INDIUM

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The year 2000 started with optimistic predictions of growth in indium usage, particularly for the largest application, transparent electrodes made from indium tin oxide (ITO).

As the year progressed, demand indeed increased but rather than stabilise the pricing, the price decreased by a further 33% during the year owing to the continuing abundance of metal supply.

Occurrence and Extraction

Indium has the same relative abundance as silver, being approximately 0.1 ppm of the earth's crust. Unlike silver, however, it does not occur in concentrated deposits which can be mined in their own right but is principally associated with the commercial ores of zinc (sphalerite), lead (galena), copper (polymetallic ores) and tin (stannite and cassiterite). Production of the metal is therefore centred around the extraction of these ores and the refining of the major metal concerned. The majority of commercial extraction is centred around zinc production. Ascertaining the exact volume of economically recoverable reserves is extremely difficult and the refining operations concerned can be situated far from the mine sources, often in different countries and on different continents. The US Geological Survey estimated that 'Reserves' were 2,500 t with a further 5,000 t in the 'Reserve Base' based on zinc ore sources only. If copper, lead and tin ores were included then total 'currently economic' reserves are probably in excess of 10,000 t.

The most significant mine sources of indium-bearing 'major' metals are China, Canada and the CIS although the refining operations are also located in other areas, the most significant being in Western Europe.

The separation of indium from flue and sinter dusts, slags, residues and drosses is technically exacting and not always completed. Indium is usually concentrated in lead bullion dross during the treatment of electrolytic zinc plant residues. The dross is treated for the recovery of matte copper and lead bullion and the resultant slag contains a few per cent indium plus high levels of copper, lead and tin. A flotation process concentrates the copper to generate tailings which are sintered and reduced electrothermally to produce a crude bullion. Electrolytic treatment of the bullion generates an anode slime containing up to 30% indium. Commercial-grade indium is produced by leaching, cementation and electro-refining. Solvent extraction is often employed to recover indium from leach residues.

Production

World primary indium production increased during 2000, with China again being responsible for most of the increase.

The principal grade of metal most commonly produced, traded and converted into products is 99.99% minimum purity (4N).

China has numerous plants in operation, some deriving their production from raw

World Primary Indium Production (t)					
	1996	**1997**	**1998**	**1999**	**2000**
European Union	66	75	75	75	80
Canada	40	25	30	35	35
Japan	20	35	25	30	25
China	25	30	40	58	80
CIS	18	30	15	15	5
Peru	4	2	4	4	4
Total	**173**	**197**	**189**	**217**	**229**

material produced by the main tin and zinc producers. In some cases indium is their sole product. The plants include Huludao (15 t), Zhuzhou (20 t), Shaoguan Huali (10 t), Liuzhou Huaxi (15 t), Lia Bin (20 t) and several others. Metaleurop of France remains the leading primary indium producer in the world, with the other major European primary source being Union Miniére of Belgium.

Canada has two producers, these being Falconbridge (Kidd Creek) and Cominco (Trail).

Applications

Indium is an extremely versatile metal and is incorporated into a wide variety of applications covering a broad range of industry, although the main area of usage is ultimately in the electronics industry.

The principal application, which accounts for around half of world demand, is as a transparent electrode for use in display screens. In this case indium is formulated as powder and compressed into a ceramic target which is then used to 'sputter' the thin film on to glass. So far, no better material has been found and therefore its use is widespread in all types of displays including liquid crystal displays and field emission displays.

The market for ITO is still growing very strongly and the display manufacturing is centred on Taiwan, Japan and Korea with powder production still mainly in Japan.

There is also a growing usage for plastic film coated with ITO, which is used in car windscreen laminations and organic light emitting diodes. Other major applications include solders, low melting point alloys, alkaline-manganese batteries, low pressure sodium lamps, sacrificial anodes, cryogenic and scientific instrument seals and for the production of compound semi-conductors.

Supply and Demand

The supply side of the equation has grown considerably in the past two years due to the extraction of the vast natural resources in China. This has resulted in an abundant supply of lower-quality indium.

With regards to demand, it is always instructive to analyse the balance of demand in the world's largest consumer country, Japan.

The main production of ITO powder is still centred on Japan even though the display coating plants may be off-shore.

Japanese Consumption by Application (t)

	1996	1997	1998	1999	2000
ITO	60	70	60	68	80
Phosphors	9	6	6	6	5
Semi-condustors	7	6	7	7	8
Batteries	4	4	4	4	4
Solder/Fusible Alloys	12	9	11	10	11
Dental Alloys	2	2	2	2	2
Others	5	8	9	9	10
Total	**99**	**105**	**99**	**106**	**120**

These requirements are satisfied by imports, some production and recycling. The import statistics are as follows.

Japanese Imports (kg)

Exporter	1996	1997	1998	1999	2000
Belgium	2,889	3,984	2,906	3,014	3,408
Canada	850	3,391	-	4,004	22,730
China	9,889	23,360	23,737	42,045	50,369
CIS	2,743	11,057	7,515	1,361	919
France	23,620	46,800	41,763	36,650	49,259
US	2,837	8,903	7,008	2,404	2,581
Others	705	3,301	2,465	1,731	3,586
Total	**43,533**	**100,796**	**85,394**	**91,209**	**132,752**

Prices

The new year started with an indium price average of US$180/kg and fell to US$120/kg by the year end. The was due to the continued overproduction of material, which even when of poor quality was able to be refined into higher grades. This decline was despite forecasts of the indium price holding up due to the continuing increased demand of higher quality material for ITO. At this stage, there is no reason for pricing to change, as increased demand is still met by adequate supply.

Outlook

The demand for indium is still growing due to its unique place in display technology as a transparent electrode. The increased use of mobile telephones and the gradual conversion of traditional cathode-ray tubes to flat-panel displays as the prices came down, will continue to support this interesting metal.