



2010 Minerals Yearbook

GALLIUM

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In 2010, no domestic production of primary gallium was reported, and imports of gallium metal and gallium arsenide (GaAs) wafer continued to account for most of the U.S. gallium consumption. Metal imports were 65% higher than those in 2009, with the United Kingdom, Germany, China, and Canada, in descending order of imports by gallium content, as the leading sources of imported gallium. Undoped GaAs wafer imports were 123% higher than those in 2009—Canada and the United Kingdom were the principal sources. Doped GaAs wafer imports were 42% higher than those in 2009—Germany and Japan were the principal sources. Almost all gallium consumed in the United States was in the form of GaAs and gallium nitride (GaN) and was used in integrated circuits (ICs) and optoelectronic devices [laser diodes, light-emitting diodes (LEDs), photodetectors, and solar cells]. Gallium consumption increased by 35% from that in 2009. In 2010, gallium consumed in the United States was less than the gallium imported because a large portion of the U.S. imports was estimated to be low-purity material that was refined in the United States and shipped to other countries.

In 2010, estimated world crude gallium production was 182 metric tons (t). Principal producers were China, Germany, Kazakhstan, the Republic of Korea, Russia, and Ukraine. Plants in Hungary and Japan also recovered gallium. Refined gallium production was estimated to be about 268 t, which may inadvertently include some refined new scrap. Refined gallium was produced in China, Japan, the United Kingdom, and the United States.

Legislation and Government Programs

In an effort to help the United States develop larger, more cost effective GaN substrates used in high-performance electronic device applications, the U.S. Department of Defense awarded Kyma Technologies Inc. (Raleigh, NC) \$2.8 million. In addition to the defense GaN device applications, the funding was expected to help the United States compete with China, Japan, and the Republic of Korea in commercial GaN device applications (Wang, 2010).

In November, TriQuint Semiconductor, Inc. (Hillsboro, OR) was awarded a \$17.4 million Defense Production Act Title III GaN manufacturing development contract by the U.S. Air Force Research Laboratory. The overall goal of the contract was to increase yield, lower costs, and improve time-to-market cycles for defense and commercial applications of GaN integrated circuits (TriQuint Semiconductor, Inc., 2010).

The U.S. Department of Energy (DOE) awarded \$13.4 million to four GaN research projects focused on accelerating development in power electronics. The award recipients included HRL Laboratories LLC, Massachusetts Institute of Technology, Transphorm Inc., and Virginia Technology (Compound Semiconductor, 2010a).

Production

No domestic production of primary gallium was reported in 2010 (table 1). Recapture Metals Ltd. [a subsidiary of Neo Material Technologies, Inc. (Toronto, Ontario, Canada)] recovered gallium from scrap materials, predominantly those generated during the production of GaAs. Recapture Metals' facilities have the capability to produce about 50 metric tons per year of high-purity gallium. The company recovered gallium from its customers' scrap on a fee basis and purchased scrap and low-purity gallium for processing into high-purity material.

Consumption

Gallium consumption data were collected by the U.S. Geological Survey from a voluntary survey of U.S. operations. In 2010, there were 12 respondents to the gallium consumption survey, representing 71% of the total canvassed. Data in tables 2 and 3 were adjusted by incorporating estimates to reflect full industry coverage. Many of these estimates were based on company 2010 10-K reports submitted to the U.S. Securities and Exchange Commission.

More than 97% of the gallium consumed in the United States was in the form of GaAs or GaN. GaAs was used to manufacture optoelectronic devices (laser diodes, LEDs, photodetectors, and solar cells) and ICs. ICs accounted for 69% of domestic consumption, optoelectronic devices accounted for 30%, and 1% was used in research and development and other applications (table 2). GaN principally was used to manufacture LEDs and laser diodes.

In 2010, U.S. consumption of gallium for use in ICs increased by 26% from that of 2009 owing to the strong growth of GaAs-rich "smartphones" (cellular telephones with advanced personal computer-like functionality) and other wireless communication devices, along with continued growth in the aerospace and defense markets. Gallium use in LEDs and laser diodes increased by 75% from that of 2009 owing to the exceptional growth in demand from the LED industry, which began in the second half of 2009 and continued throughout 2010. Gallium suppliers to the photodetector and solar cell industry, however, were negatively affected in 2010 by a combination of the worldwide economic downturn, copper-indium-gallium selenide (CIGS) manufacturing issues, and the rapidly decreasing prices of silicon-based solar cells. U.S. gallium consumption in photodetectors and solar cells decreased by 28% compared with that of 2009.

