INDIUM AND INDIUM COMPOUNDS

1. Introduction

Indium [7440-74-6] is a very soft, silvery metal. The element is found in the periodic table of the elements under Group IIIa. The atomic number is 49 and the atomic weight is 114.82. Indium is highly malleable and ductile, having a face-centered tetragonal crystalline structure.

Indium was discovered in 1863 by Ferdinand Reich and Theodor Richter. They were studying a sample of sphalerite, a zinc ore using a spectroscope, looking for thallium, which they had discovered previously. Prominent indigo blue lines caught their attention. They identified it as a new element and named it indium because of the indigo color given off in its spectrum.

2. Occurrence

The abundance of indium on the earth's crust is about 0.1 ppm. This is similar to that of silver, except that indium is very widely distributed and never in concentrations high enough to justify mining it for its own intrinsic value. Thus it is referred to as a *minor metal*.

The principal commercial source of indium is sphalerite (ZnS), which is found in trace quantities in this zinc ore. It is found in lesser quantities in association with other sulfides such as galena (PbS), stannite, (Cu_2FeSnS), and also cassiterite (SnO_2). Indium follows zinc through flotation concentration, and commercial recovery of the metal is achieved by treating residues, flue dusts, slags, and metallic intermediates in zinc smelting and associated lead and copper smelting. (See EXTRACTIVE METALLURGY; ZINC AND ZINC ALLOYS).

3. Properties

Table 1 lists many of the atomic, electrical, nuclear, physical, and thermal properties of indium. Mechanical properties are listed separately in Table 2 because of the specific sample preparation required for the various determinations.

The highly plastic nature of indium is probably its most noted feature. This results from mechanical twinning. Indium retains this plasticity at cryogenic temperatures. Indium does not work-harden, can endure considerable deformation through compression, cold-welds easily, and has a distinctive cry on bending. Tin and cadmium exhibit a similar cry on bending as well. As mentioned earlier, it is very soft—so soft, in fact, that it can be scored easily by the fingernail.

Indium metal is not oxidized by air at ordinary temperatures, but at red heat burns to form the trioxide In_2O_3. On heating, indium also reacts directly with the metalloids—arsenic, antimony, selenium, and tellurium—and with halogens, sulfur, and phosphorus. Indium dissolves in mineral acids and amalgamates with mercury but is minimally affected by alkalis, boiling water, and most organic acids. The metal surface passivates easily. Indium usually exhibits a valence of +3, but may also have valences of +2 and +1. In general, the chemistry of indium in its trivalent compounds stems from nonionic or covalent bonding characteristics. Indium is electroplated easily from a variety of baths including the cyanide (1), sulfate (2), fluoborate (3), and sulfamate (4) (See ELECTROPLATING).

4. Sources and Supplies

Indium is referred to as a minor metal. It is a by-product of other mining and refining operations, typically zinc or lead. Indium is recovered from fumes, dusts, slags, residues, and alloys from zinc or lead–zinc smelting. The source material itself—a reduction bullion, flue dust, or electrolytic slime intermediate—is leached with sulfuric or hydrochloric acid. Then the solutions are concentrated if necessary, and crude indium is recovered as 99+% metal. This crude indium is then refined to 99.99%, 99.999%, 99.9999%, or higher grades by a variety of conventional chemical and electrochemical processes.

The most important mines producing indium are found in South America, Canada, FSU (the Former Soviet Union), and China. Chinese production comes from the Zhuzhou and Huludao smelters. In addition to these mines, there are significant refining operations in western Europe, specifically Belgium and France. Production in CIS (the Commonwealth of Independent States) comes from plants in four of the republics. They include the Novosibirsk Tin Works in Russia, the Almalyk complex in Uzbekistan, the Konstantinovka complex in Ukraine, and the Leninogorsk and Ust-Kamenogorsk complexes in Kazakhstan (5). Table 3 lists the major world producers and their production values for the 1992–1996.

Canada is shown in Figure 1 as the second largest producer, but this pie chart may be misleading because the European Union (EU) appears as a single entity. Union Miniere in Belgium and Metaleurop in France combine to produce the bulk of the EU production of indium.

