INDIUM

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Indium is an important minor metal upon which the major information technologies of today rely, mainly for its use as a transparent electrode in display screens of all types. An application in which it has never been surpassed. However it also has a wide range of other applications, most of which exhibit steady demand. Overall therefore, despite the general business gloom during the year, indium did not have a bad 2002.

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 and tin 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 and Canada although refining operations are also located in other areas, such as Japan.

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

Production is still adequate for demand although supply is now concentrated in fewer hands and mainly in one geographical area – China. The largest consuming country is still Japan, hence it is always constructive to analyse that market (Tables 2 and 3).

During 2002, production remained initially steady, but several major changes began to take place not portrayed in the 2002 production figures. First of all, Metaleurop of France got into difficulty owing to problems with the low zinc price and the high costs of having a production facility in Western Europe. Whilst production continued during 2002, by the year end the closure of the company was announced, along with a cessation of all indium activities, thereby removing approximately 60 t/y of prime quality material from the market place.

Secondly, several smaller Chinese mines were closed because of accidents and environmental problems, meaning that during the year the availability of concentrates, whilst still being sufficient, became consolidated in fewer hands. This eventually started to have its affect on prices (see Table 1).

This means that the Chinese producers now dominate the market in the production of indium metal. However, total capacity is still more than adequate to cater for the demands of the market, there being at least 12 factories in China able to supply metal, including the well known Huludao and Zhuzhou Smelters, China Tin and Liuzhou Intai. Indium recycling also plays a significant role in the supply equation, contributing a further 170 t of raw material into the market for use in display screens. As the price moves up, this becomes an even more attractive option than before.

Applications

Indium has a consistent range of applications, the largest of which is the display industry. This accounts for over half of world Indium consumption. In this case indium is used in the form of indium tin oxide (ITO) which is deposited as a coating onto glass or plastic, primarily for the purpose of being a transparent electrode. The principal methods of coating are by sputtering or by using a sol-gel.

The types of screen using ITO include liquid crystal display (LCD), plasma display panel (PDP), cathode ray tube (CRT) and organic light emitting diode (OLED), the latter of which is a growing development for the future.

Japanese manufacturers still dominate the manufacture of ITO, although Korea is the largest manufacturer of LCD screens in the world (Samsung, Corning and LG Philips) and Taiwan also has a large share of manufacturing.

Other applications using indium include semiconductors, low melting point alloys, sox lamps, cryogenic seals, alkaline manganese batteries and, increasingly, lead-free solders.

Pricing

The year started with continued over-supply and the price sliding further from an average US$95/kg to around US$88/kg by the year end, a total decline over the year of 7%. However, the price actually reached its lowest level in mid-year and by the last quarter was starting to rise again – a trend likely to continue in 2003.

This was due to the factors of supply previously mentioned. The final announcement of the closure of Metaleurop, on top of an already tighter concentrate supply in China, was sufficient to start a rally in the price. This type of momentum is always unhelpfully assisted by traders as well of course, who simply add fuel to the original supply/demand in order that they themselves benefit by the price movements.

Outlook

With the continued excellent demand for metal in display applications, the future for this interesting metal is secure. Supply and reserves are certainly adequate to meet the demand, but the occasional peaks and troughs in price are to be expected, as has been the case over the previous years that this metal has been in widespread use.

Table 1
World Primary Indium Production (t) (estimated)

	1996	1997	1998	1999	2000	2001	2002
European Union	66	75	75	75	80	70	65
Canada	40	25	30	35	35	35	36
Japan	20	35	25	30	25	55	55
China	25	30	40	58	80	170	175
CIS	18	30	15	15	5	4	5
Peru	4	2	4	4	4	4	3
Total	173	197	189	217	229	338	339

Table 2
Japanese Consumption by Application (t) (estimated)

	1996	1997	1998	1999	2000	2001	2002
ITO	60	70	60	68	80	117	153
Phosphors	9	6	6	6	5	8	8
Semi-conductors	7	6	7	7	8	14	5
Batteries	4	4	4	4	4	5	5
Solder/Fusible Alloys	12	9	11	10	11	8	8
Dental Alloys	2	2	2	2	2	3	3
Other	5	8	9	9	10	24	29
Total	99	105	99	106	120	179	211

These statistics are based on virgin indium consumption.

Table 3
Japanese Imports (kg)

	1996	1997	1998	1999	2000	2001	2002
Belgium	2,889	3,984	2,906	3,014	3,408	3,286	1,894
Canada	850	3,391	-	4,004	22,730	20,110	13,830
China	9,889	23,360	23737	42,045	50,296	85,957	75,224
CIS	2,743	11,057	7,515	1,361	919	1,295	184
France	23,620	46,800	41,763	36,650	49,259	41,605	16,188
US	2,837	8,903	7,008	2,404	2,581	10913	29,987
Other	705	3,301	2,465	1,731	3,568	7,834	3,167
Total	43,533	100,796	85,394	91,209	132,752	171,000	140,474