



# 2014 Minerals Yearbook

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## GALLIUM [ADVANCE RELEASE]

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# GALLIUM

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Low-grade primary gallium is recovered globally as a byproduct of processing bauxite and zinc ores. No domestic low-grade primary gallium was recovered in 2014, and imports of gallium metal and gallium arsenide (GaAs) wafers continued to account for most of U.S. gallium consumption (metal and gallium in GaAs). Metal imports were 52% higher than those in 2013. The leading sources of imported gallium metal, in descending order, were China, the United Kingdom, Ukraine, and Germany. A significant portion of imports was thought to be low-purity gallium that was refined in the United States and shipped to other countries. Data on refined gallium exports, however, were not available. Doped GaAs wafer (a wafer with intentionally modified electrical properties) imports were 51% lower than those in 2013—Japan was the leading source, followed by Taiwan, Germany, and China in descending order of quantity. Undoped GaAs wafer imports were slightly higher than those in 2013—Canada and Taiwan were the principal sources. Almost all gallium consumed in the United States was for the production of GaAs and gallium nitride (GaN), which, along with imported wafers, were used in integrated circuits (ICs) and optoelectronic devices [laser diodes, light-emitting diodes (LEDs), photodetectors, and solar cells]. U.S. gallium consumption decreased by 5.3% from that in 2013.

In 2014, estimated world low-grade primary gallium production was 440 metric tons (t), an increase of 26% from estimated production of 350 t in 2013. China, which accounted for 82% of global low-grade primary gallium capacity (fig. 1), was the leading producer. Germany, Japan, Russia, and Ukraine were also significant producers. Additionally, plants in Hungary and the Republic of Korea recovered gallium. Kazakhstan, previously a significant producer of primary gallium, reported no production in 2014. Estimated worldwide low-grade primary gallium production increased by an average of 20% per year from 2004 through 2014 (fig. 2), owing primarily to China's large annual increases in production beginning in 2010. About 160 t of low-grade primary gallium was processed to high-purity refined gallium; the remaining low-purity primary gallium produced in 2014 was most likely stockpiled. High-purity primary refined gallium was produced in China, Japan, Slovakia, the United Kingdom, and the United States. World high-purity primary refined gallium production increased an average of 6.3% per year from 2004 through 2014. World high-purity secondary refined gallium production also increased an average of 6.3% per year. World gallium consumption, which increased an average of 6.7% per year from 2004 through 2014, was estimated to have been 285 to 300 t in 2014.

## Production

No domestic production of low-purity primary gallium was reported in 2014. Molycorp Inc. (Greenwood Village, CO)

recovered gallium from new scrap materials, predominantly those generated during the production of GaAs ingots and wafers. Molycorp's facility in Blanding, UT, had the capability to produce about 50 metric tons per year (t/yr) of high-purity gallium. The company purchased new scrap and low-purity primary gallium to refine into high-purity gallium. It also refined its customers' scrap into high-purity gallium. In 2014, the company purchased 57 t of low-purity primary gallium and 13 t of new scrap gallium materials. Molycorp's other gallium investments included an 80% interest in a gallium trichloride production facility in Quapaw, OK; a 50% interest in a primary gallium facility in Stade, Germany; a gallium recycling facility in Peterborough, Ontario, Canada; and an 80% interest in a new gallium trichloride production facility in the Hyeongok Industrial Zone in the Republic of Korea. Gallium trichloride is a precursor for many gallium compounds, including the organic gallium compounds used in epitaxial layering. At yearend, Molycorp ceased purchasing low-purity primary gallium from its Stade, Germany facility, as the joint venture was unable to provide gallium at a competitive price (Molycorp Inc., 2014, p. 45; 2015, p. 15, 47, 103).

## U.S. Consumption

Gallium consumption data were collected by the U.S. Geological Survey from a voluntary survey of U.S. operations. In 2014, 74% of the canvassed respondents replied to the gallium consumption survey. Data in tables 2 and 3 incorporated estimates for the nonrespondents to reflect full-industry coverage. Many of these estimates were based on company reports submitted to the U.S. Securities and Exchange Commission.

GaAs was used to manufacture ICs and optoelectronic devices. GaN principally was used to manufacture LEDs and laser diodes. ICs accounted for 57% of domestic gallium consumption, and optoelectronic devices accounted for 43%. Approximately 70% of the gallium consumed in the United States was contained in GaAs and GaN wafers. Trimethylgallium (TMG) and triethylgallium (TEG), metal-organic sources of gallium used in the epitaxial layering process to fabricate epiwafers for the production of LEDs and ICs, accounted for most of the remainder (table 2).

