aerospace industry's reliance on Russia

The Russian company VSMPO-Avisma is certified to produce a great variety of titanium-based *aerospace products*. According to media reports, it used to supply about *one-third* of the titanium used by the aviation sector globally and more than *45%* of the world's aerospace titanium parts. The aerospace sector accounted for around *three-quarters* of its sales. Airbus procured about *half* of its titanium demand from the Russian company before the pandemic, directly or indirectly through key suppliers. VSMPO-Avisma Corp. was also the *largest* titanium supplier for Boeing commercial production; a *third* of Boeing's titanium needs originated from Russia. At the same time, the Russian producer has been a significant titanium provider for jet-engine makers, which are critical suppliers to commercial aviation manufacturers. The French Safran SA used to source about *half* of its titanium needs from VSMPO-Avisma Corp., and the British Rolls-Royce Holdings Plc *20%*. Precise figures about the dependency on Russian titanium are not publicly available.

Boeing has established a Russia-based joint venture with VSMPO-Avisma (Ural Boeing Manufacturing (UBM)), producing *titanium parts and forgings*. The two companies *agreed* in November 2021 to expand their collaboration on titanium supplies and technology. In January 2022, the Russian company *announced* titanium supply deals with Spain's Aernnova Aerospace until 2028 and UK-based Barnes Aerospace stretching out to 2026.

It is reported that *western aerospace companies* have been creating stocks or looking to diversify their supply base to get ahead of any supply disruption before Russian invasion of Ukraine. According to media sources, Airbus stated that it is protected in the short/medium term from shortfalls as it has been stockpiling titanium for many years, and it is currently looking for *alternative sources* of titanium to safeguard its plans to increase production. Safran *announced* on 24 February 2022 that it had built up titanium stocks for a few months ahead. Media communicated in early March 2022 that Boeing *suspended* titanium purchases from Russia, despite its long-term relationship with VSMPO-Avisma, as it had created a sufficient titanium inventory in recent years. Stocks created by aircraft and engine manufacturers are reported to cover *six-to-nine months* of their needs.

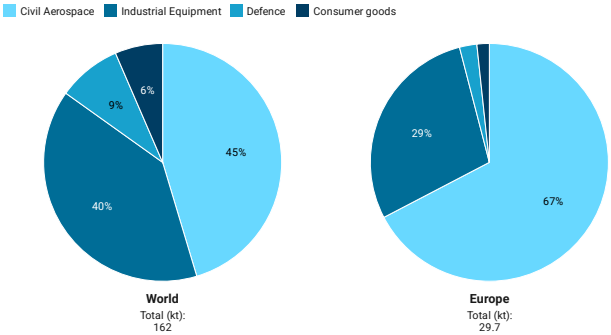


Kazakhstan, one of the possible suppliers of unwrought titanium globally to fill supply gaps, is the second most important origin of EU imports for unwrought titanium. A partnership already exists between the French industry and the Kazakh titanium producer. A possible supply restriction is related to logistics as transport routes for Kazakhstan's exports to the EU pass through Russian ports in the Baltic and the Black Sea. The reinforcement of existing ties in titanium trade with Japan (see Figure 21) — a key player in global titanium market — can also strengthen EU supply diversification, mostly for unwrought titanium. It is noted, however, that as the US is by far Japan's most significant export destination, competition might occur in sourcing additional supplies from Japan. The UK, another existing EU supplier, is also an alternative source for replacing wrought titanium products of Russian origin. Finally, yet importantly, the domestic production capacity established in France for aerospace-grade titanium from secondary sources will aid EU's autonomy from Russian supply routes.

DEMAND

On the demand side, the two major market segments are commercial aircraft production (engine parts, airframe structures and specific components) and industrial applications (chemical industry, oil, gas, and nuclear plants), making up 85% of all titanium demand (Figure 3). The segments of defence and consumer goods contribute less to global titanium consumption (9% and 6%, respectively).

Figure 3 –Titanium metal consumption by application, 2019



Source: Data from Louvigné (2021)

Figure 4 –Titanium consumption[6] in the EU manufacturing sectors

Applications	Industry	Industrial Ecosystem	Titanium metal consumption
Civil aerospace	C3030 - Manufacture of air and spacecraft and related machinery.	Aerospace & Defence	67%
Industrial equipment	C2530 - Manufacture of steam generators, except central heating hot water boilers; C281 - Manufacture of general-purpose machinery, C - 2829 Manufacture of other general-purpose machinery n.e.c.	Renewable Energy Energy-intensive Industries	29%
Military applications	C3040 - Manufacture of military fighting vehicles; C3030 - Manufacture of air and spacecraft and related machinery; C3011 - Building of ships and floating structures.	Aerospace & Defence	2%
Consumer goods and other	C3250 - Manufacture of medical and dental instruments and supplies; C3230 - Manufacture of sports goods; C2932 - Manufacture of other parts and accessories for motor vehicles; C3213 - Manufacture of imitation jewellery and related articles; C3011 - Building of ships and floating structures; F4120 - Construction of residential and non-residential buildings.	Health Mobility - Transport - Automotive	2%

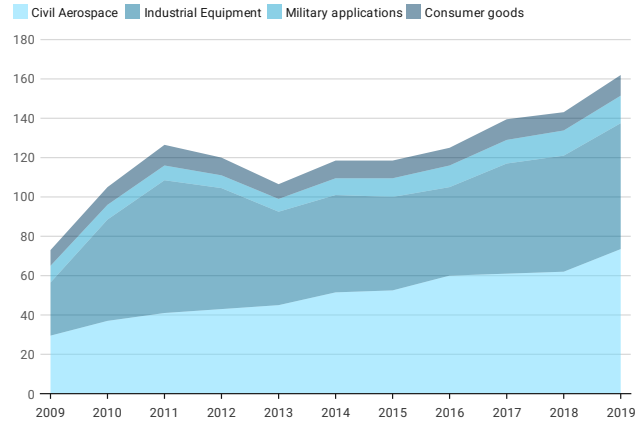
Source: JRC based on Eurostat (2008), Louvigné (2021)

