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INDIUM

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INDIUM

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All refined indium produced in the United States during 2010 came from the refining of lower grade imported indium metal and from refining of scrap. Two refineries, one in New York and the other in Rhode Island, produced the majority of indium metal and indium compounds in 2010. A number of smaller companies produced specialty indium alloys and other indium products.

Production

Though zinc was mined domestically, primary indium was not known to be recovered from these zinc concentrates. Lithic Resources Ltd. (Vancouver, British Columbia, Canada), however, completed a preliminary economic assessment for its Crypto zinc-copper-indium project in Utah in August. The assessment concluded that 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 would be 10 years. As of November 2009, indicated resources at Crypto totaled 283 metric tons (t) of indium. The company has owned the property since 2005 (Lithic Resources Ltd., 2010).

Indium metal was not produced as a byproduct in the United States at any zinc or lead refineries. 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 Indium Products (Providence, RI, a division of n.v. Umicore, s.a., Olen, Belgium) accounted for the majority of U.S. production of indium metal and products. In October, it was reported that ICA planned to purchase a facility in Utica, NY, to expand its production capabilities (Schier, 2010).

Recycling

A large portion of global secondary indium was produced from indium-tin oxide (ITO) recycling. Spent ITO target recycling was concentrated in China, Japan, and the Republic of Korea—the countries where ITO production and sputtering takes place.

Indium can also be recovered from copper-indium-gallium-diselenide (CIGS) solar cells to be used in the manufacture of new CIGS solar cells. Indium may be reclaimed directly from old liquid crystal display (LCD) panels. The panels are crushed to millimeter-sized particles and then soaked in an acid solution to dissolve the ITO from which the indium is recovered.

Indium recovery from tailings was thought to have been insignificant, as these wastes contain small percentages of the metal and can be difficult to process. However, improvements to the process technology have made indium recovery from tailings feasible when the price of indium is high.

Consumption

Indium Tin Oxide.—Production of ITO was the leading end use of indium, accounting for the majority of global indium consumption. ITO is used for electrically conductive purposes in a variety of flat-panel display devices—most commonly, LCDs. Most ITO production was concentrated in Japan. Significant quantities of ITO also were produced in China, the Republic of Korea, and Taiwan. Demand for ITO increased during the first half of 2010 from that of the second half of 2009 owing to a rise in LCD panel production. However, LCD panel inventories began to increase during the second half of 2010 owing to lower-than-expected LCD sales in the United States and global economic uncertainty. One LCD panel producer initiated a 30% production cut at one of its Japanese plants to control inventory. As a result of weakening LCD demand in the second half of 2010, LCD panel producers lowered prices, resulting in an aggressive price competition among flat-screen LCD TV producers. However, ITO producers were not able to significantly lower the price for ITO owing to higher indium prices in 2010.

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. Low-melting-point indium alloys are used as fuses or plugs for sprinkler systems. In the optical industry, low-melting-point alloys are applied to lenses and act as a surface for machine tools to grip during the polishing process. Certain types of indium alloys can be used as bonding agents between nonmetallic materials, such as glass, glazed ceramics, and quartz. Indium has also been used in dental alloys and in white gold alloys.

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 are used predominantly to optically transmit data and, to a lesser extent, in LED displays. Indium-based laser diodes are used in fiber-optic communications.

Other uses of indium included electrodeless lamps, mercury alloy replacements, and nuclear control rods. Alkaline batteries use indium to prevent buildup of hydrogen gas within sealed battery casings.

Prices

The 2010 average annual Platts Metals Week New York dealer price range for indium [99.99% minimum purity in minimum lots of 50 kilograms (kg)] was $535 to $569 per kilogram. Indium prices began the year ranging from $460 to $500 per kilogram and generally increased through May, reaching a high of $580 to $640 per kilogram. Subsequently, prices slowly declined through December, ending the year at $520 to $570 per kilogram.

According to Platts Metals Week, the ICA producer price for indium (99.97% purity, 1-kilogram bar in lots of 10,000 troy ounces) began the year at $500 per kilogram. In early February, the price was raised to $570 per kilogram and remained at that level for the rest of the year.

Foreign Trade

During 2010, U.S. imports for consumption of unwrought indium metal and indium powders totaled 117 t, a 12% increase from the 105 t imported in 2009. Leading suppliers in 2010 were China (23%), Canada (20%), and Japan (18%). Belgium, Hong Kong, Taiwan, and the United Kingdom were also significant suppliers. There was no exclusive domestic export classification code for unwrought indium and indium powders.

