Before the
UNITED STATES DEPARTMENT OF COMMERCE

PETITION OF TITANIUM METALS CORPORATION UNDER SECTION 232 OF THE TRADE EXPANSION ACT OF 1962 FOR RELIEF FROM IMPORTS OF TITANIUM SPONGE THAT THREATEN NATIONAL SECURITY

Dated: September 27, 2018

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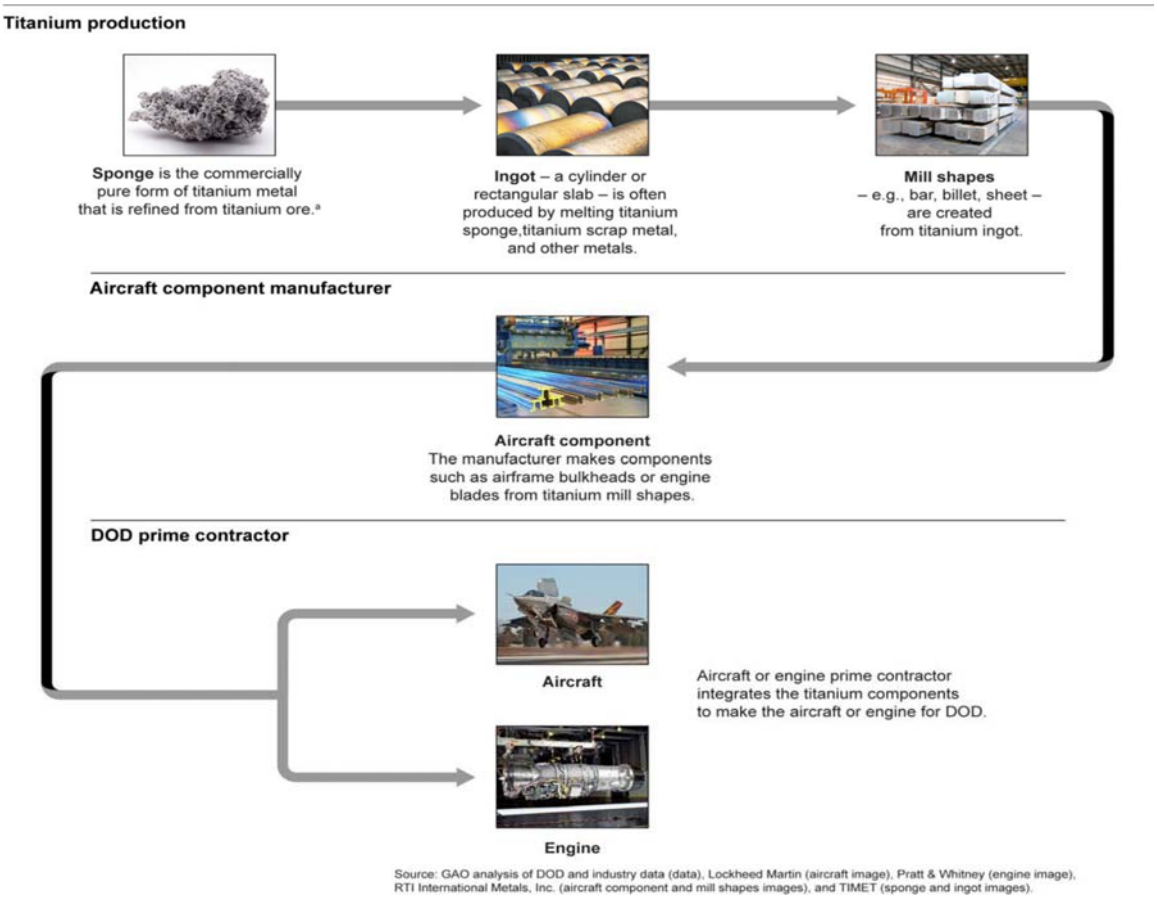
I. Executive Summary

The United States is in danger of losing its capability to produce a key strategic raw material: Titanium Sponge. Access to a secure supply of premium quality titanium sponge is required to support advanced weapons systems critical to national security and is part of the critical infrastructure that supports the civilian commercial aerospace industry. Military and commercial aircraft, the engines which propel these aircraft, helicopters, missiles, naval vessels, satellites, artillery, tanks and munitions all depend on critical components made from titanium sponge.



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[1] Source: Government Accountability Office, Factors Affecting U.S. Titanium Aircraft Component Manufacturers' Market Share of DOD Business, GAO-13-539 (July 2013) at Fig. 2. (See Exhibit 1).

Without a change to the current unsustainable economics afflicting the domestic titanium sponge industry, America's access to a secure supply of titanium sponge is at risk. One of two domestic titanium sponge plants ceased production in 2016. The last remaining domestic titanium sponge plant is Titanium Metal Corporation's ("TIMET") facility in Henderson, NV. Portions of the Henderson plant are approaching the end of their useful lives. As a result, the plant cannot continue operating without substantial near-term capital investments - investments that cannot be justified in a market distorted by a flood of low-priced imports. Closure of the Henderson plant would leave the U.S. defense and aerospace industries dependent on unreliable foreign sources for titanium sponge and could lead to dependence on Russia and China for this critical raw material.

Unrestrained Imports Will Eliminate the U.S. Titanium Sponge Industry

TIMET is an integrated producer of titanium metal products. TIMET, and all global producers of titanium sponge, use the Kroll Process to convert titanium ore into titanium sponge.

Titanium sponge is melted, usually in combination with scrap and alloying elements, to form ingots and slabs of titanium metal. The ingots and slabs are further processed by TIMET and other mills to produce titanium mill products such as plates, sheet, tubes, bars, *etc*., that are sold on the commercial market. Titanium mill products are used to produce titanium parts, principally for the defense and aerospace industries.

TIMET generally consumes all of the titanium sponge it produces, and supplements its own production by purchasing imported titanium sponge as needed. ***All of TIMET's U.S.***

competitors produce titanium mill products exclusively from low-priced imported titanium sponge.

TIMET's Henderson, Nevada plant is the last active producer of titanium sponge in the United States. In order to keep Henderson operating, TIMET will be required to make a substantial near-term investment in its sponge making facilities. However, this re-investment in Henderson is not economically justifiable given the availability of imported titanium sponge at current low prices. If TIMET's Henderson Plant closes, the United States will immediately become 100% dependent on titanium sponge from foreign suppliers located in geographically remote and/or geopolitically risky countries, *i.e.*, Japan, Kazakhstan, Russia, China and Ukraine.

In August 2017, TIMET filed an antidumping ("AD") and countervailing duty ("CVD") petition against titanium sponge imported from Japan and Kazakhstan, initially alleging dumping margins of 31% to 69%, and requesting the imposition of countervailing duties against imports from Kazakhstan to offset unlawful government subsidies. After a detailed review of TIMET's filing, the Department of Commerce (DOC) recommended revisions that resulted in even higher dumping margins: 69.7%-95.2% for Japan, and 42.2% for Kazakhstan. DOC also found credible evidence of unlawful subsidies provided by the Government of Kazakhstan.

The AD and CVD investigations were terminated on October 5, 2017, when the United States International Trade Commission (ITC) issued a negative injury determination based on its finding that TIMET's captive production of titanium sponge does not compete directly with imported titanium sponge sold on the commercial market. According to the ITC, the fact that TIMET might be forced to substitute imports for its own domestic production of titanium sponge in order to remain competitive with import-reliant titanium mill product producers was not

pertinent to the ITC's injury analysis. TIMET strongly disagrees with this rationale. Nevertheless, as a result of the ITC's determination not to grant relief under the AD and CVD laws, TIMET's operation and continued investment in its domestic titanium sponge plant is economically unjustifiable under current conditions.

TIMET's strong preference is to restore economic rationality to domestic production of titanium sponge rather than make TIMET and the United States totally dependent on potentially unreliable foreign sources for titanium sponge.

Titanium Sponge Production Is a Critical Bottleneck in the Defense Supply Chain

On December 20, 2017, the President of the United States issued Executive Order 13817, finding that the United States' dependency on foreign sources for critical minerals creates a strategic vulnerability, exposing the economy and military of the United States to adverse foreign government action, natural disaster, and other events that could disrupt supply of key minerals. The Presidential order further directed the Secretary of the Interior to compile a list of such critical minerals and develop a strategy for reducing the United States' dependency on foreign sources for such materials. On February 16, 2018, the United States Department of the Interior, United States Geological Survey ("USGS"), issued notice of its Draft List of Critical Minerals.[2] The List of Critical Materials was made final in a notice published on May 18, 2018, 83 Fed. Reg. 23295. Titanium ore was included on the List of Critical Materials due to its use in critical applications in the defense, civilian aerospace and energy industries.

[2] See Exhibit 2, Draft Critical Mineral List—Summary of Methodology and Background Information—U.S. Geological Survey Technical Input Document in Response to Secretarial Order No. 3359.

Efforts to correct America's acknowledged dependence on foreign sources for titanium ore will, of course, be pointless if TIMET is forced to close the last plant in the United States capable of extracting titanium metal from titanium ore.

TIMET's Henderson Plant, with the capacity to produce approximately 13,000 metric tons (MT) of titanium sponge per year, is capable of supplying 100% of current U.S. military requirements, estimated by TIMET to be 4000-5000 MT per year. Without TIMET's Henderson Plant, the U.S. military will be 100% reliant upon titanium sponge from geographically and/or geopolitically risky countries, namely Japan, Kazakhstan, Russia, China and Ukraine.

In 2017, an estimated 80% of titanium metal consumed in the United States was used in aerospace applications; the remaining 20% was used in armor, chemical processing, marine hardware, medical implants, power generation, and consumer and other applications.[3] U.S. sponge consumption was 26,600 MT in 2013. In 2017, U.S. titanium sponge consumption has grown to 37,000 MT, an increase of nearly 40% in only four years' time.[4] Despite this strong growth in consumption, U.S. titanium sponge production is collapsing. Allegheny Technologies Inc. ("ATI") suspended production of titanium sponge at its 11,000 MT Rowley, Utah plant in 2016.

The current economic threat to domestic titanium sponge production is a critical vulnerability in America's titanium supply chain. Without the capacity to convert titanium ore to titanium metal, the United States defense, civilian aerospace and energy industries will become totally dependent for titanium metal on the handful of foreign countries that retain the capacity to produce titanium sponge.

[3] USGS Mineral Commodity Survey 2018 at 174. See Exhibit 3.
[4] *Id.*

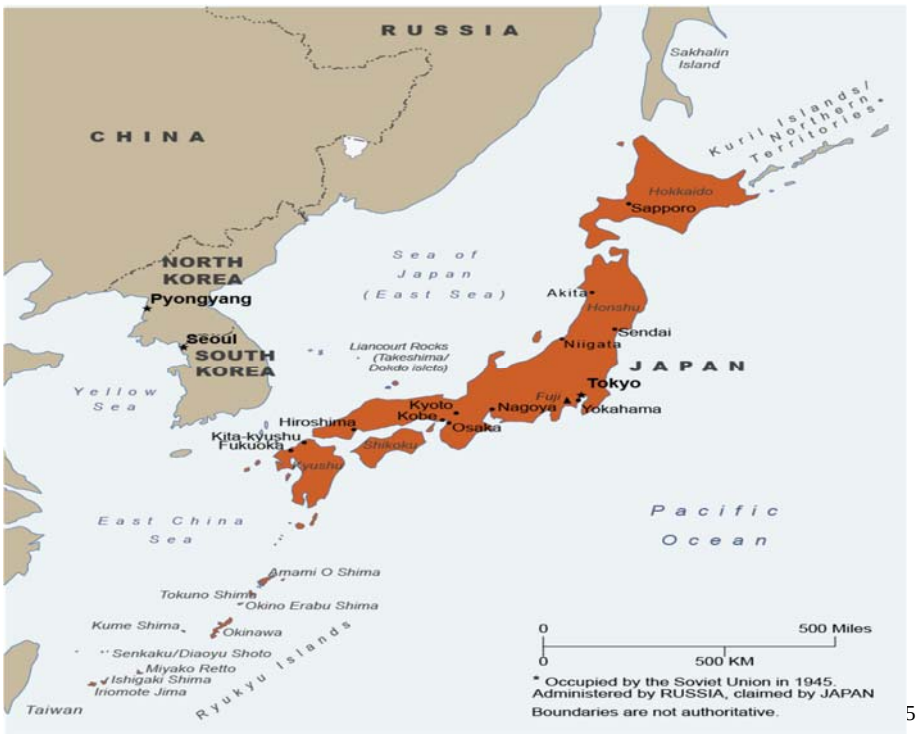
Other than TIMET, significant global sponge producers are: PSC VSMPO-Avisma Corporation ("VSMPO") in Russia; Ust-Kamenogorsk Titanium and Magnesium Plant JSC ("UKTMP") in Kazakhstan; and Zaporozhye Titanium & Magnesium Combine ("ZTMC") in Ukraine. Japan has two titanium sponge producers: Toho Titanium Company, Ltd. ("TOHO") and Osaka Titanium Company ("OTC"). China has a mix of 8-10 state-owned and independent companies, the largest being the state-controlled firm Baoji Titanium Industry Co., Ltd. ("BAOTI"). Only TIMET, VSMPO, TOHO and OTC are universally certified to produce premium grade titanium sponge for rotating parts.

