INDIUM

By Micheal W. George

Domestic survey data and table were prepared by Carolyn F. Crews, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

All refined indium production in the United States during 2003 came from the refining of lower grade imported indium metal and from recycling of scrap. Two refineries, one in New York and the other in Rhode Island, produced the majority of indium metal and indium compounds in 2003. A number of small companies produced specialty indium alloys and other indium products.

Domestic consumption of indium in 2003 was estimated by the U.S. Geological Survey to have increased to about 95 metric tons (t). An estimated increase in the use for coatings was offset by a reduction in the use for solder and alloys and for electrical components. Domestic consumption distribution for 2003 was 65% for coatings, 15% for solder and alloys, 10% for electrical components and semiconductors, and 10% for other uses. The value of indium consumed in the United States in 2003 was about $16.5 million at an average New York, NY, dealer price of $174 per kilogram, as calculated from prices published in Platts Metals Week.

World primary production decreased by 11% in 2003, compared with the production in 2002. The three major producing countries of refined indium recovered from domestic or imported concentrates or residues were Canada, China, and Japan. A small quantity of primary refined production came from Belgium, Peru, and Russia (table 2). Recycling of indium scrap continued to increase, but not enough to offset the decline in primary production. World production of indium-tin oxide (ITO) coatings for 2003 was 130 t, of which Japan produced 70 t and Canada and China each produced about 30 t (Roskill's Letter from Japan, 2004c).

World consumption increased in 2003 owing to a worldwide upturn in the markets for laptop computers, flat panel displays (FPDs), and other liquid crystal displays (LCDs) that use ITO coatings, as well as growth in the use of other technologies that used ITO coatings and indium metal. An increase in the size of the monitors and televisions produced also contributed to the higher consumption levels.

World indium reserves, which are based on estimated indium content of zinc reserves, are estimated to be about 2,500 t. The world indium consumption in 2003 was estimated to be about 500 t. If the assumption is made that more than one-half of the world's consumption will be met from the recycling of existing materials, these reserves would last approximately 10 years. Also, the world reserve estimation excludes about a 30-year supply of indium contained in the estimated zinc reserve base that could become available through new technologies or additional exploration and reserve delineation. Canada has the world's largest reserves at about 28%, and the United States holds about 12% of the world's reserves.

Legislation and Government Programs

On the basis of the potential for substantial energy savings, various national governments have targeted solid-state technologies, which include light-emitting diodes (LEDs), for increased research funding and development. A proposal for a program to fund solid-state lighting has received considerable support in the U.S. Congress, and Japan already has a program underway (Whitaker and Newey, 2003). The U.S. Department of Energy (DOE) awarded $20.4 million for research into ways to save energy in residential and commercial buildings. One of the four areas of interest that the DOE outlined involved reducing the amount of energy used by replacing conventional lighting with LED lighting (U.S. Department of Energy, 2003§[1]).

Production

U.S. production of indium in 2003 consisted of upgrading imported indium metal. Lower grade (99.97%) and standard-grade (99.99%) imported indium was refined to purities of up to 99.9999%. Indium Corporation of America, Utica, NY, and Umicore Indium Products, Providence, RI (a division of n.v. Umicore, s.a.), accounted for the major share of U.S. production of indium metal and products.

Indium metal is sold in various forms (ingot, foil, powder, ribbon, wire, and others) as well as different grades. Many small companies produced high-purity indium alloys, compounds, solders, ITO coatings, and other indium products.

Only small amounts of new indium scrap were recycled in 2003, although it was more than in the past. Unlike most Asian countries, which recycle greater amounts of indium, there was no well established infrastructure for collection and consumption of indium-containing scrap and waste in the United States.

Consumption

The use of indium in coatings, which was mainly in the form of indium oxide and ITO, constituted two-thirds of total domestic indium use in 2003. By far, the major use was for thin-film coatings on glass and on LCDs. The use of ITO in organic LEDs and plasma displays is a relatively small segment of coating use, but it is expected to have strong growth during the next several years (O'Neill, 2003).

