March 2022

Critical Commodities Report

Report Produced by the Interos Inc.
Business Analyst Team

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Critical Commodities

Considering the augmented levels of Russian kinetic action against Ukraine in multiple areas outside the separatist-controlled areas in Donetsk and Luhansk, the following information is intended to highlight associated risks on critical commodities in the energy, as well as metals and mining, sectors.

Oil

As Russia pursues kinetic action against Ukraine, oil prices are rising and breaking levels not seen since 2014, prompting the U.S. to consider releasing further strategic reserves and coordinate with allies to mitigate ensuing supply chain disruptions. However, cooperation is unlikely to be found with OPEC countries, as Russia's sway appears to be more influential than pressure the U.S. has been exerting to boost global supply.

On 24 February 2022, oil prices jumped, with Brent above $105 a barrel for the first time since 2014 in the wake of augmented Russian kinetic action in Ukraine.[1] Now, oil is trading at roughly $120 a barrel as of 3 March 2022.[2] The U.S. will release strategic reserves as needed,[3] such as a recent move to release 50 million barrels of oil in November 2021,[4] and will coordinate with oil-producing countries to mitigate ensuing supply and price shocks as a result of recent events.[5] This comes as U.S. crude oil production is forecast to rise in 2022 and 2023 to record-high levels.[6]

These moves are offset by what is expected to be non-cooperative behavior from members of the Organization of the Petroleum Exporting Countries (OPEC), an organization led by Russia.[7] Currently there are no signs of a rift between OPEC and Russia despite pressure from the U.S. and other key oil-consuming nations for the group to release more supplies. Saudi Arabia and the United Arab Emirates have declined to pump beyond their quotas, in part to avoid upsetting the often-fragile harmony that exists within the organization.[8]

The U.S. and its allies initially declined to cut Russia out of the Society for Worldwide Interbank Financial Telecommunications (SWIFT) as part of the second tranche of sanctions against Russia. In a speech on 24 February 2022, President Biden indicated that punitive measures included in the second tranche of sanctions would be more damaging to Russia than cutting it out of SWIFT, though that move could have cut off Russia from most international financing, including international profits from oil and gas production, the foundation of the Russian economy.[9] The President did indicate that this move would be available as part of future financial countermeasures against Russian aggression.[10]

As of 2 March 2022, SWIFT said in a statement that it would disconnect seven Russian banks from their network on March 12, as required by EU regulations.[11] The following seven banks have been banned from the SWIFT system: VTB (VTBR.MM), Bank Otkritie, Novikombank, Promsvyazbank (PSKBI.MM), Bank Rossiya, Sovcombank and VEB.[12]

Natural Gas

On 22 February, the German government rescinded approval for the certification process of the Nord Stream 2 Pipeline in the Baltic Sea, a policy reversal that has the potential to exacerbate already elevated energy prices. However, the Commission of the European Union has stated that it does not expect the continent's gas supply to be negatively affected by this move against Nord Stream 2 as the pipeline had not yet been made operational.[13]

It is no secret that European countries have developed a reliance on the importation of energy from the Russian Federation.[14] Putin has sought to capitalize on this reliance with the building of Nord Stream 2, a third and fourth pipeline in the Baltic Sea estimated to be worth 11 billion USD, to transport natural gas from Russia directly to Germany. Nord Stream 2 would deprive Ukraine of several billion dollars' worth of energy transit revenue as the flow of gas would be diverted, money which in turn could have been used on security and defense against Russian aggression.

Nord Stream 2 has frequently been a divisive issue in the transatlantic alliance. The U.S. imposed sanctions on companies involved in the pipeline's construction[15] and the European Union issued directives to undermine Russian control of the pipelines for healthy market competition.[16] Germany often stood alone in defending the project on financial, rather than geopolitical, grounds, as it has been stated that U.S. concerns over the pipeline may have been driven in part to augment American exports of liquified natural gas to Europe as a more expensive alternative to Russian-source energy.[17]

Whereas the German government under Chancellor Merkel approved the project, the current government under Chancellor Scholz has rescinded that approval in light of Putin's recognition of the so-called independent republics in the Donbas.[18] This has stoked fears of a further energy crisis in Europe [19] as Russian energy companies, such as Gazprom, reduced exports to Europe towards the end of 2021.[20] Russia has demonstrated its willingness to employ energy exports as a weapon in their foreign policy arsenal,[21] a fact which has motivated European countries and supranational institutions to identify alternative energy sources with a certain degree of urgency. The results of this policy reversal are expected to elevate the cost for Russian action in Ukraine, and there are varying estimations on the negative consequences it will have for the U.S. and Europe.