Titanium is used in the form of alloys in high-performance applications in aeronautics and defence, and in its pure or low-

[6] Consumption data refer to Europe.

alloy form in industrial applications and consumer products (Louvigné, 2021). Titanium's demand is heavily dependent on industrial activity. The titanium market grew strongly from 2009 to 2019 at a compound annual growth rate of 8%, primarily driven by the aerospace sector (see also Box 4). Prior to the Covid-19 crisis, titanium demand reached a record high in 2019, with more than 160 kt tonnes of titanium consumed all over the world (Figure 5). European consumption amounted to approximately 30 kt in 2019 (18% of the global), with two-thirds for high-end aerospace applications.

Figure 5 – Trend of global titanium consumption, 2009-2019, in kt



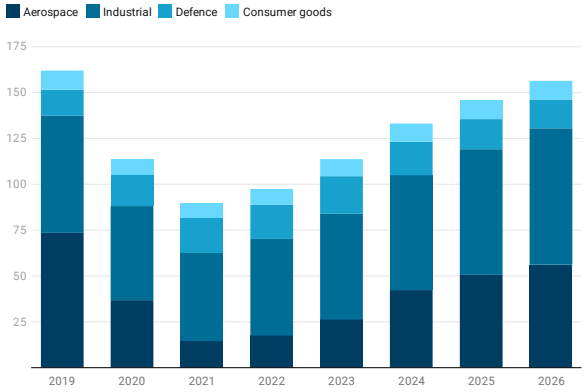
Source: Data from Louvigné (2021)

Box 4: Titanium use in aircraft structures

The structures of the A320 and B737 type civil aircraft used only a few titanium alloys (typically 3% to 5% of the total weight). The new generation aircrafts like the A350 and B787 employ a greater quantity of titanium alloy parts (15% to 18% of the total airframe) due to the better compatibility of titanium with the carbon-fibre-reinforced plastic (CFRP) composites used in the structure. Structural parts traditionally made of titanium alloys are located in the aircraft's hottest and most loaded parts (*https://titane.asso.fr/aeronautique/*).

The contraction in titanium demand in 2020 reflects the Covid-19 impact, and it is mainly due to the collapse of aviation activity. After the grounding of commercial air travel in April 2020, most airlines around the world scaled back or cancelled orders. The immediate effects of the pandemic's strike were somewhat mitigated by long supply chains[7] and the building up of "white-tail" inventories[8] (Roskill, 2020). Titanium consumption worldwide is estimated to have fallen by 30% in 2020 to 113 kt and, further, to 90 kt in 2021, i.e. 45% drop in 2021 compared to 2019, reflecting an almost 80% decline in use in aerospace (Louvigné, 2021). Beyond 2021, the annual growth rate of demand is anticipated at about 12% until 2026, and the level of consumption of 2019 is expected to be seen after 2026 (Figure 6). Nevertheless, increased defence budgets over the coming years in the aftermath of Russia's invasion of Ukraine, may speed up demand's recovery.

Figure 6 – Forecast of global consumption for titanium metal, in kt[9]



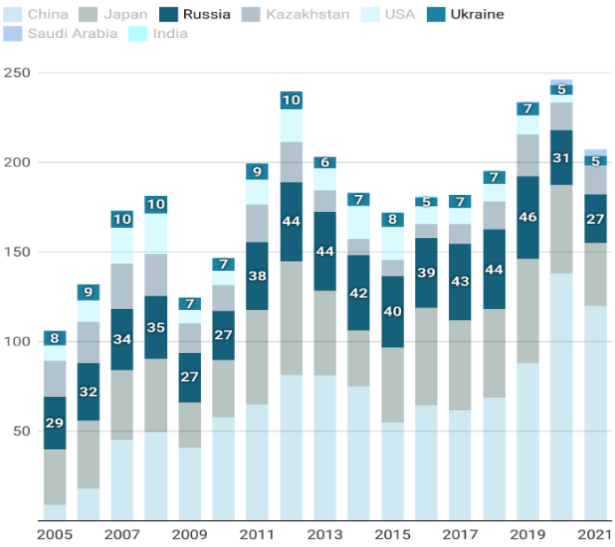
Source: Data from Louvigné (2021)

SUPPLY

Global production

According to data compiled from various sources, the global output of titanium sponge is estimated to be circa 245 kt in 2020 (Figure 7). China is the dominant producer of titanium sponge, with an upward production volume over the last few years. In 2020, Chinese output reached an all-time high[10] and accounted for more than half (56%) of the total. Japan (20%) is the world's second producer of titanium sponge, produced entirely from imported titanium minerals, followed by Russia and Kazakhstan with 13% and 6% of the global output in 2020, respectively. Ukraine accounted for 2% of global sponge production in 2020.

