

40 Gallium

Gallium is a strategic metal used in optoelectronic and defence applications. There is no primary source of gallium in the country. It is generally recovered from sodium aluminate liquors obtained in Bayer's alumina process during aluminium production. A small quantity of gallium is also recovered from residues obtained during zinc processing in some countries. Gallium present in bauxite and zinc ores is partly recoverable. It can also be extracted from polymetallic ores by leaching and from coal ash and coal. Bauxite deposits in the country contain gallium and is recovered during its processing.

USES

Gallium based compounds, such as Gallium arsenide (GaAs) and Gallium nitride (GaN), are semiconductors used in the electronic industry. It is also used in the manufacture of memory cells.

Optoelectronic devices such as LEDs, laser diodes, photodetectors and solar cells manufactured from GaAs continued to be the principal consumer of gallium worldwide. In the near future, use of GaAs is expected to increase, especially in communication markets. Increased use of cellular communications and direct broadcast satellite applications are expected to increase the demand of gallium.

A photonic crystal designed to bend light sharply with near-perfect transmission has been developed in the USA. This ability to bend light in smaller spaces would allow greater number of bends in circuits, thus reducing the circuit size, leading to further miniaturisation of laser and optical computer chips.

Gallium is used in gallium nitride laser diodes and light-emitting diodes (LED). The new gallium nitride devices are used in high density data storage (compact disk players and digital video disk players), high quality laser printing, communications and lighting.

PRODUCTION

There is no large-scale gallium production in India. Gallium is recovered as a by-product while producing alumina. Two plants namely, Hindalco Industries Ltd at Renukoot, Uttar Pradesh and National Aluminium Co. Ltd, at Damanjodi alumina refinery, Orissa, recover gallium.

Hindalco

Hindalco Industries have a capacity for gallium recovery at 55 kg per year at its Renukoot plant. The sodium aluminate liquor obtained in the Bayer's alumina process contains 0.012% gallium by weight. It is electrolysed with mercury as cathode. The amalgam is leached and the resultant sodium gallate solution is further electrolysed to produce gallium of 99.99% purity.

NALCO

NALCO's Panchpatmali bauxite deposit contains around 0.027% gallium oxide and this content is considered as the highest in Indian bauxite deposits.

A 950kg per annum 5N purity gallium extraction plant based on indigenous technology is under implementation at Damanjodi. NALCO has been pursuing plans to produce raw and refined gallium in association with the Ministry of Defence and Department of Science & Technology.

SUBSTITUTES

Liquid crystals made from organic compounds are used in visual displays as substitutes for LED. Researchers are also working to develop organic-based LED that may compete with GaAs in future. Indium phosphide components can be substituted for GaAs-based infrared laser diodes in some specific wavelength applications. The GaAs

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competes with helium-neon lasers in visible laser diode applications. Silicon is the principal competitor for GaAs in solar cell applications. GaAs-based integrated circuits are used in many defence applications because of their unique properties and there are no effective substitutes for GaAs in these applications. In some bipolar transistor applications, silicon-germanium may substitute GaAs.

WORLD REVIEW

The world resources of gallium are estimated to be over one billion kilograms. Besides, substantial resources are available in coalescence with zinc resources in the world. However, only a small fraction of these gallium resources is economically recoverable.

Data on world production of primary gallium is not available. However, the world primary gallium production was estimated to be about 80 tonnes in 2007 with China, Germany, Japan and Ukraine being the leading producers. Besides, Kazakhstan, Russia, Hungary, and Slovakia were the countries with smaller output. Refined gallium production including that from scrap refining was estimated at 103 tonnes. China, Japan and the USA were the principal producers of refined gallium. Gallium

was recycled from new scrap in Germany, Japan, the UK and the USA. World primary gallium production capacity in 2007 was estimated to be 184 tpy, refinery capacity 167 tpy and recycling capacity 78 tpy.

The world demand has been strongest in optoelectronic applications, particularly in light-emitting displays. Because of the enhanced properties, GaAs-based integrated circuits are used in place of silicon in many defence applications. The cellular telephone market was responsible principally for the growth in the gallium consumption in the past few years.

FUTURE OUTLOOK

With the vast bauxite resources, India has potential for increasing alumina production with greenfield export-oriented plants which can contribute substantially in meeting the domestic demand of gallium by establishment of gallium recovery units. The demand for gallium is likely to increase with the growth of electronic industry in the country. Strategic importance of gallium makes it imperative for development of indigenous technology and also collaboration with foreign countries for refining and production.