Gallium Arsenide.—The value of worldwide GaAs device consumption increased to \$4.9 billion in 2010, a 32% increase from \$3.7 billion in 2009. The rapid adoption of sophisticated third-generation (3G) and fourth-generation (4G) smartphones accelerated demand for GaAs power amplifiers.

Fourth-generation smartphones use up to six times the amount of GaAs that a standard cellular telephone does. In 2010, smartphone market sales increased by 66% compared with a 16% increase in 2009. GaAs was also consumed in LED applications, supplying approximately 35% of the LED market, with GaN still being the primary LED technology (Compound Semiconductor, 2010b; Semiconductor Today, 2011d, f).

To meet growing GaAs power amplifier demand, WIN Semiconductors Corp. (Taiwan, China) announced plans to increase its 6-inch GaAs wafer production capacity to 20,000 wafers per month by yearend 2011, an increase of approximately 40% from that of 2010 (Semiconductor Today, 2010c).

Gallium Nitride.—Increased demand for GaN device applications, namely laser diodes, power electronics, and radio-frequency (RF) electronics, provided significant growth opportunities for advanced GaN-based products. GaN power management applications, in particular, have shown much promise. GaN power transistors operate at higher voltages and with a higher power density than current GaAs devices. GaN power transistors and amplifiers have enabled microwave designers to reduce heat sink requirements and part counts, leading to smaller systems with higher performance and greater efficiency. The key drivers of this emerging GaN-based technology have been military and defense applications, but the technology also was being driven by automotive, industrial, medical, and other consumer applications.

The value of worldwide GaN LED consumption increased to \$8.4 billion in 2010, a 75% increase from \$4.8 billion in 2009. LED-backlit televisions were the leading end use for GaN LEDs (Manners, 2011).

In November, Sumitomo Electric Industries Ltd. (Tokyo, Japan) announced that it had developed the world's first 6-inch diameter GaN substrates to be used for white LEDs. Sumitomo planned to bring the 6-inch substrate into large-scale production and expected the material to be used in white LEDs and power devices (Semiconductor Today, 2010b).

Light-Emitting Diodes.—The worldwide high-brightness (HB) LED market increased to \$10.8 billion in 2010, a 93% increase from \$5.6 billion in 2009. HB-LEDs experienced record growth as a result of the rapid shift to LEDs in mobile display applications and liquid crystal display (LCD) monitors and televisions using LED-based backlighting. LED-based backlighting allows for lighter and thinner screens, higher color saturation, and lower power consumption compared with traditional cold-cathode fluorescent lamp backlighting sources. Research and consulting firm Strategies Unlimited estimated that the television and monitor LED-based backlighting segment increased by approximately a factor of 10 compared with that in 2009, to reach 33% of the overall HB-LED market in 2010. Mobile display applications (such as cellular telephones, computer notebooks and tablets, eBooks, MP3 players) were the largest HB-LED market segment in 2010, with a 39% share—doubling in size from the 2009 share. Other HB-LED market segments in 2010 included automotive, general lighting, and signage, with respective market shares of 8%, 8%, and 6% (Whitaker, 2011a).

Japan and the Republic of Korea supplied 33% and 28%, respectively, of the 2010 worldwide HB-LED market.

Additionally, the United States and Europe supplied 23% of the market, Taiwan supplied 14%, and China supplied 2%. China's HB-LED market share was expected to increase greatly by 2015 owing to the large investments it was making in its domestic solid state lighting industry (Whitaker, 2011a).

LED firms continued expanding their manufacturing capacities in 2010 in response to the growing popularity of LED backlighting and mobile display applications. Semiconductor Equipment and Materials International (SEMI) of San Jose, CA, indicated that 19 new LED fabrication plants came online worldwide in 2010. Investment in LED fabrication plants increased to \$1.78 billion in 2010, a 194% increase from \$606 million in 2009. SEMI announced that the regions with the largest investments in LED fabrication plants were Taiwan (\$593 million), followed by the Republic of Korea (\$482 million), and China (\$467 million) (Tseng, 2011).

