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INDIUM

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INDIUM

By Amy C. Tolcin

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

All refined indium produced in the United States during 2006 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 2006. A number of small companies produced specialty indium alloys and other indium products.

In 2006, domestic consumption of indium was estimated by the U.S. Geological Survey to have increased to 125 metric tons (t), based on import levels of unwrought indium and indium powder. The value of indium consumed in the United States was about $102 million at an average New York dealer price of $815 per kilogram, as calculated from weekly price ranges published in Platts Metals Week.

World primary production rose by 17%, compared with production in 2005, owing to increases from China and the Republic of Korea. China accounted for 60% of world production, roughly the same percentage as in 2005. Other major producing countries of refined indium recovered from domestic or imported concentrates or residues were Canada, Japan, and Republic of Korea, each producing about 9% of total global production (table 2).

Global indium consumption was thought to have increased in 2006 owing to a continued strong demand for indium tin oxide (ITO) coatings used in the manufacturing of flat panel displays for consumer electronic devices including computer monitors, televisions, and cell phones, as well as growth in other ITO-containing technologies.

Production

Though zinc was mined domestically, primary indium was apparently not recovered as a byproduct in the United States. 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 Corporation of America, Utica, NY, and Umicore Indium Products, Providence, RI (a division of n.v. Umicore, s.a., Olen, Belgium), accounted for the major share of U.S. production of indium metal and products. Indium metal was sold in various forms (ingot, foil, powder, ribbon, wire, and others) and grades. Many small companies produced high-purity indium alloys, compounds, solders, ITO coatings, and other indium products.

Consumption

World refined indium consumption in 2006 increased from that of 2005. Production of ITO thin film coatings was the leading end use of indium, accounting for more than 80% of global indium consumption. Leading producers of ITO included Nikko Materials Co., Ltd. (Tokyo, a subsidiary of Nippon Mining Holdings Inc.), Mitsui Mining & Smelting Co., Ltd. (Tokyo), and Tosoh Corporation (Tokyo). ITO thin film coatings were mostly used for electrically conductive purposes in a variety of flat panel display devices—most commonly, liquid crystal displays (LCDs). In 2006, monitors (33%) were the leading application for LCDs, followed by televisions (24%), notebook personal computers (15%), and cell phones (11%). The LCD market was expected to show considerable growth within the next several years. Global LCD television (TV) shipments increased by 119% in 2006 from those of 2005 to 46.4 million units. Europe (39% share) was the leading region for LCD TV shipments. In 2011, LCD shipments were forecast to increase to 106.2 million units (Young, 2006; DisplaySearch LLC, 2007; Roskill's Letters from Japan Ltd., 2007). Mainstream LCDs were also trending toward larger panel sizes, which require more indium per unit. In November, Samsung Electronics Co. Ltd. and Sony Corporation completed construction of the first 8th generation LCD fabrication (8G) line at the Tangjeong production complex located in the Republic of Korea. The 8G line will have the capacity to produce 50,000 mother-glass substrates per month of a record-breaking dimension of 2,200 millimeters [mm] by 2,500 mm. In addition, production capacity on the 7G line was ramped up to 75,000 units (1,870 mm by 2,200 mm dimension) per month in July, and Samsung planned to increase capacity further to 90,000 units per month in early 2007 (Samsung Electronics Co. Ltd., 2006).

Alloys and solders were the second leading end use of indium. Indium-containing solders reportedly 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 and temperature indicators. 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 also be used as a bonding agent between nonmetallic materials, such as glass, glazed ceramics, and quartz. Indium has also been used in dental alloys and in white gold alloys.

Other uses of indium included electrode-less lamps, mercury alloy replacements, nuclear control rods, and phosphors. Alkaline batteries use indium to prevent buildup of hydrogen gas within sealed battery casings. Indium was also used in semiconductors, including light-emitting diodes for fiber optic communications.