Figure 7 – Global production of primary titanium (sponge), in kt[11]



Source: Data from ITA (2021), CNIA (2021), Louvigné (2021), Gehler (2020), Gehler (2013)

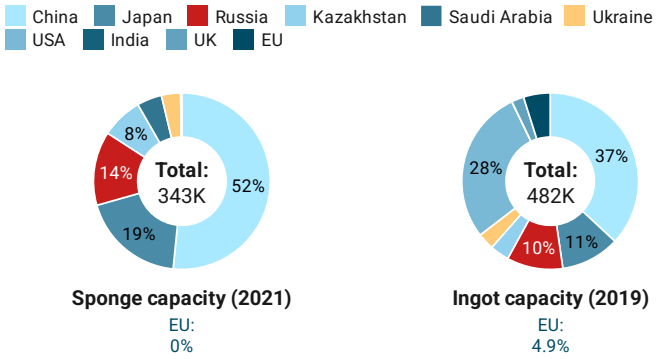
[7] Due to the lengthy assembly rate of aircrafts, titanium purchased today may serve aircraft production two-three years in the future.
[8] A 'white-tail' refers to a plane built but not delivered to a buyer.
[9] Figures for 2021 are a forecast.

[10] Chinese production equalled 138 kt in 2020 according to China's Nonferrous Metals Industry Association. The US Geological Survey in (Roux *et al.*, 2020) estimates the Chinese output to 123 kt in 2020.
[11] Figures for 2021 are a preliminary estimate by (USGS, 2022).

Among the prominent events in recent years is the closure of the last US sponge plant (Timet Henderson) in August 2020[12]. The start of commercial production in September 2019 of a new plant in Yanbu, Saudi Arabia[13,14] is another significant event for the titanium industry. The Saudi plant is operated by a joint venture (ATTM) of the Japanese sponge producer Toho Titanium and Tronox from the US and aims to become a supplier of aeronautical titanium sponge quality.

China's dominance in sponge production capacity is also indisputable (Figure 8). However, the Chinese titanium sponge is qualified only for common applications (metallurgical quality) and not for aerospace (Louvigné, 2021). Sources of supply for titanium sponge suitable for critical aircraft equipment are limited. After the closure of the US plant, the only qualified producers for the production of aviation-grade sponge are Japanese, Russian and Kazakh. In 2020, the sponge production capacity of an aeronautical quality accounted for about 40% of global capacity.

Figure 8 – Titanium sponge and ingot production capacity[15]



Source: JRC based on Louvigné (2021), Roberts (2018), USGS (2022)

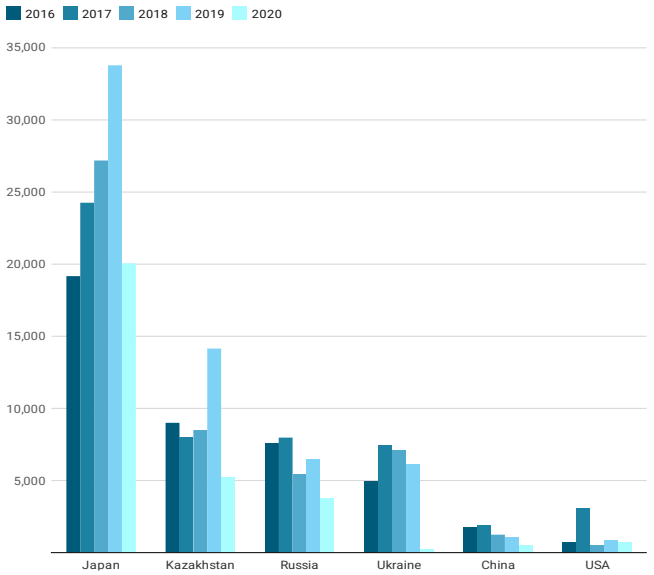
Regarding ingot production, China (37%) and the US (28%) are the world's principal operators of melting capacity (Figure 8). Furnaces capable of recycling titanium scrap to make titanium ingots are largely concentrated in the US. The rest of the international capacity is located in Japan, Russia, Kazakhstan, Ukraine, and the EU (about 5%). The qualified melting capacity for aerospace alloys accounts for 54% of the total capacity, or approximately 100 kt/year of solid products (Louvigné, 2021).

Global trade

Titanium sponge

Japan is by far the leading global exporter of titanium sponge, with an increasing share over 2016-2020. In 2020, Japan supplied two-thirds of sponge export volumes worldwide (Figure 9). The US is the top destination for Japanese sponge exports, with a share ranging from 73% to 87% in 2016-2020, whereas the EU is the second partner for Japan's exports of titanium sponge, with a share between 9% and 17% in the same period. China's exports are minor in comparison with its massive sponge production, as the Chinese output is consumed domestically.

Figure 9 – Titanium sponge exporters in 2016-2020, in tonnes

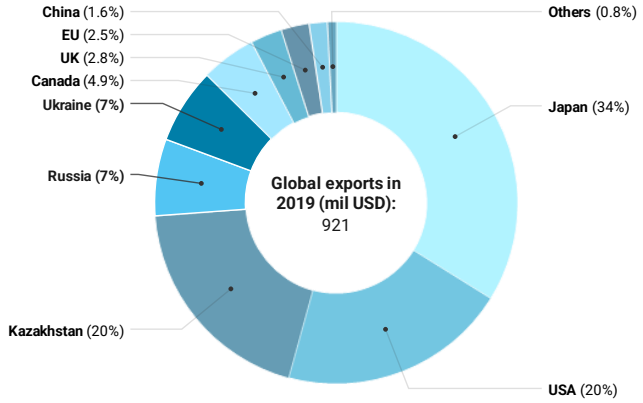


Source: Data from ITA (2021)

Unwrought titanium & powders

Japan, Kazakhstan and the US accounted for about three-quarters of exports of unwrought titanium and powders in 2019[16] by value (Figure 10). In 2020-2021 exports from Kazakhstan and the US plunged, and Japanese exports represented more than half of global export value in 2021 (Figure 11).