Two kinds of coatings contain indium—electronically conductive and infrared-reflective. LCDs for portable computer screens, television screens, video monitors, and watches, which were the major commercial applications, use electrically conductive coatings. They are also used to defog aircraft and locomotive windshields and to keep glass doors on commercial refrigerators and freezers frost-free. Indium coatings on window glass take advantage of indium's infrared reflective properties and

[1]References that include a section mark (§) are found in the Internet References Cited section.

limit the transfer of radiant heat through the glass. This property of indium can be used to heat and cool buildings more efficiently.

The technologies of glass coatings and semiconductors have been the largest areas of research and development for indium during the past several years. Although coatings remained the most widespread use for indium, the production of electrical components and semiconductors is expected to be a major growth application for indium during the next several years.

In recent years, LEDs have shown growth potential. Anything that uses lights or some type of electronic display can use LEDs. LEDs now come in many colors and can be bright enough to be used for lighting. For example, the U.S. Department of the Interior's National Park Service recently teamed up with Osram Sylvania (a division of Osram GmbH) to relamp the Thomas Jefferson Memorial in Washington, DC, by using 17,000 LEDs. The electrical requirements were reduced by 80%, with 20% fewer fixtures and 30% more lighted area. In addition to cost savings, the amount of mercury used in the original 35-year-old lighting system was reduced. These LED lights are mechanical-shock-, temperature-, and weather-resistant and have a long life (National Park Service, 2004§). Other examples of LED applications were airport lights, backlighting, infrared transmitters, outdoor signs, Jumbotrons, personal electronic displays, variable message signs on highways, vehicle lights, as well as emergency lights, flashlights, and other low-wattage applications (Whitaker, 2003).

About one-sixth of the indium consumed was used in combination with other metals to form low-melting-point alloys and solders. The alloys are used in electrical fuses and fusible links and as gripping tools for the grinding of delicate materials. The advantages of indium-containing solders are that they have lower melting points, are more flexible over a wider temperature range, and inhibit the leaching of gold components in electronic apparatus.

Alkaline batteries used indium to prevent buildup of hydrogen gas within sealed battery casings. Indium was also used in semiconductors, including semiconductors in fiber optics. This use fell over the last few years because of the reduction in investments in telecommunication systems. Other uses of indium included dental alloys, electrode-less lamps, mercury alloy replacements, nuclear control rods, phosphors, and white gold alloys.

Prices

The average New York dealer price range, as reported by Platts Metals Week, for 99.97%- to 99.99%-pure indium began the year at $85 to $95 per kilogram. The price more than doubled during the first 6 months, and by mid-July, the price range was $180 to $200 per kilogram. The price did not change until late October when the upper price increased to $225 per kilogram. In mid-November, the price range increased to $305 to $335 per kilogram in 3 weeks and remained at this level for the remainder of the year. The average dealer price of indium in 2003 increased to $320 per kilogram from $90 per kilogram, representing a 355% increase from the beginning of 2003.

According to Platts Metals Week, the Indium Corporation of America producer price started the year at $110 per kilogram. The price increased to $140 per kilogram at the beginning of June. By early August, the price increased again to $180 per kilogram. In November, the price rose twice, first to $225 and then to $265 per kilogram, where it remained for the rest of the year.

The rise in indium prices in 2003 occurred because a large supply-demand imbalance developed. There was a large growth in demand for ITO for use in LCDs, especially in Japan and the Republic of Korea, and there was a growth in demand for low-melting-point indium in China. Production of indium was lower than last year because of shortages of raw material in China and the closure of primary production facilities in France. In addition to the supply shortage, some experts thought that high prices fueled market speculation driving prices even higher (Roskill's Letter from Japan, 2004e).

Trade

U.S. imports of indium in 2003 increased by almost 10% (weight percent) to 123 t, and the values increased by almost 115% compared with those of 2002. This was owing to a combination of increased consumption and higher prices for indium.