Photovoltaic applications could become another large market opportunity for indium. Research was underway to develop a low-cost manufacturing process for flexible thin film copper indium gallium diselenide (CIGS) solar cells that would yield high production throughput. Flexible CIGS solar cells could

be used in roofing materials and in various applications in the aerospace, military, and recreational industries. Indium would have to be produced at a rate of 400 metric tons per year (t/yr) to generate 20 gigawatts per year of solar power by 2050 (U.S. Department of Energy, 2004).

Trade

During 2006, U.S. imports for consumption of unwrought indium and indium powders totaled 100 t, a decrease of 30% from the 142 t imported in 2005. Leading suppliers included—in descending order—China (38%), Canada (22%), and Japan (18%) (table 1). There was no exclusive domestic export classification code for unwrought indium and indium powders.

Price

Platts Metals Week publishes a weekly New York dealer price range for indium (99.99% minimum purity; at warehouse [Rotterdam]; cost, insurance, and freight; in minimum lots of 50 kilograms). At the start of the year, indium prices ranged from $830 to $880 per kilogram and increased through March, reaching a high of $980 to $1,025 per kilogram. After March, however, prices generally declined through yearend. In late December, New York dealer prices ranged from $650 to $710 per kilogram.

According to Platts Metals Week, the Indium Corporation of America producer price for indium (99.97% purity, 1 kilogram bar in lots of 10,000 troy ounces, free on board) began the year at $965 per kilogram, increased to $1,000 in late February, then decreased to $835 in July and remained at that level for the rest of the year.

World Review

Globally, secondary refined indium production was thought to have increased at a more significant rate than primary production during the past several years and now accounts for a higher amount of production than primary. This trend was expected to continue in the future. Secondary refined indium is commonly recovered from scrap ITO sputtering targets. The indium market, however, remained in deficit as a rapidly increasing demand for the metal, supported largely by ITO demand, continued to outpace supply.

Canada.—Refined indium was produced at Falconbridge Limited's[1] (Toronto, Ontario) Kidd Creek refinery located in Timmins, Ontario, and Teck Cominco Limited's (Vancouver, British Columbia) metallurgical complex at Trail, British Columbia. Teck Cominco produced 51.5 t of indium in 2006, a 58% increase from the 32.5 t produced in 2005. Indium production was forecast to increase even further to 60 t in 2007. The rise in annual production was attributed to the commissioning of a new tin removal plant during the second quarter of 2006, which allowed for a higher indium input (Teck Cominco Limited, 2007, p. 28-29).

Geodex Minerals Ltd. (Vancouver, British Columbia) signed a contract in late November to begin a drilling program on its Mount Pleasant West project located in southwestern New Brunswick. The site, which surrounds the former Mount Pleasant Mine, has mineralized boulders, soil geochemical anomalies, and vein occurrences, including the Pomeroy vein-type deposit. Surface trenches at Pomeroy exposed boulders with up to 1,240 grams per metric ton indium (Geodex Minerals Ltd., 2006).

China.—Several companies in China announced their indium production levels for the year. Liuzhou China Tin Group (Guangxi Province) announced that its indium production in 2006 would remain on par with that of 2005 at 35 t. The company has the capacity to produce between 40 and 45 t/yr of indium. However, a shortage of raw material limited production (Platts Metals Week, 2006). Hechi Jinhe Mining and Smelting Co. (Guangxi Province) began indium production in early 2006. The new indium production lines were constructed in 2005 during an equipment and technology renovation and have the capacity to produce 10 t/yr of indium. Most of the concentrate feed will be supplied from the company's mine in Hechi (Metal-Pages, 2006a). Huludao Zinc Industry Co., Ltd. reportedly was expected to raise indium production to 40 t in 2006 from the 28.7 t produced in 2005 as a result of technological upgrades (Mining Journal, 2006).