U.S. gallium consumption decreased by 5.3% from that in 2013, most likely owing to a 51% decrease in doped GaAs wafer imports mostly for use in analog ICs. U.S. gallium consumers opening new facilities in Asia (or moving their operations to Asia) to be closer to the Asian-dominated LED industry may have also contributed to decreased U.S. consumption. Gallium consumed in the production of domestic LEDs and laser diodes, however, increased by 72% from that in 2013 owing to the growing popularity of LEDs.

## Global Consumption

**Gallium Arsenide.**—The value of worldwide GaAs devices consumed increased by 17% in 2014, to \$6.9 billion from \$5.9 billion in 2013. Wireless applications accounted for approximately 80% of the revenue. Developments in cellular telephone technology, particularly sophisticated third-generation (3G) and fourth-generation (4G) smartphones, continued to drive the GaAs device industry, accounting for 53.1% of the GaAs device market in 2014. Fourth-generation smartphones use up to 10 times more GaAs than second-generation (2G) cellular telephones. Non-cellular wireless applications including Wi-Fi®, wireless infrastructure, and satellite systems accounted for 27% of the GaAs device market. Remaining sectors included consumer applications, 6.9%; fiber-optic communications, 5.2%; military applications, 5.1%; and automotive and miscellaneous applications, 2.7% (Higham, 2015b).

Worldwide sales of smartphones in 2014 totaled approximately 1.2 billion units, an increase of 28% from that of 2013, and the proportion of smartphones sold worldwide increased to 66% of total handset sales in 2014. China, the United States, and India accounted for the majority of smartphone growth in 2014, with China accounting for 405 million smartphone sales, the United States accounting for 148 million sales, and India accounting for 82 million sales. By 2017, India was expected to overtake the United States as the second largest smartphone consuming country in the world (Gartner, Inc., 2015a; Oh, 2015).

**Gallium Nitride.**—Increased demand for GaN devices, namely opto semiconductors (LEDs and laser diodes) and power semiconductors [pure power devices and radio frequency (RF) devices], provided significant growth for advanced GaN-based products. In 2014, the worldwide GaN devices market was estimated at \$482 million. GaN opto semiconductors accounted for 78% of the total market, primarily owing to the widespread adoption of LEDs; GaN power semiconductors accounted for the remaining 22% of the market (Transparency Market Research, 2015).

Owing to increased adoption of GaN RF devices in wireless, cable television (CATV), and broadband infrastructure applications, commercial applications accounted for slightly more than 50% of the total worldwide GaN RF device revenue, whereas military applications accounted for the remaining revenue. Increased demand from the military for enhanced battlefield performance stimulated demand for GaN pure power devices in 2014. The main application of GaN in the military is in discrete high electron mobility transistors (HEMT), which allow for high-frequency operations used in radar and electronic warfare systems (Higham, 2015a; Transparency Market Research, 2015).

GaN power semiconductors operate at higher voltages, power densities, and switching frequencies, and offer greater power efficiency than existing GaAs and silicon devices. They are used in aerospace, automotive, defense, industrial, medical, and commercial applications, such as CATV, power electronics, and wireless infrastructure.

**Light-Emitting Diodes.**—In 2014, the worldwide packaged LED market increased by 7.6% to \$15.6 billion and had increased by an average of 20% per year from \$1.2 billion in

2000. LEDs for general lighting applications remained the largest segment of the LED market and, according to research and consulting firm Strategies Unlimited, accounted for about 34% of LED sales, an increase from 31% of sales in 2013. Other LED markets in 2014, in decreasing order of market share, included mobile display applications (such as cellular telephones, computer notebooks and tablets, eBooks, and MP3 players), 19%; television and monitor backlighting, 16%; signage, 12%; automotive, 11%; and other uses, 8% (Strategies Unlimited, 2014a, 2015). Packaged LEDs also account for the largest end use of all GaN devices. GaN dominates key LED applications, such as televisions, computer monitors, notebook computers, and tablet computers, and has been increasingly in demand for general lighting applications (IHS Inc., 2014).

