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2012 Minerals Yearbook

INDIUM

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Indium

By Amy C. Tolcin

Domestic tables were prepared by Wanda G. Wooten, statistical assistant, and the world refinery production table was prepared by Glenn J. Wallace, international data coordinator.

All refined indium produced in the United States during 2012 came from the refining of lower grade imported indium metal. Two refineries, one in New York and the other in Rhode Island, produced the majority of domestic indium metal and indium compounds in 2012. A number of smaller companies produced specialty indium alloys and other indium products. During 2012, U.S. imports for consumption of unwrought indium metal and indium powders totaled 109 metric tons (t), a 25% decrease from the 146 t imported in 2011 (table 1). Globally, refined indium production was estimated to have increased by 8% in 2012 from that of 2011 (table 3).

Production

Globally, zinc concentrates were the principal source of primary indium. Although the United States was a significant producer of zinc concentrates, primary indium was not known to be recovered from these concentrates. Two indium-containing deposits were actively being developed in the United States in 2012—Lithic Resource Ltd.'s (Vancouver, British Columbia, Canada) Crypto zinc-copper-silver-indium deposit (renamed the West Desert Project in January 2013) in Utah and Mexivada Mining Corp.'s (Vancouver) Jefferson gold-silver-tellurium-indium deposit in Nevada.

In the United States, indium metal was not produced as a byproduct at any zinc or lead refinery. Domestic production of indium consisted of upgrading imported indium metal and powder. Lower grade (99.97%) and standard-grade (99.99%) imported indium was refined to purities of as much as 99.99999%. Indium metal was sold in various forms (foil, ingot, powder, ribbon, wire, and others). Indium Corp. of America (ICA) (Utica, NY) and Umicore Thin Film Products (Providence, RI, a division of Umicore NV, Brussels, Belgium) accounted for the majority of U.S. production of indium metal and products.

Consumption

Indium Tin Oxide.—Production of indium tin oxide (ITO) was the leading use of indium. ITO production was estimated to account for 55% to 85% of global indium consumption. ITO is a transparent conducting oxide, principally used as a thin-film coating on flat-panel displays—most commonly, liquid crystal displays (LCDs). Global ITO production capacity increased by 7% in 2012 from that of 2011 to 2,110 metric tons per year (t/yr), and the leading three ITO producers accounted for 90% of capacity. ITO production capacity was concentrated in Japan and the Republic of Korea. Significant quantities of ITO were also produced in China and Taiwan. In the United States, ITO was produced by AIM Specialty Materials USA (Cranston, RI), Exotech Inc. (Pompano Beach, FL), ICA, 5N Plus Inc. (Saint Laurent, Quebec, Canada), and Umicore (Burton, 2012; Roskill's Letter From Japan, 2013b).

Alloys and Solders.—Alloys and solders were the second leading global end use of indium. Indium-containing solders have lower crack propagation and improved resistance to thermal fatigue when compared with tin-lead solders. They also inhibit the leaching of gold components in electronic apparatus. Certain indium alloys can be used as bonding agents between nonmetallic materials, such as glass, glazed ceramics, and quartz. Indium was also used in dental alloys and in white gold alloys. Other indium alloys were used as a substitute for mercury and for nuclear control rods.

Other.—Another important use of indium was for III-V semiconductor materials for light-emitting diodes (LEDs) and laser diodes. In indium-based semiconductors, indium antimonide, indium arsenide, or indium phosphide can be used as the substrate, and several indium-containing compounds can be used as the epitaxial layer (or substrate coating), such as indium gallium arsenide. Indium-based LEDs were used to transmit data optically and in displays. Indium-based laser diodes were used in fiber-optic communications. Indium consumption for the production of semiconducting compounds for LEDs and laser diodes was thought to have increased in 2012 from that of 2011; the value of the total global LED lighting market increased by 54% during 2012. The value of Japan's shipments of indium phosphide increased by 5% during April–September 2012 compared with shipments during the same period of 2011 owing to a rise in fiber optic network installations in China (O'Neill, 2013; Roskill's Letter from Japan, 2013a).

Prices

In 2012, the average annual Platts Metals Week New York dealer price range for indium [99.99% minimum purity in minimum lots of 50 kilograms (kg)] was about $520 to $550 per kilogram. Indium prices began the year ranging from $630 to $670 per kilogram and steadily declined during the year, averaging $560 to $585 per kilogram in the first quarter, $540 to $560 per kilogram in the second quarter, $500 to $530 per kilogram in the third quarter, and $490 to $530 per kilogram in the fourth quarter. At yearend, prices ranged from $490 to $520 per kilogram.