World Review

Australia.—North Queensland Metals Ltd. (Fortitude Valley, Queensland) owned the Baal Gammon copper, tin, silver, and indium project near Herberton. Estimated probable ore reserves at Baal Gammon reportedly were 3.1 million metric tons (Mt) of ore grading 29.6 grams per metric ton of indium. North Queensland Metals was acquired by Conquest Mining Ltd. (Bondi Junction, New South Wales) in the fourth quarter (North Queensland Metals Ltd., 2009, p. 18; 2010).

Belgium.—Indium metal (foil and ingots) 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 metric tons per year (t/yr) of indium. Umicore recently installed a new process at Hoboken, which allows the company to reclaim the copper, indium, gallium, and selenium from CIGS solar cells, which Umicore then uses to manufacture new CIGS solar cells (Metal-Pages, 2010c).

Bolivia.—Bolivia was a significant producer of indium-bearing concentrates, which were exported and processed elsewhere.

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. Actual production would be determined by the availability of indium-bearing concentrates.

Xstrata plc's (Zug, Switzerland) Kidd Creek copper-zinc metallurgical operations at Timmins, Ontario, usually produced approximately 10 to 15 t/yr of refined indium. Xstrata began to ramp-down operations at the smelter in May and ceased operations in mid-June. Previously, the smelter's copper operations were temporarily idled in August 2009 owing to a lack of concentrate feed from third parties. Concentrates from the nearby Kidd Creek copper-zinc-silver mine were redirected to Xstrata's Horne smelter in Quebec, which does not have the capability to extract indium. ICA had a supply contract with Xstrata for the indium produced at Kidd Creek (American Metal Market, 2010).

Canada has several indium-containing deposits that were being explored or were under development. Adex Mining Inc. began a drilling program in October to upgrade the inferred resources at the tin-indium-zinc North Zone deposit on its Mount Pleasant Mine property in New Brunswick to National Instrument (NI) 43–101 compliant indicated resources. The drilling program was being conducted as part of the feasibility study of the deposit (Adex Mining Inc., 2010).

Alexco Resource Corp. (Vancouver) completed construction of the Bellekeno silver-lead-zinc mine and mill in September. The mine is in the Keno Hill Silver District in the Yukon Territory. By November, the mill was operating at design capacity and was producing silver-lead and zinc concentrates that possibly contained payable indium. The company entered into offtake agreements with Glencore International AG (Baar, Switzerland) that allowed for the payment of indium once commercial quantities of the metal had been demonstrated within the concentrates (Alexco Resource Corp., 2010).

Avalon Rare Metals Inc. continued to evaluate the possible development of its East Kemptville tin-indium project in Nova Scotia. The company undertook an exploration program in areas surrounding the former East Kemptville tin mine to assess the indium and tin resources of the deposit. Avalon planned to commence a work program to identify resources that would comply with NI 43–101 requirements once approval for the program was gained from the government of Nova Scotia (Metal-Pages, 2010a).

China.—China was the leading global producer of primary indium, with some secondary production as well. Chinese indium production in 2010 increased from that of 2009, although some small- and medium-sized producers were reported to have reduced or stopped production during the year owing to increased environmental controls (Metal-Pages, 2010b).

Zhuzhou Keneng New Material Co., Ltd. added an indium production line with a 5 t/yr capacity. The company was reported to have produced 46 t of indium in 2009 (Metal-Pages, 2010d).

The total 2010 indium export quota was 233 t, unchanged from that of 2009. Zhuzhou Smelter Group was given the largest quota of 45.1 t, followed by Nanjing Foreign Economic & Trade Development Co., Ltd. (30.1 t), Guangxi China Tin Group Co., Ltd. (25.5 t), Zhuzhou Keneng New Material (24.9 t), Huludao Nonferrous Metals Group Import and Export Co., Ltd. (14.9 t), and Nanjing Germanium Factory Co., Ltd. (14.4 t). In 2010, China exported 124 t of indium metal, powder and scrap, of which 73% went to Japan (Roskill's Letters From Japan, 2010b; 2011, p. 2).

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.

Germany.—Indium was produced at PPM Pure Metals GmbH (Langelsheim) and Norddeutsche Affinerie 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. Norddeutsche Affinerie AG also produced high-purity indium, which it consumed for the development of solar cells.

