Indium: Understanding its Behavior Today in Order to Meet Tomorrows Demand

LMDR-Laboratory for Mineral Deposits Research

Introduction

Indium has been characterized by DOE in their Critical Materials Strategy (2010), as **"most critical"**: criticality is a measure that combines risk of short term supply disruption, and importance to clean energy production. Indium is a vital component in solar cells, and in indium tin oxide (ITO), an electrically conductive, optically transparent material that forms the basis for touch screens and high-end LCDs. Despite its importance, we know little about its behavior in magmatic-hydrothermal systems. Indium is so dispersed in nature that deposits exploited exclusively for indium are very rare. Where indium reaches high concentrations, for example, at the Mount Pleasant Deposit in New Brunswick, enrichment is related to granite magmatism. There, it has been postulated that indium was concentrated in high-temperature magmatic-hydrothermal fluids exsolved from granite magmas, and subsequently deposited as indium-rich minerals at low-temperature (Sinclair et al., 2006).

Indium in the Earth

Indium is a rare metal in the crust of the Earth, present in concentrations of about 50 parts per billion (about 50 times that of gold). Metallic indium is uncommon in the Earth, but indium is present in low concentrations in some minerals, and rarely occurs at high-concentrations in the minerals indite ($FeIn_2S_4$) and roquesite ($CuInS_2$).

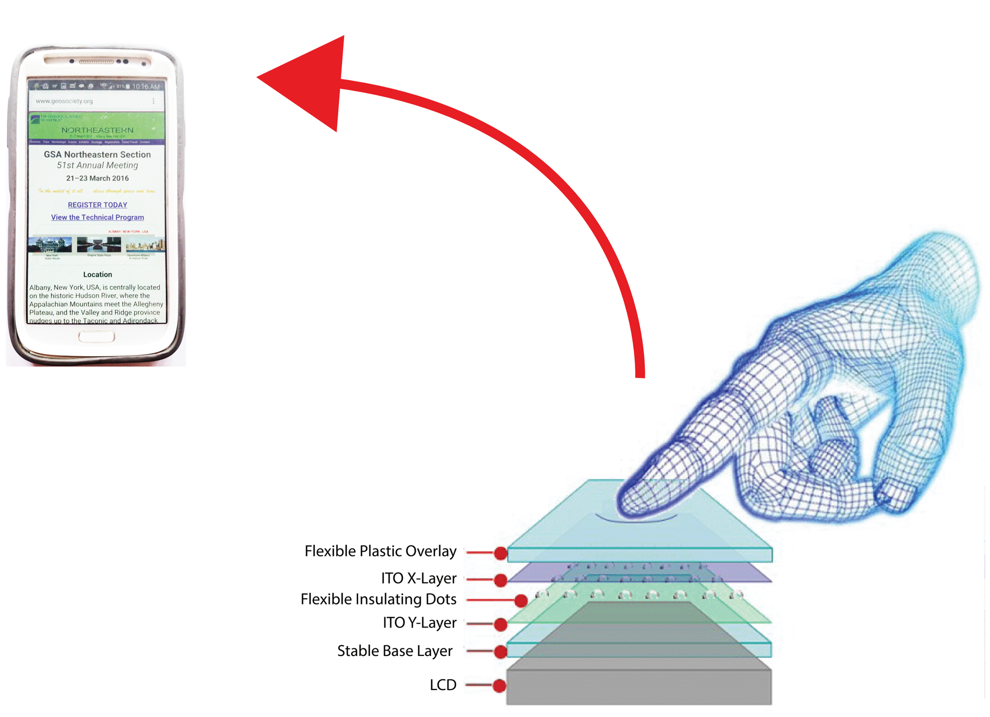
Indium-bearing Ore

The most important ore mineral that hosts indium is sphalerite (photo above), a common zinc-sulfide. In sphalerite, indium can reach concentrations of tens of percent, but that is rare. In many cases, indium can be mined as a by-product of zinc mining.

Photo of sphaleite from the Ouray District, Colorado. Photo by Rob Lavinsk.