Among these countries, only Japan can fairly be called a reliable political ally. But, titanium sponge production in Japan is economically vulnerable because its free-market producers are subject to the same economic forces as TIMET. Losses incurred by OTC and TOHO over the past few years indicate that the current economic conditions afflicting the titanium sponge market will discourage them from making the capital investments needed to remain reliable suppliers of titanium sponge. These developments could eventually leave the United States dependent on Russia, China, Ukraine and Kazakhstan for titanium sponge.

Making the United States dependent on Russia, China, Kazakhstan and Ukraine for a critical element like titanium metal will increase the risk that those governments will use titanium as a political bargaining chip, in the manner that Russia has exploited Western Europe's dependence on Russia for natural gas.

All of the world's foreign titanium sponge producers (including Japan) are geographically remote from the United States, making the titanium supply chain vulnerable to disruption from both political turmoil and natural disasters. Finally, in the event of military

hostilities, none of these remote foreign producers can be counted on to maintain shipments of titanium sponge to the United States. Russia, China, Ukraine and Kazakhstan are unlikely to support the United States in any military action. Japan, despite its political reliability, is particularly vulnerable to disruptions caused by an armed conflict. Japan sits across a narrow sea from China, North Korea and Russia.



[5]

In its 2017 report on the North Korean Nuclear Challenge, the Congressional Research Service ("CRS") observed that "any move involving military forces by either the United States/Republic of Korea (U.S./ROK) or the DPRK might provoke an escalation of conflict that could have catastrophic consequences for the Korean Peninsula, Japan, and the East Asia region."[6]

[5] CRS: The U.S.-Japan Alliance (2016) at Fig. 1. See Exhibit 4.
[6] CRS: The North Korean Nuclear Challenge: Military Options and Issues for Congress (November 6, 2017), Summary. See Exhibit 5.

A significant disruption in deliveries of titanium sponge for any reason would quickly have major economic consequences for the United States defense, aerospace and energy industries. The Defense Logistics Agency ("DLA") sold off the last remnants of its strategic stockpile of titanium sponge in 2005.[7] Under just-in-time delivery practices currently prevailing among U.S. titanium sponge consumers, the United States will exhaust its on-hand supplies of titanium sponge within 90 to 120 days after new shipments from foreign suppliers are stopped for any reason.

America's reliance on foreign suppliers for titanium sponge is even more tenuous with respect to titanium sponge that is certified for use in the most demanding applications, *i.e.*, rotating parts for jet engines and some critical aerospace structural applications. Among current titanium sponge producers, only TIMET, Russia's VSMPO and the Japanese producers, OTC and TOHO, are universally certified for the production of titanium sponge used in rotating parts for jet engines. If TIMET's Henderson plant closes, and imports of rotating quality titanium sponge are disrupted for any reason, it will take at least several years to restart a U.S. sponge plant and achieve the necessary production standards to certify its output for use in rotating parts for jet engines for military and/or civilian use.

An Economic Solution for the Strategic Threat to America's Titanium Supply Chain

At the end of 2016, ATI closed a newly-built titanium sponge production facility in Rowley, Utah, because imports were available for at least a five-year period at a delivered, duty-paid price that was more than 15% below ATI's variable cost to produce titanium sponge in its

[7] The shortcomings of stockpiling as a solution to potential shortages of titanium sponge are discussed *infra*.

Rowley, UT facility.[8] As a result of the Rowley closure, ATI incurred charges of roughly half a billion dollars.[9] ATI closed its Rowley plant because it could not justify a $150 million investment in chlorination and/or titanium tetrachloride production to create a closed-loop production process like that at TIMET's Henderson sponge plant.[10] Instead, ATI chose "to pursue idling Rowley due to the availability of long-term supply commitments at globally competitive prices… ."[11]

Imports of titanium sponge have continued to surge as prices for imported titanium sponge have declined. Volume and pricing trends on sponge imported from Japan into the U.S. over the past five years illustrate the problem.[12]

Titanium Sponge (HTS: 8108.20.0010)
Imports from Japan (2013-2017)

Japan	2013	2014	2015	2016	2017
Quantity (kg)	13,414,795	13,320,789	15,487,583	15,848,926	19,169,243
% of reported total imports (kg)	70%	78%	86%	98%	89%
Value (CIF, USD)	168,674,383	157,902,666	164,642,273	147,921,118	179,573,370
AUV (USD/kg)	12.57	11.85	10.63	9.33	9.37

Source: ITC Dataweb

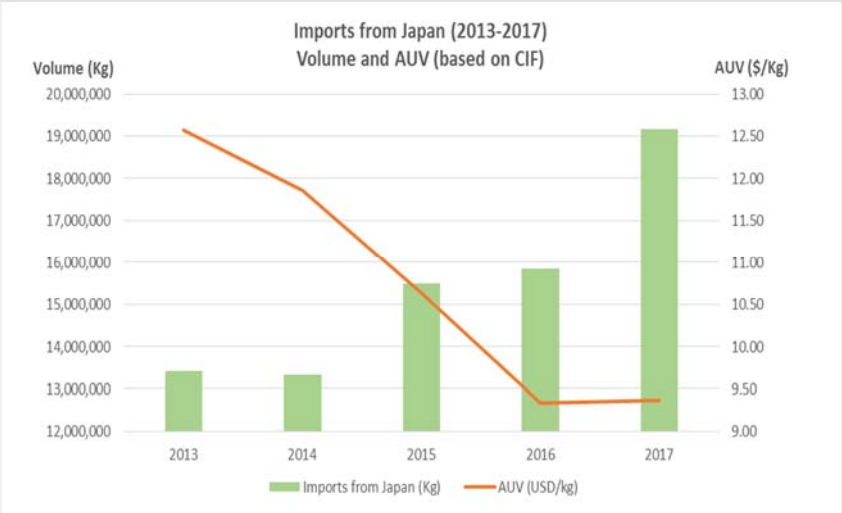
[8] See Exhibit 7, Complaint in *US Magnesium, LLC v. ATI Titanium, LLC, et al*., Case No. 2:16-CV-1158 TS (US District Court for the District of Utah) at ¶¶ 15-22 and Exhibit A to the Complaint, "Supply and Operating Agreement" at § 11.2.

[9] See United States Securities Exchange Commission, Allegheny Technologies Incorporated, Form 8-K (August 24, 2016.).

[10] *Titanium Sponge from Japan and Kazakhstan*, Inv. Nos. 701-TA-587, 731-TA-1385-1386 (Preliminary), Staff Conference Transcript at 147-148, 180. https://www.usitc.gov/trade_remedy/731_ad_701_cvd/investigations/2017/Titanium%20Sponge%20from%20Japan%20and%20Kazakhstan/Preliminary/titanium_sponge_from_japan_and_kazakhstan-conference-09-14-2017.pdf

[11] *Id.*, Staff Conference Transcript at 110.

[12] We have used imports from Japan, which represent the majority of imported sponge into the US. We excluded Kazakhstan from the data because import quantities from that country were not available from the ITC's database.



During the past five years, Japan and Kazakhstan accounted for 70% to 98% of imports into the U.S. The price from Japan has declined by more than 26% from 2013 to 2017. Imports from Kazakhstan are also increasing considerably as a result of the ATI Rowley closure.

TIMET, as the last American titanium sponge producer, is subject to the same extraordinary financial pressure from unfairly priced imports that led to the idling of ATI's Rowley plant. TIMET is facing a painful "make/buy" decision forced upon it in a market distorted by a surge in low-priced imports of titanium sponge.

TIMET believes America's titanium sponge industry can be put on sound economic footing again by restoring prices for titanium sponge to 2013 levels, which were about 30% above current levels. Those price levels allowed TIMET and ATI, as well as Japanese producers, to operate their titanium sponge plants at a sustainable cost that encouraged reinvestment in the titanium sponge industry. A combination of bilateral agreements, tariffs and quotas can achieve sustainable economics.

TIMET estimates that raising current price levels by at least 30% would increase the current costs for imported titanium sponge by an aggregate of approximately $64 million annually. According to a 2017 report generated by the Aerospace Industries Association, the United States aerospace and defense sector, which requires a reliable source of titanium metal to maintain their operations, generates $872 billion in annual sales in the United States.[13] Thus, the cost of maintaining a secure domestic source for titanium metal would amount to only 0.007% of total aerospace and defense sales in the United States. Such a minimal increase in titanium costs is a small price to pay to insure that the United States aerospace and defense sector will always have reliable access to titanium metal in times of natural, political and/or military disruptions affecting the titanium supply chain.

Importantly, the restoration of stable economic conditions in the titanium sponge industry will encourage private parties to reinvest in the titanium sponge industry. In this way, a secure domestic supply chain for titanium sponge will be preserved at minimal cost to the United States aerospace and defense sectors.

[13] Aerospace Industries Association, 2017 FACTS & FIGURES: U.S. AEROSPACE & DEFENSE at 3. See Exhibit 6.

II. Request for Relief; Product Scope; Legal Standard

TIMET requests that the Secretary of Commerce initiate an investigation under section 232 of the Trade Expansion Act of 1962, *as amended*, 19 U.S.C. §1862 ("Section 232"), regarding the effect of imports of titanium sponge on the national security of the United States.

Titanium sponge is currently classified under subheading 8108.20.0010 of the Harmonized Tariff Schedules of the United States (HTSUS). Expressly excluded from the scope of this investigation is ultra-high purity sodium-reduced titanium sponge.[14]

Legal Standard

In its recent investigation of the Effect of Imports of Steel on the National Security (January 2018), the Department of Commerce summarized the legal standard applicable to investigations under Section 232. The Report stated that Section 232 authorizes the Secretary to conduct investigations to determine the effect that imports of any article may have on the national security of the United States. The Secretary will conduct an investigation if requested by the head of any department or agency, upon application of an interested party, or upon the Secretary's own initiative. See 19 U.S.C. § 1862(b)(1)(A).

Section 232 requires the Secretary to advise the President if any article "is being imported into the United States in such quantities or under such circumstances as to threaten to impair the national security." See 19 U.S.C. § 1862(b)(3)(A). The Secretary is also directed to submit a report to the President with recommendations for "action or inaction under this section." *Id.*

[14] See Exhibit 9.

Section 232(d) directs the Secretary and the President to give consideration to the domestic production needed for projected national defense requirements and the capacity of the United States to meet national security requirements. See 19 U.S.C. § 1862(d).

Section 232(d) also directs the Secretary and the President to "recognize the close relation of the economic welfare of the Nation to our national security, and …take into consideration the impact of foreign competition on the economic welfare of individual domestic industries" by examining whether any substantial unemployment, decrease in revenues of government, loss of skills or investment, or other serious effects resulting from the displacement of any domestic products by excessive imports, or other factors, result in a "weakening of our internal economy" that may impair the national security. See 19 U.S.C. § 1862(d).

Section 232 does not contain a definition of "national security." But, Section 232 does contain a non-exclusive recitation of factors that Commerce and the President should consider in evaluating the effect of imports on the national security. The Act directs the Secretary of Commerce and the President to:

> …give consideration to domestic production needed for projected national defense requirements, the capacity of domestic industries to meet such requirements, existing and anticipated availabilities of the human resources, products, raw materials, and other supplies and services essential to the national defense, the requirements of growth of such industries and such supplies and services including the investment, exploration, and development necessary to assure such growth, and the importation of goods in terms of their quantities, availabilities, character, and use as those affect such industries and the capacity of the United States to meet national security requirements. In the administration of this section, the Secretary and the President shall further recognize the close relation of the economic welfare of the Nation to our national security, and shall take into consideration the impact of foreign competition on the economic welfare of individual domestic industries; and any substantial unemployment, decrease in revenues of government, loss of skills or investment, or other serious effects

> resulting from the displacement of any domestic products by excessive imports shall be considered, without excluding other factors, in determining whether such weakening of our internal economy may impair the national security.

Section 704 of the Commerce Department's regulations, 15 C.F.R. §704, describes the relevant inquiry under Section 232:

> **(a)** To determine the effect on the national security of the imports of the article under investigation, the Department shall consider the quantity of the article in question or other circumstances related to its import. With regard for the requirements of national security, the Department shall also consider the following:
>
> > **(1)** Domestic production needed for projected national defense requirements;
> >
> > **(2)** The capacity of domestic industries to meet projected national defense requirements;
> >
> > **(3)** The existing and anticipated availabilities of human resources, products, raw materials, production equipment and facilities, and other supplies and services essential to the national defense;
> >
> > **(4)** The growth requirements of domestic industries to meet national defense requirements and the supplies and services including the investment, exploration and development necessary to assure such growth; and
> >
> > **(5)** Any other relevant factors.
>
> **(b)** In recognition of the close relation between the strength of our national economy and the capacity of the United States to meet national security requirements, the Department shall also, with regard for the quantity, availability, character and uses of the imported article under investigation, consider the following:
>
> > **(1)** The impact of foreign competition on the economic welfare of any domestic industry essential to our national security;
> >
> > **(2)** The displacement of any domestic products causing substantial unemployment, decrease in the revenues of government, loss of investment or specialized skills and productive capacity, or other serious effects; and

(3) Any other relevant factors that are causing or will cause a weakening of our national economy.