Boosted by the rapidly growing HB-LED market, more than 780 metal-organic chemical vapor deposition (MOCVD) reactors were shipped during 2010. The MOCVD reactors were used to make GaN LEDs. Aixtron AG (Herzogenrath, Germany) and Veeco Instruments Inc. (Plainview, NY) were the leading MOCVD manufacturers (Compound Semiconductor, 2011b).

As HB-LED demand increased throughout 2010, materials suppliers began adding more capacity for trimethylgallium (TMG), a metal-organic chemical used in the fabrication of epiwafers. When TMG and nitrogen gas are fed into the MOCVD reactor and heated, a GaN layer is formed on the epiwafer. TMG's purity and quality determine an LED's brightness and reliability (Seok-hyeon, 2010). In the United States, AkzoNobel N.V. (Amersfoort, Netherlands) increased TMG production capacity at its plant in Texas, and Dow Electronic Materials (Philadelphia, PA) announced it would expand TMG production capacity at its plant in Massachusetts. Albermarle Corp. (Baton Rouge, LA), Chemtura Organometallics GmbH/UP Chemical Co., Ltd. (Bergkamen, Germany and Republic of Korea), and Dow Electronic announced they would build TMG production facilities in the Republic of Korea. Lake LED Materials (Daejeon, Republic of Korea) and ATMI Inc. (Danbury, CT) completed construction of a TMG plant in South Chungcheong Province. SAFC Hitech (St. Louis, MO) announced it would expand TMG production capacity at its plant in Bromborough, United Kingdom (Whitaker, 2011b).

Solar Cells.—Sustained high energy prices continued to spark interest in solar energy. In 2010, the solar cell market continued to be dominated by crystalline silicon solar cells, which account for approximately 90% of the market. However, a lightweight, flexible, durable, and low-cost thin-film photovoltaic technology—CIGS—has entered the printed solar cell market. CIGS modules can be directly integrated into building materials, consumer electronics for portable power, space applications, or configured as stand-alone modules for large-scale terrestrial deployment. Industry experts thought CIGS 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, the continued global economic downturn affecting the photovoltaic industry, and a complicated

manufacturing process that has impeded commercial mass production of CIGS panels.

Several records for CIGS efficiency were achieved in 2010. In August, scientists at the Center for Solar Energy and Hydrogen Research, ZSW in Stuttgart, Germany, achieved a record 20.3% efficiency for their CIGS solar cell in a laboratory setting. The Fraunhofer Institute for Solar Energy Systems in Freiburg, Germany, confirmed the new results (Compound Semiconductor, 2010c). In December, MiaSolé (Santa Clara, CA) achieved a record 15.7% efficiency for its commercial-scale CIGS solar cell. The results were confirmed by the DOE's National Renewable Energy Laboratory (Cartledge, 2010).

SoloPower Inc. (San Jose, CA) announced it would build a high-volume CIGS manufacturing facility in Wilsonville, OR, with a production capacity of 300 megawatts (MW). In August, AQT Solar (Sunnyvale, CA) opened a CIGS manufacturing facility in Sunnyvale, CA, with an initial production capacity of 15 MW. The company also announced it would build a CIGS manufacturing facility in Blythewood, SC, with an initial production capacity of 40 MW. AQT expected the production capacity of the Blythewood facility to increase to 1 gigawatt by the end of 2014 (Semiconductor Today, 2011a, c).

Researchers at the University of Illinois developed an efficient, lower cost method of manufacturing photovoltaic GaAs compound semiconductors that also allows versatility in the types of devices into which they could be incorporated. The manufacturing method allows creation of bulk quantities of flexible GaAs-based solar cells that can be incorporated onto surface areas much larger than conventional solar panels (Brumfiel, 2010).

Prices

Since 2002, producer prices for gallium have not been quoted in trade journals. Data in table 4 represent the average customs value of gallium imported into the United States. Reports in Metal-Prices indicated that low-grade gallium prices increased significantly in 2010. At the beginning of the year, the low-grade gallium price was reported to be about \$395 per kilogram. By August, the price had increased to about \$595 per kilogram. By December, the price had increased to about \$635 per kilogram.