China was the leading source of U.S. indium imports in 2003 and accounted for 50% [61,400 kilograms (kg)] of the total imported, followed, in declining order of importance as a source, by Canada, Japan, and Russia. Import reductions from Canada, France, Russia, and Switzerland were exceeded by increases from China and Japan (table 1). Data on U.S. exports of indium were not available but were estimated to have remained at the 2002 level of about 10 t.

World Review

Belgium.—n.v. Umicore s.a. announced that it was increasing its production of ITO. This reduced the amount of indium it sold to third parties (Metal-Pages, 2004c§).

Canada.—Falconbridge Ltd.'s Kidd Creek, Ontario, zinc refinery was restarted and operated at full capacity in late October following a 12-week shutdown. The refinery was idled for annual maintenance but remained closed longer than usual owing to low zinc prices (Brooks, 2003). Kidd Creek refinery and Teck Cominco's Trail, British Colombia, smelter and refineries were the two indium producers in Canada (McCutcheon, 2001§).

China.—Concentrate supplies that were left after mine closures were dwindling. Chinese authorities closed mines in Nandan County, Guangxi Zhuang Autonomous Region, in response to several mine accidents in 2001. The mines probably will not reopen in fewer than 3 years, which could cause some indium producers to idle capacity for lack of indium-bearing concentrates. China produced 25.3 t of indium concentrates in 2003 and was projected to increase production by 63 t of concentrates in 2004. Although this will be an improvement, it is still well below the average of 316 t of indium concentrates during 1996-2001. Of the 60 mines closed in 2001, only 5 have been allowed to resume operations. Out of those, only one mine has a significant amount of indium (Metal-Pages, 2003a§).

Liuzhou Zinc Product Co., Ltd. temporally closed down all indium operations because of a lack of low-cost concentrates. It has an overall capacity of 20 tons per year (t/yr) of indium. The company announced that this will not be a permanent closure, but it is unsure when the operation will restart (Paxton, 2003).

Not all smelters cut back in 2003. The Huludao Zinc Smelter Co. operated near the previous year's production level of 14 t at its 20-t/yr smelter. It announced that it cannot increase production because the source of zinc ore, of which indium is a byproduct, was limited (Platts Metals Week, 2003). China Tin Group completed a second-stage zinc expansion project in August 2003, which will increase the amount of indium produced (Metal-Pages, 2003b§).

China's largest indium smelter Zhuzhou Smelter Non-ferrous Co., Ltd. completed an ITO project in August 2003. The trial production rate of the 30-t/yr smelter was less than 15 t/yr. Zhuzhou Smelter announced that it hoped to have the ITO plant running at full capacity by 2005. This was not China's only ITO operation; China Tin Group Co. Ltd. operated a 10-t/yr facility. Zhuzhou estimated that its smelter would produce about 50 to 60 t/yr of indium ingot, which was more than enough for the ITO facilities (Metal-Pages, 2003j§).

Yunnan Mengzi Minerals announced that it has started the construction of a 50-t/yr indium plant that will be finished in 2005. The raw material will come from the companies zinc mines (Metal-Pages, 2003i§, k§).

France.—Metaleurop S.A.'s exit from primary zinc production at its Noyelles-Godault smelter reduced worldwide indium supply by an estimated 55 t. The closure of this plant in November 2002 was a factor in the supply shortage and resulting higher indium prices (Guerriere, 2003).

Japan.—Japanese imports of indium, ITO scrap, and recycled indium materials increased by more than 88% as compared with imports in 2002. Japan's imports of these materials from the United States during this same period increased by more than 59%, to 48 t from 30 t. Other exporters to Japan showing increases were Belgium (48%, to 2.8 t from 1.9 t), Canada (114%, to 30 t from 14 t), China (107%, to 156 t from 75 t), and the Commonwealth of Independent States (6,890%, to 13 t from 0.2 t). France reduced exports of these indium materials to Japan by 68%, to 5 t from 16 t (Roskill's Letter from Japan, 2004e).