III. The Titanium Sponge Industry

a. Titanium

Titanium (chemical symbol "Ti"; Atomic Number 22) is the ninth-most abundant element in the earth's crust and fourth-most abundant structural metal, behind aluminum, iron and magnesium. The USGS estimates that 98% of igneous rocks and derived sediments contain titanium. However, titanium does not exist naturally in a pure form and is always bonded to other elements. The extraction of titanium metal from these other elements is a technically challenging and expensive process. Only ilmenite and rutile forms of titanium ore have economic importance and they are difficult to find in high concentrations.

Titanium sponge is the basic form of titanium metal that results from the chemical reduction of titanium-bearing ores and slag. Titanium sponge is the primary form of titanium metal from which virtually all other titanium metal products are made.

While metallic titanium was identified and isolated more than a hundred years ago, it was not commercialized until the 1950's when titanium proved advantageous for use in aerospace applications. Titanium metal is particularly valued for its high strength to weight ratio, resistance to corrosion and, more recently, for its ability to bond with high strength polymers. These characteristics have made titanium an essential material in the production of strategic military articles such as military aircraft (especially in stealth aircraft), space vehicles, satellites, naval vessels and munitions. Titanium is also widely used in commercial applications such as civilian aircraft, chemical plants, oil and gas plants, power plants, desalination plants, building

structures, automotive products, bio-medical devices, jewelry, eyeglass frames, golf clubs, bicycles, etc.

b. Titanium Sponge

1. Feedstock

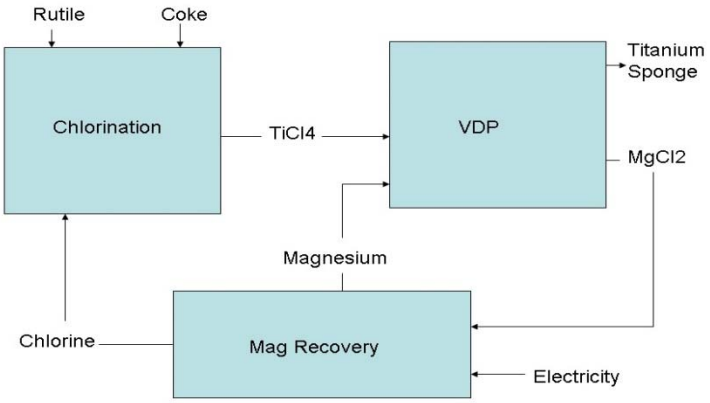
The most significant drivers of the variable cost to produce titanium sponge are labor, energy and titanium feedstocks. Principal forms of titanium feedstock utilized in sponge manufacture are rutile, ilmenite, slag and synthetic rutile.[15] The commercial forms of titanium ore are rutile (titanium dioxide) and ilmenite (titanium-iron oxide). Ilmenite may be chemically upgraded to produce "synthetic rutile" containing a higher percentage of titanium metal than naturally occurring ilmenite ore. Titanium metal may also be recovered from upgraded slag.

In recent years, TIMET has utilized rutile ore, primarily from Australia, South Africa and Ukraine, to produce titanium sponge. TIMET has also utilized upgraded slag (a form of ilmenite) from Canada. TIMET's supply pattern is based upon economic preference. However, in the event imported sources were not available, TIMET could rely exclusively on titanium ore mined in the United States and Canada.

[15] See Exhibit 21.

2. Titanium Sponge Production

All of the world's major producers[16] of titanium sponge use the Kroll Process[17] to extract titanium metal from titanium ore or slag. First, titanium ore (rutile or ilmenite) is combined with chlorine and coke to produce titanium tetrachloride. Then, the titanium tetrachloride (TiCl4) is reduced by reacting it with magnesium in a steel vessel. The steel vessel is welded shut and heated to 1200 °C. This vacuum distillation process produces magnesium chloride and a large mass of metal consisting of titanium sponge. The magnesium chloride is electrolytically separated, allowing the chlorine and magnesium to be reused in the titanium extraction process. This closed loop manufacturing process, which allows for the recovery and reuse of essential materials, is critical to the economic viability of the titanium sponge manufacturing process.

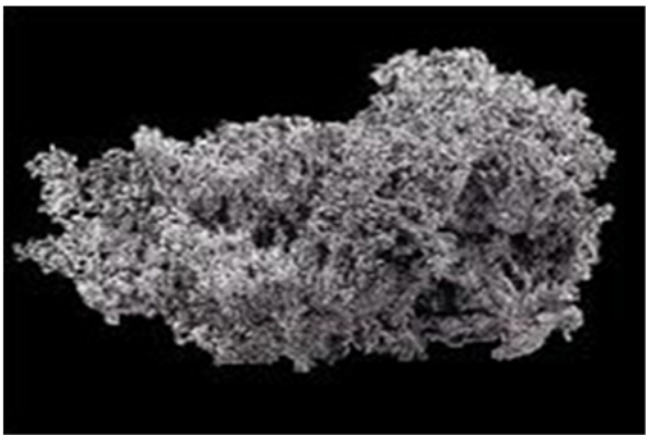


[16] Honeywell Electronic Materials produces ultra-high purity crystalline titanium sponge at a facility in Salt Lake City, Utah, using a sodium reduction process. Honeywell's titanium sponge is used principally in the manufacture of semiconductors rather than titanium metal products. See Exhibit 9.

[17] Despite many initiatives on the part of companies and governments, an effective replacement for the Kroll Process has yet to be implemented beyond large research/pilot plants. For a discussion of alternatives to the Kroll Process, see Exhibit 8.

The large mass of titanium sponge is crushed into smaller particles, sorted, tested and graded before being packed into steel drums for storage and delivery to customers.

Titanium Sponge Particle



Because titanium sponge can degrade and, potentially, explode if exposed to oxygen, the drums containing titanium sponge are infused with argon gas to prevent the titanium sponge from reacting with oxygen in the atmosphere. Despite the use of argon gas to minimize exposure to oxygen, titanium sponge does degrade over time, rendering stockpiled sponge unsuitable for use in the most demanding applications (e.g., rotating parts for jet engines), which require the use of certified, premium quality titanium sponge.

3. Certification of Titanium Sponge

There are two major grades of titanium sponge: 1) premium-quality ("PQ") and 2) standard-quality ("SQ") sponge. PQ sponge is used in rotating engine parts for the aerospace industry. Manufacturers of rotating engine parts and aircraft engines, such as Pratt & Whitney, General Electric (GE), Rolls Royce, and Safran, as well as the original equipment manufacturers (OEMs) that assemble aircraft, (e.g. Airbus and Boeing), require that PQ titanium sponge producers complete a certification process to demonstrate they have sufficiently strict quality

control systems in place to ensure that their product is free of dangerous technical flaws.[18] In addition to having a premium quality certification, PQ sponge may differ from SQ titanium sponge by having lower quantities of trace elements that make up its chemical composition.

It can take several years for a titanium sponge producer to achieve certification to produce premium-quality titanium sponge used in rotating engine parts. ATI's Rowley plant, which began production in 2009, did not achieve PQ certification until 2015.[19]

Standard grade titanium sponge is used in airframes and non-rotating parts of aircraft engines, and in non-aerospace industrial applications such as equipment for desalination, nuclear power plants, chemical processing equipment, medical implants, and other products.[20]

At this time, only four companies in the world are certified to produce premium grade titanium sponge for use in rotating parts of jet engines: TIMET in the United States; the Russian producer, VSMPO-Avisma; and the two Japanese producers, Toho and OTC. Titanium sponge producers in Kazakhstan, Ukraine, India and China are not certified as producers of premium grade titanium sponge.

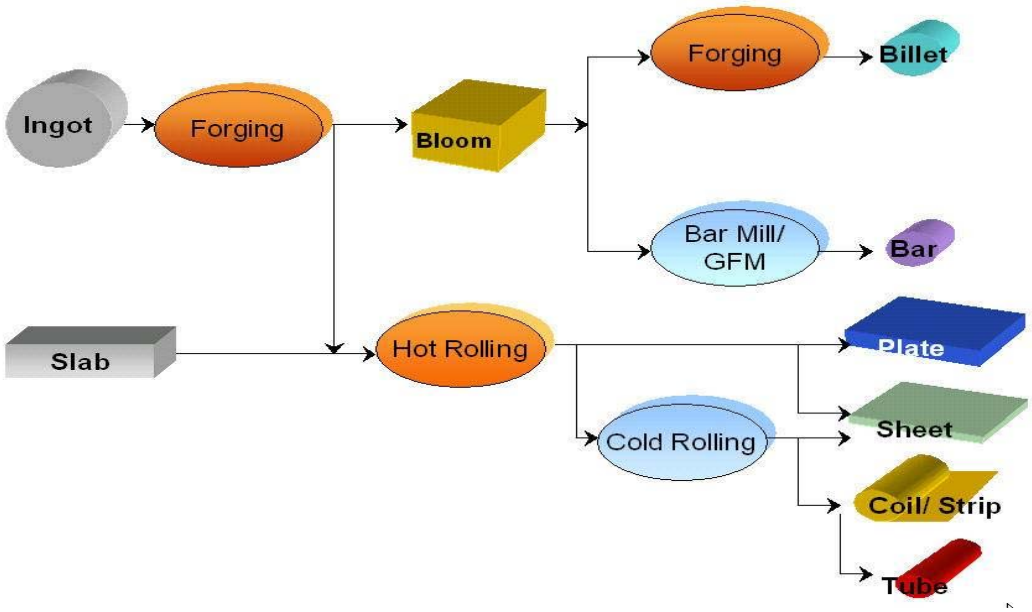
c. Melting Titanium Sponge & Conversion to Mill Products

Two melting processes can be used to convert titanium sponge into titanium ingots: 1) a vacuum arc remelt (VAR) process; or 2) a hearth melting process. In either case, the resulting molten titanium metal is cast into shapes referred to as ingots or slabs.

As ingots and slabs cool, they develop long columnar crystals. These long crystals are undesirable because they weaken the metal. To mitigate this problem, titanium ingots and slabs

[18] *Titanium Sponge from Japan and Kazakhstan*, Inv. Nos. 701-TA-587, 731-TA-1385-1386 (Preliminary) USITC Pub. 4736 (October 2017) at I-7-8 (footnotes omitted).
[19] See Exhibit 24.
[20] Id.

almost always undergo forging or rolling processes that refine the grain structure to achieve greater strength, in effect recrystallizing the metal by breaking up the long crystals.



d. Global Titanium Sponge Producers

The market for titanium sponge is global in nature. But only a handful of countries and companies are involved in the titanium sponge market as feedstock suppliers, titanium sponge producers, and/or melters who convert titanium sponge into titanium mill products. Hundreds of companies around the world buy titanium mill products for conversion into myriad articles of titanium.

According to the USGS, only five countries outside the United States are significant producers of titanium sponge:

Country	2017 Production (MT)	2017 Capacity
United States	Withheld	13,100
China	60,000	110,000
india	500	500
Japan	48,000	68,800
Kazakhstan	9,000	26,000
Russia	40,000	46,500
Ukraine	8,000	12,000
Total	165,550	276,900

[21]

The principal companies producing titanium sponge in former Soviet states are: PSC VSMPO-Avisma Corporation ("VSMPO") in Russia; Ust-Kamenogorsk Titanium and Magnesium Plant JSC ("UKTMP") in Kazakhstan; and Zaporozhye Titanium & Magnesium Combine ("ZTMC") in Ukraine. Japan has two sponge producers: Toho titanium Company, Ltd. ("TOHO") and Osaka Titanium Company ("OTC"). Only TIMET, VSMPO, TOHO and OTC are universally certified to produce premium grade titanium sponge for rotating parts.

China has about ten companies that dominate production of titanium sponge, but, according to China's largest producer, Baoji Titanium Industry Co., Ltd ("BAOTI"), only four of those are certified for the production of non-rotating aerospace grade titanium for the Chinese market.[22] None of the Chinese producers are certified to produce rotating grade titanium sponge.

In addition to selling titanium sponge, VSMPO, UKTMP, TOHO and OTC, as well as some Chinese companies, melt titanium sponge to produce ingots and/or slabs, *i.e.*, melted

[21] Source: USGS Mineral Commodity Survey 2018. See Exhibit 3.
[22] See Exhibit 10.

products. Melted Products are an essential intermediate step between titanium sponge and titanium mill products.

Business Confidential Exhibit 14-A sets forth TIMET's internal estimates of the capabilities of each of the world's titanium sponge producers.

IV. State of the Domestic Titanium Sponge Industry

Despite strong U.S. demand for titanium metal, America's titanium sponge industry is shrinking and now faces the imminent prospect of a complete shutdown due to a flood of low-priced imports. There is vastly more foreign capacity to produce titanium sponge than the U.S. market can possibly absorb. As a result, even captive producers of titanium sponge like ATI's Rowley plant and TIMET's Henderson plant have seen their production curtailed. Surging imports have impaired the value of the U.S. industry's productive assets and discouraged the investment needed to maintain U.S. production of titanium sponge.

