

40 Gallium

Gallium is a strategic metal used in optoelectronic and defence applications. It expands by 3.1% when it solidifies. 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 occurs in trace amount in bauxite & zinc ores and 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 it is recovered during its processing.

USES

Gallium is the backbone of the electronic industry. 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.

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.

Gallium is used in some high temperature thermometers and a eutectic alloy of gallium, indium and tin is widely available in fever

thermometers, replacing mercury. It is also used as a component in low melting alloys and in creating brilliant mirrors. Gallium salts such as gallium citrate and gallium nitrate are used in medical imaging as radio contrast agents.

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

It is having 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.

Preparation of Techno-Economic Feasibility Report (TEFR) for setting up of gallium extraction plant from spent liquor of alumina refinery at Damanjodi in collaboration with NLN/JFEST, Japan has been completed by EIL and the IRR was not found to be encouraging.

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 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 in bauxite are estimated to be over one billion kilograms. Besides, substantial quantity is available in zinc reserves in the world. However, only a small fraction of the gallium content in bauxite and zinc ores is economically recoverable.

Data on world production of primary gallium is not available. However, the world primary gallium production was estimated to be about 78 tonnes in 2009 with China, Germany, Kazakhstan and Ukraine being the leading producers. Besides, Hungary, Japan, Russia and Slovakia were the countries with smaller output. Refined gallium production including that from scrap refining was estimated at 122 tonnes. China, Japan, UK and USA were the principal producers of refined gallium. Gallium was recycled from new scrap in Canada, Germany, Japan, UK and USA. World primary gallium production capacity in 2009 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. In Malaysia, a new facility was completed in Penang for production of Indium gallium nitride (InGaN) - based LED chips. In Taiwan also several companies commissioned GaAs wafers plants due to growing demand.

China

MCP Group SA formed a joint venture with Chinese company Golden Harvest Ltd to create an integrated gallium operation capable of producing both low-purity and high-purity gallium. The joint venture named MCP Crystal would produce 70 to 80 tpy of 4N gallium (99.99%), besides 6N and 7N purity production. Plants are located in Henan, Shangxi and Sichuan Provinces.

Taiwan

To meet the increasing demand for GaAs wafers, WIN Semiconductors Corp. of Taiwan opened the second of its 6-inch GaAs wafer fabrication plants. The new plant's capacity of 5,000 wafers per month augments WIN's existing capacity of 7,000 wpm.

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. Zinc deposits, as alternative source, may sometimes in future, become important when easily accessible sources are used up.