

# Germanium

*U.S. Geological Survey Germanium Commodity Specialist John D. Jorgenson has prepared the following information on germanium, a critical component in many cutting-edge technologies.*

Germanium is a hard, brittle semimetal that first came into use over a half-century ago as a semiconductor material in radar units and in the first transistor ever made. Most germanium is recovered as a byproduct of zinc smelting, but it has also been recovered at some copper smelters and from the fly ash of coal-burning industrial power plants.

A highly dispersed element, germanium occurs in trace amounts in many common minerals, where it substitutes in the crystal lattice for arsenic, gallium, silicon, tin, zinc and other elements. It is primarily concentrated in base-metal sulfide ore minerals. U.S. reserves of germanium are located mainly in the zinc deposits of the Red Dog district in Alaska, with lesser amounts in the zinc ores of central Tennessee. Worldwide, between 25 and 35 percent of the total germanium used is derived from recycled scrap.

Germanium owes its utility to several of its salient properties. It is an intrinsic semiconductor that is particularly effective at high frequencies and low operating voltages. Germanium is transparent to the infrared spectrum and forms glass, much like silicon. It also has an exceptionally high refractive index that does not change greatly with the wavelength of incident radiation.

These properties have made germanium a valuable alloying component used in semiconductor electronic microchips. Silicon-germanium (SiGe) chips, often referred to as Siggie chips, operate at much higher frequencies and speeds, use less power and create less electronic noise than the standard silicon-only chips. Germanium's thermal (infrared) imaging properties have made it ideal for new military and civilian applications, such as night vision systems. Germanium is also used as a polymerization catalyst for polyethylene terephthalate (PET), a commercially important plastic widely used in the beverage container industry. The primary use of germanium, however, is as a component of the glass in telecommunications fiber optic cable.

Germanium is one of the metals still held in the National Defense Stockpile. The full inventory, currently valued at \$36 million, has been authorized for sale by the Defense Logistics Agency. Germanium sold from the government stockpile for \$461 per kilogram in December 2002. Spot prices for germanium metal have recently been listed in the \$500 to \$600 per kilogram range. Germanium is also traded as germanium dioxide, mainly in powder form.

U.S. refinery production of germanium from primary and secondary materials in 2001 was estimated at 20 metric tons. Domestic consumption in 2001 was estimated at 28 metric tons. The estimated germanium content of imports in 2001 was 8.2 metric tons, with China, Belgium and Russia supplying 89 percent of these imports.

Originally published as *Geotimes* Mineral Resource of the Month, June 2003  
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Sample of the metal germanium with penny for scale. Image from *Minerals in Your World*.