Without a change to the current unsustainable economics afflicting the titanium sponge industry, America's access to a secure supply of titanium sponge is at risk. One of two domestic titanium sponge plants ceased production in 2016. The last remaining domestic titanium sponge plant in Henderson, NV, cannot continue operating without a substantial near term capital investment that cannot be economically justified in a market distorted by a surge in low-priced imports.

Defense and commercial aerospace account for approximately 80% of US titanium demand. The health of these industries is critical to the national security of the United States. Closure of the Henderson plant would leave the U.S. defense and commercial aerospace industries 100% dependent on foreign sources and could lead to dependence on Russia and

China for this critical raw material. The viability of these industries should not be placed at risk by excessive reliance on imported titanium sponge.

a. Consumption Trends

Demand for titanium sponge in the United States market has been strong for several years, with consumption rising from 26,500 MT in 2013 to 37,000 MT in 2017.[23] Strong titanium sponge demand has not, however, prevented the displacement of American production. The high volume of low-priced titanium sponge imports has overwhelmed even the strongest titanium demand. U.S. titanium sponge prices have declined by nearly 25% since 2013 despite what, in historical terms, is a period of strong demand for titanium in the United States.

b. Production Trends

In 2009, the RAND Corporation published a study sponsored by the United States Air Force entitled "Titanium: Industrial Base, Price Trends, and Technology Initiatives."[24] At the time, the Air Force was concerned about a rapid increase in titanium prices. The RAND Report began:

> Titanium is an important raw material that accounts for a significant portion of the structural weight of many military airframes. It offers an excellent set of properties, such as high strength-to-weight ratio, high strength at high temperatures, corrosion resistance, and thermal stability, that make it ideal for airframe structures. However, in recent years a combination of multiple factors caused a major spike in titanium prices that is expected to significantly influence the acquisition costs of future military aircraft.[25]

RAND Corp reported that in response to the rapid surge in titanium prices during the 2003-2007 time period, domestic producers TIMET, ATI and RTI (now Arconic) all planned significant

[23] See Exhibit 3.
[24] https://www.rand.org/content/dam/rand/pubs/monographs/2009/RAND_MG789.pdf
[25] Id. at iii.

expansion of their capacity to produce titanium sponge.[26] These plans to expand domestic titanium sponge capacity were completely frustrated by foreign capacity expansions.

1. RTI/Arconic's Aborted Titanium Sponge Plant

In 2007, RTI International Metals Inc. (now part of Arconic) announced plans to build a $300 million titanium sponge plant in Mississippi. In 2009, RTI abandoned the Mississippi project in favor of long-term agreements to buy titanium sponge from Japanese producers TOHO and OTC.[27]

2. ATI Closures of Titanium Sponge Plants

ATI restarted a previously-idled titanium sponge plant in Albany, Oregon, in 2006. By 2009, ATI had suspended production at Albany. At the beginning of 2016, ATI announced that the suspension of titanium sponge production at its Albany, Oregon plant was permanent.

In 2009, ATI began producing titanium sponge at a brand new facility in Rowley, Utah, that cost nearly $500 million to build. Six years later, in 2015, ATI announced that it had finally achieved certification to produce premium quality titanium sponge for use in the production of rotating parts for jet engines.[28] Little more than a year later, at the end of 2016, ATI stopped production at its newly-built titanium sponge production facility in Rowley, Utah, in favor of using imports that were available at a delivered, duty-paid price that was more than 15% below ATI's variable cost to produce titanium sponge in its Rowley facility.[29]

[26] Id. at 74-75.
[27] See Exhibit 23.
[28] See Exhibit 24.
[29] See Exhibit 7, Complaint in *US Magnesium, LLC v. ATI Titanium, LLC, et al*., Case No. 2:16-CV-1158 TS (US District Court for the District of Utah) at ¶¶ 15-22 and Exhibit A to the Complaint, "Supply and Operating Agreement" at § 11.2.

When ATI announced it was suspending production of titanium sponge at its Rowley, Utah plant, ATI stated that it "has entered into long-term, cost competitive supply agreements with several leading global producers of premium-grade and standard-grade titanium sponge. The lower cost titanium sponge purchased under these supply agreements will replace the titanium sponge produced at ATI's Rowley facility."[30] ATI further reported that: "As a result of these actions, ATI expects to record total pre-tax, non-cash impairment charges of approximately $470 million for idled facilities…, and pre-tax shutdown and idling costs of approximately $34 million… ."[31]

3. TIMET: America's Last Titanium Sponge Producer

With the closure of ATI's Rowley plant, TIMET's Henderson, Nevada plant is America's last remaining producer of titanium sponge. TIMET employs about 500 skilled workers in Henderson. TIMET's Henderson Plant has the capacity to produce approximately 13,000 MT of titanium sponge per year. TIMET's capacity utilization rate has fallen from near 100% to about 80% over the past three years.

TIMET is currently capable of supplying 100% of U.S. military requirements for titanium metal, estimated by TIMET to be 4000-5000 MT per year. Without TIMET's Henderson Plant, the U.S. military will be 100% reliant upon titanium sponge from foreign sources.

In order to keep Henderson operating, TIMET will be required to make a substantial near term capital investment in portions of its sponge making facilities that are approaching the end of their useful lives. However, this re-investment in Henderson is not economically justifiable

[30] United States Securities Exchange Commission, *Allegheny Technologies Incorporated*, Form 8-K (August 24, 2016.).
[31] *Id.*

given the availability of imported titanium sponge at current low prices. If TIMET's Henderson Plant closes, the United States will immediately become 100% dependent on titanium sponge from foreign suppliers

c. Regulatory Environment Encourages Reliance on Imported Titanium Sponge

At present, there are no meaningful barriers to the use of imported titanium sponge in America's defense and aerospace supply chains.

1. TIMET's Antidumping and Countervailing Duty Petition

In August 2017, TIMET filed an antidumping ("AD") and countervailing duty ("CVD") petition against titanium sponge imported from Japan and Kazakhstan, alleging dumping margins of 31% to 69%, and requesting the imposition of countervailing duties against imports from Kazakhstan to offset unlawful government subsidies. After a detailed review of TIMET's filing, the Department of Commerce (DOC) estimated higher dumping margins (69.7%-95.2% for Japan and 42.2% for Kazakhstan). DOC also found credible evidence of unlawful subsidies provided by the Government of Kazakhstan.

The AD and CVD investigations were terminated on October 5, 2017, when the International Trade Commission (ITC) issued a negative injury determination based on its finding that TIMET's captive production of titanium sponge does not compete directly with imported titanium sponge sold on the commercial market. According to the ITC, the fact that TIMET might be forced to substitute dumped and subsidized imports for its own domestic production of titanium sponge in order to remain competitive with other import-dependent titanium mill product producers was not pertinent to the ITC's injury analysis. As a result of the ITC's determination, imports of titanium sponge are effectively exempt from special

antidumping and countervailing duties because TIMET internally consumes the titanium sponge it produces in the United States.

2. Drawback of Customs Duties

Titanium sponge is currently classified under subheading 8108.20.0010 of the Harmonized Tariff Schedules of the United States (HTSUS). The current duty rate for imported titanium sponge is 15% *ad valorem*. However, the drawback regulations administered by United States Customs and Border Protection ("CBP") significantly reduce the actual amount of customs duties paid by importers of titanium sponge because a substantial volume of titanium articles produced in the United States are later exported. Customs regulations, 19 C.F.R. Part 191, allow importers to drawback of up to 99% of the duties paid on imported titanium if the titanium sponge is consumed in the manufacture of articles exported from the United States.[32] Importers may also avoid assessments of regular customs duties through the use of temporary importation bonds.

3. Titanium Sponge Is Exempt from Specialty Metals Law

The Specialty Metals Law, 10 U.S.C. § 2533b, prohibits the Department of Defense ("DoD") from acquiring certain defense articles if they contain specialty metal that is "not melted or produced in the United States." The covered defense articles are military aircraft, missiles, spacecraft, ships, tanks, weapons, and ammunition. Specialty metals covered by the provision include nickel, cobalt, titanium, zirconium and stainless steel.

[32] See Exhibit 16 for a complete discussion of the drawback regulations work with regard to imported titanium sponge.

DoD may purchase defense articles containing titanium parts derived from imported titanium sponge because imported titanium sponge is melted in the United States after importation. Thus, the Specialty Metals Law has promoted the development of America's downstream titanium mill products industry but left the United States titanium sponge industry unprotected from foreign competition.

d. TIMET's Make or Buy Dilemma

TIMET internally consumes virtually all of the titanium sponge it produces. However, TIMET is not immune from the effects of low priced imports. TIMET must compete with titanium mill product producers who have access to low priced imports of titanium sponge. In order to remain competitive in the mill products market, TIMET's titanium sponge costs must be comparable to what its competitors are paying for imported titanium sponge. If TIMET can acquire imported titanium sponge at the same prices paid by its competitors, and that price is lower than TIMET's cost to produce titanium sponge, TIMET will be forced to substitute imported titanium sponge for its own domestic production, just as ATI and RTI have done.

In an internal White Paper dated March 21, 2016, TIMET analyzed its options for addressing the need to replace and modernize the chlorination facility used in TIMET's production of titanium sponge.[33] After considering various options, including the termination of titanium sponge production, TIMET initially opted to build a new chlorination unit at a cost in excess of $100 million. However, the facts underlying TIMET's analysis, including the prices for imported titanium sponge and the expected return on investment, have continued to deteriorate since early 2016, making it impossible to justify the capital investment needed to

[33] See Exhibit 18.

sustain production of titanium sponge in the United States in the face of massive imports of unfairly priced titanium sponge.

e. Offers of Long Term Supply Agreements at Reduced Prices

During the fourth quarter of 2017, following termination of the AD/CVD investigations, TIMET revisited its make-versus-buy analysis in order to determine whether to replace the chlorination portion of the Henderson, Nevada sponge plant or close the plant in favor of long-term agreements to purchase titanium sponge from foreign suppliers. The results of TIMET's analysis are set forth in Business Confidential Exhibit 19. In sum, the substantial capital investment needed to sustain domestic production of titanium sponge cannot be justified in economic terms unless the United States government intervenes to remedy the market distortions created by high-volume, low-priced imports of titanium sponge.

V. International Titanium Sponge Markets

a. World Titanium Sponge Capacity

According to the USGS, there are currently only five countries in addition to the United States that are significant producers of titanium sponge: Russia, China, Kazakhstan, Ukraine and Japan:

Country	2017 Production (MT)	2017 Capacity
United States	Withheld	13,100
China	60,000	110,000
india	500	500
Japan	48,000	68,800
Kazakhstan	9,000	26,000
Russia	40,000	46,500
Ukraine	8,000	12,000
Total	165,550	276,900 [34]

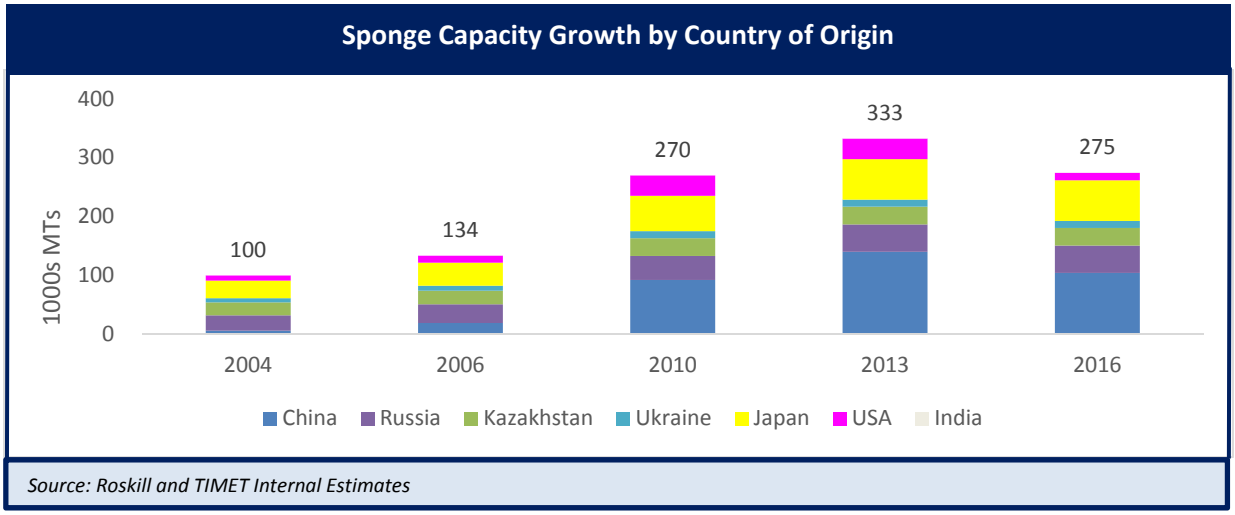
According to the most recent information compiled by Roskill, the capacity of the United States to produce titanium sponge peaked in 2013 at nearly 35,000 MT.[35] At that time TIMET was operating at full capacity in Henderson, NV, and ATI had two sponge plants in the United States, one in Albany, Oregon, and the other in Rowley, Utah. In January 2016, ATI announced the permanent closure of its Albany, Oregon titanium sponge plant. In December 2016, ATI announced that it was suspending production of titanium sponge at its Rowley, Utah facility indefinitely. As a result of these ATI closures, the United States lost nearly two thirds of its capacity to produce titanium sponge.