Canada has the potential to eventually be the largest source of indium in the world. Mount Pleasant mine in southern New Brunswick, Canada is being developed by Adex Mining Corp. of Toronto. This is essentially a tin mine where both indium and bismuth are produced as by-products. It was hoped that this mine would be fully operational by 1998 with production capacity of 25 t of indium per year. However, until the tin market improves, production here will not be drastically increased and substantial amounts of indium will not be seen from this source.

5. Uses

In the 130+ years since its discovery, indium has found numerous uses in a wide variety of applications. These uses can be broken down into several categories; metallurgical, chemical, and fusible alloy. Each category contains many diverse applications, which are discussed in detail below. The following discussion of indium uses is by no means exhaustive. However, a "best effort" will be made to discuss all of the major applications for indium.

5.1. Metallurgical. The characteristics and properties of indium make it useful for a wide variety of metallurgical applications. Pure indium metal has a number of uses by itself. When used as a metallurgical additive, indium provides certain benefits to the other metals with which it is alloyed. Indium alloys have unique characteristics that make them ideal for certain applications.

5.2. Seals. Indium's wetting ability makes it useful as a sealing material. It will wet glass, ceramic or quartz. It is useful for glass-to-glass, glass-to-metal, ceramic-to-metal, and other seals. Indium foil, strip, and wire as well as indium–tin alloys are usually used for the sealing applications described here (see also SEALANTS).

5.3. Vacuum Seals. Indium's sealing ability along with its low vapor pressure make it ideal for use in vacuum applications.

5.4. Cryogenic Seals. Because it retains its ductility at very low temperatures, indium is ideal for use in cryogenic applications for making seals. It can be conformed to any space to be sealed. As the temperature drops, the tensile strength increases, improving the performance of the seal (see CRYOGENICS).

5.5. Bonding. Indium's wetting ability makes it useful for bonding in the manufacture of sputtering targets. The fact that it is soft and melts at a low temperature makes this application quite attractive as the targets can be removed for replacement easily.

5.6. Metal Lubricant. The low melting point and low coefficient of friction of indium make it a suitable candidate for applications requiring a metal lubricant. A thin layer of indium applied to a surface greatly reduces the coefficient of friction and works as a lubricant.

5.7. Thin Films. Indium is sputtered in a very thin transparent coating onto glass for use in windscreens. The sputtered indium is, in fact, an electrically conductive coating of indium oxide. By applying electric current to this conductive coating, it is possible to heat the glass to prevent icing or fogging. This is a widespread use in the aircraft industry today (see also THIN FILMS).

A similar type of coating of indium oxide on structural glass can be used to limit the transfer of radiant energy through the windows of a building while letting sunlight in. The difference with this coating is that it is not electrically conductive; instead, it is infrared-reflecting. This application has the great potential of saving energy on heating and cooling costs.

5.8. Metallurgical Additives. *Corrosion Resistance.* Added to various alloys, indium brings strength and corrosion resistance.

Sacrificial Anodes. Indium metal is added to aluminum and zinc alloys used in sacrificial anodes. It increases both efficiency and potential of the anodes. This is particularly useful for off shore oil platforms.

Bearings. Indium is used in the coatings of bearings for use in high-performance engines. The addition of the indium to the coating material improves the corrosion and abrasion resistance of the coating and helps retain an oil film on the bearing surface.

Nuclear Reactor Control Rods. Because of its high cross section for capturing thermal neutrons, indium is added into the nuclear control rods that are introduced into the nuclear reactor core to moderate the progress of the nuclear fission reaction.

5.9. Indium Alloys. *Lens Blocking.* Indium containing low-melting-point alloys have become particularly useful in the optical industry for securing lenses for grinding processes. The low melting point provides that the lenses may be secured without preheating. The alloys have high strength, ensuring good control throughout the grinding process. The density of the alloy provides for a damping of the vibrations caused by the grinding. After processing, the lenses are immersed in a hot-water bath to remove the alloy, which is reused.

For the processing of plastic lenses, the indium content of the alloy serves as a form of temperature control, protecting from damage or distortion the sensitive plastic lenses of the alloy, due to excessive heat. The higher-temperature alloys are used only for processing of glass lenses.