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 also is a leading consumer of indium. After declining each year since 2006, indium consumption was thought to have increased in 2010 from that of 2009. Most of the increase was attributed to rises in ITO production, which accounts for about 90% of Japan's indium consumption. Major Japanese indium consumers included ITO producers Mitsui Mining & Smelting, Nippon Mining & Metals, Sumitomo Metal Mining, Tosoh Corp., and Ulvac Technologies, Inc. Nippon Mining & Metals operated the world's leading ITO production plant—the 50-metric-ton-per-month (t/mo) Isohara plant near Tokyo. Mitsui Mining & Smelting operated the second-ranked ITO manufacturing plant, the Omuta plant in southern Japan, which had the capacity to produce about 20 to 30 t/mo of ITO (Platts Metals Week, 2008; Ryan's Notes, 2008; Watanabe, 2008).

Japanese shipments (including exports) of the semiconductor alloy, indium phosphide, increased by 15% in the second half of fiscal year 2009 (October 2009–March 2010) from that of the same period in the prior fiscal year. The increase in shipments was attributed to an overall recovery in demand for fiber optics (Roskill's Letters From Japan, 2010a).

Korea, Republic of.—Korea Zinc Co., Ltd. produced primary and secondary indium at its Onsan zinc refinery. Production capacity at the plant was thought to be 200 t/yr of indium, of which 100 t/yr was primary and 100 t/yr was secondary. Primary feedstock was sourced from zinc concentrates originating from Bolivia, and secondary feedstock was sourced from Japanese ITO producers. Korea Zinc produced 120 t of indium in 2010 (Roskill's Letters From Japan, 2011, p. 1).

Peru.—Refined indium was produced at Votorantim Metais' Cajamarquilla zinc refinery. Doe Run Peru's La Oroya metallurgical complex, which has the capacity to produce a small amount of indium, has been closed since June 2009.

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

Outlook

Demand for indium will continue to follow demand for ITO and, more broadly, LCDs. Shipments of mobile devices continue to increase, with substantial increases forecast for media tablets and smart phones. The market share of LCD televisions is increasing, while that of plasma display panels is remaining level, and cathode ray tube televisions, decreasing. In 2011, shipments of flat-panel display televisions (FPD TVs) were expected to increase 6% from those of 2010 to 206 million units followed by a 9% increase in 2012. Globally, growth in demand for FPD TVs will be the strongest in developing areas—specifically, Africa, Asia Pacific, China, Eastern Europe, Latin America, and the Middle East—and demand in developed regions will decline slightly (DisplaySearch, 2011).

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; however, there are no known plans to build additional primary refineries. The closure of Kidd Creek and La Oroya has removed nearly 20 t/yr of primary capacity. Several exploration projects at deposits containing recoverable amounts of indium are advancing, but it remains uncertain when many of these projects will come onstream.

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TABLE 1
U.S. IMPORTS FOR CONSUMPTION OF UNWROUGHT INDIUM METAL, BY COUNTRY[1]

	2009		2010	
Country	Quantity (kilograms)	Value (thousands)	Quantity (kilograms)	Value (thousands)
Belgium	8,790	$2,860	12,300	$6,040
Canada	44,600	13,400	23,500	12,300
China	19,000	7,040	27,400	13,600
Germany	57	19	344	164
Hong Kong	5,910	2,050	6,540	3,350
Japan	12,000	3,690	21,300	10,700
Kazakhstan	--	--	164	83
Korea, Republic of	3,320	973	450	181
Laos	--	--	652	46
Malaysia	322	69	921	334
Peru	2,570	737	--	--
Russia	--	--	3,390	1,870
Switzerland	594	26	209	123
Taiwan	1,600	563	6,760	3,490
Thailand	--	--	697	68
United Kingdom	6,500	3,780	12,900	6,350
Total	105,000	35,200	117,000	58,700

-- 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, 2]

(Metric tons)

Country	2006	2007	2008	2009	2010
Belgium	30	30	30	30	30
Brazil	--	--	--	--	5
Canada	52 [r]	61 [r]	57 [r]	50 [r]	67
China	400	370	340	330 [r]	340
Germany[3]	10	10	10	10	10
Italy	5	5	5	5	5
Japan	55	60	65	67	70
Kazakhstan	(4)	(4)	(4)	(4)	(4)
Korea, Republic of	60	70	75	70	120
Netherlands	5	5	5	5	5
Peru	6	5	6	2 [r]	2
Russia	10	10	10	4	NA
Ukraine[5]	NA	NA	NA	NA	NA
United Kingdom	5	5	5	5	5
Total	638 [r]	631 [r]	613 [r]	583 [r]	659

[r]Revised. NA Not available. -- 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 August 4, 2011.

[3]Production of indium reinstated, because both PPM Pure Metals GmbH (PPM) and Norddeutsche Affinerie AG (NA) reported that they were producing indium in 2007. NA 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.

[4]Less than ½ unit.

[5]Information is not adequate to estimate production.