

ARSENIC

(Data in metric tons, arsenic content,¹ unless otherwise specified)

Domestic Production and Use: Arsenic trioxide and primary arsenic metal have not been produced in the United States since 1985. The principal use for arsenic compounds was in herbicides and insecticides. Arsenic trioxide was predominantly used for the production of arsenic acid, which is a key ingredient in the production of chromated copper arsenate (CCA) preservatives. CCA preservatives are used for the pressure treating of lumber for primarily nonresidential applications such as light poles, marine applications, and retaining walls. Seven companies produced CCA-treated wood in the United States in 2023. High-purity (99.9999%) arsenic metal was used to produce gallium-arsenide (GaAs) semiconductors for solar cells, space research, and telecommunications. High-purity arsenic also was used for germanium-arsenide-selenide specialty optical materials. Indium-gallium-arsenide (InGaAs) was used for shortwave infrared technology. The grids in lead-acid storage batteries were strengthened by the addition of arsenic metal. Arsenic metal also was used as an antifriction additive for bearings, to harden lead shot, and in clip-on wheel weights. The value of arsenic compounds and metal imported domestically in 2023 was estimated to be \$8 million. Given that arsenic metal has not been produced domestically since 1985, it is likely that only a small portion of the material reported by the U.S. Census Bureau as arsenic exports was pure arsenic metal, and most of the material that was reported under this category reflects the gross weight of alloys, compounds, residues, scrap, and waste products containing arsenic. Therefore, the estimated consumption reported under U.S. salient statistics reflects only imports of arsenic products. Domestically, the leading uses of arsenic were as follows: herbicides and insecticides and wood preservatives, 80%; semiconductor, 6%; metallurgical, 3%; batteries, 1%; and other, 10%.

Salient Statistics—United States:	2019	2020	2021	2022	2023^e
Imports for consumption: ²					
Arsenic metal	391	522	835	858	710
Compounds	<u>7,090</u>	<u>7,750</u>	<u>4,760</u>	<u>9,750</u>	<u>5,700</u>
Total	7,480	8,270	5,600	10,600	6,400
Exports, all forms of arsenic (gross weight)	56	29	31	82	15
Consumption, estimated, all forms of arsenic ³	7,480	8,270	5,600	10,600	6,400
Price, metal, annual average, U.S. warehouse, ⁴ dollars per pound	1.01	1.08	1.11	1.67	2
Net import reliance ⁵ as a percentage of estimated consumption, all forms of arsenic	100	100	100	100	100

Recycling: Arsenic metal was contained in new scrap recycled during GaAs semiconductor manufacturing. Arsenic-containing process water was internally recycled at wood treatment plants where CCA was used. Although scrap electronic circuit boards, relays, and switches may contain arsenic, no arsenic was known to have been recovered during the recycling process to recover other contained metals. No arsenic was recovered domestically from arsenic-containing residues and dusts generated at nonferrous smelters in the United States.

Import Sources (2019–22):² Arsenic acid: Malaysia, 95%; Hungary, 4%; and China, 1%. Arsenic metal: China,⁶ 93%; Japan, 5%; Germany, 1%; and other, 1%. Arsenic trioxide: China, 59%; Morocco, 35%; Belgium, 4%; Germany, 1%; and other, 1%. All forms of arsenic: China,⁶ 58%; Morocco, 30%; Malaysia, 7%; Belgium, 4%; and other, 1%.

Tariff:	Item	Number	Normal Trade Relations 12–31–23
	Arsenic metal	2804.80.0000	Free.
	Arsenic acid	2811.19.1000	2.3% ad valorem.
	Arsenic trioxide	2811.29.1000	Free.
	Arsenic sulfide	2813.90.1000	Free.