Low-Temperature Solders. Today's electronics are manufactured with delicate circuit boards that often cannot stand high temperatures that typically are produced by soldering with conventional tin/lead solders. The addition of indium to these solders lowers the melting range of the material, thus making it possible to solder with a lower temperature and to protect the delicate electronic components from damage.

Dental Alloys. Dental alloys are improved with the addition of small amounts of indium. This addition enhances tensile strength and ductility and improves tarnish resistance (see also DENTAL MATERIALS).

Seals. As mentioned under metal uses, indium–tin alloys can be used in the sealing applications mentioned above. One example of an indium/tin alloy used for sealing is AMALLOY 120°C, a product of Atlantic Metals & Alloys, Inc., in Connecticut. This alloy softens at 118°C and is completely molten at 120°C. This provides for a seal that can be permanent or can be disassembled with the addition of relatively low heat.

In this application, the clean surfaces to be joined are warmed to 120°C and the alloy is applied on the surfaces. With gentle warming of the surfaces again, the alloy melts and the pieces can be put together. Once the pieces are joined, the alloy solidifies immediately to form a hermetic bond (6).

Table 4 lists several of the most commonly used low-melting-point indium alloys. Among these the 47°C alloy is the most widely used. This alloy is used primarily in the lens blocking application. The area of growth in lenses is in the area of plastic lenses. With the multiple millions of people in the world who wear glasses, it is easy to see why this alloy gets the most use out of the low-melting indium alloys.

5.10. Indium Compounds. *Indium Oxide [71243-84-0].* This is a bright yellow powder that has found use in, for example, the communications industry. Indium oxide, In_2O_3, is an ingredient in a ceramic piece used in the base of cordless phones.

Indium Tin Oxide. This gray-yellow powder is made by two *possible* methods. The first is blending of indium oxide and tin oxide powders. The second and preferred method is the precipitation of the indium tin oxide powder out of a solution containing both indium and tin, referred to as *coprecipitation*. Indium tin oxide (ITO) is a relatively new development in the history of indium, having found widespread use only since 1990 or so.

Indium tin oxide is considered the best transparent electrode and is widely used in flat-panel displays. As the computer industry has grown, almost everyone has a personal computer (PC) at home, and an ever-growing population of people on the go have laptop and notebook PCs. This has created a huge demand for flat-panel displays, applications for which abound, from aircraft and automobile instrument displays to consumer electronics.

The Japanese were the first to dominate the flat-panel-display business. Recently, however, other Asian countries such as China, Taiwan, and Korea have developed their own flat-panel-display capabilities.

Indium Trichloride [10025-83-8]. This compound is made by the heating of indium in excess chlorine or by the chlorinating of lower chlorides. $InCl_3$ is widely used to coat the inside of glass for use in street-lamp production.

Indium Hydroxide. This material is often used in the production of alkaline batteries.

5.11. Semiconductor Compounds. Indium combines readily with nonmetallic elements and with metalloids such as N, P, Sb, As, Te, and Se. Many of the latter compounds are semiconducting. Indium antimonide [1312-41-0], (InSb), indium arsenide [1303-11-3] (InAs), and indium phosphide [22398-80-7] (InP) are the principal semiconducting compounds. These are all prepared by direct combination of the highly purified elements at elevated temperature under controlled conditions (see SEMICONDUCTORS).

World demand, production, and stock values for indium are difficult to gauge because there is no definitive source for these values. Some of the data published are misleading and so are not useful. With world *production* running between 150 and 200 tons since the mid-1990s, it is important to note that Japan is the world's largest consumer.

Table 5 shows the amounts of Japanese consumption for 1992–1996. Each year, the amount of total supply has been about half of the world production. The exception to that was in 1996 when the Japanese recovered large quantities of indium from stocks of ITO scrap that had been previously uneconomical to refine.

6. Manufacture, Processing, and Shipment

Indium is produced primarily in ingot form by most refiners. These ingots range from 0.5 to 10 kg in size. The normal purity of commercial-grade indium is 99.99% (see Table 6 for analysis), although lower grades are sometimes available. The material normally produced by Cominco in Canada usually runs close to 99.999% in purity. Indium ingots are generally used for metallurgical additives, sacrificial anodes, manufacturing of alloys, and bonding applications.

