

GALLIUM



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(Part- II : Metals & Alloys)

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GALLIUM

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**GOVERNMENT OF INDIA
MINISTRY OF MINES
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7 Gallium

Gallium is a soft, silvery-white strategic metal used in opto electronic and defence applications. There is no primary source of gallium in the country. Gallium does not occur in elemental form in nature. It usually occurs as trace component in zinc & bauxite ores. It is generally recovered from sodium aluminate liquors obtained in Bayer's alumina process during aluminium production and from residues obtained during zinc processing in some countries. It can also be extracted from polymetallic ores by leaching and also from coal ash and coal. Gallium is also recycled from scrap generated from industries that manufacture GaAs and GaN- based devices. Though India is endowed with bauxite ores in abundance, due to limitation in the viability of economically producing gallium, no production has been reported in the recent past.

USES

Gallium is predominantly used in the Electronic Industry. It has an unusual property that it expands by 3.1% when it solidifies. Gallium based compounds, such as, Gallium arsenide (GaAs) and Gallium nitride (GaN), are used in the production of semi-conductors for use in Electronic Industry. GaAs and GaN are increasingly used in production of light-emitting diodes (LEDs) and diode lasers. It is also used in the manufacture of memory cells and other optoelectronic devices such as photo detectors and solar cells. In the near future, use of GaAs is expected to increase, especially in Electronics & Communications Industry. Increased use of cellular communications and direct broadcast satellite applications are expected to inflate the demand of gallium.

Gallium is increasingly used in the manufacture of the new gallium nitride devices used in high-density-data-storage (compact disk players and digital video disk players), high-quality laser printing, communications and lighting purposes. Gallium nitride power transistors operate at high voltages and with higher power density than current GaAs devices.

Gallium nitride is also used as a semi-conductor and in Blu-ray Technology, mobile smartphones and LEDs.

Gallium is used in some high temperature thermometers and an eutectic alloy of gallium, indium and tin is widely utilised 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. The plutonium used in nuclear weapon pits is machined by alloying with gallium to stabilise its phase. It is used as the alloying element in the "Magnetic-shape-memory alloy" Ni-Mn-Ga". Gallium gadolinium garnet (GGG) is used as substrate for a bubble memory device.

PRODUCTION

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, Odisha, had recovered gallium in the past. A typical analysis of the Bayer liquor obtained from different alumina smelters and the estimated gallium production potentiality is shown in the Table below. It is estimated that for production of one tonne of aluminium, five tonnes of bauxite are consumed. Assuming an average gallium content of 0.006% in bauxite and overall recovery of gallium is 20%, an estimated 90-92 TPA expected gallium recovery could be arrived at from the aluminium plants in India.

HINDALCO

The Belgaum plant in 2014-15 disposed of approximately 1,66,000 tonnes of Red Mud for use in cement Industries.

During the year 2013-14, 60,000 metric tonnes of Red Mud was given to various customers for reuse in their process.

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Table – : Expected Gallium Production Potentiality

Name of the Aluminium Plant	Aluminium Production (TPY)	Estimated Gallium recovery (TPY)
NALCO	316492	19.00
HINDALCO	403367	24.20
BALCO	252807	15.16
VAL	542253	32.53
Total	1514919	90.89

NALCO

NALCO is reportedly in the process of sourcing environmentally friendly technology for establishing a gallium extraction plant. There are plans to set up 10 tpy gallium extraction plant at its Alumina Refinery in Damanjodi (Odisha). NALCO has targets to produce gallium metal with a purity of 99.99%.

VAL

Vedanta Aluminium Co. Ltd (VAL) reportedly has received offers from Nippon Aluminium in Japan for setting up of gallium plant with a capacity to produce 50-60 tonnes of gallium at an initial investment of 25 crores. The plant is likely to come up at its alumina refinery at lanjigarh in Odisha.

SUBSTITUTES

Researchers are 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 but these are no effective substitutes for GaAs in these applications. In some bipolar transistor applications, silicon-germanium is used as substitute for GaAs.

WORLD REVIEW

The world resources of gallium in bauxite are estimated to be over one million tonnes. Besides, substantial quantity is available in zinc reserves in the world. However, only small fractions of the gallium content in bauxite and zinc ores are economically recoverable. Scrap is significant source of supply for gallium principally because the process required to make wafers for a range of gallium products. This secondary gallium is produced by a variety of chemical dissolution processes suitable for treatment of scraps obtained from specific sources.

World production of primary gallium in 2014 was estimated to be 440 tonnes. China is believed to be the leading producer followed by Germany, Ukraine, Japan and Russia. Hungary & Rep. of Korea too have reported gallium production. China, Japan, Slovakia, UK and USA were the principal producers of refined gallium. Gallium was recycled from new scrap in Canada, Germany, Japan, UK and USA. Worldwide, primary gallium production capacity in 2014 was estimated to be 680 tonnes, 200 tonnes secondary capacity and 230 tonnes refinery capacity.

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

China

China's primary gallium producers were Aluminium Corporation of China Ltd, Beijing Jia Semi-conductor Material Co. Ltd, China Crystal Technologies Ltd, East Hope Mianchi Gallium Industry Co. and Zhuhai Fangyuan.

Canada

Orbite Aluminae Inc. announced that construction of its high purity alumina plant (located in Cap-Chat, Quebec), experienced significant delays and that the commercial operation was to commence in 2015. A separation facility was to be built at alumina plant to recover 4 N purity (99.99%) gallium and other rare metals and rare earth elements. Production capacity was 90 tonnes per year of primary gallium.

FUTURE OUTLOOK

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 has raised the imperative demand for development of indigenous technology and also the need for collaboration with foreign countries for refining and improving production of gallium. Zinc deposits, as an alternative source, may attract attention in the future, when the present accessible sources would deplete.

