

HIGH-TECHNOLOGY METALS: DEMAND, RESOURCES AND DEPOSITS - FOCUS ON GERMANIUM AND INDIUM

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Many metals of daily use play an inconspicuous role in society. Examples are the “electronic metals”, used for the production of electronic devices, coatings, solar applications and polymerisation catalysts. They comprise rare elements with semiconductor properties, e.g. germanium, indium, gallium, arsenic, cadmium, selenium, tellurium and thallium. These elements share common geochemical and economic features such as low abundance in the average crust, lack of significant enrichment in deposits, low production capacities and high production costs.

About 30 tonnes of germanium-bearing material (metal, oxide and scrap) is annually imported to Germany. The actual world mine production is down from 90 tonnes (1990) to 50 tonnes, while the recycling rate increased to 35 percent in 2004. Indium production and consumption increased from 150 tonnes (1990) to 360 tonnes in 2003. The recycling rate is variable; about 50 to 60 percent of the Japanese ITO (In-Sn oxides) production, primarily used for liquid crystal screens, is recycled. Yearend kilogram prices of germanium decreased from >1000 US\$ in 2000 to <500 US\$ in 2003, and are currently at 640 US\$. Indium prices were below 100 US\$ in 2000 and reached a record high of 600 US\$ in 2004.

Current major resources of germanium and indium are contained in some base metal sulfide deposits, and production as by-products comes from zinc, copper and lead smelting processes. Mining operations designed at the production of electronic metals as the only commodity proved uneconomic. The present supply of germanium is mainly from sediment-hosted (clastic and/or carbonate) deposits, where Ge substitutes for Cu in the sphalerite and wurtzite structures. An example is the Red Dog deposit, Alaska. Future production may come from coal ashes.

In the past, large quantities of germanium were produced from the Neoproterozoic, carbonate-hosted polymetallic (Cu, Pb, Zn) Tsumeb (Namibia) and Kipushi (DR Congo) deposits. Germanium is contained in copper thiogermanate minerals such as germanite, reniérite, germanocolusite and briartite, and occurs as substitution in enargite and tennantite. Smaller deposits of this type were recently discovered and developed, and may eventually contribute to the future supply of the metal. Significant germanium resources are contained in slags stored at the Tsumeb and Lubumbashi smelter sites.

Indium is mainly extracted from volcanic-hosted zinc-copper-(tin) ores. Rich deposits may contain up to 600 ppm indium in the zinc concentrate. A major producer is the carbonate-hosted lead-zinc-copper deposits at Dachang, China. Indium is mainly associated with sphalerite and is related to replacement processes by copper-indium-bearing fluids. The world supply originates from a small number of large-tonnage massive sulphide deposits, and limited smelter capacities furthermore result in economic shortage and raising prices.