Figure 10 – Global exporters of unwrought titanium & powders in 2019 by value



Source: Data from WITS (2022)

[12] https://www.argusmedia.com/en/news/2145390-us-looks-to-revive-domestic-titanium-supply

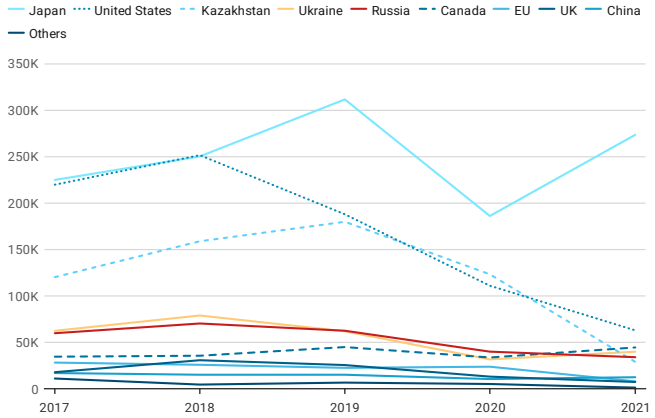
[13] https://www.toho-titanium.co.jp/en/business/timetal.html

[14] https://www.argusmedia.com/en/news/1991192-saudijapanese-venture-begins-titanium-sponge-output

[15] Data of ingot capacity refer to melting furnace capacity, i.e. in liquid tonnes. The actual available capacity is much lower as the production process may include r before casting into solid products.

[16] 2019 is chosen as the base year for describing trends in titanium's global trade.

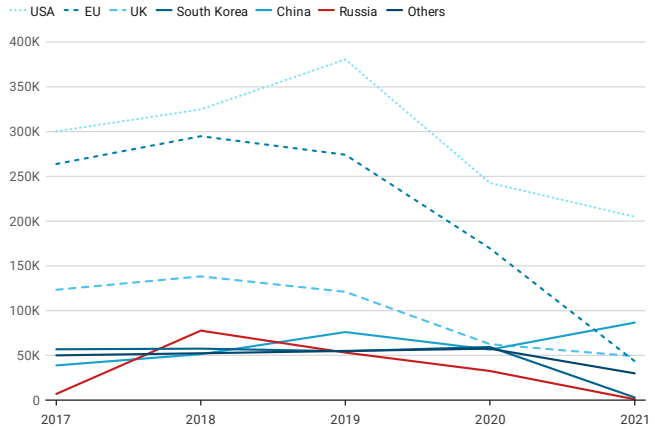
Figure 11 – Evolution of global exports of unwrought titanium & powders, in '1000 USD[17]



Source: Data from WITS (2022)

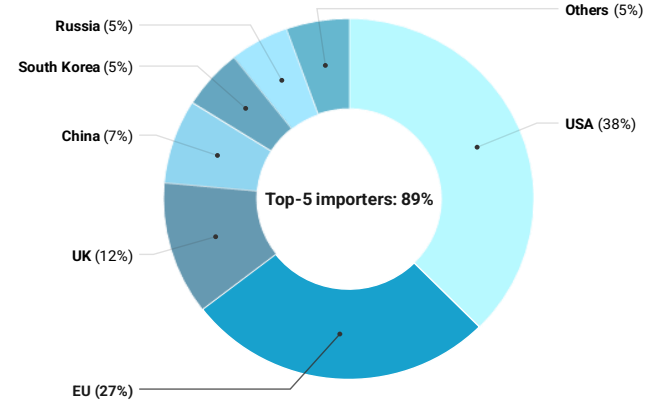
The US is the world's largest importer of unwrought titanium. The EU's import value declined considerably in 2020-2021 (by 84% in 2021 compared to 2019) in the wake of the Covid-19 impact on demand for aerospace applications (Figure 12).

Figure 12 – Evolution of global imports of unwrought titanium & powders, in '1000 USD



Source: Data from WITS (2022)

Figure 13 – Global importers of unwrought titanium & powders in 2019 by value

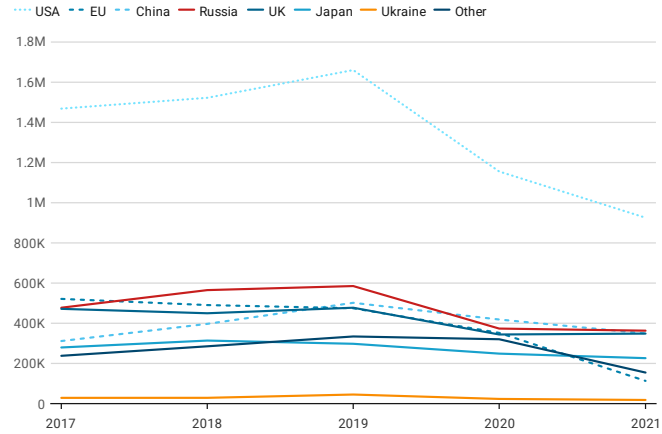


Source: Data from WITS (2022)

Wrought titanium (Mill products & titanium articles)

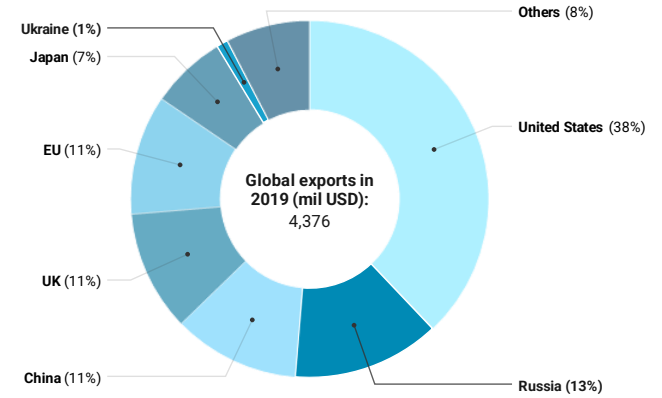
The US is the leading exporter of wrought titanium products, followed distantly by Russia and other countries (Figure 14).

