

GERMANIUM

By a Special Contributor

Germanium is a relatively common semi-conducting element that has similar properties to silicon metal. Germanium is mostly produced as a by-product of zinc and copper-zinc smelting where it is recovered from flue dust. There is also a significant resource of germanium in carbonaceous materials such as coal, where there is interest in recovering the material from post-combustion flue dust.

Germanium is well known as an excellent semi-conductor, and is used in a variety of products that include night vision enhancement devices. Germanium dioxide is a highly effective polymerisation catalyst, which represents its highest single end-use. GeO_2 is used as a catalyst, or as an additive, in the production of polyethylene terephthalate (PET), which is the basis for the production of plastic bottles, sheet, film and textile fibres. Germanium dioxide, the most frequently-traded form of germanium, is transparent to infrared light, in much the same way that window glass is transparent to optical light.

Estimated end-uses for germanium in 2004 were:

Polymerisation catalysts:	35%
Infrared optics	25%
Fibre optics	20%
Electronics and solar applications	12%
Other (research, metallurgy, chemotherapy)	8%

Production

Production of germanium is reported by only a few countries, of which China is the largest. Power shortages in China in 2004, and extending into 2005, reduced the country's output of germanium by about 15%, although production is now thought to be recovering.

World production of germanium metal (tonnes)

Country	1999	2000	2001	2002	2003	2004
US	20	23	20	12	12	15
China	14	14	21	*20	*20	*18
Japan	1	2	2	1	1	1
Ukraine	1	-----	-----
World Total (rounded)	39	43	47	36	36	40

Source: British Geological Survey

Notes:

1. Significant quantities of germanium are also believed to be recovered from imported or domestic material in Canada, China, France, Germany, Russia and to a lesser extent Italy. An estimate of their contribution to world production is incorporated in the world total

2. Because germanium production is not generally reported, most world total production estimates vary between 40 t and 50 t
 3. Zinc concentrates from US-based Red Dog and Pend Oreille mines are processed at the Teck Cominco plant in Trail, Canada. It is, therefore, not possible to reliably distinguish between Canada production and US production. Estimates for production in Canada have been incorporated in the world total.
- * Including production of secondary metal

Prices

The nature of germanium as a by-product of zinc smelting means that germanium production responds slowly to changes in demand. At times of high zinc prices germanium supply tends to outstrip demand, with the opposite happening during low zinc prices and consequent lower production. This slow response to market demand tends to introduce a certain degree of volatility to the germanium price.

Annual average price for germanium dioxide (US\$/kg)

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
345	648	1264	923	812	791	683	650	488	307	358

Source: USGS

The value of germanium metal produced in 2004 is estimated at US\$39 million at average 2004 prices.

Recycling

Secondary material is an important source of germanium, with new (process) scrap accounting for up to 60% of germanium consumed during the manufacture of electronics. Germanium is also recycled from end of life electronics that are used as feed to refineries, although due to the small amounts of germanium present in electronic devices this is only a small proportion of secondary sourced germanium. The introduction of new EU Directives on Waste Electrical and Electronic Equipment (WEEE) is expected to result in more germanium availability from old scrap.

Companies

The world's largest integrated germanium producer is Teck Cominco Ltd at its Trail smelter and refinery complex in British Columbia, Canada. Teck Cominco processes ores and concentrates from the Red Dog zinc mine in Alaska and from other mines in the US, Canada and South America. The company has a production capacity of 20 t/y of contained germanium, and plans to increase this figure to 40 t/y in the future. In July 2005, workers at the Trail smelting complex went on strike over stalled wage negotiations, resulting in a small increase in germanium prices prompted by fears of short-term supply difficulties.

The US is the world's second-largest producer and produced about 15 t of germanium in 2004 from various refineries. The feedstock to US-based refineries is a mixture of process scrap, imported concentrates and residues from US-based zinc-mining operations.

The major European producer of high-purity germanium and germanium compounds (particularly germanium dioxide) is Umicore in Belgium. In China the largest producer is Yunnan Chihong Zinc-Germanium Co Ltd, a subsidiary of Yunna Metallurgical Group General Co, which produced about 10 t of germanium in 2004. Shanghai Longtai Industry Corp is one of the largest germanium smelters in China, with a capacity of about 800 kg/mth. There are several other smelters in China that report germanium production, and in 2004 most of them either stockpiled material or scaled back production owing to weak prices. Total productive capacity in China is estimated at about 50 t/y.

In Russia the sole germanium producer is The Germanium Plant in Krasnoyarsk, Siberia. The plant has experienced difficulty in obtaining sufficient feed, and it has been reported to have been operating at only 25% of capacity during 2004 and into 2005.

Market outlook

Primary germanium supply fell below consumption during 2004, with the difference coming from above ground stocks. The price remained volatile as a result of the dependence of germanium supply on zinc demand. The future outlook for germanium is positive, with demand for infrared devices (particularly in safety devices fitted to automobiles and for military equipment) growing throughout 2004 and expected to grow by 3-4% in 2005.

Demand for fibre optics and germanium-based PET catalysts appears to have been steady throughout 2004. A new silicon-germanium (SiGe) compound that could potentially replace gallium arsenide-based components in wireless communication devices continues to be developed in several countries. This newly-developed material carries the dual benefits of exceptionally high speed and the utilisation of existing low-cost, established production techniques that are designed for the manufacture of silicon-based computer chips.

The price for germanium is predicted to rise as demand for infrared devices continues to grow. However, prices may be lower than expected as germanium consumption in catalysts for PET production is reduced by substitution of other, less efficient, catalysts as the germanium price rises. Of particular interest is the US Department of Defence's plan to equip all tanks in the Iraq theatre with new infrared night vision devices. When implemented this plan may add as much as 10% to current world germanium consumption.