Owing to significant LED capacity expansion in 2011 and the resulting LED surplus, prices for packaged LEDs decreased in 2012 and remained low through 2014. Prices in 2014 were, on average, 20% lower than those of 2013. The lower prices were beneficial to the LED general lighting sector and more than offset the decline in LED revenue from the backlighting sector (Strategies Unlimited, 2014a, 2015).

As LED demand increased throughout 2010 and the first half of 2011, producers began adding more capacity for TMG, the metal-organic chemical used to fabricate LED epiwafers. When TMG and nitrogen gas are fed into the metal-organic chemical vapor deposition (MOCVD) reactor and heated, a GaN layer is formed on the epiwafer. TMG's purity and quality determine an LED's brightness and reliability. In 2013 (the last year with available data), an estimated 47 t of TMG was consumed worldwide, an increase of about 57% from that of 2012, with 80% consumed by China, the Republic of Korea, and Taiwan (IHS Inc., 2013). In September, Albemarle Corp. (Baton Rouge, LA) began commercial TMG production in the Republic of Korea (Albemarle Corp., 2015, p. 9).

The Asia Pacific region (East Asia, South Asia, Southeast Asia, and Oceania) was the leading consumer of LED material, followed by North America and Europe. The demand for LED material in Asia Pacific was mainly from the large number of LED manufacturing facilities located in China, the Republic of Korea, and Taiwan (Persistence Market Research, undated).

**Solar Cells.**—The solar cell market continued to be dominated by crystalline silicon solar cells, which accounted for about 90% of the market. In 2008, industry experts had thought that copper indium gallium selenide (CIGS) technology would eventually be able to compete with conventional silicon-based photovoltaic technology. CIGS technology, however, has been slow to enter the commercial market owing to a decline in prices of silicon-based solar cells, a complicated manufacturing process that has impeded commercial mass production of CIGS panels, and financial instability among many of the research-based startup CIGS companies. To keep CIGS technology competitive, CIGS manufacturers have trimmed production costs, increased production capacities, improved module conversion efficiencies, and increased CIGS adoption in commercial rooftops. Several large corporations acquired select small startup companies and increased utilization of their production capacities. China's Hanergy Holding Group Ltd. and Japan's Solar Frontier K.K. were the two predominant CIGS

manufacturers. In 2014, worldwide shipments of CIGS solar modules totaled approximately 800 megawatts, and accounted for about 2% of all solar modules shipped during the year (NanoMarkets, LC, 2014, p. 4–6; Benson, 2015, p. 12).

In September, scientists at the Center for Solar Energy and Hydrogen Research (ZSW) in Baden-Wurtemberg, Germany, achieved a record 21.7% efficiency for their CIGS solar cell in a laboratory setting (Gifford, 2014).

## Prices

Since 2002, producer prices for gallium have not been quoted in trade journals. From U.S. Census Bureau data, the annual average value for imported low-grade gallium in 2014 was estimated to be \$239 per kilogram, about 13% less than that in 2013 (table 4). The estimated annual average import value for high-grade ( $\geq 99.9999\%$ -pure) gallium decreased by 28% to \$363 per kilogram. Import data reported by the U.S. Census Bureau do not specify purity, and the estimated price distinction between gallium grades was based on the average customs value of the material and the country of origin.

According to Metal-Pages reports, gallium prices also decreased in China during 2014. At the beginning of 2014, the low-grade ( $\leq 99.99\%$ -pure) gallium price in China was reported to be about \$230 per kilogram (a decrease of 18% from that in January 2013), as significant increases in China's low-grade gallium production continued to exceed increases in worldwide consumption. By June, the price had decreased to about \$220 per kilogram and by December, the price decreased to about \$200 per kilogram.

## Foreign Trade

In 2014, U.S. gallium metal imports were 52% greater than those in 2013 (table 5), mostly owing to increased imports from China and the United Kingdom. China (33%), the United Kingdom (27%), Ukraine (19%), and Germany (17%) were the leading sources of imported gallium. As U.S. gallium consumption in 2014 was estimated to be significantly less than imports, a significant portion of low-purity gallium imports from China were most likely refined to higher purities in the United States and exported to other countries. A portion of the high-purity refined gallium imported from the United Kingdom was most likely either stockpiled or reexported. Nonaggregated data of U.S. gallium exports were not available.

In addition to gallium metal, GaAs wafers were imported into the United States (table 6). Undoped GaAs wafer imports were slightly higher than those in 2013. Doped GaAs wafer imports decreased by 51% from that of 2013 based on reduced imports from Japan. The data listed in table 6 may include some packaging material weight and, as a result, quantities may be higher than the actual total weight of imported wafers.