[34] Source: USGS Mineral Commodity Survey 2018. See Exhibit 3.
[35] See Exhibit 15. Roskill is a management consulting firm based in the United Kingdom. Roskill periodically publishes reports providing a comprehensive analysis of individual metal or mineral markets, including the global titanium market.

The last 13,000 MT of American sponge making capacity is threatened because the substantial, near-term financial investment needed to keep TIMET's Henderson, Nevada sponge plant operating cannot be justified under current market conditions.

b. Foreign Capacity Expansions

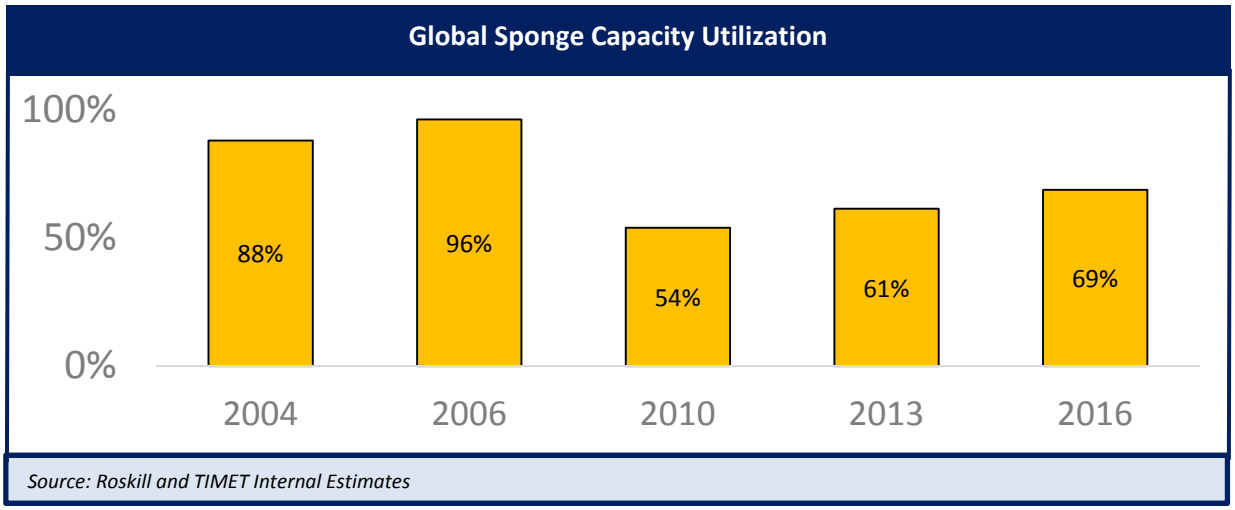
The drastic reduction in America's titanium sponge-making capacity followed a vast expansion in foreign sponge producing capacity. China's titanium sponge capacity grew from 6,000 MT in 2004 to more than 100,000 MT in 2016. During the same time period, Japan's capacity more than doubled from 30,000 MT in 2004 to 68,800 MT in 2016. Russia's capacity grew by 20,000 MT, from 26,000 MT to 46,500 MT. Kazakhstan's capacity grew by 36%. Ukraine increased its sponge-making capacity by more than 70%.



Source: Roskill and TIMET Internal Estimates

c. Foreign Capacity Utilization

The vast expansion of foreign sponge making capacity far exceeded demand. According to USGS, the capacity utilization rate for sponge producers outside the United States was about 63% in 2017.[36] According to Roskill, global capacity utilization (including U.S. capacity) dropped from a high near 95% in 2006, to less than 70% in 2016.



[37]

d. Excess Foreign Capacity

Total U.S. consumption of titanium sponge in 2017 was approximately 35,000 metric tons ("MT"). According to USGS, foreign titanium sponge producers have nearly 100,000 MT in excess capacity to produce titanium sponge. Foreign producers can maintain their current levels of supply to all the other markets for titanium sponge throughout the world and still have more than enough excess capacity to entirely displace American production of titanium sponge.

[36] See Exhibit 3.
[37] See Business Confidential Exhibit 15.

Due to the overwhelming imbalance between global demand for titanium sponge and the huge excess supply of foreign titanium sponge, titanium sponge prices have declined steeply in recent years despite historically strong demand for titanium metal products in the United States.

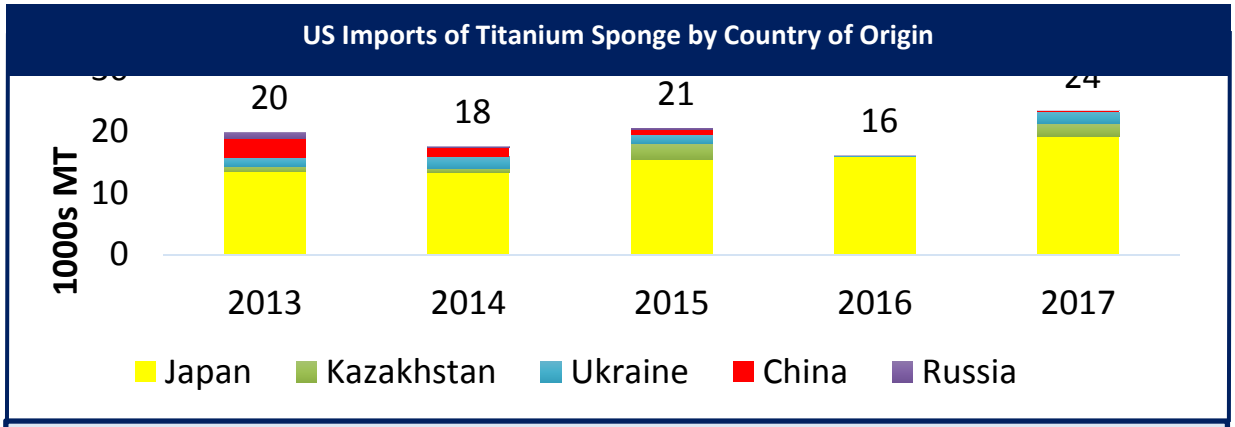
VI. Impact of Imported Titanium Sponge

Demand for titanium sponge in the United States market has been strong for several years, with consumption rising from 26,500 MT in 2013 to 37,000 MT in 2017. Strong titanium demand has not, however, prevented the displacement of American production. The high volume of low-priced titanium sponge imports has overwhelmed even the strongest titanium demand. As a result, U.S. titanium sponge prices have declined by nearly 25% since 2013 despite what, in historical terms, is a period of strong demand for titanium in the United States.

a. Volume trends

In the absence of any significant restrictions on imports of titanium sponge, the vast expansion in foreign capacity to produce titanium sponge has led to an increase in imports of titanium sponge into the United States, from 20,000 MT in 2013 to 23,400 MT in 2017.[38] Imports from japan have surged by more than 40% from 2013 to 2017.

[38] See Exhibit 17.

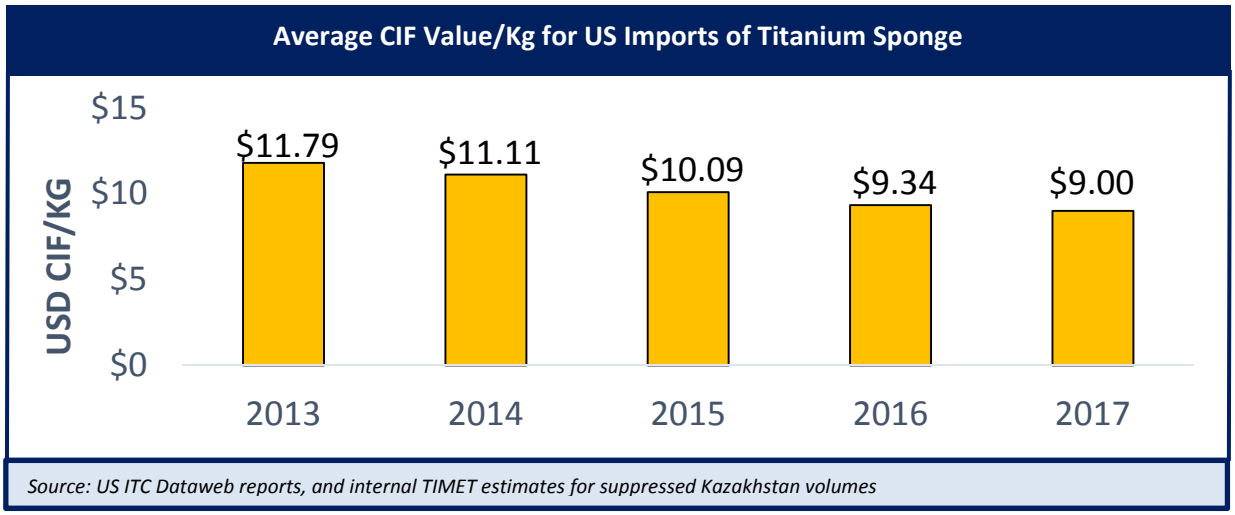


Source: US ITC Dataweb reports, and internal TIMET estimates for suppressed Kazakhstan volumes

1000s MT	**2013**	**2014**	**2015**	**2016**	**2017**
China	3.1	1.5	0.9	0.0	0.2
Japan	13.4	13.3	15.5	15.9	19.1
Kazakhstan	0.9	0.7	2.6	0.0	2.0
Russia	1.2	0.2	0.4	0.2	0.1
Ukraine	1.4	1.9	1.3	0.0	1.9
TOTAL	**20.0**	**17.7**	**20.7**	**16.2**	**23.5**

b. Price Trends

Over the same period, the average price for titanium imports declined by about 25%, from approximately $12.00/kg CIF to $9.00/kg CIF.[39]



c. Capacity Reductions

America's capacity to produce titanium sponge was cut nearly in half when ATI closed Rowley and replaced 100% of its production volume with foreign imports. In addition to the catastrophic injury inflicted upon ATI's titanium sponge operations, unfairly priced subject imports also adversely affected TIMET's sponge production. TIMET's production of titanium sponge at its Henderson, NV, facility dropped steeply between 2014 and 2016, from 100% to about 80%.

[39] *Id.*

d. Financial Losses

ATI suffered a massive financial loss associated with the closure of the Rowley, Utah titanium sponge plant. Published reports put its total charges related to the Rowley closure at more than $500 million.

TIMET's titanium sponge operations were profitable in 2014 and 2015, but suffered losses in 2016 and 2017.

The full financial impact of the low-priced sponge imports on TIMET is reflected in the decline in mill product pricing. It is beyond dispute that lower raw material costs will produce lower prices for downstream products. This is clearly true in the titanium industry. On November 2, 2016, American Metal Market ("AMM") reported that: "Titanium sponge overcapacity continues to inhibit spot price gains for semi-finished and finished goods… ." AMM specifically linked excess titanium sponge capacity to downward pressure on ingot prices. TIMET's U.S. melted and mill product revenues declined by approximately $97 million in 2016 due to lower prices for mill products attributable in large part to the utilization of low-priced imported titanium sponge by TIMET's competitors.

e. Discouragement of Capital Investment

During the fourth quarter of 2017, following termination of the AD/CVD investigations, TIMET revisited its make-versus-buy analysis in order to determine whether to replace the chlorination portion of the Henderson, Nevada sponge plant or close the plant in favor of long-term agreements to purchase titanium sponge from foreign suppliers. The results of TIMET's analysis are set forth in Business Confidential Exhibit 19. In sum, the substantial capital investment needed to sustain domestic production of titanium sponge cannot be justified in

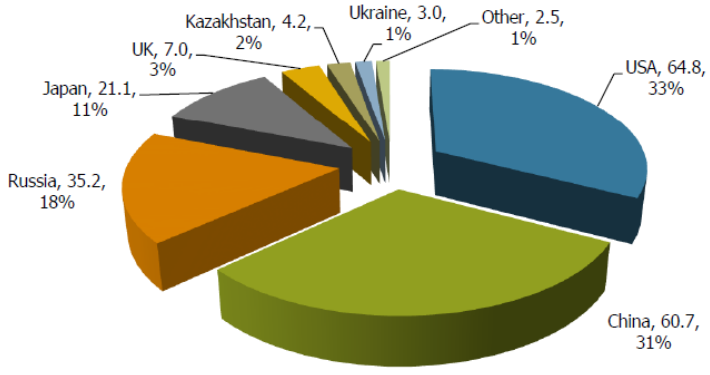
economic terms unless the United States government intervenes to remedy the market distortions created by high-volume, low-priced imports of titanium sponge.

VII. Downstream Markets

There are only four companies in the United States capable of melting titanium sponge to produce titanium ingots or slabs: TIMET, Allegheny Technologies Inc. ("ATI"), Arconic and the Perryman Company. ATI, Arconic and Perryman import 100% of the titanium sponge they use to produce titanium ingots, slabs and mill products. Each of these companies is highly focused on aerospace and defense markets. Business Confidential Exhibit 14-B sets forth TIMET's internal estimates of the capabilities of each of the world's titanium mill product producers.

