INDIUM

By Robert D. Brown, Jr.

Domestic indium production was confined almost entirely to the upgrading of imported metal. There was no known production at domestic mines. Two companies, one each in New York and Rhode Island, were the major producers of indium and indium products. Several smaller firms also produced high purity indium alloys, compounds, solders, sputtering targets, and related products.

Domestic consumption increased from 35 to 40 metric tons. The estimated use pattern was as follows: coatings, 45%; solder and alloys, 35%; electronic and semiconductor uses (including batteries), 15%; and research and other uses, 5%. The estimated value of primary metal consumed in 1994 was $5.4 million.

World refinery production was estimated at 145 tons, a slight increase over that of 1993. Eleven countries produced indium; the top five producers accounted for 83% of the total. World consumption increased, nearly equaling production. This caused world prices to remain steady most of the year. In 1993, the average domestic producer price had dropped from $200 per kilogram in January to $175 at yearend; it fell to $150 per kilogram in the first quarter of 1994 and fluctuated very little throughout the remainder of the year.

Legislation and Government Programs

The Defense National Stockpile Center inventory of indium on December 31 was 1,561 kilograms, the same as it was a year before. The stockpile goal for indium was 7,740 kilograms.

Late in 1992, telemarketing firms began selling indium to investors at highly inflated prices. These activities were investigated by law enforcement agencies in the United States and Canada. The Federal Trade Commission prepared a consumer information brochure on Investing in Indium and other "Strategic Metals."[1] Most of these firms were based in Canada, but as investigations increased, several of them moved to the Caribbean. As the real price showed signs of increasing at the end of 1994, several investors began to try to sell. Some found for the first time that they had bought at inflated prices.

Production

U.S. production consisted of upgrading standard grade indium (99.97% or 99.99%) into higher purity metal. There was no known production at domestic mines; all the standard grade indium was imported. Indium can be refined to purities up to 99.99999% in the United States. Domestic secondary production was mainly from new scrap and spent sputtering targets. The amount of indium produced from scrap was small compared to that produced from imported metal.

Consumption

Domestic consumption was estimated at 40 metric tons, a 14% increase from 1993. Indium was available in various forms, such as ingot, foil, powder, ribbon, shot, and wire.

Thin film coatings on glass, which included indium oxide and indium-tin-oxide (ITO), constituted 45% of total domestic indium use in 1994. The coatings, produced by sputtering the material onto the glass, have been the largest area of growth and research for indium in the past several years.

There are two kinds of indium-containing coatings, electrically conductive and infrared reflecting. Electrically conductive coatings, the largest group, are used primarily in liquid crystal displays (LCD's) for watches, television screens, portable computer screens, video monitors, etc. They are also used to defog aircraft and locomotive windshields and to keep glass doors on commercial refrigerators and freezers frost free. Infrared reflecting coatings on window glass are used to control energy losses by reflecting heat inward in winter and outward in summer.

About 35% of the indium was used as an addition to bismuth, cadmium, lead, or tin alloys to lower their melting points. These alloys are used in such applications as electrical fuses, fusible links, or as holding material for the grinding of optical glass. Indium is used as a strengthening agent for lead solder and as the base material for many low-melting-point solders. Indium-based solders have the advantages of lower melting points, flexibility over a greater temperature range, no leaching from gold components, and the possibility of being made lead-free. A new solder, Indalloy 227, containing 20% indium, 2.8% silver, and the balance tin, was introduced in 1994. This alloy was designed to be a direct competitor to conventional 63% tin-37% lead solder.[2]

The use of indium in batteries has grown in the last 2 years; it replaces mercury in alkaline batteries, preventing the build up of hydrogen gas in the sealed container. The batteries were available in popular small consumer sizes, and together with other electronic uses, accounted for 15% of the indium consumed domestically.

Prices

The domestic producer price for 99.97%-99.99% pure indium remained nearly steady throughout the year. Having been lowered from $200 to $175 per kilogram during 1993, it was lowered to $150 per kilogram during 1994 and was increased to $170 per kilogram in the first week of 1995. By midyear, 1994, it had become apparent that Japanese imports were increasing dramatically, but a fairly steady flow of indium from Russia kept prices from being increased.[3] Prices for higher grades of metal were not available.

