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INDIUM

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Indium

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All refined indium produced in the United States during 2011 came from the refining of lower grade imported indium metal and from the refining of scrap. Two refineries, one in New York and the other in Rhode Island, produced the majority of domestic indium metal and indium compounds in 2011. A number of smaller companies produced specialty indium alloys and other indium products.

Production

Globally, zinc concentrates were the principal source of indium. Although the United States was a significant producer of zinc concentrates, primary indium was not known to be recovered from these concentrates.

Lithic Resources Ltd. (Vancouver, British Columbia, Canada), continued to develop its Crypto zinc-copper-indium project in Utah. The deposit would be developed as an underground mine with an onsite mill that would produce zinc-indium and copper-gold-silver concentrates. The mill would be designed to process 3,500 metric tons per day of ore, and mine life was expected to be 10 years. Based on a November 2009 evaluation, indicated resources at Crypto contained 283 metric tons (t) of indium. The company has owned the property since 2005 (Lithic Resources Ltd., 2010).

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 up to 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 was principally used for electrically conductive purposes in a variety of flat-panel display devices—most commonly, liquid crystal displays (LCDs). Global ITO production capacity was about 1,970 metric tons per year (t/yr). Most ITO production was concentrated in Japan. Significant quantities of ITO were also produced in China, the Republic of Korea, 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, Canada), and Umicore. Umicore reported increased sales volumes of ITO targets in 2011 compared with that of 2010 owing to increased demand for architectural glass and flat-panel displays, specifically high-end consumer LCDs and touch screens (Roskill's Letters From Japan, 2011; Umicore NV, 2012, p. 34).

Alloys and Solders.—Alloys and solders were the second leading end use of indium globally. Indium-containing solders have lower crack propagation and improved resistance to thermal fatigue when compared to tin-lead solders. They also inhibit the leaching of gold components in electronic apparatus. Certain types of 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 predominantly to optically transmit data and, to a lesser extent, in LED displays. Indium-based laser diodes were used in fiber-optic communications.

Sensors Unlimited Inc. (Princeton, NJ) developed a shortwave infrared camera which uses indium gallium arsenide imaging. The camera can image through low visibility conditions (such as, dust, haze, fog, and smoke) and was developed for use in aerospace, marine, and military applications that would require persistent surveillance (Sensors Unlimited Inc., 2011).

Prices

In 2011, 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 $665 to $705 per kilogram. Indium prices began the year ranging from $520 to $570 per kilogram and increased through the first half of the year, reaching a high of $800 to $875 per kilogram in June. Subsequently, prices generally declined through December, ending the year at $630 to $670 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 $570 per kilogram. ICA raised the price to $690 per kilogram in early April and then to $785 per kilogram in May, where it remained for the rest of the year.

Foreign Trade

During 2011, U.S. imports for consumption of unwrought indium metal and indium powders totaled 146 t, a 24% increase from the 117 t imported in 2010. Leading suppliers in 2011 were

China (34%), Belgium (16%), and Canada (15%). There was no exclusive domestic export classification code for unwrought indium and indium powders.

World Review

Australia.—At the Baal Gammon polymetallic (copper-tin-silver-indium) project near Herberton, owned by Monto Minerals Ltd. (West Perth) and operated by Kagara Ltd. (Perth), blasting and prestripping began in October, and by late November, the first shipments of ore were trucked to the nearby Mt. Garnet copper mill for processing. Inferred and indicated resources at Baal Gammon were 2.8 million metric tons (Mt) containing 39 grams per metric ton (g/t) of indium (Monto Minerals Ltd., 2012).

Belgium.—Indium metal was produced at Umicore's precious metals refinery at Hoboken, near Antwerp. A special metals plant at the refinery recovered indium from dusts and residues generated by the facility's lead refinery. Production capacity was 50 t/yr of indium. The facility also reclaimed copper, indium, gallium, 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.—Bolivia was a significant producer of indium-bearing concentrates, which were exported and processed elsewhere.

In May, South American Silver Corp. (Vancouver, Canada) released an updated economic assessment of its Malku Khota silver-indium project. The new assessment raised the projected indium production rate at the mine during the first 5 years of production to 80 t/yr from the previously expected 40 t/yr. The company planned to move the project into the feasibility stage during 2012 (South American Silver Corp., 2011).

Brazil.—Votarantim Metais (São Paulo) resumed construction of the polymetallic plant at its zinc smelter in Juiz de Fora after construction was put on hold in 2009 owing to declining economic conditions. 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 would increase zinc production capacity at Juiz de Fora by 15,000 t/yr and recover a few metric tons per year of refined indium (American Metal Market, 2011c).