According to Platts Metals Week, the ICA producer price for indium [99.97% purity, 1-kilogram bars in lots of 311 kg (10,000 troy ounces)] began the year at $785 per kilogram. ICA lowered the price to $580 per kilogram in early May, where it remained for the rest of the year.

Foreign Trade

During 2012, U.S. imports for consumption of unwrought indium metal and indium powders totaled 109 t, a 25% decrease from the 146 t imported in 2011. Leading suppliers in 2012 were Canada (24%), the Republic of Korea (17%), Japan (16%), and China (14%). Data on indium exports were not available as there was no exclusive domestic export classification code for unwrought indium and indium powders.

World Review

Australia.—Operations at the Baal Gammon polymetallic (copper-tin-silver-indium) mine [owned by Monto Minerals Ltd. (West Perth)] were suspended from April through October while the operating company, Kagara Ltd. (Perth), carried out an environmental evaluation at the mine following a potential discharge of contaminated water. In December, Kagara sold its North Queensland Central Region assets, including the Minerals Rights Agreement to operate the Baal Gammon Mine, to Snow Peak Mining Pty. Ltd., an investment group associated with Consolidated Tin Mines Ltd. (Cairns North). Inferred and indicated resources at Baal Gammon were 2.8 million metric tons (Mt) containing 39 grams per metric ton of indium (Monto Minerals Ltd., 2012a, p. 11, 16; b).

Belgium.—Indium metal was produced at Umicore's precious metals refinery at Hoboken. A plant at the refinery recovered indium from dusts and residues generated by the facility's lead refinery. The facility also reclaimed copper, gallium, indium, and selenium from scrap copper-indium-gallium-diselenide (CIGS) solar cells, which the company then used in the manufacture of new CIGS solar cells.

Bolivia.—Sinchi Wayra S.A. (a subsidiary of Glencore International plc, Baar, Switzerland) was a significant producer of indium-bearing concentrates in Bolivia, which were exported and processed elsewhere.

In August, South American Silver Corp. (Vancouver) received an official Nationalization Decree from the Bolivian Government for the Malku Khota silver-indium project in Potosi, and shortly thereafter, the Bolivian State Mining Co. (COMIBOL) took over operations and exploration work at the site. In response, South American Silver announced that it would seek full compensation for the project. In October, the Bolivian Government contended that South American Silver was operating illegally in the country and denied that it owed the company compensation for the expropriation of its mining concessions. In April 2013, South American Silver announced that it had filed international arbitration proceedings against the Government of Bolivia through the United Nations Commission on International Trade Law. South American Silver discovered Malku Khota in 2007 and reportedly invested more than $16 million in its development (South American Silver Corp., 2012; 2013; Ministerio de Minería y Metalurgia, Bolivia, 2013).

Brazil.—Votarantim Metais Ltda. (São Paulo) continued construction of the polymetallic plant at its Juiz de Fora zinc smelter. The plant was designed to recover metals from zinc-containing wastes, such as electric arc furnace dust and leaching residues, as well as ores with a low zinc content. Upon completion, the plant was expected to increase zinc production capacity at Juiz de Fora by 15,000 t/yr and recover refined indium (American Metal Market, 2011).

Canada.—Refined indium was produced at Teck Resources Ltd.'s (Vancouver) metallurgical complex at Trail, British Columbia, as a byproduct of processing lead-zinc concentrates.

Several indium-containing deposits were being explored or were under development in Canada, including Adex Mining Inc.'s (Toronto) North Zone deposit in southwestern New Brunswick, Alexco Resource Corp.'s (Vancouver) Onek Mine deposit in northern Yukon, Avalon Rare Metals Inc.'s (Toronto) East Kemptville deposit in southwest Nova Scotia, and Silver Range Resources Ltd.'s (Vancouver) Silver Range deposit in southern Yukon.

China.—China was the leading producer of refined indium, accounting for more than one-half of global primary production. Production was estimated by the USGS to have increased by 7% from that of 2011 to 405 t owing to a rise in output at small-scale facilities (table 3). The China Nonferrous Metals Industry Association, which may not have accounted for all the small-scale producers, reported that production was 383 t of indium, 9 t less than the amount produced in 2011 (Antaike Minor Metals Monthly, 2013c).