From U.S. Census Bureau import data, the annual average value for low-grade (99.99%-pure) gallium was estimated to be \$307 per kilogram, about the same as the estimated average value for 2009. For high-grade (>99.99%-pure) gallium, the annual average estimated value increased to \$600 per kilogram, about 34% higher than that in 2009. Import data reported by the U.S. Census Bureau do not specify purity, so the values listed in table 4 were estimated based on the average value of the material imported and the country of origin.

Foreign Trade

In 2010, U.S. gallium imports were 65% higher than those in 2009 (table 5). The United Kingdom (35%), Germany (24%), China (21%), and Canada (7%) were the leading sources of imported gallium.

In addition to gallium metal, GaAs wafers were imported into the United States (table 6). In 2010, 63,200 kilograms (kg) of

undoped GaAs wafers and 166,000 kg of doped GaAs wafers were imported. Imports of undoped GaAs wafers were 123% higher than those in 2009, while imports of doped GaAs wafers were 42% higher than those in 2009. The large volumes of undoped GaAs wafers were primarily imported from Canada and the United Kingdom. The large increase was most likely owing to intercompany transfers between foreign and U.S. subsidiaries of the same company. The data listed in table 6 may include some packaging material 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, the two leading consuming countries, were used as the basis for estimating world gallium production. In addition, Roskill Information Services Ltd. provided updated Chinese gallium production estimates, expanding China's production considerably owing to the contributions from newer Chinese gallium operations. Estimated worldwide crude gallium production was 182 t in 2010. Principal world producers were China, Germany, Kazakhstan, the Republic of Korea, Russia, and Ukraine. Gallium also was recovered in Hungary and Japan. Refined gallium production was estimated to be about 235 t, which may inadvertently include some new scrap refining. To avoid double counting previously produced gallium, the refined gallium production figure attempts to eliminate recycled new scrap. China, Japan, the United Kingdom, and the United States refined gallium.

Neo Material Technologies and Roskill Information Services estimated worldwide gallium consumption at 280 t in 2010. Neo Material also estimated that 50% of gallium consumed worldwide in 2010 came from recycled sources (Roskill Information Services Ltd., 2011, p. 47; Seeley, 2011). Gallium was recycled from new scrap in Canada, Germany, Japan, the United Kingdom, and the United States.

China.—In 2010, China's LED industry increased by 34% in value from that of 2009 owing to the rapid growth of the HB-LED backlighting, mobile display applications, and general lighting markets. China installed nearly 300 MOCVD reactors in 2010, which resulted in a 78% increase in value of its LED epitaxy sector from that of 2009; the country was expected to account for a significant share of the MOCVD market in upcoming years. Significant incentives were established by the Chinese Government to build a dominant LED industry. The Chinese Government also implemented a widespread street-lighting program that was expected to create strong domestic demand for LED-based lighting (Semiconductor Today, 2011b; Young, 2011).

China's primary gallium producers were Aluminum Corporation of China, Ltd.; Beijing JiYa Semiconductor Material Co., Ltd.; China Crystal Technologies, Ltd.; East Hope Mianchi Gallium Industry, Co.; and Zhuhai Fangyuan. China's total primary gallium production capacity in 2010 was estimated to be 141 t. Capacity was expected to increase in 2011 (Roskill Information Services, Ltd., 2011, p. 13–15, 21–26).

Japan.—The Japan Oil, Gas, and Metals National Corp. (JOGMEC) estimated that Japan consumed 116 t of gallium in 2010, with the LED market accounting for 43% of consumption

(Kita Yoshiyuki, director Rare Metals Stockpile Department, Japan Oil, Gas, and Metals National Corp., written commun., February 23, 2011).

Outlook

According to IQE plc, smartphones represented a fundamental structural shift in mobile communications. Increased use of smartphones, which on the average contain 480% more GaAs-rich RF content than standard cellular telephones, was expected to account for 28% of all handset sales in 2011, increasing to 50% by 2016. Installation of 3G and 4G mobile networks in India and the Republic of Korea was expected to increase sales of smartphones further. Additional increases in GaAs demand will also result from new applications for wireless fidelity (WiFi), such as point-to-point communications, smart meters, and tablet personal computer technologies. Strategy Analytics predicted that GaAs industry sales would increase at a compound annual growth rate of 5%, increasing to \$4.7 billion by 2014 (IQE plc, 2010; Semiconductor Today, 2011g).