Canada.—Refined indium was produced at Teck Resources Ltd.'s (Vancouver) lead-zinc metallurgical complex at Trail, British Columbia. Indium production capacity at Trail was about 75 t/yr.

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 area in northern Yukon, and Avalon Rare Metals Inc.'s (Toronto) East Kemptville deposit in southwest Nova Scotia. In 2011, Adex continued to develop the North Zone zinc-tin-indium deposit at the Mount Pleasant Mine area. The company built a pilot plant that produced zinc-indium concentrates containing 5,310 g/t indium, as well as developed a hydrometallurgical process involving solvent extraction and solution purification that produced indium sponge grading 96.25% indium. In October, Adex began a definitive feasibility study of Mount Pleasant and expected a production decision by yearend 2012, which could lead to full production startup in 2014 (Adex Mining Inc., 2011, p. 4, 6).

China.—In 2011, China was the leading producer of refined indium, accounting for more than one-half of global primary production. The country produced 380 t of indium in 2011, a 12% increase from that of the previous year (table 2).

China exported 106 t of indium in 2011, 15% less than in 2010, and the leading destinations were Japan (68%) and Hong Kong (28%). China continued to restrict domestic exports of refined indium through an export licensing and quota system. In November, China raised the average production levels new applicants must have achieved in order to be eligible to receive an export license for 2012. From 2009 to 2011, base-metal smelters must have produced an average of 12 t/yr of indium, up from 4 t/yr; zinc chemical producers, 18 t/yr, up from 10 t/yr; and independent indium producers, 22 t/yr, up from 15 t/yr. Companies that already had export licenses were exempt from meeting the new criteria. The total indium export quota for 2011 was 233 t, unchanged from that of 2010. Eighteen companies received an export license for 2011 with Zhuzhou Keneng New Material Co. Ltd. receiving the largest quota of 39.7 t (Yao, 2011a; Antaike Precious & Minor Metals Monthly, 2012; Roskill's Letters From Japan, 2012).

Chinese indium consumption increased in the past few years alongside an increase in domestic ITO production. 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. Five Chinese companies were reported to have consumed indium for the production of ITO in 2011, 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. (Yao, 2011b).

In 2011, two commodity exchanges trading indium were opened—the Kunming Fanya Nonferrous Metal Exchange in Yunnan Province and the Hunan Southern Precious Metals Exchange in Hunan Province. The Kunming Fanya was established partly to promote the nonferrous industry in Yunnan Province. Indium production in the Province accounts for about one-quarter of China's total indium production. Hunan is also an important indium-producing Province in China. In November, China's State Council ordered the Securities Regulatory Commission to begin investigating these small electronic commodity exchanges (there were reportedly more than 200) as many of them operated with Provincial, but not state approval (American Metal Market, 2011b; Metal-Pages, 2011a–c).

France.—Nyrstar NV's Auby zinc smelter had an indium recovery plant that produced a concentrate grading 20% indium, which was sold to third parties for further processing. In 2011, Nyrstar committed capital to build a plant at Auby that could produce refined indium. The plant was expected to be commissioned in the first half of 2012 (Nyrstar NV, 2012, p. 9).

Germany.—Indium was produced at PPM Pure Metals GmbH (Langelsheim) and Aurubis AG (Hamburg). PPM recovered

indium from indium-containing materials at its special 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 development of solar cells.

India.—India's Planning Commission began organizing a Government agency that would create and maintain a national stockpile of strategic metals, including indium. Initial investment to start the stockpile was to be about $200 million. The Planning Group also suggested that the Government form bilateral agreements with foreign countries for the supply of strategic materials, as well as offer incentives to private companies to produce these metals as byproducts of base-metal mining and smelting (Surendran, 2011).

Japan.—Japan was a significant recycler of indium. Indium-recycling companies included Asahi Pretec Corp., Dowa Metals & Mining Co. Ltd., Nikko Metals, Mitsui Mining & Smelting, Sumitomo Metal Mining Co. Ltd., and Toho Zinc Co. Ltd. Dowa Metals & Mining operated an indium recycling facility in Akita Prefecture. Production capacity at the facility was 150 t/yr of secondary indium. Dowa also had the capacity to produce 70 t/yr of primary indium. Dowa's production was sold to consumers in Japan. Asahi Pretec had the capacity to produce 200 t/yr of secondary indium at its ITO target recycling plant in Fukuoka.