Ukraine has completed upgrades to its pipeline network that will allow natural gas imports to flow through Hungary amid fears that Russia could halt gas shipments through the country after a transit agreement with Gazprom expires at the end of 2024, or even earlier.[22] However, such an arrangement would not be possible if Russia halts gas transit flows.[23]

In this round of sanctions, the United States and its European allies have avoided hitting the Russian energy sector as officials are concerned about disrupting the energy flows to European nations as the conflict escalates. Sberbank (SBER.MM), Russia's largest

lender, and Gazprombank were not included because it has been stated that "[…] they are the main channels for payments for Russian oil and gas, which EU countries are still buying despite the conflict in Ukraine." Additionally, officials have indicated that it is technologically impossible to allow energy-related transactions and exclude others as the technical limitations of the SWIFT system do not allow for the differentiation between types of payments.[24]

Iron Ore

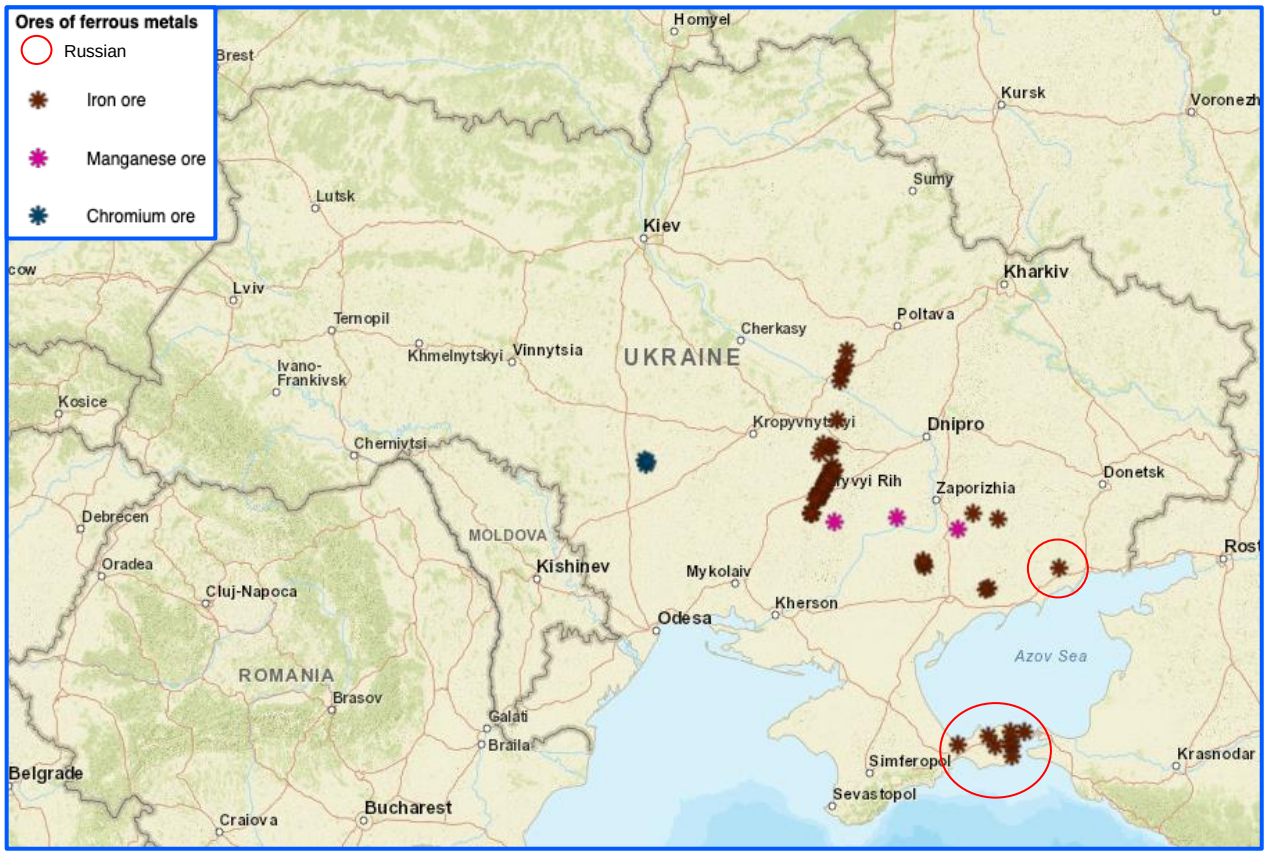
Ukraine is the fifth largest exporter of iron ore in the world, accounting for 4.2% of world exports.[25] The primary destination country for Ukrainian iron ores is China, where approximately 38.3% of exports travel.[26] As a result, recent events are unlikely to severely impact U.S. imports of iron ore. Despite the U.S. being reliant upon imports to supplement supply and a non-existent strategic stockpile, the U.S. Defense Industrial Base is buttressed by domestic production, multiple trading partners, and scrap recycling capabilities.