Research and consulting firm iSuppli Corp. predicted the GaN power management market would reach \$184 million in revenue by 2013. The firm indicated that two events—silicon attaining its practical limits in power management semiconductors and technologic breakthroughs in growing GaN layers on silicon—favored GaN power management devices taking market share away from conventional metal oxide semiconductor field-effect transistors, driver ICs, and voltage regulator ICs. The GaN power management devices' improved efficiency and smaller size would be in high demand for portable electronic products as well as for power-hungry enterprise servers and wired communications infrastructure equipment (Shaw, 2010). GaN power management devices accounted for 3.5% of the global semiconductor market in 2010 (Compound Semiconductor, 2011a).

Strategy Analytics indicated that the U.S. defense industry would continue to be the major customer influencing the RF and power management GaN microelectronics market. The firm expected military applications to represent nearly one-half of the market by 2014 (Semiconductor Today, 2010a).

According to market research firm TrendForce, the HB-LED market was forecast to increase by 8% in 2011 owing to weak demand in the LED backlighting market and lowered LED selling prices, which would result in an oversupply in the LED market. A main factor for the weak demand was the advance in LED technology that allowed reduction in the number of LED units required for television backlighting. Significant LED capacity expansions in 2011 were expected to put further pressure on prices (Semiconductor Today, 2011e).

IMS Research forecast that 833 MOCVD reactors would be shipped worldwide in 2011, a 4% increase from that of 2010. Approximately 570 MOCVD reactors were expected to be shipped in 2012 (Compound Semiconductor, 2011c).

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TABLE 1
SALIENT U.S. GALLIUM STATISTICS¹

(Kilograms unless otherwise specified)

| | 2006 | 2007 | 2008 | 2009 | 2010 | |
|-------------------------|----------------------|--------|--------|--------|--------|-----|
| Production | -- | -- | -- | -- | -- | |
| Imports for consumption | 26,900 | 37,100 | 41,100 | 35,900 | 59,200 | |
| Consumption | 20,300 | 25,100 | 28,700 | 24,900 | 33,500 | |
| Price ² | dollars per kilogram | 443 | 530 | 579 | 449 | 600 |

-- Zero.

¹Data are rounded to no more than three significant digits.

²Estimate based on average value of U.S. imports of high-purity gallium.

TABLE 2
U.S. CONSUMPTION OF GALLIUM, BY END USE^{1,2}

(Kilograms)

| End use | 2009 | 2010 |
|--|--------|--------|
| Optoelectronic devices: | | |
| Laser diodes and light-emitting diodes | 5,370 | 9,390 |
| Photodetectors and solar cells | 849 | 612 |
| Integrated circuits: | | |
| Analog | 17,200 | 21,200 |
| Digital | 1,280 | 2,100 |
| Research and development | 135 | 235 |
| Other | 68 | -- |
| Total | 24,900 | 33,500 |

-- Zero.

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

²Includes gallium metal and gallium compounds.

TABLE 3
STOCKS, RECEIPTS, AND CONSUMPTION OF GALLIUM, BY GRADE^{1,2}

(Kilograms)

| Purity | Beginning | | | Ending stocks |
|-------------------------|-----------|----------|-------------|------------------|
| | stocks | Receipts | Consumption | |
| 2009: | | | | |
| 99.99% to 99.999% | 2,710 | 528 | -- | 3,240 |
| 99.9999% | 929 | 927 | 1,120 | 740 |
| 99.99999% to 99.999999% | 173 | 383 | 438 | 118 |
| Total | 3,820 | 1,840 | 1,550 | 4,100 |
| 2010: | | | | |
| 99.99% to 99.999% | 3,240 | 624 | -- | 3,870 |
| 99.9999% | 740 | 500 | 280 | 960 |
| 99.99999% to 99.999999% | 118 | 501 | 475 | 144 |
| Total | 4,100 | 1,630 | 755 | 4,970 |

-- Zero.

¹Consumers only.