Regional melting capacities tend to align with mill product capacities. There is some export activity involving melted products (*i.e.*, ingots and slabs), but it is limited as compared to trade in sponge and mill products. The only significant exceptions are TIMET's U.S. exports of melted products to support European mill product production and Kazakhstan's exports of melted products to support European and South Korean mill product production.

Figure 37: World: Production of titanium melted products by country (kt and %), 2016



Source: *Roskill*

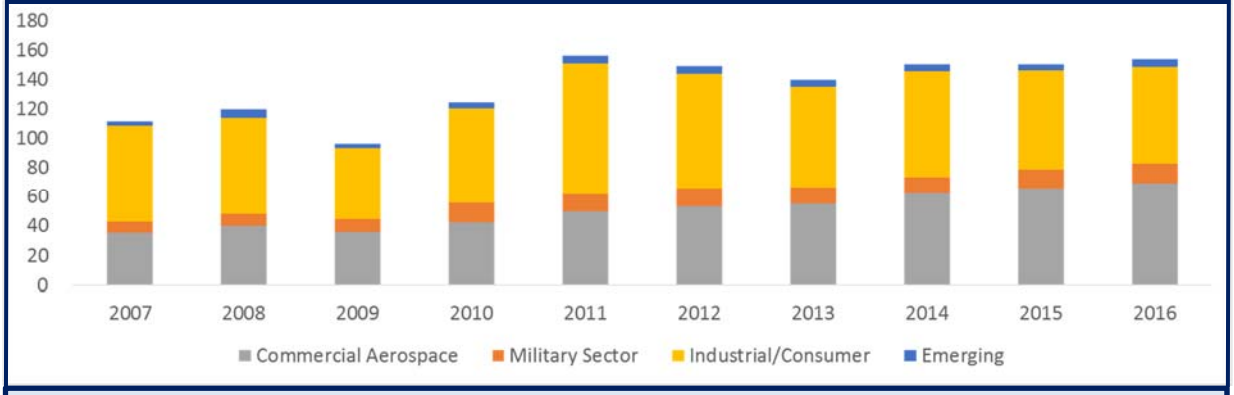
a. Titanium Mill Production

Titanium mill products include billets, bars, plates, sheets, strips, tubes, wire and extrusions. These products are offered in a range of shapes and finishes. Mill products are then machined, forged, or fabricated further into finished titanium parts.

1. Global Market Demand by End Use Market

Roskill splits the global market demand for titanium mill products into three main segments: Aerospace, Industrial, and Consumer. In 2016 the splits were 45%, 46% and 9%, respectively. Roskill did not include a historical view by end use market in their 2016 edition. TIMET estimates for the period 2007 – 2016 are expressed below. TIMET's estimates by end use track closely with Roskill's annual region estimates.

World: Production of Titanium Mill Products 2007 – 2016 (kt)



Source: Internal TIMET estimates

2. Global Mill Product Supply by Region

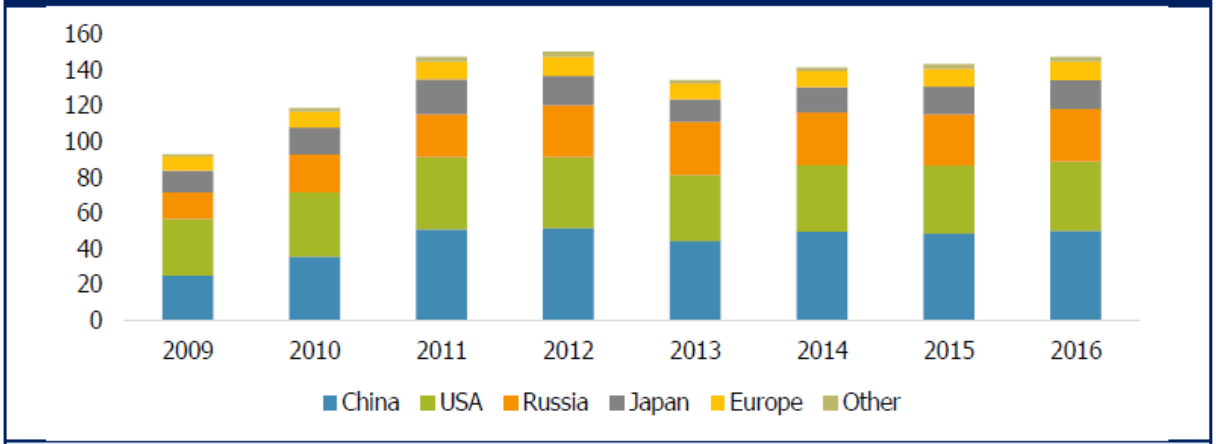
The demand for titanium mill products is satisfied by a supply base primarily located in the U.S., Russia, and China. Together these three regions comprised 85% of the global mill product supply in 2016, which is on par with historical norms.

World: Production of Titanium Mill Products 2007 – 2016 (kt)

1000s MT	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
US	33.2	34.8	27.7	38.3	45.4	39.5	34.6	37.3	38.0	38.0
Japan	19.1	19.7	12.0	13.8	19.4	16.2	12.4	14.0	15.5	16.5
Russia	21.0	20.0	18.5	18.8	22.1	23.7	27.0	27.7	27.3	23.7
China	23.6	27.7	25.0	38.3	51.0	51.6	44.5	49.7	48.6	49.5
Others	14.8	17.9	13.6	15.3	18.5	17.8	21.1	21.4	21.1	22.2
Total	**111.8**	**120.1**	**96.7**	**124.5**	**156.4**	**148.9**	**139.5**	**150.0**	**150.5**	**149.9**

Source: US Geological Survey (USGS), Annual Reports, Industry Conferences, TIMET internal estimates
Notes: US is USGS reported total; Others includes estimate for USGS non-reporters and other European and Asian producers

Figure 4: World: Titanium mill product supply, 2009-2016 (kt)



Source: Roskill

In addition to leading the supply base, Roskill estimates that in 2016 the US and China were also leaders in mill product consumption. The EU is the third leading consumer of mill products; Russia was in the top three suppliers of mill products. Russia exports the majority of the mill products it produces. As Figure 5 shows, the U.S. and EU consume mill products predominantly for aerospace end use, and China for industrial applications. Aerospace and industrial applications account for 90% of titanium mill product demand.

Non-aerospace markets include industrial end use, consumer, medical, and other applications (which include non-aerospace defense requirements). Industrial markets are project oriented and their historical highs and lows have been driven by capital expenditures. Industrial projects do not require the same, stringent quality requirements as aerospace applications and have lower barriers to entry.

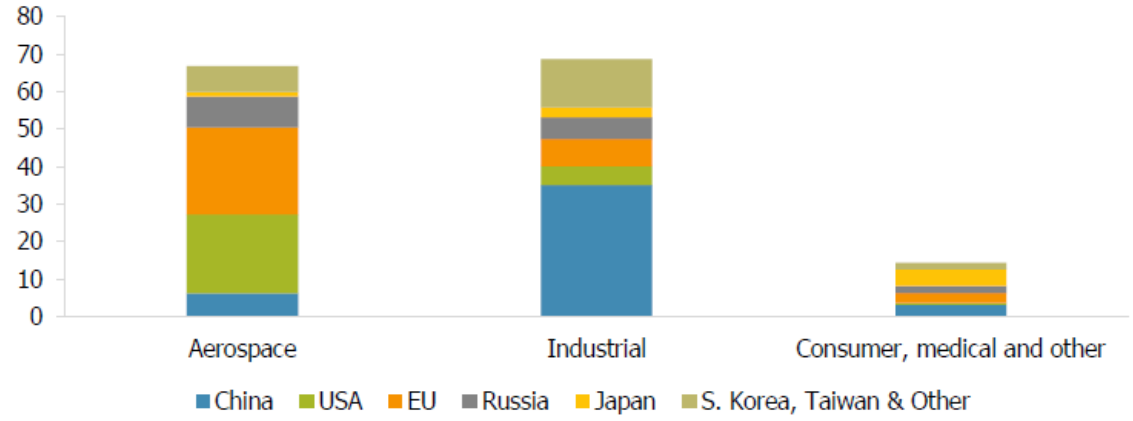
China has seen growth in recent years as production has increased in line with their growing industrial sector. As a result market share of the global industrial market is heavily skewed to Asian producers. China is in the process of establishing a local aerospace supply chain reaching from sponge production through aircraft assembly.

Titanium usage in the U.S. and EU has been and continues to be heavily concentrated in aerospace. Roskill's 2016 mill product demand estimates show the EU and U.S. as the largest consumers of mill products for aerospace end use. Aerospace is clearly a U.S.-centric market.

Manufacturing in the global aerospace industry is centered on two manufacturing hubs: the U.S. (Boeing) and Europe (Airbus). Within the European market approximately 90% of aerospace is for commercial aviation (structures and engines). The remaining 10% is for military aerospace applications. In the US, aerospace titanium demand is 80% commercial and 20% military.

3. Global Mill Product Consumption by Region and End Use Market

Figure 5: World: Estimated consumption[1] of titanium mill products by region, by use, 2016 (kt)



Source: *Roskill*
Notes: *1-Based on apparent consumption, which includes inventory*
Consumer, medical and other includes non-aerospace military applications

b. Aerospace Supply Chain

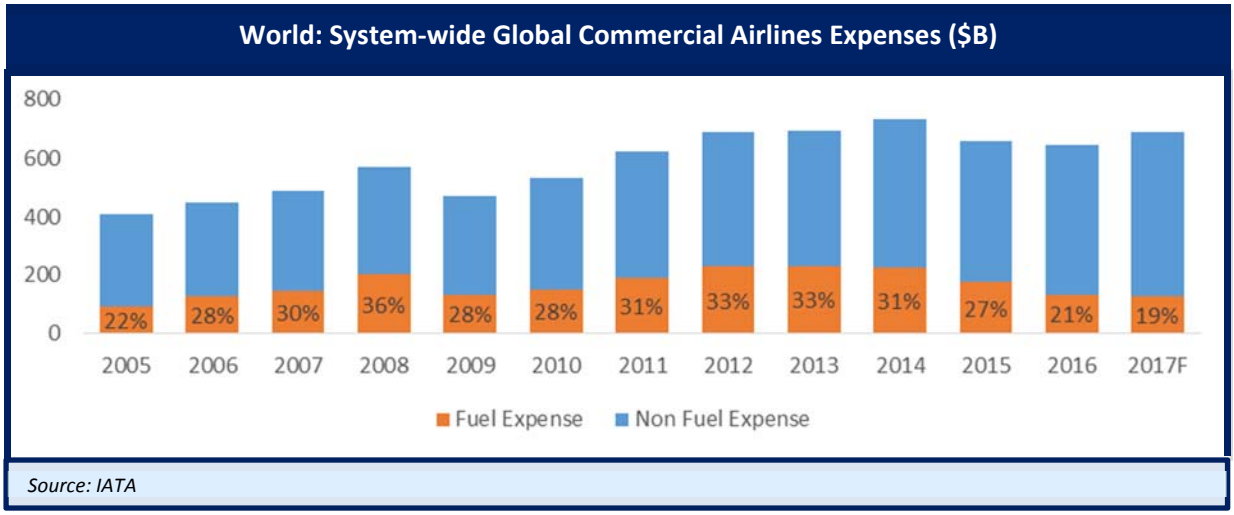
The aerospace supply chain is heavily dependent on mill products from U.S. producers TIMET, ATI, and ARCONIC as well as Russian producer VSMPO. Producers in China and Japan are attempting to enter the aerospace mill product market. Rigorous safety-driven fixed practices and lengthy qualification processes, in each case driven by airframe and engine OEMs, are high barriers to entry for new producers. TIMET estimates that more than 75% of global aerospace and military mill product is supplied by the three U.S. and one Russian producer.

c. Airlines and OEMs

The aerospace market is currently in the midst of a twelve-year "supercycle." Aircraft deliveries are driven by air traffic growth. As air traffic (the demand for air travel) increases, airlines pass this demand on to aircraft OEMs, who pass this demand for raw materials to their

supply chains in order to build more aircraft. The chart below shows that average annual air traffic growth has historically been 5%, but has averaged 7% annually since 2010.

Fuel costs constitute a significant expense for airline operators. Fuel, as a share of airline expenses, peaked in 2008 at 36%. Fuel costs came down to 21% of airline expenses in 2016, and were expected to drop below 20% in 2017 for the first time in over a decade. Reduced fuel costs have resulted in increased operating profits for airlines and stimulated new aircraft purchases.



Airlines are currently operating at a profitable sweet spot of high demand for air travel and low fuel costs. These factors, combined with low interest rates, make purchasing newer model aircraft particularly attractive.