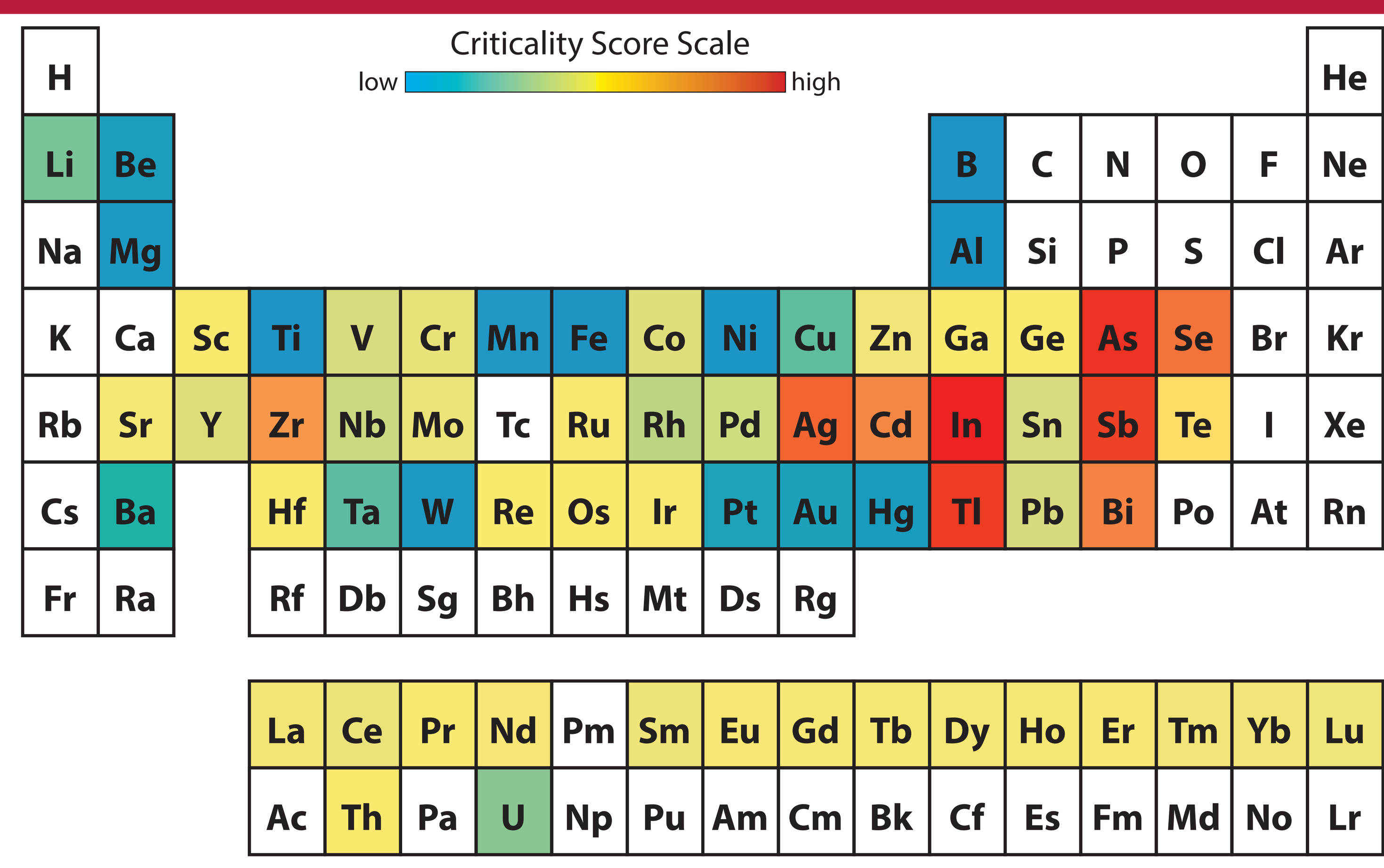
What is indium used for?

Resistive Touchscreens
(Capacitive Touchscreens)