In 2021, Ukraine exported 44.4 million metric tons of iron ore products, down from 46.2 metric tons in 2020. This export level makes Ukraine the fifth largest exporter of iron ore in the world.[27]

Data indicates that Ukraine amassed 3.36 billion USD of profit from the critical mineral commodity in 2019. Available intelligence indicates that Ukraine's iron ore trading relationship with China contributes to Chinese dominance in the sector as China was the destination for 38.3% of total exports of Ukrainian iron ore. Additionally, the Czech Republic (12.5%) and Poland (11.7%) accounted for the second and third most prominent destinations for the commodity. It is also important to note that Russia was Ukraine's only source of iron ore imports which totaled 565 million USD.[28]

From 2018 to 2020 the U.S. maintained a low reliance on Ukraine for imports of iron ore at 3.7% total imports as of 2020. Most imports came from Canada, Brazil, and Mexico which combine to form 45.7% of all imported iron ore.[29] According to data pulled from the International Trade Center, exports of Ukrainian iron ores and concentrates, including roasted iron pyrites, to the U.S. vacillated between 2018 and 2020. In 2018, 6.9 million USD worth of the critical mineral commodity was imported by the United States. This number declined to 0 USD for unknown reasons in 2019 and steeply increased to 25.2 million USD in 2020.[30]

The majority of identified iron ore deposits are located outside the so-called People's Republic of Donetsk and Luhansk in Ukraine. Data indicates that only one identified iron ore deposits is located within Russian-controlled Donetsk. [31] Those located within Crimea are already under Russian control. The remainder iron deposits are vertically dispersed across three main administrative units; Dnipropetrovsk, Zaporizhzhya, & Poltava.



Steel

Despite elevated tensions, Ukraine's largest steelmaker, Metinvest BV, planned to invest 1 billion USD this year in modernization and new production facilities.[32] However, considering the events of 24 February 2022, Metinvest officially announced the suspension of some of its operations for a period of 7 days, after which a restart may be scheduled depending on how the situation develops. Undoubtedly, this voluntary cessation of operations, coupled with other expected operation suspensions, will disrupt Ukrainian steel exports.

In 2021, Ukraine produced 21.4 million metric tons of crude steel[33], up from 20.6 million metric tons in 2020.[34] Despite this increase, Ukraine moved from the 12th largest steel-producing country in 2020 to the 13th largest in 2021. In 2020, Metinvest Holding ranked as the 45th largest steel-producing company, producing 10.16 tons.[35]

Iron and Steel Alternatives

The United States government does not maintain a strategic stockpile of iron and steel.[36] Available intelligence indicates that defense-related projects requiring steel in the event of a mass shortage or supply chain crisis would be required to resort to aluminum, plastics, concrete, alternative metallics, engineered timber, and fiber-reinforced plastics (FRPs). The period in which the United States can ready replacements for steel is dependent on procurement capabilities for these alternatives.

While no one alternative has become a standard to replace steel, materials like engineered timber and metal composites are becoming more common. Iron is the least expensive and most widely used metal. In most applications, iron and steel compete either with less expensive nonmetallic materials or with more expensive materials that have a performance advantage. Iron and steel compete with lighter materials, such as aluminum and plastics in the automotive industry; aluminum, concrete, and wood in construction; and aluminum, glass, paper, and plastics in containers.[37]

Composite materials like FRPs and alternative metal alloys are gaining popularity as alternative options to steel and iron components. Composites can be more durable than steel, and repairing damaged composite components is often less costly and requires less heavy machinery. The disadvantage with FRP alternative materials is the cost of production.[38]

Recycled iron and steel scrap is a vital raw material to produce new steel and cast-iron products. The steel and foundry industries in the United States have been structured to recycle scrap and, as a result, are highly dependent upon scrap. Overall, the scrap recycling rate in the United States has averaged between 80% and 90% during the past decade, with automobiles making up the primary source of old steel scrap. More than 15 million tons of steel is recycled from automobiles annually.[39]

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Coal

Russia's invasion of Ukraine in the Donbas, a coal-rich area of Ukraine, comes as Russia recently agreed to supply China with 100 million tons of coal[40] on top of a separate deal to supply India with 40 million tons of coal. [41] Given these recent export deals, Russian interest in controlling resource extraction in the Donbas has certainly been elevated.

Since spring 2014, the conflict in Donbas left Ukraine with little control over its coal-mining assets in the temporarily occupied territories of Donetsk and Luhansk oblasts. Mariupol, a port on the Sea of Azov, is one of Ukraine's most significant ports for steel and mineral exports, alone handling 50%. This comes as no surprise due to Mariupol's proximity to the Donbas. The *Donbas* itself is a portmanteau, an amalgamation of 'Donets Coal Basin' (UKR: Донецький вугільний басейн), and it is a region containing one of the major coalfields in the world.[42] Consequently, Ukraine ranks seventh in the world after the United States, China, India, Russia, and Australia in terms of proven coal reserves.[43]

Russian forces have subjected the Ukrainian port of Mariupol to relentless bombardment, one of Ukraine's Black Sea ports, which lies approximately 50 miles from the Russian border. [44] Control of the port would grant the so-called Donetsk People's Republic (DPR) a strategic access point to the Black Sea.[45] Russia has already taken steps to increase its control over Ukrainian access to sea trade by closing shipping in the Sea of Azov on 24 February 2022.[46] Though there are alternative methods to transporting goods, it is estimated that 70% of Ukraine's trade travels by sea.[47]

Titanium

Russia's invasion of Ukraine is unlikely to severely impact U.S. imports of titanium and titanium ore from Ukraine. However, there is a risk of sanctions negatively affecting aerospace and defense entities that maintain ties to VSMPO-AVISMA which supplies titanium to plane makers Boeing and Airbus.