Depletion Allowance: 14% (domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Peru, China, and Morocco, in descending order of production, continued to be the leading global producers of arsenic trioxide, accounting for about 97% of estimated world production in 2023. China and Morocco continued to supply about 91% of United States imports of arsenic trioxide in 2023. China was the leading world producer of arsenic metal and supplied 98% of United States arsenic metal imports as of September 2023. Malaysia supplied all of the arsenic acid that was imported as of September 2023.

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High-purity arsenic metal was used to produce GaAs, indium-arsenide, and InGaAs semiconductors that were used in biomedical, communications, computer, electronics, and photovoltaic applications. Total revenues from GaAs devices decreased in 2023 because of inflation, high interest rates, and fears of a recession have caused a lower deployment of fifth-generation networks and consumer devices. A variety of GaAs wafer manufacturers ranging from large, multinational corporations to small, privately owned companies competed in this industry, but the top six producers accounted for more than 75% of the global market.

World Production and Reserves:

	Production^{e, 7} (arsenic trioxide, gross weight)		Reserves⁸
	<u>2022</u>	<u>2023</u>	
United States	—	—	World reserves data were unavailable but were estimated to be more than 20 times world production.
Belgium	1,000	1,000	
Bolivia	40	—	
China	24,000	24,000	
Japan	40	40	
Morocco	7,500	8,000	
Peru	27,000	27,000	
Russia	500	200	
World total (rounded)	60,100	60,000	

World Resources:⁸ Arsenic may be obtained from copper, gold, and lead smelter flue dust, as well as from roasting arsenopyrite, the most abundant ore mineral of arsenic. Arsenic has been recovered from orpiment and realgar in China, Peru, and the Philippines and from copper-gold ores in Chile, and arsenic is associated with gold occurrences in Canada. Orpiment and realgar from gold mines in Sichuan Province, China, were stockpiled for later recovery of arsenic. Arsenic also may be recovered from enargite, a copper mineral. Arsenic trioxide was produced at the hydrometallurgical complex of Guemassa, near Marrakech, Morocco, from cobalt-arsenide ore from the Bou Azzer Mine.

Substitutes: Substitutes for CCA in wood treatment include alkaline copper quaternary, ammoniacal copper quaternary, ammoniacal copper zinc arsenate, alkaline copper quaternary boron-based preservatives, copper azole, copper citrate, and copper naphthenate. Treated wood substitutes include concrete, plastic composite material, plasticized wood scrap, or steel. Silicon-based complementary metal-oxide semiconductor power amplifiers compete with GaAs power amplifiers in midtier third-generation cellular handsets. Many semiconductor manufacturers were moving away from GaAs- and silicon-based lateral diffused metal-oxide-semiconductor field-effect transistors to those using gallium nitride. Indium phosphide components can be substituted for GaAs-based infrared laser diodes in some specific-wavelength applications, and helium-neon lasers compete with GaAs in visible laser diode applications. Silicon is the principal competitor with GaAs in solar-cell applications. In many defense-related applications, GaAs-based integrated circuits are used because of their unique properties, and no effective substitutes exist for GaAs in these applications. In heterojunction bipolar transistors, GaAs is being replaced in some applications by silicon-germanium.

^eEstimated. — Zero.

¹Arsenic content of arsenic metal is 100%; arsenic content of arsenic compounds is 77.7% for arsenic acids, 60.7% for arsenic sulfides, and 75.71% for arsenic trioxide.

²Arsenic content estimated from the reported gross weight of imports.

³Estimated to be the same as total imports.

⁴Minimum 99% arsenic. Source: Argus Media group, Argus Non-Ferrous Markets.

⁵Defined as imports.

⁶Includes Hong Kong.

⁷Includes calculated arsenic trioxide equivalent of output of elemental arsenic compounds other than arsenic trioxide; inclusion of such materials would not duplicate reported arsenic trioxide production. Chile and Mexico were thought to be significant producers of commercial-grade arsenic trioxide but have reported no production in recent years.

⁸See Appendix C for resource and reserve definitions and information concerning data sources.