## World Review

Imports of gallium into Japan and the United States, two leading consuming countries, and an updated gallium production estimate for China were used as the basis for estimating world gallium production. Metal-Pages reported that China increased production of low-grade primary gallium in 2014 by at least

35% (Shen, 2014a). Estimated worldwide low-grade primary gallium production was 440 t in 2014. Principal world producers were China, Germany, Japan, and Ukraine. Gallium also was recovered in Hungary, the Republic of Korea, and Russia. Kazakhstan, which had been a leading producer in 2012, did not produce any low-grade primary gallium in 2013 and 2014, most likely owing to the worldwide surplus. Production of high-purity primary refined gallium in 2014 was estimated to be about 160 t, 64% less than low-purity primary production. China, Japan, Slovakia, the United Kingdom, and the United States refined high-purity gallium from primary material.

Roskill Information Services Ltd. (2014a) estimated worldwide gallium consumption to be about 300 t in 2014. Japan's DOWA Electronics Materials Co., Ltd. (Tokyo) estimated 2014 worldwide gallium consumption to be about 285 t (Roskill's Letter from Japan, 2014). Approximately 40% to 45% of total consumption was estimated to come from recycled material (Spicer, 2013). Gallium was recycled from new scrap in Canada, Germany, Japan, the United Kingdom, and the United States. By 2020, Roskill expected worldwide gallium consumption to increase to approximately 420 t, with LED general lighting applications accounting for 33% of consumption (Roskill Information Services Ltd., 2014b).

**Canada.**—Orbite Aluminae Inc. (Montreal, Quebec) (formerly Exploration Orbite V.S.P.A. Inc.) announced that construction of its high-purity alumina plant, located in Cap-Chat, Quebec, continued to experience delays in 2014. The plant was now expected to begin commercial operation in the third quarter of 2015. A separation facility was to be built at the alumina plant to recover 4N purity (99.99%) gallium and other rare metals and rare-earth elements (Orbite Aluminae Inc., 2012, 2014).

**China.**—Beginning in 2011, the Chinese Government passed a series of policies to stimulate domestic LED lighting demand and production, and began investing substantially in the country's LED manufacturing infrastructure. General lighting was the largest share of China's LED market growth in 2014, accounting for \$3.8 billion (57%) of the country's total packaged LED revenues of \$6.7 billion (Compound Semiconductor, 2015). China, which was reported to have produced at least 400 t of low-grade primary gallium in 2014, increased its low-grade primary gallium manufacturing capacity to 550 t in 2014 from 450 t in 2013 (Shen, 2014a). Roskill (2014a) estimated that China consumed about 57 t of gallium in 2014, approximately 19% 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.

China's low-grade primary gallium producers include Aluminum Corporation of China Ltd. (Beijing); Beijing JiYa Semiconductor Material Co., Ltd. (Beijing); China Crystal Technologies Co., Ltd. (Beijing); Chinalco Mining Corp. International (Guangxi Zhuang Autonomous Region and Henan Province); East Hope Mianchi Gallium Industry Co., Ltd. (Shanghai); Xiaoyi Xing'an Gallium Co., Ltd. (Guangxi); and Zhuhai Fangyuan Inc. (Roskill Information Services Ltd., 2011, p. 21–26; Shen, 2014b). China's high-purity primary refined gallium producers include Beijing JiYa Semiconductor Material; 5N Plus Inc. (Shenzhen, Guangdong Province); Nanjing Jingmei

Gallium (Nanjing, Jiangsu Province); and Zhuzhou Keneng New Material Co., Ltd. (Zhuzhou, Hunan Province) (Shen, 2015).

**India.**—National Aluminum Co. Ltd. (NALCO), India's largest aluminum producer, solicited gallium manufacturers to provide NALCO with the technology for extraction of gallium from NALCO's Bayer liquor and the production and marketing of low-purity primary gallium metal or gallium compounds. The gallium plant was to be located at NALCO's alumina refinery in Damanjodi, Odisha, and was expected to have a capacity of 10 t/yr of gallium (Metal Bulletin, 2014).