Foreign Trade

After reaching a record high of 73,400 kilograms during 1993, domestic imports fell 4% to 70,200 kilograms during 1994. Canada had the largest increase in exports to the United States and remained the largest supplier. Russia became the second ranked supplier. Export data were unavailable.

World Review

Italy.—The Indium Corporation of America opened a sales office in Turin, Italy, to serve both European and Japanese Markets in 1994. The company's other office in Europe is in Bedford, United Kingdom.[4]

Japan.—Japan remained the world's largest consumer of indium. Its consumption was estimated at more than 80 metric tons in 1994, compared with nearly 70 tons in 1993. In 1994, about 45 tons was used for ITO.[5]

The Sharp Corporation, Takicho, Japan, began operations at what it says is the world's largest factory for thin film transistor LCD's in January 1994. In the making of these

transistors, layers of ITO are coated onto the glass plates of LCD screens. The NEC Corporation is also rapidly increasing its LCD output. In spite of this activity, prices remained steady. This was partly because the yields for ITO coatings can be quite low (20% to 30%), but the scrap can be directly recovered. Additionally, as a new plant progresses on its learning curve, there is less scrap as yield increases.[6]

Russia.—Although Western indium producers felt that uneven quantity and quality of Russian exports would continue to account for a premium for Western indium, the presence of Russian metal in the market was the main factor leading to steady or decreasing prices.[7]

Current Research and Technology

Researchers at Northwestern University, Evanston, IL, discovered that replacing some of the aluminum in AlGaAs diode lasers with high purity indium would increase the lifetimes of these devices. At the Indium Corporation of America, Utica, NY, ultrafine indium powders were being developed. The smaller particle size allows an increase in the density (to nearly 95% of single crystal density) of sputtering targets for depositing layers of ITO on flat panel displays. The higher density prevents premature target failure.[8]

Outlook

World reserves and increases in production capacity are sufficient to meet expected demand for indium through the next decade. Consumption of indium is expected to increase during this period, especially for liquid crystal displays, high definition TV, semiconductor materials, batteries, and low temperature solders for military and electronic applications. Other uses, such as replacement nuclear control rods and fusible alloys, should remain steady. Apparent surges in demand or breaks in supply may cause increases in price. If indium prices go too high, research into substitutes for ITO for LCDs will be stimulated. Zinc-tin-oxide could possibly be used as a substitute, but currently its properties are not as good as those of ITO.

---

[1]Federal Trade Commission Bureau of Consumer Protection Office of Consumer & Business Education Washington, DC 20580 Telephone: 202-326-3650. To register a complaint, the FTC recommends calling the National Fraud Information Center at 1-800-876-7060 or a local office of the Federal Bureau of Investigation.

[2]Metal Bulletin, Bright Prospects Seen for Lead-free Solder. No. 7913, 15 September, 1994, p. 9.

[3]———. Producers Try to Meet Indium Demand. No. 7888, June 16, 1994, p. 9.

[4]———. Japanese Imports of Indium Rise. No. 7962, March 13, 1995, p.11.

[5]Fineburg, S., Indium Opens Sales Office in Italy. Am. Met. Mark., v. 102, No. 190, Oct. 3, 1994, p. 6.

[6]Metal Bulletin Indium Outlook Bright Despite Low Prices., No. 7857, Feb. 21, 1994, p. 9.

[7]———. Indium Producers Dismiss CIS Threat. No. 7834, Nov. 25, 1993, p. 9.

[8]R&D Magazine, Reducing Impurities Pays Off Big in High-Tech Applications. V. 36, No. 12, Nov. 12, 1994, p. 31.

TABLE 1
U.S. IMPORTS FOR CONSUMPTION OF INDIUM, BY CLASS AND COUNTRY 1/

Class and country	1993		1994	
	Quantity (kilograms)	Value (thousands)	Quantity (kilograms)	Value (thousands)
Unwrought and waste and scrap:				
Belgium	4,850	$735	2,880	$338
Brazil	90	20	--	--
Canada	25,900	4,940	39,500	5,030
China	399	47	--	--
Estonia	--	--	91	10
Finland	3,100	313	78	8
France	11,500	1,690	5,130	750
Germany	68	7	160	16
Italy	17,200	2,180	3,750	392
Japan	1,490	360	1,930	643
Peru	--	--	2,660	279
Russia	3,790	425	11,600	1,220
United Kingdom	5,000	740	2,470	258
Total	73,400	11,500	70,200	8,950

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

Source: Bureau of the Census.