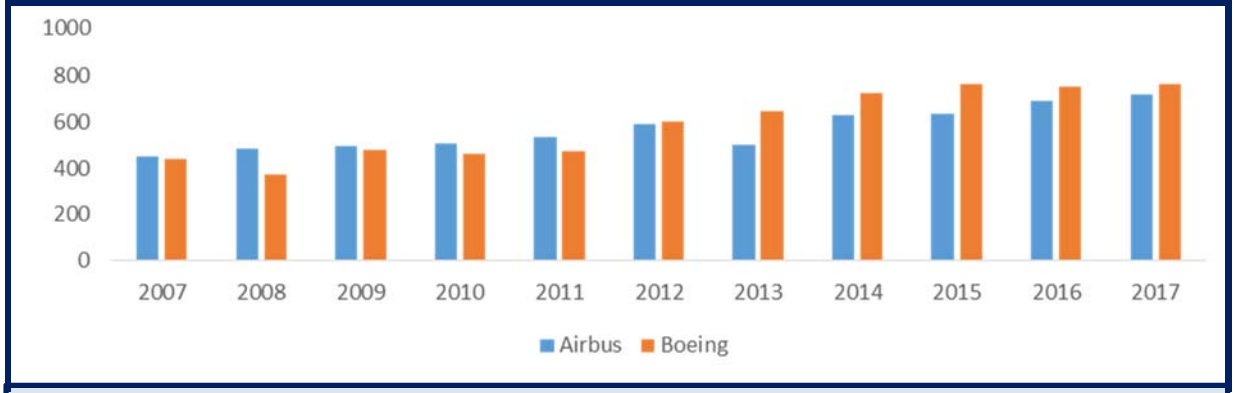
Boeing and Airbus are also both achieving record deliveries for their respective companies and the industry, and are ramping up to higher production rates than previously achieved by the industry.

Airbus and Boeing Reported Revenues

		2012	2014	2016
Airbus	*Euros (B)*	€57	€61	€67
Boeing	*USD (B)*	$82	$91	$93

Source: Airbus and Boeing Full-Year Results Press Releases

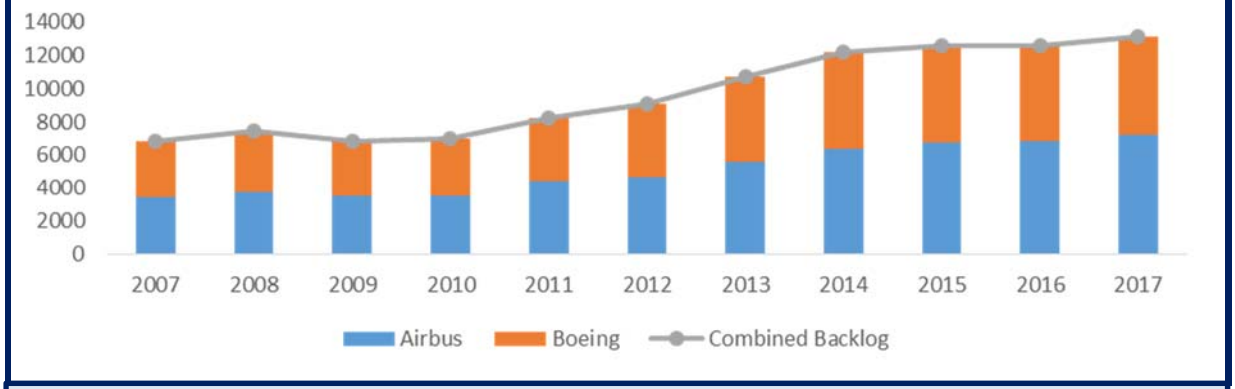
Airbus and Boeing Commercial Aircraft Deliveries: 2007 – 2017 (# of aircraft)



Source: Airbus and Boeing

Increased airline profitability has led to record aircraft orders for aircraft OEMs. Boeing and Airbus have unprecedented backlogs, totaling nearly 12,000 aircraft.

Airbus and Boeing Commercial Aircraft Backlog Growth: 2007 – 2017 (# of aircraft)



Source: Airbus and Boeing

d. Aerospace Supply Chain Dynamics

Instead of thriving along with airlines and aircraft OEMs, titanium sponge producers are experiencing financial distress. The divergent results for the titanium sponge industry are largely attributable to the prevalence of long-term, fixed-price product supply agreements for titanium mill products and overcapacity in the global titanium sponge industry.. Prior to the mid-1990s, there were no long-term titanium mill product supply agreements in place in the aerospace industry. The initial agreements established in the mid-1990s included cost-based price adjustments to account for changes in sponge and other raw material costs.

This did not solve the historic disconnect between the timing of an order for a new aircraft and the delivery of the product. The long lead time of an aircraft exposes an aircraft OEM to risk. When it receives an order for aircraft from an airline for delivery years in the

future, the aircraft OEM does not have a mechanism to hedge titanium mill product costs to the selling price agreed to by the airline.

This circumstance has led OEMs to demand long-term, fixed price product supply agreements for titanium mill products. Boeing, Airbus and engine OEMs have demanded and effectively extracted mill product price reductions from their titanium suppliers. In many cases OEMs have demanded long-term, sustained year-over-year reduced prices.

As a direct result of these demands, there has been a precipitous decline in titanium mill product prices since 2013. TIMET's U.S. melted and mill product revenues declined by approximately $97 million in 2016 due to lower prices. TIMET does not have access to similar information from ATI and ARCONIC, but believes the situation would be similar at its U.S. competitors.

Mill product suppliers exploited the overcapacity in the global titanium sponge market by demanding and successfully extracting lower prices from foreign sponge suppliers. Since sponge producers have limited ability to control their input or manufacturing costs, this situation has resulted in lower prices and financial distress for U.S. and Japanese titanium sponge producers.

VIII. Threat to Impair National Security & Critical Infrastructure

In its Strategic and Critical Materials 2015 Report on Stockpile Requirements, the Department of Defense reported that the United States was dependent on imports for 79% of its titanium requirements.[40] With the closure of ATI's Rowley, UT titanium sponge plant in 2016, and the potential closure of TIMET"s Henderson, NV titanium sponge plant due to unrestrained

[40] See Exhibit 12.

imports at unfairly low prices, the United States will become 100% dependent on foreign sources for titanium metal. Those sources are located in Russia, China, Kazakhstan, Ukraine and Japan.

All of the world's foreign titanium sponge producers (including Japan) are geographically remote from the United States, making the titanium supply chain vulnerable to disruption from military hostilities, political turmoil and natural disasters. In the event of military hostilities, none of these remote foreign producers can be counted on to maintain shipments of titanium metal to the United States. Russia, China, Ukraine and Kazakhstan are unlikely to support the United States in any military action. Japan, despite its political reliability, is particularly vulnerable to disruptions caused by an armed conflict. Japan lives in the shadow of China, Russia and North Korea.

[41]

[41] CRS: The US-Japan Alliance (2016) at Fig. 1. See Exhibit 4.

The folly of relying on Russia, China, Kazakhstan, Ukraine and Japan for a strategically critical material like titanium sponge becomes manifest when placed in the context of the Strategic Environment described in the Defense Department's National Defense Strategy for 2018:

> The central challenge to U.S. prosperity and security is the reemergence of long-term, strategic competition by what the National Security Strategy classifies as revisionist powers. It is increasingly clear that China and Russia want to shape a world consistent with their authoritarian model—gaining veto authority over other nations' economic, diplomatic, and security decisions.
>
> China is leveraging military modernization, influence operations, and predatory economics to coerce neighboring countries to reorder the Indo-Pacific region to their advantage. …
>
> Concurrently, Russia seeks veto authority over nations on its periphery in terms of their governmental, economic, and diplomatic decisions, to shatter the North Atlantic Treaty Organization and change European and Middle East security and economic structures to its favor.
>
> *****
>
> Rogue regimes such as North Korea and Iran are destabilizing regions through their pursuit of nuclear weapons or sponsorship of terrorism. North Korea seeks to guarantee regime survival and increased leverage by seeking a mixture of nuclear, biological, chemical, conventional, and unconventional weapons and a growing ballistic missile capability to gain coercive influence over South Korea, Japan, and the United States. In the Middle East, Iran is competing with its neighbors, asserting an arc of influence and instability while vying for regional hegemony, using state-sponsored terrorist activities, a growing network of proxies, and its missile program to achieve its objectives. [42]

Titanium sponge producers in Russia and China are subject to government control by the revisionist powers that are in competition with the United States. Those governments have shown their willingness to use predatory economics to achieve political ends. Moreover, Russia

[42] Department of Defense, *Summary of the 2018 National Defense Strategy of the United States of America*, at 2. See Exhibit 11.

and China are actively seeking to enlarge their spheres of influence by exerting political and economic control over neighboring titanium sponge-producing countries such as Ukraine and Kazakhstan.

In its 2017 report on the North Korean Nuclear Challenge, the Congressional Research Service ("CRS") observed that "any move involving military forces by either the United States/Republic of Korea (U.S./ROK) or the DPRK might provoke an escalation of conflict that could have catastrophic consequences for the Korean Peninsula, Japan, and the East Asia region."[43] China, Russia and North Korea are all strategically opposed to the United States and each of them has the ability to inflict catastrophic harm on Japan's economy in the event of a military conflict. Such an event would almost certainly eliminate Japan's ability to supply the United States defense and aerospace industries with the titanium sponge that is essential to the production of defense articles and commercial aerospace products.

The current economic threat to domestic titanium sponge production is a critical vulnerability in America's titanium supply chain. Without the capacity to convert titanium ore to titanium sponge, the United States defense, civilian aerospace and energy industries will become totally dependent for titanium metal on the handful of foreign countries that retain the capacity to produce titanium sponge. Other than TIMET, significant global sponge producers are located in Japan (Toho Titanium and Osaka Titanium Technologies), Kazakhstan (Ust Kamenogorsk Titanium and Magnesium Combine), Russia (VSMPO-AVISMA), Ukraine (Zaporozhye) and China (a mix of 8-10 state-owned and independent companies).

[43] CRS: The North Korean Nuclear Challenge: Military Options and Issues for Congress (November 6, 2017), Summary. See Exhibit 5.

Among these countries, only Japan can fairly be called a reliable political ally. But, titanium sponge production in Japan is economically vulnerable because its free-market producers are subject to the same economic forces as TIMET. Losses incurred by OTC and TOHO over the past few years indicate that the current economic conditions afflicting the titanium sponge market will discourage them from making the capital investments needed to remain reliable suppliers of titanium sponge. These economic developments could eventually leave the United States dependent on Russia, China, Ukraine and Kazakhstan for titanium sponge.

Making the United States dependent on Russia, China, Kazakhstan and Ukraine for a critical element like titanium metal will increase the risk that those governments will use titanium as a political bargaining chip, in the manner that Russia has exploited Western Europe's dependence on Russia for natural gas. The susceptibility of the titanium supply chain to disruptions caused by political turmoil is a very real possibility. In 2014, Dow Jones reported that the Boeing Company and United Technologies had begun stockpiling titanium parts following Russia's incursion into Crimea, which was then part of the sovereign territory of Ukraine.[44] The companies feared that political tensions between the United States and Russia would jeopardize access to parts that were being sole sourced from Russia. A disruption in such shipments could have stopped production of both military and civilian aerospace products.

A significant disruption in deliveries of titanium sponge for any reason would quickly have major economic consequences for the United States defense, aerospace and energy industries. The Defense Logistics Agency ("DLA") sold off the last remnants of its strategic stockpile of titanium sponge in 2005. Under just-in-time delivery practices currently prevailing

[44] See Exhibit 13.

among U.S. titanium sponge consumers, the United States will exhaust its on-hand supplies of titanium sponge within 90 to 120 days after new shipments from foreign suppliers are stopped for any reason.

America's reliance on foreign suppliers for titanium sponge is even more tenuous with respect to titanium sponge that is certified for use in the most demanding applications, *i.e.*, rotating parts for jet engines and some critical aerospace structural applications. Among current titanium sponge producers, only TIMET, Russia's VSMPO and the Japanese producers, OTC and TOHO, are universally certified for the production of titanium sponge used in rotating parts for jet engines. If TIMET's Henderson plant closes, and imports of rotating quality titanium sponge are disrupted for any reason, it will take at least several years to restart a U.S. sponge plant and achieve the necessary production standards to certify its output for use in rotating parts for jet engines for military and/or civilian use.

TIMET's assessment of the reliability of each titanium supplier in response to natural, political and/or military disruptions is appended as **Business Confidential Exhibit 26**. TIMET's Henderson, Nevada titanium sponge plant is the free world's most secure source for titanium sponge, which is an indispensable raw material for the United States defense industrial base and the civilian aerospace industry. TIMET's highly skilled workforce is currently operating a closed-loop titanium sponge manufacturing process that is both efficient and fully capable of producing titanium sponge for the most demanding titanium applications. Maintaining TIMET's ongoing production is superior to any other option as a hedge against supply disruptions which could disable the United States defense industrial base and America's civilian aerospace industry.

IX. Possible Remedies

In suggesting a remedy that will sustain U.S. production of titanium sponge, TIMET is mindful of the fact that it cannot alone supply the needs of the U.S market. TIMET recognizes that foreign titanium sponge producers must continue to have access to the U.S market to enable the domestic melting and mill product industry to support critical infrastructure demand. TIMET recommends a solution which both cures the unsustainable economics currently afflicting the U.S. titanium sponge industry and enables foreign suppliers from strategic allies to sustain production when faced with reinvestment requirements in the future.