Japanese production of new indium by Dowa Mining Co., Ltd. and Nippon Mining & Metals Co., Ltd. increased by 17% to 70 t. The amount of recycled indium in Japan increased slightly to 160 t in 2003 (Roskill's Letter from Japan, 2003).

Japan's consumption of indium in 2003 was 419 t, an increase of 18% as compared with consumption in 2002. Japanese consumption was projected to increase by 18% again in 2004. ITO production accounted for 87% of the indium consumed in 2003 and was projected to increase by 19% in 2004 (Roskill's Letter from Japan, 2004).

Many LCD producers increased their output and added new production facilities. Sumitomo Chemicals started construction of two new plants in the Republic of Korea and Taiwan (Metal Bulletin, 2004). This in turn has spurred ITO production. Nikko Materials announced that it would double its production of ITO (Metal-Pages, 2004d§).

The Japan Electronics Industry Association estimated that the value of domestic output of electronic components and products increased by 6% in 2003. LCDs increased in value by 44% in 2003 as compared with that of 2002 and were forecasted to increase 58% in 2004. Overall consumer electronics production is expected to rise by 12%, led by LCD production (Roskill's Letter from Japan, 2004a).

Seiko Epson Corp. and Sanyo Electric Co. agreed to form a joint venture to fully integrate their LCD operations. Sanyo Epson Imaging Devices Corp. was formed to develop, manufacture, and sell LCDs used in personal electronics (Roskill's Letter from Japan, 2004b).

Many computer monitor producers halted or severely curtailed the production of cathode ray tubes (CRTs) and switched over to FPD production. It was estimated that Japan's production of CRTs will fall 25% during the next 4 years (Roskill's Letter from Japan, 2003).

The four glass producers for the LCD industry increased their investment in new plants to supply the new production and size of glass used in LCDs. Corning Inc. in the United States and Asahi Glass, Nippon Electric Glass, and NH Techno Glass Corp. in Japan were the only producers of LCD glass substrates for supplying LCDs (Metal-Pages, 2003g§).

Namibia.—ZincOx Resources plc announced that the preliminary cost estimate for recovering indium from Tsumbe slags was substantial and that the potential revenue for the project would not be enough to warrant development. Until new cost-effective methods are discovered, the project will be abandoned. An extension of the contract to process the slag was sought to keep alive the prospect of continuing the project at a later date (ZincOx Resources plc, 2003§). A newly discovered method was considered at Tsumbe, but the cost of the process was not released, and the future of this process is unknown (Metal-Pages, 2003k§).

Peru.—The only indium-producing smelter in Peru was the La Oroya Refinery, owned by Doe Run Peru SRL. Approximately 5 t of indium was produced solely for export to Italy, Japan, and the United States (Mondragón, 2004).

Current Research and Technology

There are a number of innovative research projects into new LEDs and other uses for indium. Many companies are creating new indium-base LEDs that are brighter, longer lasting, have better color, are more resistant to externals, and are cheaper to produce. An example of one of these newer LEDs was the aluminum-indium-gallium-phosphide (InGaAlPO) LED produced by Showa Denko KK. This LED was three times brighter than any other LED and was planned as a replacement for traditional lights (Metal-Pages, 2003h§). A new device made from indium gallium phosphide and gallium arsenide would combine LEDs and the world's fastest transistor to create the first light-emitting transistor (Metal-Pages, 2004a§). California-based LEDtronics, Inc. announced that it has upgraded its replacement for incandescent lamps. The new LED lamps would save energy and have an average life span of 100,000-plus hours (11 years). The technologies used in the upgraded LED were the integration of InGaAlPO and silicon-carbide/gallium-nitride (SiC/GaN) LED technologies and the 25-millimeter Edison screw bases (Metal-Pages, 2003f§). Other new LEDs were being developed for airport landing lights, car headlights, traffic lights, and underwater lights (Whitaker, 2003). Other non-LED research projects included expanding the use of indium-phosphide (InP) semiconductor chips and fiber-optic communication devices (Newey, 2003).