Indium is made in shot form in 99.99% purity primarily, but also 99.999% and higher purity for the manufacture of specialty alloys where small-quantity additions need to be made. The higher-purity shot is used in the semiconductor industry.

Gasket applications require indium in either wire or foil forms. Ingot is rolled into foil typically 0.005 or 0.010 in. (0.0127 or 0.0254 cm.) thick and in small quantities of 0.003 in. (0.00762 cm) thickness. This is sold in either sheet form or strip of various widths. The softness of indium makes this material difficult to work with in the 0.003 in. (0.00762 cm) thickness because it is so easily damaged in handling.

The other indium form for gasket use is wire. This is available in both metric and U.S. measurements from 20 to 80 thousandths and from 0.5 to several millimeters in size. Gasket material is produced as 99.99% purity normally.

Indium is also produced in ball form approximately 1 in. (2.54 cm) in diameter. This is useful for anodes in indium plating operations. The plating of indium on aluminum conductors has made these usable in place of copper conductors in some applications for telephones. However, this usage is very small.

Indium is made in purities from 99.999% (5N) purity to 99.99999+% (7N+) in small-size ingots. They can range from five grams to several hundred grams each, often with very specific dimensions depending on the use and the needs of the customer. Major producers of high-purity indium include in no particular order, Mining and Chemical Products, Ltd. in the United Kingdom, Nippon Mining in Japan, and Arconium Specialty Metals, and Indium Corporation of America, both in the United States High-purity indium is used in the electronics industry in the manufacture of indium arsenide and indium antimonide for the manufacture of light-emitting diodes (LEDs).

Table 7 shows the typical analysis of high-purity indium as determined by glow discharge mass spectroscopy (GDMS).

7. Processing

Indium is recovered form fumes, dusts, slags, residues, and alloys from zinc or lead−zinc smelting. Indium has a high chemical affinity for other elements, particularly its parent metals, and of those, *especially* lead. Therefore, indium tends to disperse throughout the process circuit, complicating the recovery.

During the treatment of electrolytic zinc plant residues, indium concentrates in the zinc leach residues. This material is leached with sulfuric or hydrochloric acid; the solutions are concentrated, if necessary; and crude indium is recovered as 99+% metal. This impure indium is then refined to higher grades by a variety of convention chemical and electrochemical processes.

8. Economic Aspects

As mentioned earlier, indium is a minor metal; it is not mined for its own intrinsic value but rather as a by-product of other mining operations. The supply of indium is not easily changed because it is dependent on the supply of the associated metals with which indium is mined. Operation of the normal principles of supply and demand with minor metals differs from that with major metals. When the need for copper or zinc increases, it is possible to mine more copper or zinc. This is not the case with a minor metal.

To increase the supply of indium by 1000 troy ounce, it would be necessary to mine an additional 1000 tons of zinc in order to get more indium from the ore. It does not make economic sense for mines to increase production in order to produce more of what is in effect a contaminant in the ore. It would also cause the prices of those metals to fall as excess material would become available on the market.

Indium pricing is published twice weekly in Europe, by *Metal Bulletin*, which lists both a high and a low price. In the United States, pricing is published weekly, by *Platt's Metals Week*. The price has fluctuated from a low in 1972 of $27.33/kg ($0.85/troy ounce) to a high in January 1980 of almost $650.00/kg (20.00/troy ounce).

Pricing since 1994 has fluctuated widely. The lowest point was in June 1994 at around $135.00/kg ($4.20/troy ounce) and the highest price was $580.00/kg ($14.93/troy ounce) in November 1995.

In looking at the price chart shown in Figure 2, it is clear that indium has suffered some wide swings in prices over the years. Many things contributed to the wide swings in prices. The years 1993 and 1994 were characterized by an oversupply of material. The former Soviet Union was shipping much material to the West. This caused prices to drift downward as material was readily available.

Near the end of 1994, two things happened that contributed to the precipitous price rise. The laptop computer market took off. Everyone was buying laptops, and the need for flat-panel displays increased sharply. The Japanese were and still are the biggest producers of flat-panel displays using huge quantities of indium tin oxide.