Figure 14 – Evolution of global exports of titanium mill products & titanium articles, in '1000 USD[18]



Source: Data from WITS (2022)

Figure 15 – Global exporters of titanium mill products & titanium articles in 2019 by value



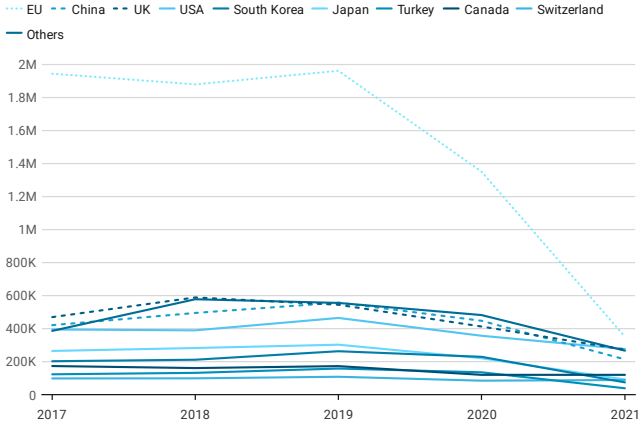
Source: Data from WITS (2022)

The EU is the top importer of wrought titanium products in the world. Its share in 2019 reached 39% of global import value (Figure 17). The downturn in manufacturing that came with the pandemic led to a sharp decrease in EU's import value in 2021, i.e. by 82% in comparison with 2019 (Figure 16). For comparison, the value of global imports in 2021 plummeted to one-third of the 2019 level.

[17] 2021 exports data for Kazakhstan, Russia and China are estimated from 'mirror' imports

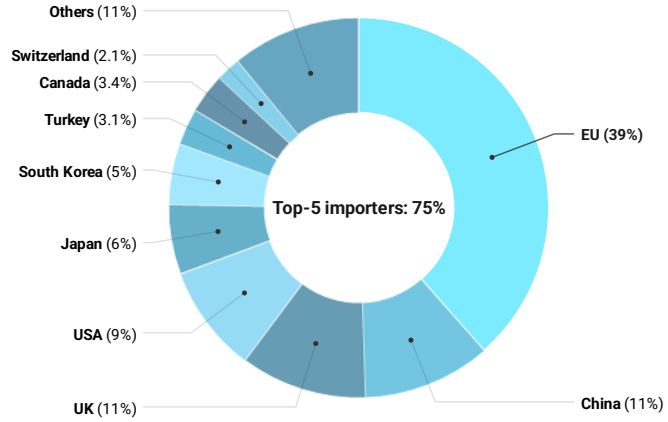
[18] 2021 exports data for Russia and China in 2021 are estimated from 'mirror' imports

Figure 16 – Evolution of global imports of titanium mill products & articles, in '1000 USD[19]



Source: Data from WITS (2022)

Figure 17 – Global importers of titanium mill products & articles in 2019 by value



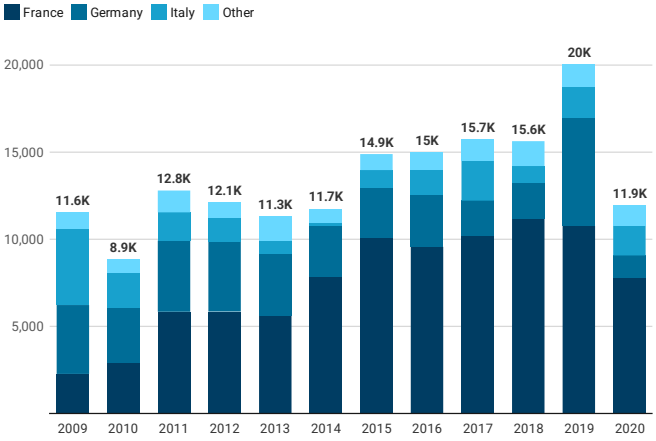
Source: Data from WITS (2022)

EU IMPORT DEPENDENCY

EU production

The EU does not produce primary titanium metal (sponge). Yet, some Member States produce titanium ingots from imported titanium sponge and/or scrap feedstock. The domestic production of downstream wrought titanium products is more developed. In 2020, the EU production of all titanium products was 12 kt, down from a record level of 20 kt in 2019. France (65% share in shipments of all titanium products in 2020) is the most significant producer in the EU, followed by Germany (14% in 2020) and Italy (11% in 2020) (Figure 18). Box 5 provides a brief overview of the EU's titanium industry.

Figure 18 – EU production (sold) of titanium products (unwrought, powders, wrought) by country[20], in tonnes



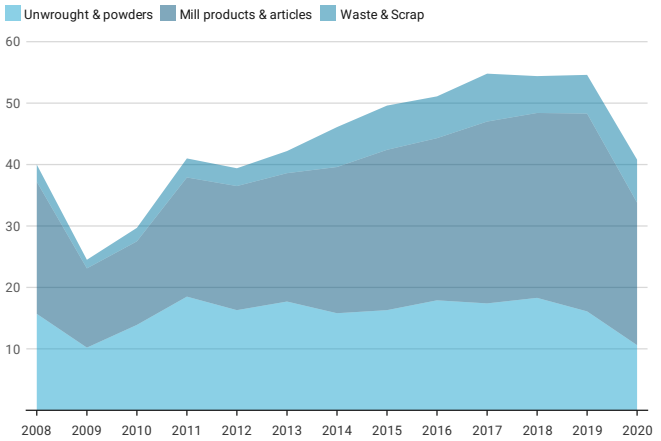
Source: Data from Eurostat Prodcom (2021)

EU imports

The total EU imports of titanium products and scrap were 55 kt annually in 2017-2019, while imports fell by 25% in 2020 to approximately 40 kt (Figure 19). The import value totalled EUR 1.2 billion in 2020. Imports of titanium metal in the EU are mostly in the form of wrought products (57% by volume and 85% by value in 2020; see Figure 20) with an increasing trend over 2012-2019.