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

TABLE 4
ESTIMATED AVERAGE GALLIUM PRICES

(Dollars per kilogram)

| Gallium metal | 2009 | 2010 |
|--|------|------|
| Purity ≥ 99.9999%; average value of U.S. imports | 449 | 600 |
| Purity ≤ 99.99%; average value of U.S. imports | 304 | 307 |

TABLE 5
U.S. IMPORTS FOR CONSUMPTION OF GALLIUM (UNWROUGHT, WASTE, AND
SCRAP), BY COUNTRY¹

| Country | 2009 | | 2010 | |
|----------------|-------------------------|--------------------|-------------------------|--------------------|
| | Quantity (kilograms) | Value ² | Quantity (kilograms) | Value ² |
| Canada | 10,500 | \$3,670,000 | 4,170 | \$1,480,000 |
| China | 6,100 | 2,240,000 | 12,200 | 3,960,000 |
| France | 719 | 325,000 | 601 | 378,000 |
| Germany | 7,110 | 2,630,000 | 14,400 | 3,760,000 |
| Japan | 915 | 504,000 | 649 | 409,000 |
| Netherlands | 20 | 9,000 | 1,400 | 745,000 |
| Norway | 62 | 26,200 | -- | -- |
| Russia | -- | -- | 1,000 | 395,000 |
| Singapore | -- | -- | 530 | 218,000 |
| Slovakia | -- | -- | 3 | 3,540 |
| Taiwan | 24 | 3,480 | -- | -- |
| Ukraine | 3,750 | 990,000 | 3,810 | 1,360,000 |
| United Kingdom | 6,740 | 2,170,000 | 20,500 | 6,450,000 |
| Other | -- ^r | -- ^r | -- | -- |
| Total | 35,900 | 12,600,000 | 59,200 | 19,200,000 |

¹Revised. -- Zero.

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

²Customs value.

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF
GALLIUM ARSENIDE WAFERS, BY COUNTRY¹

| Material and country | 2009 | | 2010 | |
|----------------------|-------------------------|------------------------|-------------------------|--------------------|
| | Quantity (kilograms) | Value ² | Quantity (kilograms) | Value ² |
| Undoped: | | | | |
| Austria | 30 | \$16,000 | 34 | \$22,500 |
| Canada | 15,800 | 2,480,000 | 19,500 | 1,720,000 |
| Germany | -- | -- | 103 | 12,700 |
| India | -- | -- | 9,030 | 12,000 |
| Japan | 72 | 3,600 | 1 | 5,400 |
| Singapore | -- | -- | 100 | 24,200 |
| Taiwan | 886 | 173,000 | 2,140 | 128,000 |
| United Kingdom | 11,500 | 21,900 | 32,200 | 55,700 |
| Other | 13 | 24,200 | 9 | 14,100 |
| Total | 28,300 | 2,720,000 | 63,200 | 1,990,000 |
| Doped: | | | | |
| China | 5,680 | 10,200,000 | 14,100 | 21,200,000 |
| Czech Republic | 309 | 236,000 | 1,460 | 1,350,000 |
| Finland | 1,370 | 1,410,000 | 4,180 | 2,440,000 |
| France | 1,630 | 4,290,000 | 7,050 | 7,220,000 |
| Germany | 29,500 | 18,200,000 | 30,500 | 25,700,000 |
| Italy | 6,120 | 196,000 | 193 | 126,000 |
| Japan | 52,800 | 57,000,000 | 72,100 | 84,800,000 |
| Korea, Republic of | 2,610 | 946,000 | 1,100 | 787,000 |
| Poland | 473 | 205,000 | 1,230 | 691,000 |
| Singapore | 6,430 | 10,100,000 | 8,800 | 12,900,000 |
| Taiwan | 7,560 | 22,000,000 | 20,300 | 28,500,000 |
| United Kingdom | 1,160 | 2,280,000 | 2,950 | 1,750,000 |
| Other | 1,350 ^r | 1,390,000 ^r | 2,010 | 1,740,000 |
| Total | 117,000 | 129,000,000 | 166,000 | 189,000,000 |

^rRevised. -- Zero.

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

²Customs value.

Source: U.S. Census Bureau.

TABLE 7
ESTIMATED WORLD ANNUAL PRIMARY GALLIUM
PRODUCTION CAPACITY, DECEMBER 31, 2010¹

(Metric tons)

| Country | Capacity |
|--------------------|----------|
| China | 141 |
| Germany | 35 |
| Hungary | 8 |
| Japan | 10 |
| Kazakhstan | 25 |
| Korea, Republic of | 16 |
| Russia | 10 |
| Ukraine | 15 |
| Total | 260 |

¹Includes capacity at operating plants as well as at plants on standby basis.