At the same time that the Japanese were buying large quantities of indium, shipments of indium out of Russia dried up. Recycling of ITO targets was not yet practical or economical. All of these factors caused the price of the metal to reach $580.00/kg, nearly its all-time high price. In a 12-month period the indium price increased fourfold. Then the price dropped nearly as quickly over the next-twelve months by two thirds as producers caught up with demand. It was during this period from December 1995 to November 1996 that indium tin oxide recycling became practical.

One of the unknowns regarding CIS-origin indium is that people in the Western Hemisphere were never certain whether the former Soviet Union was producing dozens of tonnes of material yearly or simply shipping from some huge stockpile. The fact that the shipments dried up suddenly indicates that the Russians were likely shipping most often out of their stockpile. Since the breakup of the Soviet Union, we are left with another question about the Russian stockpile of indium. Was there only one stockpile, or does each republic have its own stockpile or stockpiles? The latter situation could lead to price instability if each of the republics happens to offer large quantities of material simultaneously.

An important factor to always take into consideration during times of great price swings is the speculative activity factor. As prices increased in 1995, many people were buying up material to try to grab some of the profits from the drastic price increase. This, of course, only added to the short supply and drove prices higher. Again, when the prices started falling, speculators dumped their inventory, which drove the prices further south.

Another factor to consider regarding pricing involves the U.S. Defense Logistics Agency (DLA). Although they are not a consumer in the strictest sense of the word, the DLA has bought indium. In 1993, they bought 50,000 troy ounces from Indium Corporation of America. This material was supposed to be in the

U.S. stockpile in case it was ever needed and not available elsewhere in the world.

The DLA never needed the indium. They were authorized to sell off the entire quantity of material, but they have as of 1997 sold only a portion of it. Even though the DLA is not a producer in the strictest sense of the word, they have sold indium and may sell more.

9. Analytical Methods

As with most elements, there are many ways available for the determination of indium, including volumetric and electrolytic determination. The method most generally used is spectroscopic. Indium can be detected below 1 ppm by this method of analysis, using its characteristic lines in the indigo blue region, at wavelengths of 4511.36, 4101.76, 3256.09, and 3093.36 nm. Procedures for the quantitative determination of indium in ores, compounds, and alloys and for the analysis of impurities in indium metal are covered thoroughly in the literature (7).

10. Environmental Concerns

Indium metal in and of itself poses little or no environmental risks. However, the form that indium takes or the other metals associated with it may pose some dangers to the environment. For example, indium alloys that contain lead or cadmium could be considered hazardous to the environment because of the lead or cadmium. Indium trichloride could be considered hazardous to the environment because of the hydrochloric acid solution that is an essential component of it. Care should be exercised by all who use indium whether in alloy or chemical form to handle the materials properly so as not to pose a hazard to anyone or to the environment.

11. Recycling

Indium metal has an inherent value that must not be taken for granted or wasted. Since it is a minor metal, the supply cannot be considered unlimited. Any scrap that is generated in the processing or use or indium metal or chemicals should be safely collected, stored, and returned to the supplier if possible for reclaim. In particular, the alloys that can be made containing indium are readily reclaimed because of their low melting point. Connecticut, has a reclaim program that allows customers to return indium scrap for cash, credit toward future purchases, or return for replacement with additional product.

12. Health and Safety Factors

Physiologically indium is a nonessential element. In commercial use, it can be considered nonhazardous. There have been no reported cases of systemic effects in human exposure to indium. The threshold limit value of the American Conference of Governmental Industrial Hygienists (ACGIH) is 0.1 mg/m^3. The primary toxic effects of ionic indium are on the kidneys. Indium has no demonstrated irritating effects on skin, but there may be effects on the respiratory system. Absorption through digestion is about 0.5% of intake and through respiration, about 5%. There have been no reports of accidental or industrial poisoning.

As with all industrial situations, personal hygiene is extremely important. Handing indium with bare hands will leave a gray-to-black residue on the skin. All people working with this material should wash their hands before eating or smoking or going to the bathroom. Nail biting should be avoided. Employees should shower and change clothes at the end of their shift.