The U.S. does not maintain a supply of titanium in the National Defense Stockpile. Data collected by the USGS corroborates that the U.S. is 90 percent net import reliant as a percentage of apparent consumption for titanium sponge. This import reliance notably falls on Japan, Kazakhstan, and Ukraine for imports of the critical commodity.[48] Percentage breakdown for import sources between 2017 and 2020 are as follows: Japan, 88%; Kazakhstan, 8%; Ukraine, 3%; and other, 1%.[49]

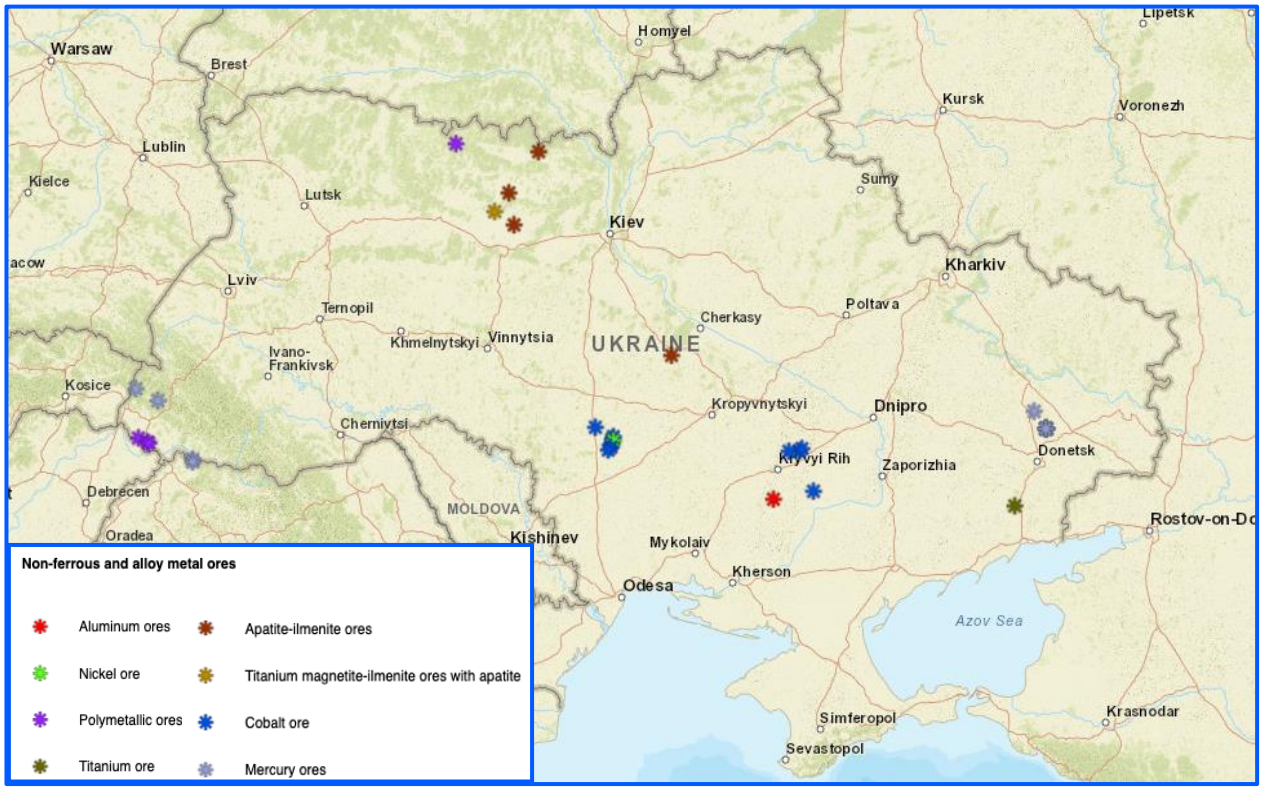
In the U.S., titanium is mined in smaller quantities in Nevada, Virginia, and Utah.[50] Recent legislation has managed to significantly reduce net import reliance of the strategic material from both China and Russia for reasons pertaining to the protection of the U.S. DIB.