The EU imported about 6.5 kt of titanium scrap annually in 2017-2019. Russia used to account for between 30% and 60% of EU imports in the period 2014-2018. Since then, imports of titanium scrap from Russia have decreased significantly. It is underlined that the EU is a net exporter of titanium scrap.

Figure 19 – Evolution of EU imports of titanium products and scrap, in kt

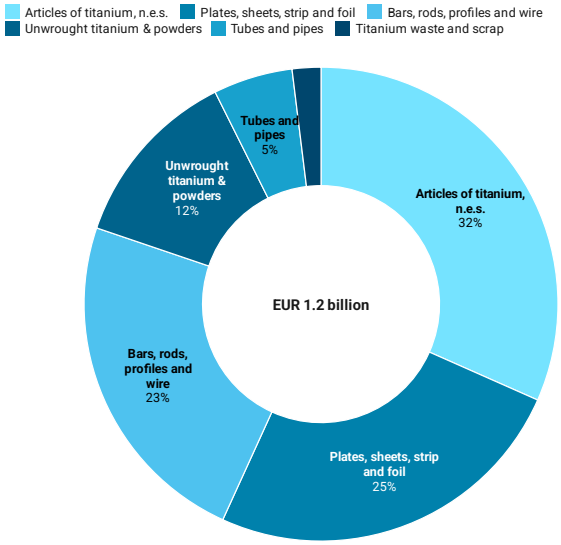


Source: Data from Eurostat Comext (2022)

[19] 2021 imports of China, South Korea and Turkey are derived from 'mirror' exports.

[20] The production of countries for which figures are withheld in the data source is included in the group "Other". As the output of these countries could not be deduced from available data in 2019 and 2020, it was assumed to equal the figure for 2018.

Figure 20 –EU titanium import value by product group, in 2020



Source: Data from Eurostat Comext (2022)

The US is the principal source for total EU imports of titanium metal (37% in 2020 by value) and for each product group (unwrought, wrought, and scrap). In descending order, Russia, the UK, Japan, and China are other important suppliers to the EU (Figure 21). Russia and Ukraine together accounted for 16% of import value in 2020. The EU particularly relies on Russian supply for long (bars, rods, profiles and wire) and flat mill products (plates, sheets, strips and foil) (Figure 22).

Figure 21 – EU import value of titanium product groups by trade partner, in 2020

	Total Imports by value	Unwrought & powders	Waste & scrap	Wrought & articles (total)
	37%	35%	41%	38%
	15%	9%	21%	16%
	15%	8%	14%	16%
	9%	5%	4%	10%
	9%	6%	0%	9%
	3%	0%	2%	3%
	2%	17%	0%	0%
	2%	0%	9%	2%
	2%	12%	0%	0%
	1%	8%	0%	0%
Others	3%	0%	6%	4%

Source: Data from Eurostat Comext (2022)

Figure 22 – EU import value of titanium wrought products (mill products and articles) by trade partner, in 2020

	Bars, rods, profiles, wire	Plates, sheets, strip, foil	Tubes, pipes	Articles of titanium
	48%	25%	24%	44%
	22%	28%	3%	6%
	15%	9%	14%	23%
	3%	28%	0%	3%
	10%	9%	21%	7%
	0%	0%	35%	3%
	0%	0%	0%	0%
	1%	0%	0%	5%
	0%	0%	0%	0%
	0%	0%	2%	0%
Others	1%	0%	0%	9%

Source: Data from Eurostat Comext (2022)

As a share of the EU's annual sourcing (production+imports), imports of wrought titanium products represent at least 45% (Figure 23). The EU's reliance[21] on imports for wrought titanium

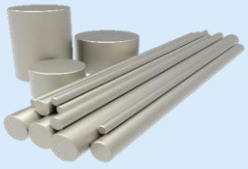
Box 5: The titanium industry in the EU

A coherent industrial cluster exists in France. UKAD, a 50-50 joint venture between the French company Aubert & Duval and the Kazakh UKTMP, *produces* semi-finished forged titanium and titanium alloy products (billets and bars) since 2011. The sponge producer UKTMP supplies the titanium ingots. *Aubert & Duval* carries out further manufacturing (forging and rolling) for products destined for high-tech industries (including aerospace) in various production sites in France. In addition, *EcoTitanium*, a joint venture by UKAD, the French State (ADEME) and Crédit Agricole, operates in France since September 2017. This is the first European plant producing aerospace-grade titanium ingots from recycled materials. The company produces ingots of titanium alloys (e.g. TA6V) by recycling new scrap from aircraft makers and subcontractors, most of which was previously *exported* to the US. The titanium ingots are processed downstream by UKAD to semi-milled products, and final products are produced at Aubert & Duval.

In a bid to secure strategic supplies and technology, the European air industry manufacturers Airbus and Safran *announced* on 22 February 2022 an agreement to acquire their supplier *Aubert Duval SAS* from Eramet SA, a French producer of titanium alloys and forged products used in the aerospace and other industries. The French manufacturer of aerospace components Figeac Aéro *publicised* on December 2021 the establishment of a joint venture with Saudi companies that aims to build a manufacturing facility in Saudi Arabia to produce aerospace components, including titanium parts.