**Japan.**—DOWA Electronics Materials reported that Japan's gallium supply in 2014 totaled about 160 t, a 14% increase from 140 t in 2013, with 51% of the gallium supply sourced from recovered scrap, 44% from imports, and 5% from low-purity primary gallium produced in Japan as a byproduct of zinc refining (Industrial Rare Metals, 2014). Roskill (2014a) estimated that Japan remained the leading gallium-consuming country and consumed about 140 t of gallium in 2014, approximately 47% of worldwide consumption. Japan's share of worldwide consumption was forecast to decrease to 41% in 2020 owing to competition from China's LED industry. Japan was, by far, the leading producer of commercial GaN wafers, accounting for approximately 85% of worldwide production (Compound Semiconductor, 2014).

## Outlook

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 74% of all worldwide handset sales by 2015 (Gartner, Inc., 2015b; IDC Research, Inc., 2015). 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. Market research firm Strategy Analytics Inc. forecast that while commercial GaAs device sales would increase by less than 5% per year through 2018, military GaAs device sales are expected to increase by approximately 13% per year through 2018 owing to increasing use of GaAs technologies in radar, electronic warfare, communications, and other military applications. The largest use of military GaAs devices is expected to come from radar applications, accounting for approximately 60% of GaAs military market revenue (Semiconductor Today, 2014a).

Yole Développement forecast that RF GaN-based devices could reach more than 18%, by volume, of the overall RF device market by 2020, increasing by 9% per year between 2013 and 2020. High frequency (over 3.5 gigahertz) RF applications, including military radar and electronic warfare systems, commercial wireless telecommunications, and CATV applications, require the high voltage and high power capabilities of GaN devices. GaAs and silicon devices cannot operate at such high frequencies (Yole Développement, 2014).

Owing to significant expansion of LED manufacturing capacity, reduced prices, and government incentives, the LED industry is expected to expand its general lighting applications for the rest of the decade. The highest growth is forecast to be in LED-based tubes that replace fluorescent tubes used in commercial applications, LED-based street lights, and LED luminaires of varying sizes. Strategies Unlimited predicted that global unit shipments of LED street lights would increase to approximately 8 million units in 2017 from 2 million units in 2012 (Strategies Unlimited, 2014b).

China's LED lighting market is forecast to more than double to \$7.4 billion in 2017 from \$3.1 billion in 2013 owing to the country's ongoing urbanization, policy support, energy goals, and reduced LED prices. The LED share of the lighting market in China is predicted to increase from 9.6% to 18% during the same timeframe. China's residential LED market is expected to show the largest percentage growth, increasing at an average annual growth rate of 92% to \$310 million in 2017 from \$23 million in 2013 (Lux Research Inc., 2013).

As the market for general LED lighting increases, global demand for the precursors TMG and TEG is expected to more than double by 2016. China is forecast to consume up to 45% of the precursors in 2016. Led by aggressive expansion plans of leading Chinese LED companies, 220 GaN MOCVD systems are expected to be installed worldwide in 2015. MOCVD system shipments are forecast to increase an average of 14% per year between 2013 and 2018 (IHS Inc., 2013; Semiconductor Today, 2014b, 2015).

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## GENERAL SOURCES OF INFORMATION

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TABLE 1  
SALIENT U.S. GALLIUM STATISTICS<sup>1</sup>

(Kilograms unless otherwise specified)

	2010	2011	2012	2013	2014	
Production, primary crude	--	--	--	--	--	
Imports for consumption	59,200	85,700	58,200	35,400	53,900	
Consumption	33,500	35,300	34,400	37,800	35,800	
Price <sup>2</sup>	dollars per kilogram	600	688	529	502	363

-- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits.

<sup>2</sup>Estimate based on average value of U.S. imports of high-purity gallium.

TABLE 2  
U.S. CONSUMPTION OF CONTAINED GALLIUM, BY END USE<sup>1,2</sup>

(Kilograms)

End use	2013	2014
Optoelectronic devices:		
Laser diodes and light-emitting diodes	8,460	14,500
Photodetectors and solar cells	922	732
Integrated circuits:		
Analog	23,900	14,700
Digital	4,200	5,620
Research and development	312	182
Total	37,800	35,800

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes gallium metal and gallium contained in compounds produced domestically.