In March, Zhuzhou Smelter Group Co., Ltd. (Hunan Province) commissioned an ITO manufacturing plant in Zhuzhou City. The plant reportedly would consume up to 24 t/yr of indium, most of which will be sourced from its own output. The ITO was expected to be sold domestically to LCD and thin film transistor manufacturers (Metal Bulletin, 2006b).

Early in September, China announced that it would cancel the 13% export tax rebate on indium exports, effective September 15 (Abrams and Wantanabe, 2006). Beginning January 1, 2007, China would impose a 15% export tax on unwrought indium, powder, and scrap.

Japan.—Two of Japan's major indium recyclers, Asahi Pretec Corp. (Kobe-shi) and Dowa Metals & Mining Co., Ltd. (Tokyo, a subsidiary of Dowa Holdings Co., Ltd.), planned to increase their indium recovery capacities. In early 2006, Asahi Pretec began expanding its 100-t/yr indium recycling plant located in Fukuoka prefecture in western Japan. During the 2006-07 fiscal year ending March 31, Dowa Metals & Mining increased its indium recovery capacity and constructed a new furnace capable of processing 150 t/yr of scrap. Japan's overall indium recycling capacity reportedly was 300 t/yr (Watanabe, 2006; Dowa Holdings Co., Ltd., 2007, p. 15).

Toho Zinc Co., Ltd. (Tokyo) continued to ramp up crude indium production at the Annaka zinc smelter during 2006. The company resumed producing indium in November 2005 after ceasing production for more than 19 years owing to low prices. Toho planned to produce between 10 and 20 t of crude indium during the 2006-07 fiscal year ending March 31, all of which would be sold to domestic refiners (Ryan's Notes, 2006b).

Several of Japan's leading ITO producers planned to increase production capacity. Nippon Mining Holdings Group accounted for approximately 45% of global ITO target production, according to the company. In an effort to further expand its market share, the company planned to raise ITO target production capacity at its Isohara Works, Tao-Yuan Plant (Taiwan), and Pyeongtaek Plant (Republic of Korea). In the

[1]Xstrata plc (Zug, Switzerland) acquired Falconbridge Limited in November 2006.

2005-06 fiscal year ending March 31, Nippon sold 313 t of ITO targets. The company forecast sales to increase by 38% to 431 t in 2006-07 and by an additional 42% to 611 t in 2008-09. Nippon planned to stop indium production after its Toyoha zinc mine in northern Japan closed owing to resource depletion. The mine produced approximately 30 t/yr of indium. As a result, the company would need to purchase 150 to 200 t/yr of indium metal for its ITO production from outside sources (Nippon Mining Holdings Group, 2006a, p. 8; 2006b; Platts Metals Week, 2007). Mitsui Mining & Smelting Co., Ltd. planned to increase ITO production capacity by 66% to 600 t/yr from 360 t/yr as a result of an expansion program at its Omuta plant in Japan and Mitsui Electronic Materials subsidiary in Taiwan (Shaw, 2006). Tosoh Corp. planned to double ITO production capacity by April 2008. The company was producing at an approximate rate of 180 t/yr (Ryan's Notes, 2006a).

Showa Shell Solar K.K. [a subsidiary of Showa Shell Sekiyu K.K. (Tokyo)] completed construction of a copper indium diselenide (CIS) thin film photovoltaic (PV) module factory in October, and commercial production was forecast to begin in early 2007. The facility, located in Miyazaki Prefecture, reportedly will manufacture two sizes of solar cell panels—30 centimeters (cm) by 120 cm and 60 cm by 120 cm. The facility has the capacity to produce 500,000 panels measuring 30 cm by 120 cm in size. According to the company, the CIS PV modules are one hundredth the thickness of conventional liquid crystal silicon solar cells and require less energy to manufacture (Metal-Pages, 2006c; Showa Shell Sekiyu K.K, 2007, p. 11).

