

## INDIUM

(Data in metric tons unless otherwise noted)

**Domestic Production and Use:** Indium was not recovered from ores in the United States in 2009. Indium-containing zinc concentrates produced in Alaska were exported to Canada for processing. Two companies, one in New York and the other in Rhode Island, produced indium metal and indium products by upgrading lower grade imported indium metal. High-purity indium shapes, alloys, and compounds were also produced from imported indium by several additional firms. Production of indium tin oxide (ITO) continued to be the leading end use of indium and accounted for most global indium consumption. ITO thin-film coatings were primarily used for electrically conductive purposes in a variety of flat-panel devices—most commonly liquid crystal displays (LCDs). Other end uses included solders and alloys, compounds, electrical components and semiconductors, and research. The estimated value of primary indium metal consumed in 2009, based upon the annual average U.S. producer price, was about \$60 million.

<b>Salient Statistics—United States:</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009<sup>e</sup></b>
Production, refinery	—	—	—	—	—
Imports for consumption <sup>1</sup>	142	100	147	144	95
Exports	NA	NA	NA	NA	NA
Consumption, estimated	115	125	125	130	120
Price, average annual, dollars per kilogram					
U.S. producer <sup>2</sup>	946	918	795	685	500
New York dealer <sup>3</sup>	961	815	637	519	390
Stocks, producer, yearend	NA	NA	NA	NA	NA
Net import reliance <sup>4</sup> as a percentage of estimated consumption	100	100	100	100	100

**Recycling:** Data on the quantity of secondary indium recovered from scrap were not available. Indium is most commonly recovered from ITO. Sputtering, the process in which ITO is deposited as a thin-film coating onto a substrate, is highly inefficient; approximately 30% of an ITO target material is deposited onto the substrate. The remaining 70% consists of the spent ITO target material, the grinding sludge, and the after-processing residue left on the walls of the sputtering chamber. It was estimated that 60% to 65% of the indium in new ITO target material will be recovered, and research was underway to improve this rate further. ITO recycling is concentrated in China, Japan, and the Republic of Korea—the countries where ITO production and sputtering take place.

An LCD manufacturer has developed a process to reclaim indium directly from scrap LCD panels. Indium recovery from tailings was thought to have been insignificant, as these wastes contain low amounts of the metal and can be difficult to process. However, recent improvements to the process technology have made indium recovery from tailings viable when the price of indium is high.

**Import Sources (2005-08):**<sup>1</sup> China, 40%; Japan, 19%; Canada, 18%; Belgium, 7%; and other, 16%.

<b>Tariff:</b>	<b>Item</b>	<b>Number</b>	<b>Normal Trade Relations</b>
	Unwrought indium, including powders	8112.92.3000	<u>12-31-09</u> Free.

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

**Events, Trends, and Issues:** The U.S. producer price for indium remained at \$500 per kilogram from the start of 2009 through mid-October. The New York dealer price range for indium began the year at \$350 to \$400 per kilogram, decreased steadily until mid-July, reaching a low of \$290 to \$340 per kilogram, and then rose until at least mid-October to \$495 to \$510 per kilogram.

The flat-panel and ITO industry reportedly was supported by a surge in flat-panel shipments to North America during the first quarter of 2009. However, spot prices for indium remained low during this time as leading Japanese ITO producers continued to work off of their indium inventories, which were built up from purchases made in 2008. ITO demand began to pick up pace around midyear, particularly in the Republic of Korea where exports of flat panels rose significantly owing to China's household appliance subsidy program and the weaker won. In December 2008, China began a 4-year, 13% subsidy program in certain agricultural regions to encourage farmers to purchase home appliances, mobile phones, and televisions. The program was initiated to bolster rural consumer spending and may significantly increase China's demand for flat-panel televisions in the long term.

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In mid-2009, the Japanese Government announced plans to include indium and gallium in its national stockpile of rare metals, which was initially created to support stable economic conditions for domestic industries that consume these raw materials. For each rare metal, the Government stockpiles a quantity equivalent to 42 days of standard Japanese consumption. Reportedly, the Government initially was seeking to purchase at least 1 metric ton of indium, but the exact quantity was not specified.

### World Refinery Production and Reserves:

	Refinery production		Reserves <sup>5</sup>
	2008	2009 <sup>e</sup>	
United States	—	—	Quantitative estimates of reserves are not available.
Belgium	30	30	
Brazil	5	10	
Canada	45	50	
China	310	300	
Japan	65	60	
Korea, Republic of	75	85	
Peru	6	20	
Russia	12	12	
Other countries	<u>25</u>	<u>30</u>	
World total (rounded)	570	600	

**World Resources:** Indium's abundance in the continental crust is estimated to be approximately 0.05 part per million. Trace amounts of indium occur in base metal sulfides—particularly chalcopyrite, sphalerite, and stannite—by ionic substitution. Indium is most commonly recovered from the zinc-sulfide ore mineral sphalerite. The average indium content of zinc deposits from which it is recovered ranges from less than 1 part per million to 100 parts per million. Although the geochemical properties of indium are such that it occurs with other base metals—copper, lead, and tin—and to a lesser extent with bismuth, cadmium, and silver, most deposits of these metals are subeconomic for indium.

Vein stockwork deposits of tin and tungsten host the highest known concentrations of indium. However, the indium from this type of deposit is usually difficult to process economically. Other major geologic hosts for indium mineralization include volcanic-hosted massive sulfide deposits, sediment-hosted exhalative massive sulfide deposits, polymetallic vein-type deposits, epithermal deposits, active magmatic systems, porphyry copper deposits, and skarn deposits.

**Substitutes:** Indium's recent price volatility and various supply concerns associated with the metal have accelerated the development of ITO substitutes. Antimony tin oxide (ATO) coatings, which are deposited by an ink-jetting process, have been developed as an alternative to ITO coatings in LCDs and have been successfully annealed to LCD glass. Carbon nanotube coatings, applied by wet-processing techniques, have been developed as an alternative to ITO coatings in flexible displays, solar cells, and touch screens. Poly(3,4-ethylene dioxythiophene) (PEDOT) has also been developed as a substitute for ITO in flexible displays and organic light-emitting diodes. PEDOT can be applied in a variety of ways, including spin coating, dip coating, and printing techniques. Graphene quantum dots have been developed to replace ITO electrodes in solar cells and also have been explored as a replacement for ITO in LCDs. Researchers have recently developed a more adhesive zinc oxide nanopowder to replace ITO in LCDs. The technology was estimated to be commercially available within the next 3 years. Indium phosphide can be substituted by gallium arsenide in solar cells and in many semiconductor applications. Hafnium can replace indium in nuclear reactor control rod alloys.

<sup>e</sup>Estimated. NA Not available. — Zero.

<sup>1</sup>Imports for consumption of unwrought indium and indium powders (Tariff no. 8112.92.3000).

<sup>2</sup>Indium Corp.'s price for 99.97% purity metal; 1-kilogram bar in lots of 10,000 troy ounces. Source: Platts Metals Week.

<sup>3</sup>Price is based on 99.99% minimum purity indium at warehouse (Rotterdam); cost, insurance, and freight (in minimum lots of 50 kilograms). Source: Platts Metals Week.

<sup>4</sup>Defined as imports – exports + adjustments for Government and industry stock changes; exports were assumed to be no greater than the difference between imports and consumption.

<sup>5</sup>See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see [Introduction](#).