BUSINESS

A commodity no more

The flat-screen television boom has materials scientists scrambling to replace the valuable metal oxide that coats the screens. **Andrea Chipman** reports.

The headlong rush to flat-screen technology has been warmly welcomed by couch potatoes and office drones alike. But it puts materials scientists on the spot. Can they replace indium tin oxide (ITO) — the material that coats these screens — if overwhelming demand drives its price through the roof?

Demand for indium has skyrocketed in recent years, mainly because of its use in liquid crystal displays (LCDs) and plasma screens. The electrical conductivity and transparency of ITO has turned it into a crucial industrial component, which can be readily etched and patterned to create a thin film of transparent circuits on both sides of the glass screen.

"For years, indium was a niche material, with no major end markets, used in small quantities in hundreds of odd applications," says Brian O'Neill of AIM Specialty Materials, Rhode Island. "In the past ten years it has found one major application, and that is LCDs."

The quandary that this presents is a good example of how high demand for commodities in the booming world economy is forcing materials scientists and engineers to revisit their options. Indium is mined almost entirely as a by-product of zinc — a much more widely used commodity — so little can be done to step up global production in line with demand.

A decade ago, the world was using less than 200 tonnes of indium a year. Now, annual consumption exceeds 1,500 tonnes, according to AIM. Production from mining has grown, but it is still less than 500 tonnes a year and the gap is being filled in the short term by recycling indium, mainly from the scrap produced as ITO films are applied to glass on LCDs.

S. YONG/REUTERS

Industry demand has inflated the price of indium.

Expensive element

The price of the soft, silvery-grey metal ballooned from less than US$100 as recently as 2002, to $1,000 a kilogram — more than twice the price of silver — in 2005, but has since subsided to a still-hefty $680 (see graph). That means that the ITO part of a typical flat-panel screen costs about $2, according to O'Neill. In such a fiercely competitive business, that's a substantial cost.

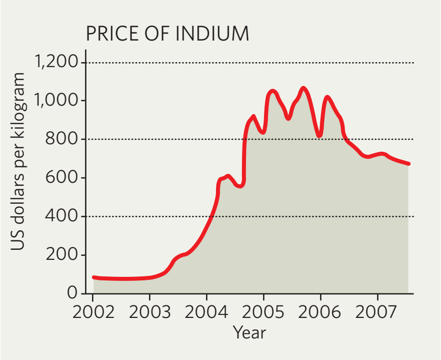
Uncertainty in supply is bolstered by the fact that most zinc deposits are found in places such as Bolivia and China, where exports of the metal are already restricted. And large oscillations in the price deter mining companies from investing heavily in processes to recover traces of indium from the zinc ore.

At the same time, with overall demand for the metal forecast by AIM to rise nearly 60% by 2009, even a projected increase in recycling won't bridge the gap between supply and demand for long. So researchers are testing a range of substitutes for ITO.

Fluorinated tin oxide, used in the doors of supermarket freezer compartments, provides a low-cost method for applying coatings to glass. It has comparable electrical properties to ITO, but is harder and takes much longer to etch, restricting its use in displays. Cadmium tin oxide has the right electrical and physical properties, but is highly toxic.

Zinc aluminium oxide has been cited as a promising substitute, but it needs a thicker film to achieve the same electrical conductivity, says O'Neill, leading to a loss of transparency — and screen brightness.

Researchers are also pursuing solutions that could become viable in the longer term. In Japan — home to many of the largest flat-screen producers — a group from the Japan Science and Technology Agency in Kawasaki is developing a transparent electrical insulating material made from calcium and aluminium oxides that becomes conductive when exposed to ultraviolet light. The material would mirror the properties of ITO, but would be cheaper to make and simpler to pattern, the researchers say. Another potential alternative is carbon nanotubes, which are more durable and flexible than ITO, although they haven't yet been tested on a large scale.



SOURCE: AIM

But even the best substitute will create problems. "You find very complex chemical compounds interacting in an electronic device, such as an LCD display," says Armin Reller, a chemist at the University of Augsburg in Germany. "If you replace one thing you have to adjust the other components. You can develop any system in the lab, but to implement it in a functioning device is not easy."

And, O'Neill notes, even a technically viable candidate will have to overcome the fact that display manufacturers have already invested billions of dollars in production equipment dedicated to applying ITO.

Solar power

Further market pressure looms on the horizon. As the second-largest consumer of indium after flat panels, photovoltaics already uses some 20 tonnes of indium a year. But according to O'Neil, that could rise to 150 tonnes a year by 2010 if growth continues at the current rate.

Here, too, materials scientists are working on alternatives. Copper indium gallium diselenide, better known as CIGS, is the main component in one of the leading solar cells under development by the US Department of Energy. Although the approach is less efficient than other solar cells, such as those based on silicon, it is vaunted as cheaper to build. But according to Tim Coutts, a research fellow at the National Renewable Energy Laboratory in Golden, Colorado, 50 tonnes of indium would be needed to produce cells to generate a gigawatt of solar power — the broad equivalent of a large power station.

At the same time, photovoltaics could ultimately be much more vulnerable to the price volatility of indium than the display business is, because it needs so much of the element. The flat-panel industry, Coutts notes, "can afford to pay if the price goes up. In photovoltaics, with increasing prices, it could become non-competitive." ■