Most recently available data indicates that Ukrainian exports of titanium ore totaled 186 million USD, comprising only 0.38% of the country's exports in 2019. However, titanium ore was among the fifth most exported commodities within the Ukrainian mining industry; 49.3% of all titanium ore was exported to Russia, whereas just 7.04% was exported to the United States.[51]

Detailed 2021 consumption data points were withheld to avoid disclosing proprietary information. Most titanium metal was used in aerospace applications, and the remainder was used in armor, chemical processing, marine hardware, medical implants, power generation, consumer, and other applications. The value of imported sponge was about $140 million, a significant decrease compared with $173 million in 2020.[52]

Recently introduced legislation, H.R.6470 - Defending Ukraine Sovereignty Act of 2022 Section 309, stipulates that additional sanctions on individuals or entities within specified industries pertaining to natural resource extraction are possible should Russian aggression against Ukraine continue. VSMPO-AVISMA has not yet been targeted by sanctions; however, they qualify to be listed as a sanctioned organization should the U.S. make that determination if this legislation moves forward.

Identified titanium magnetite-ilmenite ores in Ukraine with apatite are only found within one administrative unit, Zhytomyr, which is located west of Kyiv. One Titanium ore deposit resides just outside of the border of separatist-controlled Donetsk.[53]



PJSC VSMPO AVISMA

[Resilience Entity ID: d9d064a7-3666-4cb2-977a-97f9b3c885ed]

PJSC VSMPO-AVISMA Corporation is the largest titanium producer in the world, with over 30% of the global market share.[54] The entity poses high FOCI risk, with Russian state ownership and executive leadership ties to Putin.

Organization Summary

VSMPO-AVISMA Corporation, together with its subsidiaries, manufactures and sells titanium products in Russia and internationally. It offers titanium ingots, billets, slabs, large size die-forgings, disks, rolled rings, profiles, seamless tubes, hot-rolled bars, blades, hot-rolled sheets and plates, cold-rolled sheets, strips, bands, foils, and welded tubes; and aluminum ingots, profiles, panels, extruded pipes, cold-shaped pipes, and pipes for the nuclear industry. Its products are used in aircraft manufacturing, power engineering, oil-and-gas production, shipbuilding, construction, medical, and sports industries. VSMPO-AVISMA Corporation was founded in 1933 and is based in Verkhnyaya Salda, Russia. public stock company VSMPO-AVISMA Corporation is a subsidiary of ZAO Business Alliance.

VSMPO-AVISMA is a part of Rostec, Russia's state-owned arms conglomerate. Rostec owns over 25% of the company's shares.[55] VSMPO AVISMA's Chairman of the Board, Sergei Chemezov, is the CEO of Rostec. Chemezov is also a personal friend of Russian President Vladimir Putin from their days in the KGB as a part of Operation "Luch" in Dresden.[56] Chemezov has also been awarded the honor "Hero of the Russian Federation" and holds the rank of Colonel-General in the Russian armed forces.[57] The majority shareholder (65.27%) and vice-chairman of the board of VSMPO-AVISMA is Mikhail Shelkov, a Russian oligarch known for his investment in state-backed projects, such as infrastructure and the development of Rostec's new Campus in Tula.[58]

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VSMPO-AVISMA Corporation (ВСМПО-АВИСМА)

Location: Verkhnyaya Salda, Russia

Known Subsidiaries

- VSMPO Titan Ukraine — UKR
- VSMPO-Tirus US — USA
- Uniti Titanium — USA
- NF&M International — USA
- VSMPO-Tirus UK — GBR
- Tirus International SA — CHE
- VSMPO – Tirus GmbH — DEU
- VSMPO-Tirus (Beijing) Metallic Materials Ltd — CHN
- VSMPO Titan Scandinavia AB — SWE

POI: Sergey Chemezov

Relevant OSINT
- Became chairman of **VSMPO-AVISMA** in November 2006
- Holds military rank of Colonel General
- Close associate of Vladimier Putin
- Barred from entering the United States by the Obama Admin. in 2014
- Former KGB Agent.

Chairman of the Board of Directors of a Number of Large Russian Companies
- VSMPOAVISMA, OJSC
- KAMAZ, OJSC
- Rosoboronexport, OJSC
- Uralkali, OJSC
- Concern VKO AlmazAntey, OJSC

Member of the Board of Directors
- AVTOVAZ, OJSC – Deputy Chairman of the Board of Directors,
- United Aircraft Corporation, OJSC
- International Financial Club, OJSC
- Aeroflot Russian Airlines, OJSC
- Alliance Rostec AUTO BV Joint Venture
- Head of the Russian part of the Board of Directors of Mongolrostsvetmet, a Russian/Mongolian joint venture company with limited liability
- Head of the Russian part of the Board of Directors of Enterprise Erdenet, a Russian/Mongolian joint venture company with limited liability

Global VSMPO-AVISMA Locations

O Headquarters
× Joint Venture
+ Subsidiary

VSMPO-AVISMA Corporation Connections

Nearly 75% of the company's revenue is derived from contracts with aerospace companies. [59] Two significant American defense contractors, Boeing[60] and Allegheny Technologies,[61] maintain joint ventures with VSMPO AVISMA with operations in Russia. The company holds a longstanding agreement to supply most of titanium parts for Boeing, specifically for the Boeing 737, 767, 787, 777 and 777X airplanes.[62] In 2017, Rolls Royce and VSMPO-AVISMA signed an agreement to procure rings, blisks and fan disks for Rolls-Royce's jet engines.[63] The company provides roughly half of Airbus's titanium, which is incorporated into all its projects. This relationship is so deeply ingrained that Airbus has given VSMPO-AVISMA three separate supplier awards from 2017-2019.[64] Most recently, in late January 2022 Airbus confirmed that it would continue to order titanium from VSMPO-AVISMA for its Airbus A350 aircraft until 2028.[65]