In France, titanium ingots are also produced by Timet Savoie, a US Titanium Metal Corp. subsidiary, mostly for aerospace. In other Member States, *Tifast Titanium* in Italy produces titanium alloy ingots from scrap and sponge, and wrought titanium products (billets, bars, and wire). Titanium alloy ingots and wrought products are also produced in Romania by *Zirom Titanium* from sponge and scrap. In Germany, *GfE Metalle und Materialien GmbH* (AMG Titanium Alloys & Coatings) produces advanced titanium alloys and titanium aluminides, including scrap recycling. Titanium alloy ingot producer VDM Metals GmbH *closed* its facility in Germany in 2016.

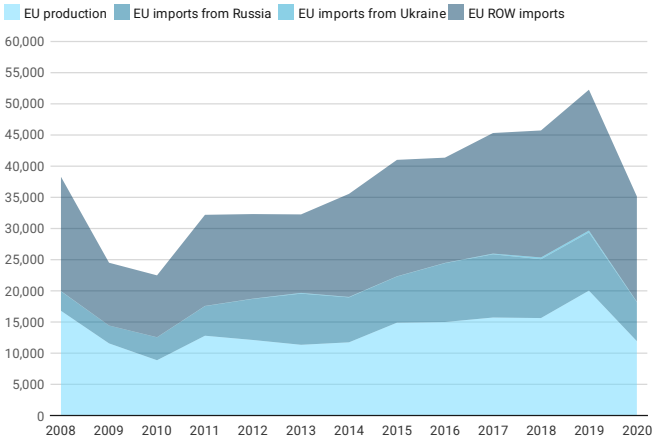
Production sites for wrought titanium products such as forgings, extrusions, tubes, castings and machined components are located in various countries, e.g. *Voestalpine Böhler Aerospace* in Austria, *Arconic Engines Tital GmbH* in Germany, *UAC Cefival* and *Neotiss* in France. EU countries producing titanium powders include Germany, France, and Sweden (Roux et al., 2020). Europe is well-positioned for the manufacture of 3D-printing titanium powders, with a 50% share of the global output (Blagoeva *et al.*, 2019). Titanium powders are particularly relevant to metal-based 3DP for aerospace.



[21] 'Import Reliance' Indicator = (Imports – Exports) / Apparent consumption; Apparent consumption = Domestic production + Imports - Exports

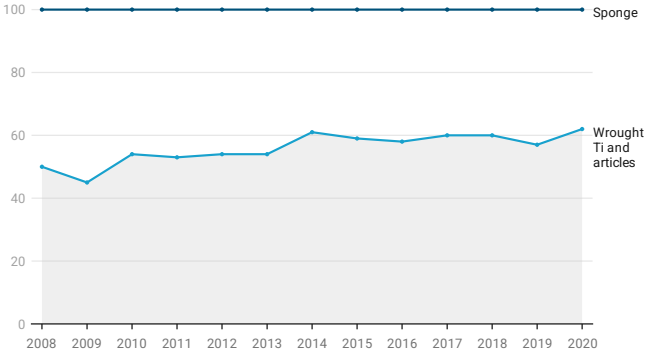
products is significant, estimated to be not less than 60%[22] (Figure 24). The reliance on imports of sponge titanium is 100%.

Figure 23 – EU structure of supply (EU sourcing) for wrought titanium products[23], in tonnes



Source: Data from Eurostat Comext (2022), Eurostat Prodcom (2021)

Figure 24 – Reliance on net imports for titanium in the EU (%)



Source: JRC elaboration based on Eurostat Comext (2022), Eurostat Prodcom (2021)

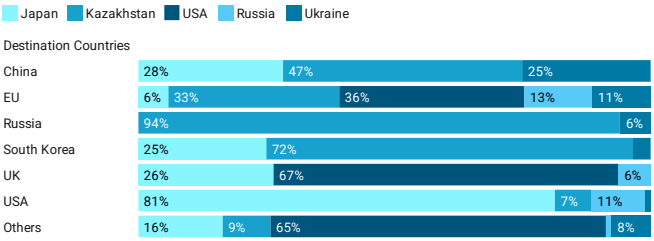
TRADE FLOWS FROM RUSSIA AND UKRAINE

About 45% of Russian export value of titanium products is destined to the EU. Imports from Russia and Ukraine equalled 17% of EU's import value in 2020. In total, the EU import flows from Russia and Ukraine corresponded to EUR 290 million in 2019 and EUR 195 million in 2020, of which more than 90% originated from Russia.

Russia and Ukraine accounted for 13% of global sponge exports in 2020, down from 20% in 2019. Russia's and Ukraine's combined global exports of titanium sponge aggregated to 4 kt in 2020, whereas in 2016-2019 ranged between 12.5 kt and 15.5 kt. As regards titanium ingots, Russia and Ukraine exported about 2 kt in 2020, whereas in 2016-2019 their global exports were between 2.5 and 4 kt (ITA, 2021).

European manufacturers source most of their unwrought titanium and powder inputs from Kazakhstan and the US. Yet, the EU's external supply has a relatively higher exposure to imports from Russia and Ukraine compared to other countries (Figure 25). EU imports of unwrought titanium (sponge, ingots) and powders from Russia and Ukraine summed at 3.5 kt in 2020. In 2019, a year of record demand for titanium throughout the world, the EU imported 4.5 kt of unwrought titanium and powders from Russia and Ukraine.

Figure 25 – Top exporters' share in export value of unwrought titanium & powders by destination country, in 2020



Source: Data from WITS (2022)

Among the top EU importers, Germany, the Netherlands, and Spain rely noticeably on imports of unwrought titanium and powders from Russia and Ukraine (see Figure 26).