Korea, Republic of.—Korea Zinc Co., Ltd. (Seoul) planned to produce indium at a rate of 60 t/yr at its refinery in Onsan during 2006 and raised its annual production capacity to 100 t/yr of indium. The company began producing indium in March 2005 (Metal-Pages, 2006b; 2007).

Mitsui Mining & Smelting announced plans to build an additional ITO production factory in the Republic of Korea. Mitsui Mining has two other ITO-producing operations—one in Japan and another in Taiwan. The production rate at the new facility was anticipated to be 120 t/yr. Output would be sent to Samsung Electronics and other major LCD manufacturers. Production was targeted to begin in September after a production and marketing subsidiary for the facility had been formed. Mitsui Mining was reportedly the world's second leading producer of ITO, supplying 30% of the global ITO market (Metal First, 2005).

Portugal.—EuroZinc Mining Corporation[2] (Vancouver, British Columbia) planned to ship indium-bearing ore from its Neves-Corvo copper-zinc mine in southern Portugal to third party smelters beginning midyear 2006. In order to take advantage of high indium prices, the company would sell the ore to smelters which had the capability to extract the metal as a byproduct (Metal Bulletin, 2006a).

Outlook

Both production and consumption of indium were expected to increase in 2007. However, without definitive consumption data, it is difficult to forecast whether the market will be in a surplus or deficit and to what degree. Several reports have indicated that demand for indium will outpace supply during the next few years. ITO production will probably increase as the LCD and flat panel display markets continue to grow. The solar cell industry is experiencing growth, and the percentage of indium consumed for this market may increase substantially in the future.

On the supply side, a critical element will be the ability of individual countries to recycle indium-containing electronic components and scrap. Because primary indium is produced as a byproduct at a limited number of nonferrous smelting operations, it is difficult for supply to quickly respond to demand. During the past decades, dwindling zinc prices forced some high cost and low-grade underground zinc mines and a few older and less efficient zinc refineries to close. Because the annual price of zinc has risen since 2002, zinc production also would be expected to rise thereby resulting in a possible increase of byproduct indium. Higher prices for indium have resulted in increased recycling.

[2]EuroZinc Mining Corporation merged with Lundin Mining Corporation (Vancouver, British Columbia) in October 2006.

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

	2005		2006	
Country	Quantity (kilograms)	Value (thousands)	Quantity (kilograms)	Value (thousands)
Belgium	8,030	$7,170	7,900	$6,470
Canada	13,200	10,700	22,100	15,500
China	60,400	29,300	38,400	28,500
Costa Rica	1,580	360	6	14
Estonia	109	19	--	--
France	91	45	9	2
Germany	3,220	1,500	234	156
Hong Kong	2,360	1,650 r	3,720	2,170
India	--	--	3	6
Italy	--	--	82	88
Japan	31,900	26,700	18,000	12,400
Korea, Republic of	12,500	9,270	--	--
Netherlands	462	406	223	132
Peru	3,350	3,200	4,270	3,320
Philippines	--	--	1,400	400
Russia	825	878	872	717
Singapore	1,340	1,470	1,210	835
United Kingdom	2,260	1,750	1,960	632
Total	142,000	94,300 r	100,000	71,400

rRevised. -- 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	2002	2003	2004	2005	2006
Belgium	40	30	30	30	30
Canada	45	50	50	50	50
China	160	180	200	300	350
France	65	10	10	10	10
Germany	-- [r]	-- [r]	-- [r]	-- [r]	--
Italy	5	5	5	5	5
Japan	60	70	70	70	55
Kazakhstan	NA	NA	NA	NA	NA
Korea, Republic of	--	--	--	--	50
Netherlands	5	5	5	5	5
Peru	6 [3]	6	6	6	6
Russia	15	15	15	15	15
Ukraine	NA	NA	NA	NA	NA
United Kingdom	5	5	5	5	5
Total	406 [r]	376 [r]	396 [r]	496 [r]	581

[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 8, 2007.

[3]Reported figure.