Tosho Co. has begun research on substitutes for indium in ITOs. Sources stated that the research was still in its early stages (Ryan's Notes, 2004). Some of the potential substitutions for indium in ITOs were copper, tin, and zinc. These materials, however, had serious problems in performance and could not realistically replace indium in the near future (Metal-Pages, 2003e§).

Outlook

Indium consumption could easily reach 660 t by 2006, up from current consumption of 450 t (Metal-Pages, 2003c§). Leading the rise in consumption will be the consumption of ITO used in LCDs. Many producers of CRTs have announced that they will either curtail production or stop producing and switch to LCDs. Several companies in Japan, the Republic of Korea, and Taiwan have announced that they are increasing the size of the glass used to make these displays, which will also increase the amount of ITO needed per unit to produce (Metal-Pages, 2004e§). Global LCD sales are expected to increase 80% by fiscal year 2005, as compared with those of 2002, to 120 million units (Metal-Pages, 2003g§).

Forces that are driving the increased demand for ITO include the drastic reduction in prices for FPDs in recent years, the consumption of less electricity compared with traditional CRTs, and the increased ease of storage and transport for FPDs (Wilkinson, 2003).

A key issue on the supply side will be the ability of individual countries to recycle the indium-containing electronic components, which tend to have a relatively short life cycle. Japan and other East Asian countries appear to be at the forefront of recycling efforts. Recent trends in indium price combined with the curtailment of primary refining capacity have added an extra incentive to the recovery of secondary indium. Sustained high prices will encourage increased recycling and primary production (Metal-Pages, 2003d§). Since indium is a byproduct of zinc, it is difficult to increase primary production unless there is an increase in zinc production. The languishing zinc market forced many high-cost and low-grade underground mines and a few of the older and less efficient zinc refineries to close. The price of zinc, however, is on the rise, and the production of indium should increase also, but production is expected to remain below worldwide demand. There is some indium mineralization associated with tin and tungsten deposits but their economic potentials are difficult to determine because their complex mineralogy makes metallurgical recovery difficult and costly. The gap between world primary production and world consumption, estimated at 200 t, will most likely come from recycling as inventories were nearly exhausted by the end of 2003 (Platts Metals Week, 2004).

LCDs producers will not pass the increased cost of ITO coatings on to the consumer; if anything, the price of these goods should continue to fall. The cost of the indium used in a 32-inch LCD screen is about 50 cents, as compared with the overall screen cost of $3,000 (Metal-Pages, 2004b§). Producers, however, are concerned about the reliability of the supply of raw material, because there are currently few viable substitutes available. Copper, tin, and zinc can be substituted but cause serious reductions in quality and energy efficiency. Currently 50% of consumed ITO is from recycled sources, but could reach as high as 75% in 2004 (Roskill's Letter from Japan, 2004c).

With the Chinese starting to produce ITO for domestic consumption, most likely for use in the production of FPDs and other LCDs, indium could become harder to find on the open market. If the higher value goods—computer FPDs and LCD televisions—follow the same rate of growth as calculators, mobile telephones, and other electronics, then China's domestic consumption of indium could easily equal the world supply (Metal-Pages, 2004c§).

Additional impetus for increased consumption of indium comes from the semiconductor industry, where the market share for InP has increased in such applications as lasers, photodiodes, and other optic telecommunications systems (Furukawa, 2000). The telecommunications industry has been in a slump for the past several years, but a turnaround is expected, which could cause increased indium consumption.

References Cited

Brooks, David, 2003, Falconbridge restarts Kidd Creek as zinc hits two-year high on LME: American Metal Market, v. 111, no. 40-3, October 8, p. 6.

Furukawa, Tsukasa, 2000, Sumitomo makes gallium, indium push: American Metal Market, v. 108, no. 220, November 14, p. 8.

Guerriere, Alison, 2003, Metaleurop exit, China slowdown boosts indium: American Metal Market, v. 111, no. 14-5, April 11, p. 8.

Metal Bulletin, 2004, Japanese producers boosting LCD capacity on strong demand: Metal Bulletin, no. 8831, March 1, p. 13.

