

Germanium and Gallium: U.S. Trade and Chinese Export Controls

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The global supply chain for germanium and gallium is expected to encounter significant changes with the Chinese government's announcement of new export controls on these critical minerals, effective August 1, 2023. Germanium and gallium hold immense importance in various industries such as semiconductors, solar panels, and electric vehicles. The United States is heavily reliant on imports for both of these critical minerals, especially from China given its dominant role as a major producer and supplier of both products. This executive briefing explores the potential implications of China's export controls on the United States.

Germanium and gallium are both vital minerals for the production of an array of goods, notably semiconductors, solar panels, and electric vehicles. On July 3, 2023, China's Ministry of Commerce announced new export controls on germanium and gallium, emphasizing the importance of these minerals on the international market. Both minerals were included in the 50 mineral commodities on the 2022 List of Critical Minerals created by the United States Geological Survey (USGS).¹ Additionally, gallium, mainly in the form of gallium nitride and gallium arsenide, is used to create integrated circuit chips and optoelectronic devices, like laser diodes, LEDs, and solar cells. Gallium-based semiconductors are used in different technologies like computers, telephones, and even military applications. In the electric vehicle industry, the enhanced electron mobility in gallium nitride semiconductors makes them more efficient and improves thermal management, which results in lower cost cooling systems. Additionally, gallium nitride is good for reducing mass in electric vehicles. Germanium is primarily used in multijunction solar cells, infrared optics, and fiber optics. Germanium's ability to minimize signal loss over long distances in fiber optics has become increasingly important given the expanding demand for high performance data networking.

Global Trade in Gallium and Germanium

China is the primary global producer of these minerals producing around 60 percent and close to 90 percent of the world's germanium and gallium in 2022, respectively.² During 2018–21, China provided 54 percent of U.S. imports of germanium and 53 percent of gallium.³ According to the USGS, the United States' net import reliance as a percentage of reported consumption for germanium and gallium in 2022 was over 50 and 100, respectively.⁴ Furthermore, from 2021 to 2022, the general customs value of gallium imports into the United States rose by nearly \$1.7 million, a 997.5 percent increase. Figure 1 shows the sharp increase in U.S. imports of unwrought gallium from China between 2019 and 2022.⁵ The term "unwrought" details how the mineral has not undergone significant processing and is in a pure form. The unwrought mineral is refined according to its intended use. According to the USGS, a supply chain disruption in gallium could have the potential to impact the electronics and computer industries as well as the automotive sector. During the week that export controls were announced, gallium prices reportedly

¹ USGS, [2022 List of Critical Minerals](#), February 2022.

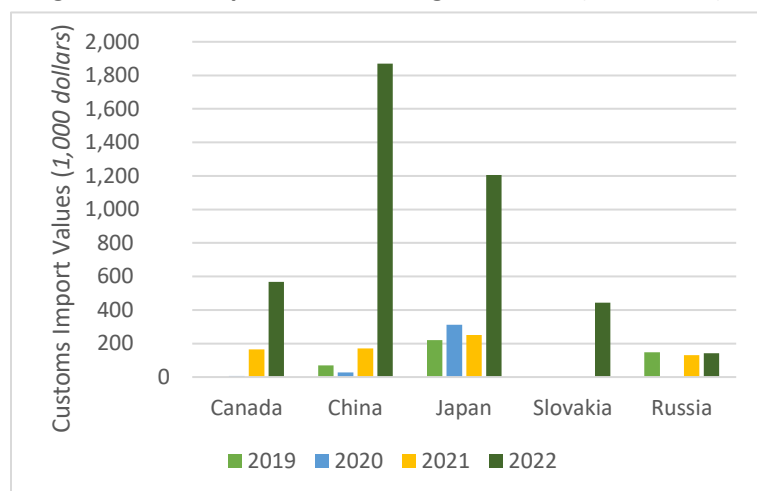
² Al Jazeera, "[Costlier cars? Why China's gallium, germanium export curbs matter](#)," July 12, 2023; Reuters, "[China's major germanium and gallium producers](#)," July 7, 2023.

³ According to section 7002(a)(2) of the [Energy Act of 2020](#), a critical mineral is "any non-fuel mineral, element, substance, or material...[which] has high risk for supply chain disruption; and serves an essential function in one or more energy technologies."

⁴ USGS, [Germanium](#), January 2023, and [Gallium](#), January 2023.

⁵ [USITC DataWeb/Census](#), HTS subheadings 8112.92.10, 8112.92.60, accessed July 27, 2023.

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Figure 1: U.S. Imports of Unwrought Gallium (2019-2022)

Source: [USITC DataWeb/Census](#); HTS subheading 8112.92.60

rose 27 percent.⁶ With a rise in prices, the output of devices that require semiconductors could fall over the coming months.⁷ Compared to gallium export controls, the effect of China's germanium export controls may be more muted. As recently as 2022, germanium was extracted from zinc deposits in Alaska and Tennessee.⁸ Furthermore, the U.S. government holds the National Defense Stockpile, with 68,671 germanium wafers; 14,047 kg of intrinsic germanium metal; and 6,905 kg of germanium scrap as of September 30, 2022.⁹ In 2022, the Department of Defense (DOD) began

recovering germanium scrap from discarded night vision lenses and Bradley Fighting Vehicle turret windows under the Strategic Materials Recovery and Reuse Program which operates under the Strategic and Critical Materials Stock Piling Act of 1939.¹⁰ The DOD program produced around 3,000 kg of pure germanium ingots to be put in the National Defense Stockpile, with the recovered amount representing around 10 percent of the U.S. demand for purified germanium.¹¹ There is currently no strategic stockpile of gallium.

According to Chinese customs data for August 2023, during the first month of export controls, China exported no wrought gallium or wrought germanium. In September 2023, China exported no wrought gallium and 1 kg of wrought germanium. In October 2023, China exported 227 kg of gallium and 590 kg of germanium. For comparison, in the month of July 2023, China exported 7,965 kg of germanium and 6,876 kg of gallium. Chinese export controls require export licenses for Chinese companies that meet the relevant requirements. The requirements state that exporters of gallium and germanium products must obtain a license for "dual-use items and technologies, or those which have potential military and civilian uses."¹² In October 2023, the price of gallium reached 1,975 yuan (\$269.95) per kg, an 18 percent increase since July 2023.¹³ Demand in European and Chinese markets led to even greater surges in gallium prices in Europe, with global prices up by 68 percent since July 2023. On December 13, 2023, germanium prices were set at \$2,839.40 per kg, a 21 percent increase since January 1, 2023.¹⁴

⁶ Burton, "China's 'first warning shot' on export controls," July 7, 2023.

⁷ Alonso, Manley, and Nassar, "Examining industry vulnerability," August 2022.

⁸ USGS, [Germanium](#), January 2023; Reuters, "Pentagon has strategic germanium stockpile," July 6, 2023.

⁹ CRS, "Emergency Access to Strategic and Critical Materials," November 14, 2023.

¹⁰ 50 U.S.C. 98 et seq.

¹¹ CRS, "Emergency Access to Strategic and Critical Materials," November 14, 2023.

¹² Reuters, "China approves export licences for chip materials gallium, germanium," September 21, 2023.

¹³ Reuters, "Chinese gallium prices hit 7-month high," October 19, 2023.

¹⁴ Reuters, "Chinese gallium prices hit 7-month high," October 19, 2023; Strategic Metals Invest, [Germanium Prices](#), accessed December 18, 2023.

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