Titanium Alternatives

According to the USGS, few materials possess titanium metal's strength-to-weight ratio and corrosion resistance. In high-strength applications, titanium competes with aluminum, composites, intermetallic, steel, and superalloys. Aluminum, nickel, specialty steels, and zirconium alloys may be substituted for titanium for applications that require corrosion resistance. Ground calcium carbonate, precipitated calcium carbonate, kaolin, and talc compete with titanium dioxide as a white pigment.[66]

Gallium

From 2017 to 2020 the U.S. maintained a low reliance on Ukraine for imports of gallium at 7% total imports, relying heavily instead on China for imports of the metal. This, coupled with intelligence that indicates Ukraine ceased domestic primary production of the metal in 2019, indicates that in the event of a Russian incursion into Ukraine, the U.S. is unlikely to suffer in its imports of gallium despite being 100% reliant upon imports as it lacks domestic production capabilities.

Gallium is not produced in the U.S., so the level of net import reliance as a percentage of apparent consumption is at 100%. From 2017-2020, major import sources include China (53%), the United Kingdom (11%), Germany (9%), and Ukraine (7%), as well as other countries (20%).[67] According to Ukrainian government sources, Ukraine is thought to have ceased primary production of gallium in 2019. In 2021, the U.S. relied primarily on gallium imports from China to satisfy demand. For that year, China produced approximately 420 metric tons of gallium, or 98% the world production total of 430 metric tons. In 2021, the U.S. consumed a reported 16 metric tons of gallium. Notably, the U.S. government does not maintain a stockpile of gallium.

Globally, primary gallium is recovered as a byproduct of processing bauxite and zinc ores. More than 95% of gallium consumed in the U.S. is in the form of gallium arsenide (GaAs).

Imports of gallium metal and GaAs wafers were valued at about $3 million and $200 million, respectively, indicating that the U.S. has a low reliance for imports of gallium metal alone. In 2021, gallium metal imports increased by an estimated 140% from those of 2020 (an estimated 10,600kg up from 4,460kg the year prior) owing to increased imports from Canada, Japan, and Singapore. Imports dropped sharply from 2018 to 2019 as import tariffs on Chinese-sourced gallium increased prices. U.S. imports of gallium come predominantly in the form of GaAs wafers. In 2021 it is estimated that the U.S. imported 270,000kg of GaAs wafers, up from 178,000kg the year prior. For comparison, of the 280,600kg of gallium metal and gallium arsenide wafers imported by the U.S. in 2021, just 3.78% was for the metal alone, whereas 96.22% was for GaAs wafers.

GaAs is used primarily to manufacture compound semiconductor wafers used in integrated circuits (ICs) and optoelectronic devices, which include laser diodes, light-emitting diodes, photodetectors, and solar cells. ICs accounted for 77% of domestic gallium consumption, optoelectronic devices accounted for 21%, and research and development accounted for 2%. Optoelectronic devices were used in aerospace applications, consumer goods, industrial equipment, medical equipment, and telecommunications equipment. Uses of ICs included defense applications, high-performance computers, and telecommunications equipment.

Gallium can also be combined with high-purity (99.9999%) arsenic metal (As) to produce GaAs semiconductors for solar cells, space research, and telecommunications. About 81% of the gallium consumed in the U.S. was contained in GaAs, GaN, and gallium phosphide (GaP) wafers.

Gallium Alternatives

Silicon is the principal competitor with GaAs in solar-cell applications. In many defense-related applications, GaAs-based ICs are used because of their unique properties, and no effective substitutes exist for GaAs in these applications. One unique property is high electron mobility,[68] which enables GaAs transistors to function at frequencies over 250 GHz.[69]

Germanium

The U.S. relies predominantly on China for imports of germanium, though the U.S. does not have as high a net percentage of reliance on imports for germanium (>50%) as it does for gallium (100%). That fact, coupled with data indicating that Ukraine is not a major supplier of gallium to world markets, indicates that in the event of a Russian incursion into Ukraine the U.S. is unlikely to suffer in its imports of germanium. Ukrainian germanium production was negatively affected by Russian incursions into its sovereign territory in 2014, and it is unlikely production has recovered as Ukraine's concentration of germanium producing sites is in the Russian-occupied regions of Donetsk and Luhansk.