China's indium consumption has increased in the past few years alongside an increase in domestic ITO production and was estimated to be about 60 t in 2012. Five Chinese companies were reported to have consumed indium for the production of ITO in 2011 (latest data available), including, Liuzhou Huaxi Indium Material Co. Ltd., Ningxia Orient Tantalum Industry Co. Ltd., Weihai Lanhu Special Materials Co. Ltd., Yunnan Tin Group Co. Ltd., and Zhuzhou Smelter Group Co. Ltd. Most of the ITO produced in China was manufactured using cold-sintering compression, which made it suitable for use in only twisted nematic (TN)-type LCDs. TN-type displays are relatively inexpensive and are commonly found in digital calculators, clocks, and watches. Chinese indium producers reportedly urged domestic LCD panel manufacturers to invest in ITO production technology that would yield high-quality ITO sputtering targets in mass quantities. Chinese LCD panel manufacturers mostly source ITO targets from imports (Yao, 2011b; Antaike Minor Metals Monthly, 2013b; Metal-Pages, 2013).

Despite domestic production being significantly greater than consumption, China became a net importer of indium in 2012 owing to a decline in global demand for indium and an increase in domestic investment and trading activity during the year. Large amounts of indium metal began to accumulate in commodity exchange warehouses in China—including the Kunming Fanya Nonferrous Metal Exchange, the Pan Asia Gold Exchange, and the Wuxi Stainless Steel Exchange—after the exchanges were opened to private investors. Reports indicated that 50 t of indium were delivered to Wuxi in August and that the Kunming Fanya held 496 t of indium in December (American Metal Market, 2012; Metal Bulletin, 2012b, Antaike Minor Metals Monthly, 2013a, c). In addition, China's State Reserve Bureau, which maintained a national stockpile of strategic materials, purchased 80 t of indium in 2012 from several state-owned smelters, including Zhuzhou Smelter Group Co. Ltd. and Hunan Zinc Co. Ltd. (Cammell, 2012a; Metal Bulletin, 2012a).

According to China's customs statistics, China imported 31 t of refined indium in 2012, mostly from the Republic of Korea. The indium export quota totaled 231 t in 2012. Zhuzhou Keneng New Material Co. Ltd. received the largest quota at 64 t, followed by Nanjing Germanium Technology Co. Ltd. (32 t), Guangxi Debang Technology Co. Ltd. (28 t), China Minmentals Non-Ferrous Metals Co. Ltd. (23 t), and Liuzhou China Tin Group Co. Ltd. (15 t). However, most of the quota remained unused by yearend. China exported only 5 t of indium in 2012, the lowest amount shipped in more than a decade. Leading destinations were Japan (60%), Belgium (24%), and the Republic of Korea (18%). China's Ministry of Commerce announced that the 2013 export quota was to remain unchanged from that of 2012 (Yao, 2011a; Antaike Minor Metals Monthly, 2012; Hao, 2012; Yi, 2013; Roskill's Letter from Japan, 2013b).

France.—Nyrstar NV's Auby zinc smelter began producing indium metal in June and produced 13 t of indium by yearend. Previously, the smelter recovered indium as a concentrate grading 25% indium, which was sold to third parties for further processing. Total investment in the metal production project was $9.9 million (7.4 million euros) (Nyrstar NV, 2013, p. 14).

Germany.—Indium was produced at PPM Pure Metals GmbH (Langelsheim) and Aurubis AG (Hamburg). PPM recovered indium from indium-containing materials at its specialty metals production facility in Langelsheim. The company produced high-purity indium ingot, semifinished products, and indium compounds. Aurubis also produced high-purity indium, which it consumed for the production of solar cells.

Japan.—Japan was a significant producer and recycler of indium. Asahi Pretec had the capacity to produce 200 t/yr of secondary indium at its ITO target recycling plant at Fukuoka, and Dowa Metals & Mining operated a 150-t/yr indium recycling facility in Akita Prefecture. Other secondary indium producers included Nikko Metals, Mitsui Mining & Smelting, Sumitomo Metal Mining Co. Ltd., and Toho Zinc Co. Ltd.

Japan was the leading consumer of indium, mostly for the production of ITO. The approximate ITO production rate in Japan was about 1,200 t/yr, equivalent to about 1,040 t/yr of indium. Leading ITO producers included Mitsui Mining & Smelting and Nippon Mining & Metals. Nippon Mining & Metals operated the world's leading ITO production plant at Isohara near Tokyo, and Mitsui Mining & Smelting operated an ITO manufacturing plant at Omuta (Roskill's Letter from Japan, 2013b).