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Table 1. **Physical Properties of Indium**

Property	Value
atomic weight	114.82
atomic number	49
melting point, °C	156.61
boiling point, °C	2080
latent heat of fusion, kJ/kg[a]	28.47
latent heat of vaporization at bp, kJ/kg[a]	1959.42
specific heat at 25°C, kJ/(kg · K)[a]	0.233
coefficient of linear expansion, 0–100°C, $\times 10^{6}$°C^{-1}	24.8
electrial resistivity, Ω · m	
at 3.38 K	superconducting
20°C	84
154°C	291
181°C	301
222°C	319
280°C	348
electrode oxidation—reduction potential,[b] V	0.38
density, kg/m^3	
at 20°C	7.300
164°C	7.026
volume increase on melting, %	2.5
thermal conductivity at 0°C, W/(m · K)	83.7
surface tension at temperature, T in K between mp and bp, mN/m (= dyn/cm)	602–0.1 T
relative isotopic abundance, wt %	
113 In	4.23
115 In	95.77
vapor pressure, p, at temperature, T in K between mp and bp, kPa[c]	$\log_{10} p = 9.835 - 12{,}860/T - 0.7 \log_{10} T$
thermal neutron cross section at 2200 m/s, $\times 10^{-28}$ m^2/atom[d]	
absorption	190 ± 10
scattering	22 ± 0.5
Brinell hardness number, HB	0.9
tensile strength, MPa[c]	
at 295 K	1.6
76 K	15.0
4 K	31.9
elongation, %	22
modulus of elasticity, GPa[c]	12.74
Poisson's ratio at 20°C	0.4498

[a] To convert J to cal, divide by 4.184.
[b] Versus the hydrogen electrode at 0.0 V.
[c] To convert kPa to atm, divide by 101.3; to convert MPa to atm, divide by 0.101; to convert GPa to atm, divide by 1.01×10^{-4}.
[d] To convert m^2 to barn, multiply by 10^{28}.

Table 2. **Mechanical Properties of Indium**

Property	Value
Annealed 1 week at 100–130°C	
Brinnel hardness, BNH	0.9
Bulk modulus (single crystal), lb/in.^{2} (psi) (Pa)[a]	6.05×10^6
Compressibility, atm^{-1} (Pa^{-1})[b]	2.6×10^{-6}
Compressive strength	
(at 10% true strain), lb/in.^{2} (Pa)	310
Elastic modulus, lb/in.^{2} (Pa)	1.57×10^6
Fatigue strength	
Cycles to failure, 0.14% strain	
Air	1.5×10^5
5×10^{-3} torr (Pa)[c]	6.0×10^5
2×10^{-6} torr (Pa)	5.5×10^5
Poisson's ratio	0.457
Ultimate tensile strength, 390	390
Percent elongation in 1 in. (2.54 cm)	22%
percent reduction in area	87%

[a] To convert pounds Force per square inch to pascals, multiply by 6.895×10^3.
[b] To convert atmospheres of pressure to pascals, multiply by 1.013×10^5.
[c] To convert torrs to pascals, multiply by 1.333×10^2

Table 3. **World Primary Indium Production (t[a])**

	1992	1993	1994	1995	1996
European Union	74	75	72	62	66
Canada	37	36	46	48	40
Japan	23	15	15	20	20
China	13	14	24	37	25
CIS	10	13	20	25	18
Peru	0.3	3	4	5	4
Total	160	156	181	197	173

[a] Source: Reference 5.

Table 4. **Typical Analysis of 99.99% Purity Indium, in ppm**

In	(99.99%)	Fe	< 2
Ag	< 1	Ni	< 3
Al	< 2	Pb	< 13
As	1	Sb	< 2
Bi	1	Sn	< 7
Cd	5	Tl	< 4
Cu	< 2	Zn	< 7N

Table 5. **Typical Analysis of High Purity Indium by GDMS, ppb**

In	(99.9999%)	Li	<2
Al	2	Mg	<0.7
As	<0.4	Mn	<0.3
B	<1	N	35
Be	<1	Na	<0.9
C	450	Ni	<0.7
Ca	<6	O	390
Cl	41	P	<1
Co	<0.4	S	<0.7
Cr	<0.5	Sc	<0.2
Cu	<2	Se	<5
F	<30	Si	19
Fe	<0.4	Ti	<0.1
Ga	<0.7	V	<0.3
Ge	<2	Zn	<2
K	<130		