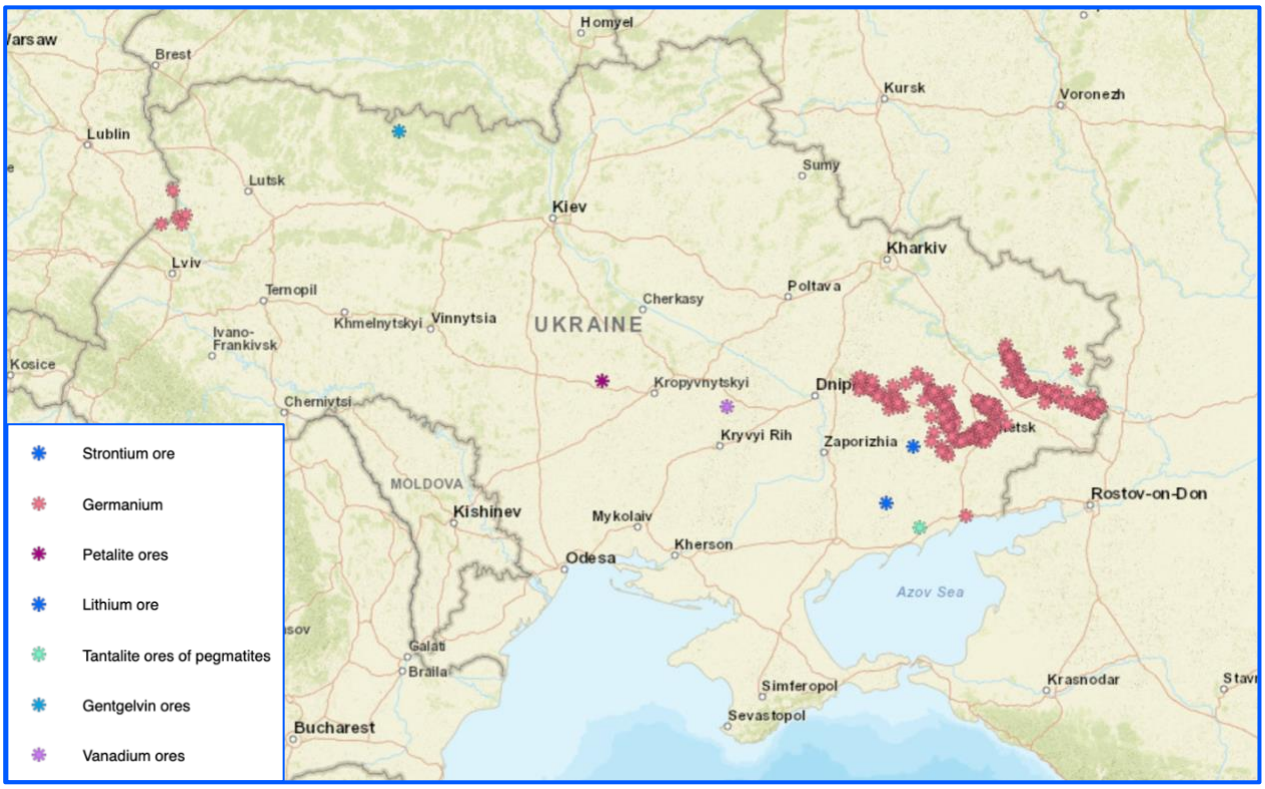
Germanium ores are exceedingly rare, and they are found in small quantities as the minerals germanite and argyrodite. Germanium minerals are also present in zinc ores, and commercial production of germanium is carried out by processing zinc smelter flue dust. It can also be recovered from the by-products of combustion of certain coals.[70]

In 2021, the U.S. imported an estimated 30 metric tons of germanium, with an import reliance of more than 50% of apparent consumption. Like gallium, the U.S. imports the most germanium from China, the world's leading producer. Of the 140 metric tons of germanium produced worldwide in 2021, China accounted for 95 metric tons, or 68% world production. Russia accounted for 5 metric tons, or 3.57% of world production in 2021, and it has maintained the same level or production since at least 2016. From 2017-2020, the U.S. imported germanium metal predominantly from China (53%), Belgium (22%), Germany (11%), Russia (9%), and other countries (5%).

In 2020, the U.S. imported from China 6,480kg of unwrought germanium and 917kg of wrought germanium. In the same year, the U.S. imported from Russia 1,760kg of unwrought germanium and 787kg of wrought germanium, both substantial increases from 2019 import levels. The U.S. government maintains a stockpile of 14,000kg of germanium material.[71] World germanium consumption has been greater than primary production in recent years, but releases of germanium from government stockpiles and increased recycling have provided adequate supply.[72]

It is estimated that about 30% of the total germanium consumed worldwide is produced from recycled materials. For example, germanium scrap can be recovered from the windows in decommissioned tanks and other military vehicles. The major global end uses for germanium were electronics and solar applications, fiber-optic systems, infrared optics, polymerization catalysts, and other uses (such as chemotherapy, metallurgy, and phosphors). Germanium is currently being applied to solar cell technology in the U.S. in the form of generating new solar arrays using germanium substrates for the International Space Station,[73] as well as a power source for the National Aeronautics and Space Administration's Gateway space station which is currently being developed.[74]