Japan's imports of indium metal, powder, and scrap declined by 65% to 171 t in 2012 from that of 2011 owing to consumer destocking. Leading import sources included the Republic of Korea (55%), Canada (16%), the United States (8%), and Taiwan (7%) (Roskill's Letter from Japan, 2013b).

Korea, Republic of.—Korea Zinc Co. Ltd. (Seoul) produced primary and secondary indium at its Onsan zinc refinery. Primary feedstock was sourced from zinc concentrates originating from Bolivia, and secondary feedstock was sourced from ITO producers. Korea Zinc reportedly produced 140 t of primary indium at Onsan in 2012 and planned to keep production at that level in 2013 (Metal Bulletin, 2013). Young Poong Corp. (Seoul) was able to produce up to 30 t/yr of indium at its Sukpo zinc refinery.

The Republic of Korea was also a notable consumer of indium. A significant amount of this consumption was by Heesung Metal Ltd. (Seoul) and Samsung Corning Precision Materials Co. Ltd. (Seoul) for the production of ITO.

Peru.—Votorantim Metais planned to produce 12 t of indium at its Cajamarquilla zinc refinery in 2012; actual output was not reported (Votorantim Metais Ltda., 2012, p. 21). Doe Run Peru's La Oroya metallurgical complex resumed zinc operations in July, followed by the lead operations in December. The facility, which has the capacity to produce a small amount of indium, had been closed since 2009 owing to environmental and financial problems (Grabski, 2013).

Russia.—Chelyabinsk Zinc Plant OJSC produced 7 t of indium in 2012, an increase from the 6 t produced in 2011. Ural Mining and Metals Co. also produced refined indium. Most of Russia's refined indium output was exported (Chelyabinsk Zinc Plant OJSC, 2013, p. 16).

Outlook

Demand for indium is expected to continue to follow demand for ITO for LCD production. Corning Inc. expected a slower rate of growth in the LCD panel market in 2013, with demand rising by 8%, compared with the 16% year-on-year increase in 2012. Demand for small- and medium-sized LCD panels may outpace demand for large-sized panels (more than 9 inches) in the next few years owing to the growing popularity of e-books, smartphones, and tablets. Sharp Corp. expected demand for small- and medium-sized panels to increase by 17% per year from 2011 to 2015, while demand for large-sized panels was expected to rise by about 1% per year. DisplaySearch, however, forecast large-area LCD panel shipments to decrease by 6% in 2013 from that of 2012, mostly owing to a decline in shipments for personal computers (Cammell, 2012b; DisplaySearch, 2013; O'Neill, 2013, p. 11).

An emerging market for indium was the semiconducting compound, indium gallium zinc oxide (IGZO) for use in LCDs. IGZO has begun to replace amorphous silicon as the thin-film transistor in some LCD displays, because it allows for more pixels per square inch and requires less voltage to operate. In March, Sharp began producing small- and medium-sized high-performance LCD panels using IGZO at its Kameyama Plant No. 2 in Japan (Cammell, 2012b).

On the supply side, China was expected to continue to be the main global supplier of primary indium. Outside of China, Japan and the Republic of Korea have increased their recycling capabilities, and some additional primary production capacity is likely to be added in Brazil. Several exploration projects, mostly in Canada and South America, were advancing, but it remained uncertain when these projects will come onstream.

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TABLE 1
U.S. IMPORTS FOR CONSUMPTION OF UNWROUGHT INDIUM AND INDIUM POWDERS BY COUNTRY[1]

Country	2011		2012	
	Quantity (kilograms)	Value (thousands)	Quantity (kilograms)	Value (thousands)
Belgium	23,700	$14,300	8,930	$4,070
Canada	21,400	13,600	26,700	13,500
China	49,700	32,300	15,300	8,050
Czech Republic	131	69	39	9
France	--	--	3,620	1,870
Germany	1,620	945	1,380	472
Hong Kong	4,020	2,100	2,090	1,150
India	300	158	--	--
Israel	93	40	103	27
Japan	11,900	7,160	17,500	8,590
Korea, Republic of	6,140	4,740	18,700	9,280
Laos	--	--	613	73
Liechtenstein	--	--	28	12
Malaysia	36	4	--	--
Mexico	--	--	45	49
Netherlands	4,050	3,140	--	--
Peru	--	--	117	59
Russia	1,340	936	2,570	1,200
Switzerland	--	--	4,030	1,950
Taiwan	7,350	4,800	3,270	1,530
Thailand	912	59	--	--
United Kingdom	11,200	6,190	4,180	2,040
Venezuela	2,000	477	--	--
Total	146,000	91,000	109,000	53,900

-- Zero.