Mondragón, Margarita, 2004, Can we imagine a world without the consumption of metals? Among them—Refined indium, *in* MinerAndina y Sociedad Expomin 2004, Santiago, Chile, April 20-24, 2004, Proceedings: Santiago, Chile, FISA S.A., p. 40-43.

Newey, Jon, 2003, InP battles to beat the slump in optical communication: Compound Semiconductor, v. 9, no. 6, July, p. 20-22.

O'Neill, Brian, 2003, Indium—Market, applications, & future prospects: Minor Metals Trade Association Conference, Genoa, Italy, April 9-11, 2003, Presentation, 8 p.

Paxton, Robin, 2003, Liuzhou forced to end indium production: Metal Bulletin, no. 8772, May 12, p. 9.

Platts Metals Week, 2003, Huludao to maintain indium output: Platts Metals Week, v. 74, no. 28, July 14, p. 13-14.

Platts Metals Week, 2004, Indium price soars to near $400/kg: Platts Meals Week, v. 75, no. 2, January 12, p. 5-6.

Roskill's Letter from Japan, 2003, Cathode ray tubes—Further reduction in domestic production: Roskill's Letter from Japan, no. 328, December, p. 7.

Roskill's Letter from Japan, 2004a, Electronic industry—Seiko Epson and Sanyo Electric form LCD joint venture: Roskill's Letter from Japan, no. 330, April, p. 18.

Roskill's Letter from Japan, 2004b, Electronics industry—7% growth forecast for Japanese output in 2004: Roskill's Letter from Japan, no. 330, February, p. 16-18.

Roskill's Letter from Japan, 2004c, Indium—ITO demand is forecast to rise by over 10% in 2004: Roskill's Letter from Japan, no. 329, January, p. 2-4.

Roskill's Letter from Japan, 2004d, Indium—Market balance tightens in 2004: Roskill's Letter from Japan, no. 331, March, p. 10-11.

Roskill's Letter from Japan, 2004e, Indium—Steep price increases continue into 2004: Roskill's Letter from Japan, no. 330, February, p. 13-14.

Ryan's Notes, 2004, Minors all stable: Ryan's Notes, v. 10, no. 18, May 3, p. 5.

Whitaker, Tim, 2003, Backlights, airports and vehicles boost LED market: Compound Semiconductor, v. 9, no. 11, December, p. 20-22.

Whitaker, Tim, and Newey, Jon, 2003, Things to watch in 2003: Compound Semiconductor, v. 9, no. 1, January/February, p. 22-24.

Wilkinson, Jennie, 2003, Indium displays clear growth: Metal Bulletin, no. 8748, February 13, p. 7.