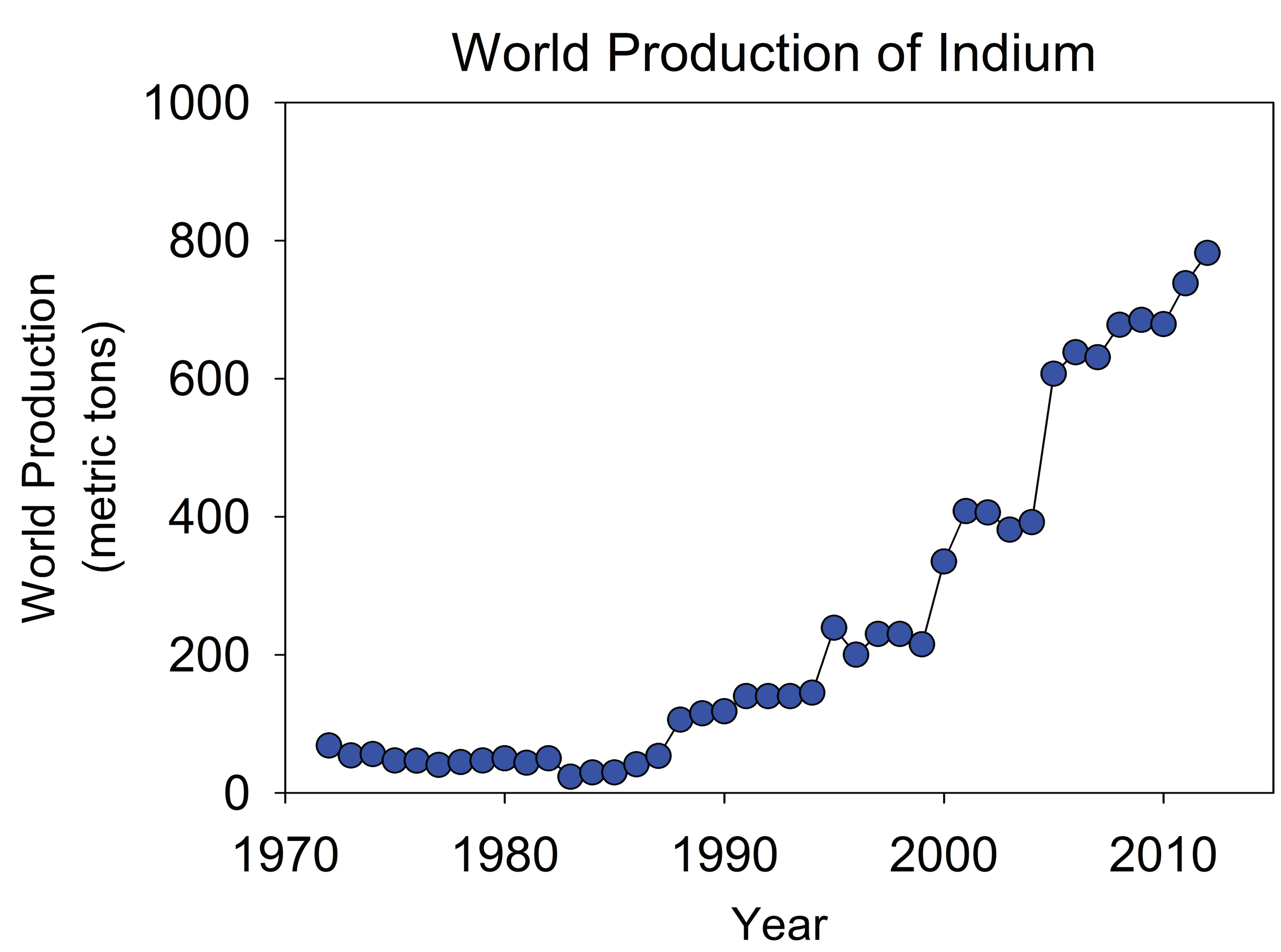
Indium is an essential constituent of touch-screens, flat screen TVs and solar panels, and is even used in the protective film on welders goggles, and on ball bearings in Formula 1 racing cars.

Criticality



Periodic table of criticality for 62 metals as of 2008, including global level for supply risk. Modified from Graedel et al. (2015).

Production of Indium



USGS Data Series 140 (2014). World production data are for smelter production of indium for 1972–74 and for refined indium for 1975 to 2012. Only one-third of the indium mined every year is being extracted and refined into high purity indium. Another third accumulates in residue and tailings for later recovery. The remaining indium is not recovered as it is mined by base metals producers who do not have the capability to extract by-products such as indium (in this case, it can be mined at a later time).

Ore Deposits:

Many magmas contain a large amount of **water** and **metals** dissolved into the liquid rock. Sometimes, as the magmas cool, they release the water along with concentrated amounts of metals. This **hot water carries the metals** as it rises away from the trapped magma through tiny cracks or faults and as it soaks through the rocks themselves. But as the water cools and rises it can no longer hold onto the metals it carries. If conditions are just right, the **metals all get left behind** in one small area. If one of these areas can be mined at a profit then it is called a **Magmatic-Hydrothermal Ore Deposit**.