The imposition of high tariffs that raises costs for consumers without curing the unsustainable economics will solve TIMET's near-term investment dilemma, but will not ensure a financially healthy titanium sponge-supply base for the industry. It is important that the remedy allow a consistent fair rate of return to key strategic titanium sponge suppliers.

Since 2013, prices for imports of titanium sponge have declined by nearly 25%.[45] Although the raw material input cost decline enables a small portion of this reduction, the magnitude of the price decline has been driven by a dramatic over-supply situation. The price leaders during this period have been various foreign producers from Kazakhstan, Ukraine, China and Russia, whose aggressive pricing strategies have consistently undersold producers from Japan. The data shows that in order to maintain high production levels and U.S. market share Japanese producers have dropped their prices in response to low-price offers from other foreign sources. Japanese producers have cut prices despite having production costs that are at least as high as costs incurred by American producers of titanium sponge. At current price levels,

[45] See Business Confidential Exhibit 17.

neither TIMET nor Japanese producers can justify reinvestment in titanium sponge production, a circumstance which jeopardizes the long term viability of titanium sponge production in both the United States and Japan.

a. Bilateral Agreements, Tariffs and Quotas

TIMET believes America's titanium sponge industry can be put on sound economic footing again by restoring prices for titanium sponge to 2013 levels, which were about 30% above current levels. Those price levels allowed TIMET and ATI, as well as Japanese producers, to operate their titanium sponge plants at a sustainable financial result that encouraged reinvestment in the titanium sponge industry. A combination of bilateral agreements, tariffs and quotas can achieve sustainable economics.

A straight-forward means of returning titanium sponge prices to sustainable levels can be achieved by implementing bilateral agreements with titanium sponge producing nations establishing reference prices for titanium sponge, as was done in the recent Agreement Suspending the Antidumping Duty Investigation on Sugar from Mexico.[46] The purpose of the Mexican Sugar agreement was to prevent price suppression or undercutting by imported products. The parties agreed not to sell in sugar in the United States at prices that are less than the reference prices established in the agreement.

Using his authority under Section 232, the President can impose tariffs immediately, on an interim basis, to induce high-volume foreign exporters like Japan to cooperate in the timely pursuit of a negotiated solution. The President can concurrently direct the Secretary of Commerce to negotiate a reference price agreement with Japan in order to preserve what is left

[46] See Exhibit 25.

of the United States titanium sponge industry. Japan is the source of a substantial majority of the titanium sponge currently being imported into the United States. These imports from Japan not only establish the value of all titanium sponge consumed in the United States. They also determine the prices for downstream titanium mill products. A reference price for imports of Japanese titanium sponge that restored titanium sponge prices to 2013 levels would allow domestic sponge producers to operate their sponge plants profitably. It would also encourage domestic and Japanese producers to make the capital investments necessary to sustain the production of titanium sponge in the United States and Japan, preserving America's access to a fully capable and completely reliable source of titanium metal that can serve the needs of the U.S defense and commercial markets.

The proposed reference price would need to be at least 30% higher than 2017 prices for imported titanium sponge. The reference price should be adjusted annually based on changes in the prices for titanium sponge feedstocks such as rutile ore to insure titanium sponge prices remain at levels that will sustain domestic titanium sponge producers without unnecessarily increasing the cost of imported titanium sponge for its consumers.

TIMET estimates that raising current price levels for titanium sponge by 30% would increase the current costs for imported titanium sponge by an aggregate of approximately $64 million annually. According to a 2017 report generated by the Aerospace Industries Association, the United States aerospace and defense sector, which requires a reliable source of titanium metal to maintain its operations, generates $872 billion in annual sales in the United States. Thus, the cost of maintaining a secure domestic source for titanium metal would amount to only 0.007% of total aerospace and defense sales in the United States.

Titanium metal is also used in many other applications in the United States, such as chemical and desalination plants. As titanium sponge costs are spread over an even wider array of downstream products, the impact of a price increase is even further reduced. Such a minimal increase in titanium costs is a small price to pay to insure that the United States aerospace and defense sector will always have reliable access to titanium metal in times of natural, political and/or military disruptions affecting the titanium supply chain. Importantly, the establishment of a negotiated reference price will encourage private parties to reinvest in the titanium sponge industry. A secure titanium supply chain will be preserved at no cost to the United States government.

A less straight-forward alternative to the reference price concept is to utilize tariffs and quotas to establish a market environment allowing producers from strategic allies to garner a fair return for the titanium sponge supplied to the U.S. titanium melting industry. As discussed above, tariffs and quotas could be imposed on an interim basis while the affected parties pursue a negotiated solution. For countries that do not enter into reference price agreements, the President should impose substantial tariffs in conjunction with quotas that will effectively prevent foreign producers in those countries from exporting low-priced titanium sponge to the United States in increased quantities that will have a negative impact on prices for titanium sponge in the United States. As explained in Exhibit 16, the existing 15% tariff rate on imports of titanium sponge is not effective due to the existence of manufacturing drawback under the Code of Federal Regulations (CFR) Title 19 Part 191. To be an effective policy tool, tariffs imposed on titanium sponge must not be eligible for any duty refund or deferral programs such as drawback, temporary importation under bond or entry into a foreign trade zone in non-privileged status.

b. Imposition of Customs Duties

TIMET believes the crisis in domestic titanium sponge production can be relieved by removing the distortions in the U.S. market caused by low-priced imports. However, simply imposing tariffs will increase costs for U.S. consumers of titanium sponge and limit imports without encouraging American and foreign suppliers like those in Japan to reinvest in their production facilities, which is crucial to the maintenance of secure and adequate supply of titanium sponge for consumers in the United States that serve the defense and commercial aerospace industries. Foreign producers like those in Japan need a fair return for their titanium sponge to justify sustained supply.

c. Expanding the Specialty Metals Law

Expanding the Specialty Metals Law, 10 U.S.C. §2533b, to require the use of domestic titanium sponge in defense articles procured by DoD, would likely have minimal impact on titanium sponge prices. Japan has signed a memorandum of understanding ("MOU") with the United States regarding defense procurement. Titanium sponge from Japan, which currently accounts for the majority of titanium sponge imports, would be eligible for use in defense articles under the MOU exception contained in the Specialty Metals Law. See 10 U.S.C. §2533b(d).

Expansion of the Specialty Metals Law to cover titanium sponge would affect only titanium sponge consumed in DoD applications, which currently account for less than 15% of the titanium sponge consumed in the United States annually. In addition, the Specialty Metals Law allows titanium consumers to comply with the law by treating domestic and foreign titanium as fungible products, meaning the prices for titanium sponge will continue to be driven by commercial demand. In these circumstances, expanding the Specialty Metals Law to include

titanium sponge would not have a beneficial impact on titanium sponge prices or encourage American titanium sponge producers to make the capital investments needed to give the United States military and commercial aerospace sectors safe and secure access to titanium metal.

d. Stockpiling Titanium Sponge

Stockpiling titanium sponge, as was done in the past, also has shortcomings in terms of maintaining a supply chain that is adequate to meet the needs of DoD and the commercial aerospace sector, which is a critical part of the United States economic infrastructure. Because titanium sponge reacts with oxygen over time, any stockpile of titanium sponge will degrade as time passes. Thus, a static stockpile will not ensure that America's military has a reliable source of titanium sponge in a crisis.

In the absence of any domestic production of titanium sponge, the United States government could not reasonably maintain a stockpile of titanium sponge large enough to serve the demands of the military and the demands of the commercial aerospace sector, which could also see its access to titanium sponge jeopardized in a natural, political or military crisis.

Most importantly, maintaining a small rotating stockpile of titanium sponge would not discourage cheap imports of titanium sponge, which have driven the domestic titanium sponge industry to the edge of extinction. Instead, the periodic sale of stockpiled sponge would contribute to reductions in commercial prices for titanium sponge and discourage investment in productive capacity, as occurred in the 1990s.[47]

[47] See RAND Corporation: "Titanium: Industrial Base, Price Trends, and Technology Initiatives" at 35-39. https://www.rand.org/content/dam/rand/pubs/monographs/2009/RAND_MG789.pdf.

X. Relief Under Section 232 Is Critical to the National Security

With its 2017 antidumping and countervailing duty petition, TIMET attempted to curtail the harm being done to America's domestic titanium sponge industry by unfairly traded imports. TIMET's efforts were frustrated by the ITC's refusal to extend AD/CVD relief to captive American producers of titanium sponge. Rather than protecting America's titanium sponge producers from the harm caused by low-priced imports, the ITC's decision has exacerbated the risk to national security that will result from the disappearance of America's titanium sponge industry, along with the capital equipment and skilled workers needed to maintain a titanium supply chain that is fully capable and completely reliable in times of natural, political and/or military turmoil.

In the absence of any other form of relief, it is imperative that the Secretary of Commerce and the President of the United States invoke Section 232 because titanium sponge "is being imported into the United States in such quantities or under such circumstances as to threaten to impair the national security." See 19 U.S.C. § 1862(b)(3)(A). As demonstrated above, the absence of a secure source of titanium sponge threatens the ability of the Department of Defense to secure in times of turmoil the titanium metal DoD needs to support the production of military aircraft, naval vessels, arms, ammunition and other defense articles. The absence of a secure titanium supply chain also threatens the ability of the United States commercial aerospace industry to maintain production when its international supply chains are disrupted.

Section 232 clearly authorizes the use of bilateral agreements as a means of adjusting imports so that those imports do not threaten the national security. See 19 U.S.C. §

1862(c)(3)(A). As explained above, agreements establishing a reference price for imported titanium sponge could be implemented at minimal cost to downstream consumers of titanium sponge. In addition, these additional costs for titanium sponge would not place U.S. companies at a competitive disadvantage because the production of titanium articles for military and aerospace applications is highly concentrated in the United States. U.S. aircraft OEMs will not be disadvantaged by TIMET's proposed remedy. The principal non-U.S. aircraft producer in the world, Airbus, (1) has production facilities in the U.S. and (2) is reliant on U.S. exports of titanium products pursuant to a long term supply contract with a vertically integrated U.S. mill products producer.

Titanium sponge consumers in the United States should themselves be wary of relying exclusively on vulnerable foreign sources for this critical input. The United States as a nation cannot make the mistake that some private companies have made of sourcing essential component materials from vulnerable allies and/or unreliable political adversaries.[48]

XI. Conclusion

The information provided herein demonstrates that high volume, low-priced imports of titanium sponge have resulted in the closure of one U.S. titanium sponge plant. These unrestrained imports threaten to eliminate the American titanium sponge industry entirely.

The rising levels of imports are impairing the national security of the United States by jeopardizing the security of the supply chain needed to produce titanium metal for weapons systems used in our national defense. Moreover, a disruption in supplies of

[48] See Exhibit 13, *Boeing and United Technologies Stockpile Titanium Parts*.

titanium sponge caused by a natural, political or military crisis would threaten the sustainability of the U.S. commercial aerospace industry, a critical part of America's infrastructure. For these reasons, the Secretary should determine that the threatened elimination of America's titanium sponge industry is "weakening our internal economy and may impair national security." See 19 U.S.C. *§* 1862(d).

Excess foreign capacity to produce titanium sponge is a circumstance that contributes to the "weakening of our internal economy" and "threaten[s] to impair" the national security as defined in Section 232. Foreign titanium sponge producers have rapidly expanded their capacity to excessive levels. For the foreseeable future, U.S. titanium sponge producers will be undermined by low prices for imported titanium sponge as foreign producers drop their prices in an effort to increase their exports to the United States. This circumstance is driving U.S. titanium sponge producers to reduce their levels of capacity and capacity utilization. Continuation of this trend will undermine the ability of U.S. titanium sponge producers to make the substantial near-term capital investments that are necessary to sustain production of titanium sponge in the United States.

American titanium sponge producers must be financially viable and competitive in commercial markets so that the United States will have a reliable source of supply for the production of defense articles and commercial products that are critical to America's defense and commercial aerospace manufacturing sector. Excessive imports of titanium sponge have already displaced a substantial portion of domestic production and reduced the skilled workforce needed to produce the highest quality titanium sponge. Now, the last American

titanium sponge producer is facing an imminent threat to its continued operation.

A U.S. industry that is not able to invest in the latest technologies, facilities, and long- term research and development, nor retain skilled workers while attracting a next-generation workforce, will be unable to meet the current and projected needs of the US military and critical infrastructure sectors, such as the U.S. commercial aerospace industry.

The displacement of domestic products by excessive imports is causing the domestic industry to reduce employment, curtail research and development, and slash capital expenditures. Thus, the Secretary should determine that the "displacement of domestic products by excessive imports" is having the "serious effect" of causing the "weakening of our internal economy." See 19 U.S.C. *§* 1862(d).

Carefully crafted bilateral agreements with producing nations and/or the imposition of quotas on imports should have the effect of restoring prices for titanium sponge to 2013 levels, which were about 30% above current levels. Those price levels would allow domestic producers to operate titanium sponge plants on a sustainable basis at an insignificant cost to downstream consumers and, most importantly, give the United States defense and aerospace industries a fully capable and always reliable source for titanium metal.