From 2011 to 2013, Ukraine produced 700kg of germanium each year.[75] Russian incursions into the Crimean Peninsula and the eastern territory of Ukraine in 2014 drove a 14.29% decrease in Ukrainian production of germanium in that year, and in 2015 and 2016 production dropped to 500kg/year, or to 71.43% of pre-invasion production levels. A data source has not been identified for Ukrainian germanium production from 2017 onwards. Sites of germanium extraction in Ukraine are present in the following areas: Volynska, Dnipropetrovsk, Donetsk, Luhansk, Lviv, and Kharkiv; however, there is clear concentration in the east in Donetsk and Luhansk, as shown below.[76]



Silicon can be a less-expensive substitute for germanium in certain electronic applications. Conversely, gallium arsenide and germanium are the principal substitutes for silicon in semiconductor and infrared applications.

Palladium

Between 25% and 30% of the world's supply of palladium is mined in Siberia by PJSC MMC Norilsk Nickel,[77] and approximately 35% of U.S. palladium is sourced from Russia.[78] The commodity's current price indicates a 70.44% increase from its record low of $1,600.00 USD/ounce in December of 2021, and it could continue to rise as sanctions are imposed on Russia for its actions in Ukraine.[79] It is important to note that PJSC MMC Norilsk Nickel has been suspended by the London Stock Exchange (LSE) as a result of the ongoing conflict in Ukraine.[80]

The platinum group metal palladium, appearing mainly in alloy states, is used as a cheaper manufacturing alternative to gold in the semiconductor manufacturing industry. Palladium-nickel and palladium-cobalt alloys[81] are most often seen on points of contact such as connectors and in plating jobs that have traditionally employed the use of gold. The two alloys offer increased protection against corrosion and low surface contact resistance, respectively. Additionally, the material can be utilized as a catalyst to promote reactions among specific materials[82]; to produce sensors; create emerging memory technologies and automotive emission systems.[83]

As of 3 March 2022, palladium trades at $2,727.79 USD/ounce.[84] With the semiconductor shortage expected to ease in the second half of 2022, Australia and New Zealand Banking Group (ANZ) analysts project that "demand for palladium for automotive catalysts will increase by 449,000 ounces in 2022, with a widening deficit in supply. ANZ's palladium forecast for 2022 has the metal trading around $2,350 per ounce by the end of December, averaging $2,088 per ounce for the year."[85]

Additionally, multiple data sources indicate that Russia and South Africa account for 33%-35% of the global palladium supply.[86] It is important to note that if the ongoing conflict in Ukraine continues to escalate, and/or if the U.S. imposes additional sanctions on Russia there could be a constrained supply of certain critical materials needed for both U.S. and global chip production. Any resources withheld from global markets could impact the balance of international supply and demand for palladium. As a result, the price for the commodity has the potential to be impacted significantly.

Palladium Alternatives

Recycled Palladium from used automobiles is expected to create a supply glut in the coming decades as demand for catalytic converters falls with vehicle electrification.[87] Electric vehicles have no need for catalytic converters as they do not produce localized emissions.

Neon

The U.S. imports 90% of its semi-conductor-grade supplies from Ukraine with Ukraine itself accounting for most of the world's supply of neon. With the recent events of Russian kinetic action in Ukraine, the White House has warned the chip industry to find ways to diversify its supply environment.[88]

Neon is often used in the manufacture of excimer lasers that create chips through a process known as lithography. It is a bi-product of Russian steel manufacturing and purified in the country of Ukraine.[89] Ukrainian companies Iceblick, Ingas, and Cryoin manufacture 70% of the world's supply of neon.[90] The potential for retaliation has garnered more attention after a report highlighting the reliance of semiconductor manufacturers on Ukrainian and Russian sourced materials like neon.[91] The global chip supply is already being impacted by COVID-19 and other factors, and demand is expected to increase. Demand for the material is estimated to rise by more than 37% over the next 4 years.[92]

While supplies may be reduced, production is not expected to be severely interrupted since both wafer and gas supply factories have inventories and diversified sources of supplies. As of now, there does not appear to be an inadequate neon supply,[93] but it is expected that supplies will be even tighter and prices steeper as tensions in Europe increase.

Both major exporters of Neon in Ukraine are in the port city of Odessa, one has been cut off from commercial shipping. Neon is an important input to the semiconductor manufacturing process as it is used in lithography; however, ASML Holding N.V., a key lithography machine manufacturer, stated it has a limited reliance on Neon imports from Ukraine even though the country accounts for most world exports.[94] This limitation to Ukrainian Neon exports to the world market is expected to drive prices up despite supply chains having developed a degree of resilience to such shocks after prices rose 600% following Russia's invasion of Crimea in 2014.

Neon Alternatives

The industry does have experiences dealing with disruptions to the supply of neon, especially after Russia invaded Crimea in 2014. The industry conducted research and found ways to reduce the usage of neon gas. Adjusting software logic and optimizing the purging process of the gas filling procedure, usage can be cut by 25~50%.[95]

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