Indian Minerals Yearbook 2019

(Part- II :Metals and Alloys)

58th Edition

GALLIUM

(FINAL RELEASE)

GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

Indira Bhavan, Civil Lines,
NAGPUR – 440 001

PHONE/FAX NO. (0712) 2565471
PBX : (0712) 2562649, 2560544, 2560648
E-MAIL : cme@ibm.gov.in
Website: www.ibm.gov.in

August, 2021

7 Gallium

Gallium is a soft, silvery-white strategic metal predominantly used in electronics. There is no primary source of gallium in the country. Gallium does not occur as a free element 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 Gallium arsenide (GaAs) and Gallium nitride (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 semiconductors for use in Electronic Industry. GaAs and GaN are increasingly used in the production of light-emitting diodes (LEDs), solar panels and laser diodes. It is also used in the manufacture of memory cells and other optoelectronic devices, such as, photo-detectors and solar cells. Use of GaAs is expected to increase especially in Electronics & Communication Industry. Increased use of cellular communications and direct broadcast satellite applications are expected to inflate the demand for gallium.

Gallium is increasingly used in the manufacture of 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 semiconductor and in Blu-ray Technology, mobile smartphones and LEDs.

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. 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.

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.

NALCO

NALCO was reportedly in the process of sourcing environment-friendly technology for establishing a gallium extraction plant. Nalco has 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%. In December 2015, NALCO has signed R & D agreement with Chalieco, China for separation of iron concentrate from Red Mud and extraction of gallium from Bayer's Liquor. An MoU was signed with Bhabha Atomic Research Centre (BARC), Mumbai on 10.05.2016 for various R & D projects for gallium recovery from Bayer's liquor.

SUBSTITUTES

Liquid crystals made from organic compounds are used in visual displays as substitutes for LEDs. Silicon-based complementary metal-oxide semiconductor power amplifiers compete with GaAs power amplifiers in midtier 3G cellular handsets. 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 is used as substitute for GaAs. Researchers are working to develop organic-based LED that may compete with GaAs in future.

WORLD REVIEW

The average gallium content of bauxite is about 50 parts per million. The world resources of gallium in bauxite are estimated to exceed one million tonnes. Besides, substantial quantity is available in zinc reserves. However, less than 10% of the gallium in bauxite and zinc resources is potentially recoverable. GaAs scrap is significant source of supply for gallium principally because the process required to make wafers for a range of gallium products yields significant amounts of scrap. This secondary gallium is produced by a variety of chemical dissolution processes suitable for treatment of scraps obtained from specific sources.

Worldwide gallium consumption was estimated to be about 355 tonnes in 2017, an increase of 4% from that of 2016. Approximately 40% to 45% of total consumption was estimated to come from recycled material. Therefore, about 195 tonnes of high-grade primary refined gallium and 160 tonnes of recycled gallium were estimated to have been consumed in 2017.

Gallium was recycled from new scrap in Canada, China, Germany, Japan, Slovakia, the United Kingdom, and the United States. As per the report of Roskill Information Services Ltd, the expected worldwide gallium consumption would increase to approximately 420 tonnes by 2020.

The world demand has been strongest in opto-electronic 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.

Primary high-purity refined gallium production in 2019 was estimated to be about 205 tonnes. China, Japan, Slovakia, and the United States were the known principal producers of high-purity refined gallium. The United Kingdom ceased high-purity gallium production in 2018. World primary low-grade gallium production capacity in 2019 was estimated to be 720 tonnes per year; high-purity refinery capacity, 330 tonnes per year; and secondary capacity, 270 tonnes per year.

Japan

Japan Oil, Gas and Metals National Corp. (JOGMEC) reported that Japan's gallium supply in 2017 totaled 165 tonnes, a 3% increase from 160 tonnes in 2016, with 57% of the gallium supply sourced from imports, 41% from recovered scrap and 2% from low-grade primary gallium produced in Japan as a by-product of zinc refining. Of Japan's 94 tonnes of imported gallium, 69% came from China; Japan remained the leading gallium-consuming country and consumed 151 tonnes of gallium in 2017. Japan's share of worldwide consumption was forecast to decrease to 41% by 2020 owing to competition from China's LED Industry. Production of GaN wafers was concentrated in Japan with more than 85% of sales held by three Japan-based companies: Mitsubishi Chemical Corp., Sciocs Co. Ltd and Sumitomo Electric Industries, Ltd.