TABLE 3  
STOCKS, NET RECEIPTS, AND CONSUMPTION OF GALLIUM METAL, BY GRADE<sup>1,2</sup>

(Kilograms)

Purity	Beginning stocks	Net receipts	Consumption	Ending stocks
2013:				
99.99% to 99.9999%	4,930	-735 <sup>3</sup>	--	4,200
99.9999%	1,090	-244 <sup>3</sup>	64	786
99.99999% to 99.999999%	194	957	660	491
Total	6,220	-22 <sup>3</sup>	724	5,470
2014:				
99.99% to 99.9999%	4,200	-1,280 <sup>3</sup>	--	2,910
99.9999%	786	10	36	760
99.99999% to 99.999999%	491	559	748	302
Total	5,470	-713 <sup>3</sup>	784	3,980

-- Zero.

<sup>1</sup>Consumers only.

<sup>2</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>3</sup>Reshipments exceeded receipts.

TABLE 4  
ESTIMATED AVERAGE GALLIUM PRICES

(Dollars per kilogram)

Gallium metal	2013	2014
Purity $\geq$ 99.9999%; average value of U.S. imports	502	363
Purity $\leq$ 99.99%; average value of U.S. imports	276	239

Source: U.S. Census Bureau.

TABLE 5  
U.S. IMPORTS FOR CONSUMPTION OF GALLIUM (UNWROUGHT, WASTE, AND  
SCRAP), BY COUNTRY<sup>1</sup>

Country	2013		2014	
	Quantity (kilograms)	Value <sup>2</sup>	Quantity (kilograms)	Value <sup>2</sup>
Canada	89	\$19,300	66	\$16,900
China	10,700	3,090,000	17,700	3,860,000
France	112	43,700	404	199,000
Germany	12,500	4,020,000	9,320	2,690,000
Japan	619	415,000	1,360	394,000
Poland	--	--	33	14,000
Singapore	94 <sup>r</sup>	39,800 <sup>r</sup>	--	--
Taiwan	67	28,600	258	57,000
Ukraine	7,510	2,000,000	10,200	2,170,000
United Kingdom	3,700	1,210,000	14,500	4,240,000
Total	35,400	10,900,000 <sup>r</sup>	53,900	13,600,000

<sup>r</sup>Revised. -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Customs value.

Source: U.S. Census Bureau.

TABLE 6  
U.S. IMPORTS FOR CONSUMPTION OF  
GALLIUM ARSENIDE WAFERS, BY COUNTRY<sup>1</sup>

Material and country	2013		2014	
	Quantity (kilograms)	Value <sup>2</sup>	Quantity (kilograms)	Value <sup>2</sup>
Undoped:				
Austria	81	\$31,800	84	\$32,600
Canada	5,870	49,400	14,100	63,700
Taiwan	34,000	329,000	65,800	511,000
United Kingdom	39,000	51,800	9	10,400
Other	15	5,540	7	16,900
Total	79,000	467,000	80,000	635,000
Doped:				
Austria	--	--	637	41,500
Belarus	7,830	2,080,000	8,050	2,140,000
Belgium	643	449,000	476	631,000
China	36,900	27,300,000	50,700	27,800,000
Finland	10,100	5,570,000	6,840	5,110,000
France	7,980	13,100,000	2,940	2,710,000
Germany	60,500	25,100,000	51,400	23,800,000
Hong Kong	--	--	29,200	4,870,000
Italy	564	245,000	2,260	241,000
Japan	443,000	59,800,000 <sup>r</sup>	71,000	36,500,000
Korea, Republic of	9,170	1,250,000	14,500	5,470,000
Malaysia	420	233,000	2,290	305,000
Mexico	1,350	53,500	--	--
Netherlands	--	--	649	23,000
Poland	404	320,000	172	144,000
Singapore	2,580	3,810,000	5,590	1,670,000
Taiwan	46,500	70,300,000	59,300	72,400,000
United Kingdom	5,500	3,320,000	4,380	1,950,000
Other	906	1,410,000	932	1,050,000
Total	635,000	214,000,000	311,000	187,000,000

<sup>r</sup>Revised. -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Customs value.