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

Source: U.S. Census Bureau.

TABLE 2
WORLD PRIMARY INDIUM PRODUCTION CAPACITY

(Metric tons)

Country	Major operating company	Location of main facilities	Primary annual capacity[e]
Belgium	Umicore NV	Hoboken	50
Brazil	Votorantim Metais Ltda.	Juiz de Fora, Minas Gerais	20
Canada	Teck Resources Ltd.	Trail, British Columbia	75
China	Guangxi Debang Technology Co. Ltd.	Guangxi, Liuzhou	75
Do.	Guangxi Tanghan Zinc & Indium Co. Ltd.	Guangxi, Hechi	30
Do.	Huludao Nonferrous Metals Group Co.	Liaoning, Huludao	50
Do.	Laibin Smelter [Liuzhou Huaxi (China Tin) Group Co.]	Guangxi, Laibin	50
Do.	Liuzhou Zinc Products Co.	Guangxi, Liuzhou	20
Do.	Nanjing Germanium Co. Ltd.	Jiangsu, Nanjing	150
Do.	Nanjing Sanyou Electronic Material Co. Ltd.	do.	50
Do.	Shaoguan Smelter (Shenzhen Nonfemet Co.)	Guangdong, Shaoquan	25
Do.	Xiangtan Zhengtan Nonferrous Metal Co. Ltd.	Hunan, Xiangtan	75
Do.	Xikuangshan Twinkling Star Antimony Co. Ltd.	Hunan, Lengshuijiang	10
Do.	Yintai Technology Co. Ltd.	Guangxi, Liuzhou	40
Do.	Yuguang Gold-Lead Co. Ltd.	Henan, Jiyuan	10
Do.	Yunnan Chengfeng Nonferrous Metals Co. Ltd.	Yunnan, Gejiu	10
Do.	Yunnan Mengzi Mining and Smelting Co. Ltd.	Yunnan, Honghe	30
Do.	Zhuzhou Smelter Group Co. Ltd.	Hunan, Zhuzhou	60
France	Nyrstar NV	Auby	35
Japan	Dowa Metals and Mining Co. Ltd.	Iijima, Akita	70
Do.	Mitsui Mining and Smelting Co. Ltd.	Takehara, Hiroshima	NA
Do.	Sumitomo Metal Mining Co. Ltd.	Harima, Hyogo	NA
Korea, Republic of	Korea Zinc Co. Ltd.	Onsan	160
Do.	Young Poong Corp.	Sukpo	30
Peru	Doe Run Peru S.R. Ltda.	La Oroya	5
Do.	Votorantim Metais Ltda.	Cajamarquilla	50
Russia	Chelyabinsk Zinc Plant OJSC	Chelyabinsk	15
Do.	Ural Mining and Metals Co.	Vladikavkaz	5

[e]Estimated; estimated data are rounded to no more than two significant digits. Do., do. Ditto. NA Not available.

TABLE 3

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

(Kilograms)

Country[3]	2008	2009	2010	2011	2012
Belgium	30,000	30,000	30,000	30,000	30,000
Brazil	-- r	-- r	-- r	-- r	--
Canada	57,000	50,000	67,000	64,000 r	62,000
China[4]	340,000	340,000 r	330,000 r	380,000	405,000
France	--	--	--	--	13,000
Germany[5]	10,000	10,000	10,000	10,000	10,000
Italy[4]	5,000	5,000	5,000	5,000	5,000
Japan	65,000	67,000	69,000	70,000	71,000
Korea, Republic of	145,000 r	160,000 r	145,000 r	155,000 r	165,000
Netherlands[4]	5,000	5,000	5,000	5,000	5,000
Peru[6]	5,976 r	1,629 r	-- r	2,499 r, p	11,080 p
Russia	9,800 r	11,600 r	12,500 r	11,600 r	12,600
United Kingdom[4]	5,000	5,000	5,000	5,000	5,000
Total	678,000 r	685,000 r	679,000 r	738,000 r	795,000

pPreliminary. rRevised. -- Zero.

[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 April 3, 2014.

[3]In addition to the countries listed, Kazakhstan and Ukraine are known to have produced indium, but information is not adequate to estimate output levels.

[4]Includes secondary production.

[5]Data represent only estimated production by PPM Pure Metals GmbH at the company's Langelsheim special metals plant. Aurubis AG was reportedly using its own indium in designing new solar cell technologies, but estimates of indium production were not available.

[6]Reported figure.