Japan was also a leading consumer of indium. ITO production accounted for about 90% of the country's consumption. Major Japanese indium consumers included ITO producers Mitsui Mining & Smelting, Nippon Mining & Metals, and Ulvac Technologies, Inc. Nippon Mining & Metals operated the world's leading ITO production plant in Isohara near Tokyo, and Mitsui Mining & Smelting operated the second-ranked ITO manufacturing plant in Omuta.

Korea, Republic of.—The Republic of Korea was 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.

The South Korean Government announced that it had designated indium as a critical overseas resource and, as such, would lend financial support to South Korean companies that invested in indium deposits abroad. The country reportedly held about 11 t of indium in a strategic metals stockpile (Metal-Pages, 2011d, e).

Korea Zinc Co. Ltd. (Seoul) produced primary and secondary indium at its Onsan zinc refinery. Indium production capacity at Onsan was thought to be 200 t/yr. Primary feedstock was sourced from zinc concentrates originating from Bolivia, and secondary feedstock was sourced from ITO producers. Young Poong Corp. (Seoul) also had the capacity to produce 30 t/yr of indium at its Sukpo zinc refinery.

Peru.—Refined indium was produced at Votorantim Metais' Cajamarquilla zinc refinery. Operations at Doe Run Peru's La Oroya metallurgical complex, which has the capacity to produce a small amount of indium, were halted in June 2009 owing to environmental and financial problems.

Poland.—Huta Cynku "Miasteczko Slaskie" S.A. (HCM), a Polish zinc producer, ran trials to recover indium in an alloy form. About 65% of HCM's feedstock was secondary material, and the balance was comprised of bulk lead-zinc concentrates sourced predominantly from the McArthur River Mine in Australia (American Metal Market, 2011a).

Russia.—Chelyabinsk Zinc Plant OJSC and Ural Mining and Metals Co. produced refined indium. Refined indium produced in Russia was exported.

Outlook

Demand for indium is expected to continue to follow demand for ITO for LCD production. Shipments of mobile devices continue to increase, with substantial increases forecast for media tablets and smartphones. The market share of LCD televisions is increasing, while that of plasma-display panels and cathode-ray-tube televisions is decreasing. In 2011, shipments of LCD televisions increased by 7% from those of 2010 and were projected to rise by 5% in 2012. Globally, growth in demand for LCD televisions will be the strongest in developing countries (DisplaySearch, 2012).

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 and France. 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	2010 Quantity (kilograms)	2010 Value (thousands)	2011 Quantity (kilograms)	2011 Value (thousands)
Belgium	12,300	$6,040	23,700	$14,300
Canada	23,500	12,300	21,400	13,600
China	27,400	13,600	49,700	32,300
Czech Republic	--	--	131	69
Germany	344	164	1,620	945
Hong Kong	6,540	3,350	4,020	2,100
India	--	--	300	158
Israel	--	--	93	40
Japan	21,300	10,700	11,900	7,160
Kazakhstan	164	83	--	--
Korea, Republic of	450	181	6,140	4,740
Laos	652	46	--	--
Malaysia	921	334	36	4
Netherlands	--	--	4,050	3,140
Russia	3,390	1,870	1,340	936
Switzerland	209	123	--	--
Taiwan	6,760	3,490	7,350	4,800
Thailand	697	68	912	59
United Kingdom	12,900	6,350	11,200	6,190
Venezuela	--	--	2,000	477
Total	117,000	58,700	146,000	91,000

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

(metric tons)

Country	2007	2008	2009	2010	2011
Belgium	30	30	30	30	30
Brazil	--	5 [r]	5 [r]	5	5
Canada	61	57	50	67	75
China	370	340	330	340	380
Germany[2]	10	10	10	10	10
Italy	5	5	5	5	5
Japan	60	65	67	69 [r]	70
Kazakhstan	NA [r]	NA [r]	NA [r]	NA [r]	NA
Korea, Republic of	70	75	70	120	70
Netherlands	5	5	5	5	5
Peru	5	6	2	2	2
Russia	10	10	4	NA	5
Ukraine[3]	NA	NA	NA	NA	NA
United Kingdom	5	5	5	5	5
Total	631	613	583	658 [r]	662

[r]Revised. NA Not available. -- Zero.

[1]Table includes data available through July 16, 2012.

[2]Production of indium reinstated, because both PPM Pure Metals GmbH (PPM) and Aurubis AG [formerly Norddeutsche Affinerie AG (NA)] reported that they were producing indium in 2007. Aurubis AG is reportedly using its own indium in designing new solar cell technologies, but no estimates of indium production were actually available. This data represents only estimated production by PPM at the company's Langelsheim special metals plant.

[3]Information is not adequate to estimate production.