Figure 26 – EU imports of unwrought titanium & powders by Member State[24]

Country	Import Value (million EUR)	Russia (%)	Ukraine (%)	ROW (%)
	60.9	0	0	100
	36.5	2	13	85
	28.1	26	18	56
	13.5	0	0	100
	10.0	30	22	48
	6.3	64	6	31
	4.1	0	5	95
	3.3	15	0	85
	1.5	74	2	24
	1.4	0	14	86
	1.1	0	12	88
	0.9	0	0	100
	0.6	0	50	50
	0.4	0	18	82
Other EU	0.4	6	0	94

Source: Eurostat Comext (2022)

In 2020, Russia exported about 16.5 kt of wrought titanium products worldwide (ITA, 2021), declining from a record high of 25.5 kt in 2019. Russian exports of wrought titanium products accounted for 13% of the global export value in 2020[25]. Ukraine's share in global exports of wrought titanium is minimal (1% by value).

[22] EU production data from Eurostat (Prodcom) aggregates the sold production of wrought titanium with unwrought titanium & powders; therefore, the figure of import reliance is expected somewhat higher.

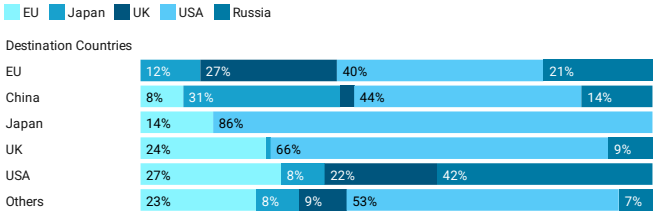
[23] The EU production reported from Eurostat (Prodcom) aggregates the sold production of unwrought & powders with the sold production of wrought titanium; therefore, double counting of sold ingots or mill products for downstream fabrication by other companies is not avoided.

[24] The Import value corresponds to the annual average of unwrought titanium imports (sponge, ingots) and powders over the period 2019-2021 (CN 81082000)

[25] For HS 810890 'Titanium; other than unwrought, n.e.c. in heading no. 8108'

The EU imported 4.5 kt of wrought products from Russia and Ukraine in 2020, down from 7 kt in 2019. EU's foreign supply of wrought titanium is less diversified from Russia compared with most of other destination countries (Figure 27).

Figure 27 – Top exporters' share in export value of wrought titanium (mill products & articles) by destination country, in 2020



Source: WITS (2022)

The highest dependence on Russian imports of wrought titanium in the EU is identified for France, Germany, Austria, Belgium, and Romania (Figure 28).

Figure 28 – EU imports of wrought titanium products by Member State[26]

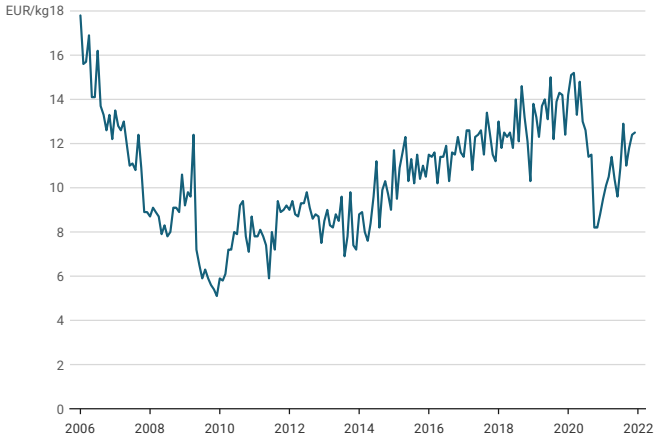
Country	Import Value (million EUR)	Russia (%)	Ukraine (%)	ROW (%)
	342	19	0	81
	339	26	0	74
	89	3	1	97
	79	0	0	100
	51	14	4	82
	35	4	1	96
	32	51	2	47
	28	1	0	99
	23	0	1	99
	23	0	0	100
	12	0	0	100
	8	6	0	94
	8	0	0	100
	8	0	0	100
	4	24	0	76
	3	0	0	100
	3	1	2	97
	3	2	1	98
	2	0	23	77
Other EU	2	3	0	97

Source: WITS (2022)

PRICES

The following figure shows the evolution of the import unit value of unwrought titanium and titanium powders as a proxy for titanium sponge's baseline price. Titanium prices collapsed in mid-2020 in response to the aerospace manufacturing downturn. In 2021, prices had an upward trend with a 40% increase over the year, recovering partly the significant losses of 2020.

Figure 29 – Unit value based on EU imports of unwrought titanium and titanium powders, monthly trend 2006-2021[27]



Source: Data from Eurostat Comext (2022)

CONCLUDING REMARK

Russia has a significant share and a key role in the global market of titanium metal. The Russo-Ukrainian war has put titanium metal supply at risk and threatens access to titanium products used in the aerospace sector. The analysis shows that a forthcoming deficit in titanium sponge supply is not expected globally as non-Russian producers could ramp up their output. For the aerospace sector in particular, a potential supply disruption may not be critical in the short term, mainly due to high industry stocks and the low – but gradually recovering – demand from the downturn that the sector endured as a consequence of the pandemic. On the other hand, it is challenging to predict the medium-term impact of cutting ties with Russian supply of aerospace mill products.

[26] The Import value corresponds to the annual average of imports of titanium mill products (bars, rods, profiles, wire, plates, sheets, strip, foil, tubes and pipes) and other articles (e.g. castings) over 2019-2021 (aggregate of CN 81083000, CN 81089050, CN 81089060, CN 81089090).

[27] Unit value based on imports of CN 81082000 'Unwrought titanium; titanium powders'. Adjusted for inflation.

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