China

China produced an estimated 300 tonnes of low-grade primary gallium in 2017 and consumed an estimated 104 tonnes of gallium approximately 29% of worldwide consumption. China's share of worldwide consumption was forecast to increase to 35% in 2020 owing to the rapid growth of the country's LED Industry. Approximately 95% of China's gallium was sourced from bauxite as a by-product from its alumina production industry. The remaining 5% was sourced from the refining of lead and zinc ores.

China's low-grade primary gallium producers included Aluminum Corp. of China Ltd (Beijing); Beijing JiYa Semiconductor Material Co., Ltd (Beijing); East Hope Mianchi Gallium Industry Co., Ltd (Shanghai); Shanxi Jiahua Tianhe Electronic Materials (Shanxi Province); Shanxi Zhaofeng Gallium Industry Co. (Shanxi Province); Xiaoyi Xingan Gallium Co., Ltd (Guangxi Province); and Zhuhai Fangyuan Inc. (Guangdong Province). China's high-grade primary refined gallium producers included Beijing JiYa Semiconductor Material Co., Ltd; 5N Plus Inc. (Shenzhen, Guangdong Province); Nanjing Jingmei Gallium Co., Ltd (Nanjing, Jiangsu Province); and Zhuzhou Keneng New Material Co., Ltd.

Canada

Orbite Technologies Inc. (formerly Orbite Aluminae Inc.) announced that construction of the purification section of its high-grade alumina plant in Cap-Chat, Quebec, was complete as of the third quarter of 2017. A separation facility was to be built at the alumina plant to recover 99.99%-purity gallium and rare-earth elements.

FUTURE OUTLOOK

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.

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.

Smartphones are a fundamental structural shift in mobile communications, offering services not available on standard cellular telephones, such as, internet access, video streaming, computer program applications ("apps"), and global positioning systems. Smartphones, which use up to 10 times the amount of GaAs-rich RF content than 2G cellular telephones, are expected to account for 76% of all worldwide handset sales by 2018 and 87% of all worldwide handset sales by 2022. Installation of 3G and 4G mobile networks in India and the Republic of Korea is expected to further increase sales of smartphones. Additional increases in GaAs demand will also result from new Wi-Fi applications, such as, point-to-point communications, smart meters, and tablet personal computer technologies.

However, market research firm Strategy Analytics Inc. forecast that while RF compound semiconductor revenue will increase to more than $11 billion in 2021, GaAs devices will not be the primary reason for this revenue growth. A slowdown in the wireless segment is expected to allow for other RF(radio frequency) compound semiconductor device technologies, including indium phosphide (InP), GaN and silicon germanium (SiGe) to drive revenue growth.

Yole Développement forecast that RF GaN device sales would increase by a compound annual growth rate (CAGR) of 23% between 2017 and 2023 owing to increased adoption of GaN technology in wireless infrastructure and defence applications, as well as implementation of new fifth-generation (5G) networks beginning around 2019. High-frequency RF applications over 3.5 gigahertz, including military radar and electronic warfare systems, commercial wireless telecommunications and CATV applications require high voltage and high power capabilities of GaN devices. GaAs and silicon devices cannot operate at such high frequencies. Owing to significant expansion of LED manufacturing capacity, Government incentives and reduced prices, global LED sales are expected to increase by a CAGR of more than 18% between 2017 and 2021.

General lighting is expected to remain the largest segment of the LED market, which would account for an estimated 77% by 2021. Sales within the Asia-Pacific region are projected to increase at a CAGR of 21% during the forecast period. The region is expected to remain the leading consumer of LED material owing to rapid construction in many Asian countries, Government incentives to encourage use of energy-efficient lighting and the presence of the majority of units under the LED Industry.