Internet References Cited

McCutcheon, Bill, 2001, Indium, Canadian Minerals Yearbook, accessed June 1, 2004, via URL http://www.nrcan.gc.ca/mms/cmy/pref_e.htm.
Metal-Pages, 2003a (September 2), Antimony and indium still stymied by Nandan mine closures, accessed September 2, 2003, via URL http://www.metal-pages.com.
Metal-Pages, 2003b (September 12), China Tin completes 2nd stage zinc expansion, accessed September 15, 2003, via URL http://www.metal-pages.com.
Metal-Pages, 2003c (April 10), Indium demand could top 660 tonnes by 2006, accessed April 11, 2003, via URL http://www.metal-pages.com.
Metal-Pages, 2003d (April 28), Indium firm on shifting fundamentals, accessed April 28, 2003, via URL http://www.metal-pages.com.
Metal-Pages, 2003e (October 21), Indium prices rising as flat screen TVs take off, accessed October 22, 2003, via URL http://www.metal-pages.com.
Metal-Pages, 2003f (August 20), InGaAIP and SiC/GaN technologies integrated for LED upgrade, accessed August 21, 2003, via URL http://www.metal-pages.com.
Metal-Pages, 2003g (September 11), Move to large LCD panels prompts major investment, accessed September 12, 2003, via URL http://www.metal-pages.com.
Metal-Pages, 2003h (December 9), Showa Denko's new LEDs brighten Ga and In markets, accessed December 12, 2003, via URL http://www.metal-pages.com.
Metal-Pages, 2003i (March 25), Yunna Mengzi to build new 50 tpy indium plant, accessed March 29, 2003, via URL http://www.metal-pages.com.
Metal-Pages, 2003j (September 15), Zhuzhou smelter completes ITO project, accessed September 16, 2003, via URL http://www.metal-pages.com.
Metal-Pages, 2003k (October 6), ZincOx turns FSU technology to process zinc and germanium from slags, accessed October 7, 2003, via URL http://www.metal-pages.com.
Metal-Pages, 2004a (January 7), In & Ga key to new device, accessed January 12, 2004, via URL http://www.metal-pages.com.
Metal-Pages, 2004b (June 28), Indium—Supply and demand, accessed June 28, 2004, via URL http://www.metal-pages.com.
Metal-Pages, 2004c (March 19), Indium up again as more ITO capacity announced, accessed March 22, 2004, via URL http://www.metal-pages.com.
Metal-Pages, 2004d (March 9), Nikko doubles indium tin oxide output, accessed March 20, 2004, via URL http://www.metal-pages.com.
Metal-Pages, 2004e (January 19), Plasma producers widening screens, accessed January 20, 2004, via URL http://www.metal-pages.com.
U.S. Department of the Interior, National Park Service, 2004, Lighting of Thomas Jefferson Memorial, accessed June 24, 2004, at URL http://www.nps.gov/partnerships/lighting_jefferson_mermorial.html.
U.S. Department of Energy, 2003 (October 15), Energy Department awards $20.4 million for project that will save energy in homes and commercial buildings, accessed June 24, 2004, via URL http://www.energy.gov.
ZincOx Resources plc, 2003, Annual report 2002, accessed May 24, 2004, via URL http://www.zincox.com.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Indium. Ch. in Mineral Commodity Summaries, annual.
Gallium, Germanium, and Indium. Ch. in United States Mineral Resources, Professional Paper 820, 1973.

Other

Indium. Ch. in Minerals Facts and Problems, U.S. Bureau of Mines Bulletin, 675, 1985.

TABLE 1
U.S. IMPORTS FOR CONSUMPTION OF UNWROUGHT AND WASTE AND SCRAP OF INDIUM, BY COUNTRY[1, 2]

	2002		2003	
Country	Quantity (kilograms)	Value (thousands)	Quantity (kilograms)	Value (thousands)
Belgium	215	$38	4,770	$742
Canada	32,100	2,340	20,800	2,410
Costa Rica	--	--	1	4
China	49,800	2,960	61,400	8,700
France	6,290	519	2,670	445
Germany	62	16	966	199
Hong Kong	--	--	1,120	205
Israel	--	--	6	4
Italy	25	2	--	--
Japan	8,280	618	19,800	2,370
Netherlands	--	--	45	10
Peru	4,560	244	4,330	655
Russia	8,520	825	6,150	776
Singapore	63	13	--	--
Switzerland	1,360	87	--	--
United Kingdom	547	91	628	106
Total	112,000	7,750	123,000	16,600

-- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes indium powder.

Source: U.S. Census Bureau.

TABLE 2

INDIUM: ESTIMATED WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons)

Country	1999	2000	2001	2002	2003
Belgium	35	40	40	40	30
Canada	42	45	45	45	50
China	40	95	100	85	100
France	43	65	65	65	10
Germany	10	10	10	10	10
Italy	5	5	5	5	10
Japan	40 [3]	55 [3]	55	60	70
Kazakhstan	NA	NA	NA	NA	NA
Netherlands	5	5	5	5	5
Peru	5 [3]	5 [3]	4 [3]	6 [3]	5
Russia	15	15	15	15	15
Ukraine	NA	NA	NA	NA	NA
United Kingdom	5	5	5	5	5
Total	245	345	349	341	305

NA Not available.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through June 10, 2004.

[3]Reported figure.