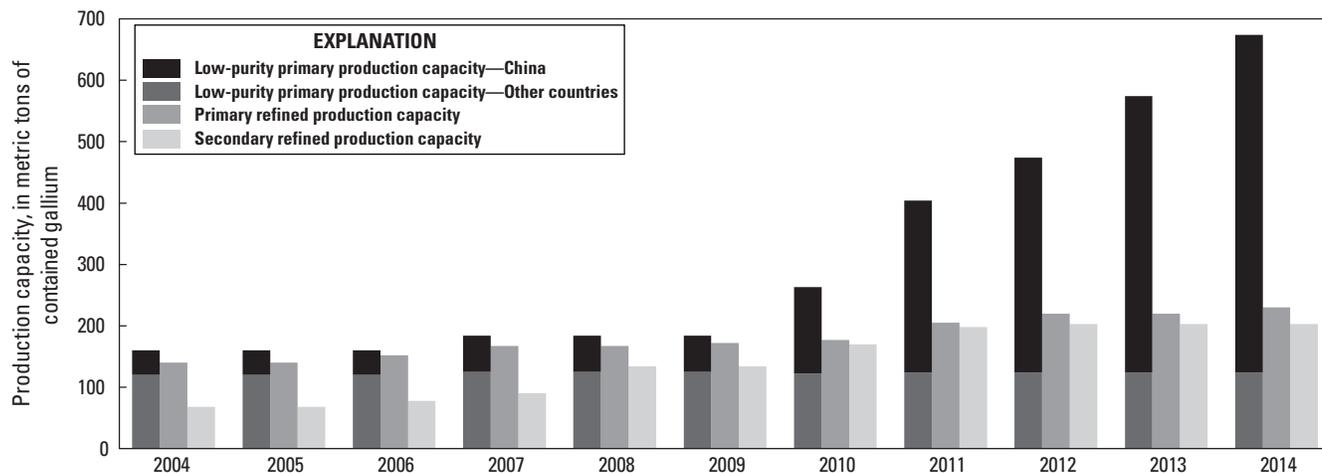
Source: U.S. Census Bureau.

TABLE 7  
ESTIMATED WORLD ANNUAL PRIMARY GALLIUM  
PRODUCTION CAPACITY, DECEMBER 31, 2014<sup>1</sup>

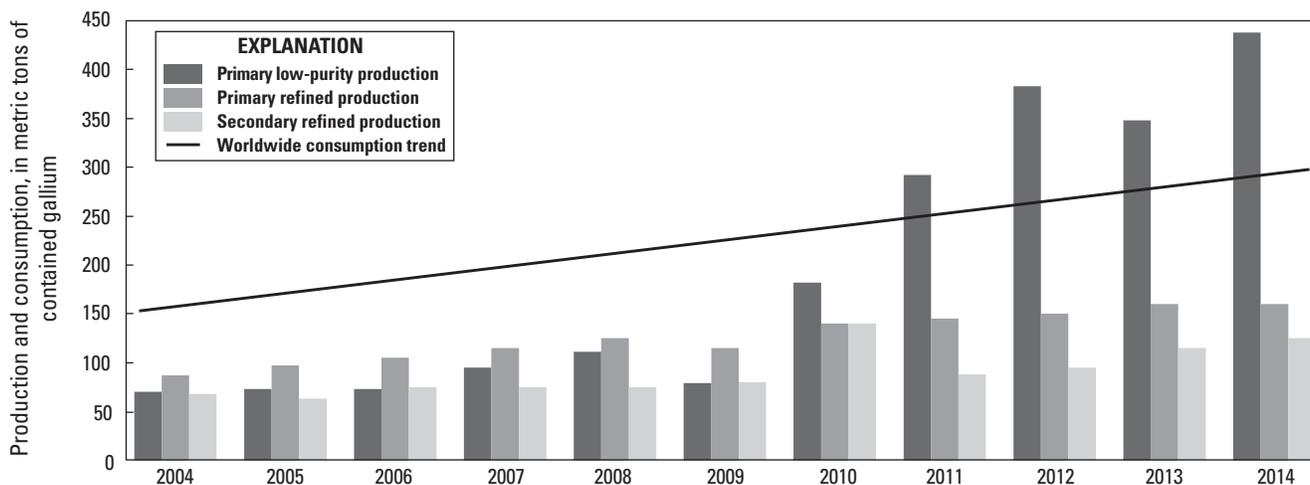
(Metric tons)

Country	Capacity
China	551
Germany	40
Hungary	8
Japan	10
Kazakhstan	25
Korea, Republic of	16
Russia	10
Ukraine	15
Total	675

<sup>1</sup>Includes capacity at operating plants as well as at plants on standby basis.



**Figure 1.** Estimated worldwide gallium production capacity from 2004 through 2014. Source: U.S. Geological Survey.



**Figure 2.** Estimated worldwide gallium production and consumption from 2004 through 2014. Source: U.S. Geological Survey.