Table 6. **Indium Alloy Compositions and Uses**

Melting Point, °C	Bismuth	Lead	Tin	Cadmium	Indium	Uses[a]
47	44.7	22.6	8.3	5.3	19.1	FSD, LB
58	49.0	18.0	12.0	0	21.0	FSD, LB
60	47.5	25.4	12.6	9.5	5.0	FSD
64	48.0	25.63	12.77	9.6	4.0	FSD
79	57.0	0	17.0	0	26.0	FSD, IC
125	0	0	50.0	0	50.0	S

[a] Abbreviations: FSD = fusible safety devices; IC = investment casting; LB = lens blocking; S = sealing.

Table 7. **Suply of Primary Indium to Japanese Market, t**[a]

Year	Imports	Domestic Production	Total Supply
1992	60	23	83
1993	47	15	62
1994	87	15	102
1995	70	20	90
1996	44	20	66

[a] Source: Reference 5.

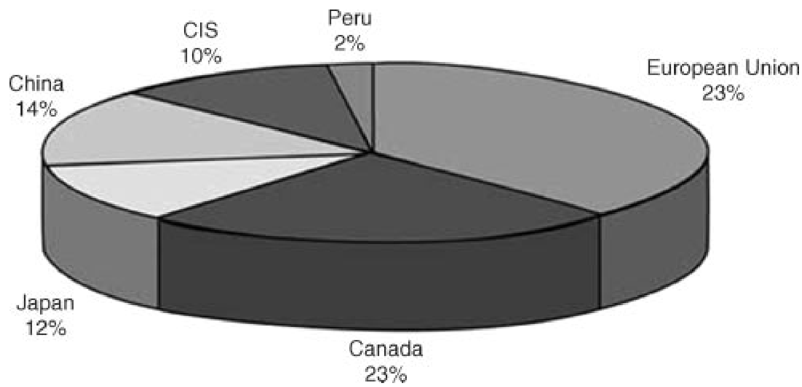

Fig. 1. 1996 indium production by country.

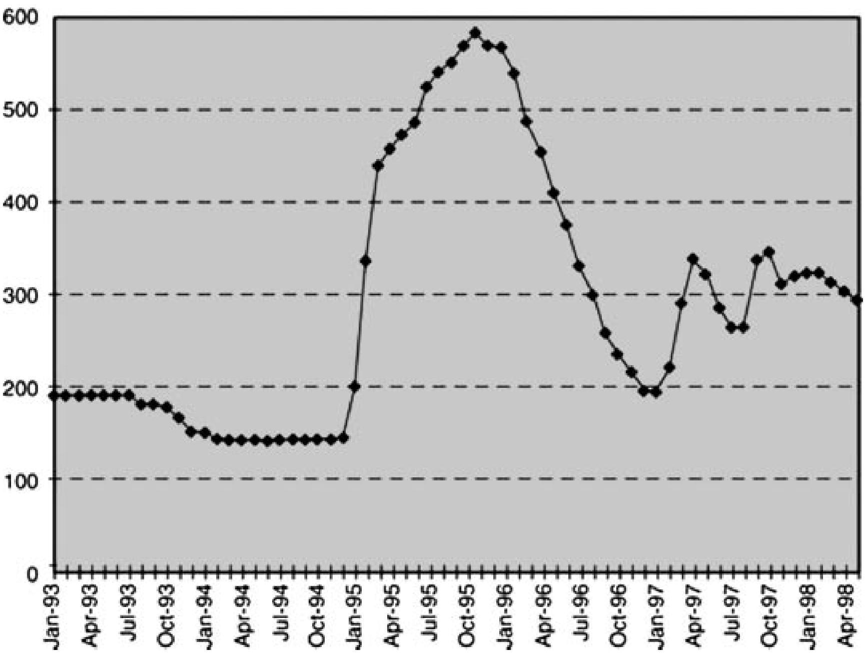

Fig. 2. Average high LMB indium price in U.S. dollars, 1983 to May 1998.