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Methods to increase indium supplies for the manufacture of thin-film solar cells

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Shortages of indium, a key metal found in thin-film solar cells, could limit their large-scale deployment in the future. A new study has outlined four ways that indium supplies could be increased to meet future demand. For example, indium could be extracted more efficiently from zinc ores, or historic wastes containing indium could be processed to extract the element.

CIGS solar cells are a thin film photovoltaic technology containing a layer of copper, indium, gallium and selenide (CIGS), which absorbs solar radiation. This emerging technology uses as little material as possible to minimise resource depletion, the energy used in production, and costs. However, their future uptake could be hindered by the scarcity of indium. Indium is currently extracted almost entirely as a by-product from zinc mining, which means supplies depend on demand for zinc.

This study linked the projected global demand for indium with various energy scenarios to assess whether indium could be supplied in sufficient quantities to enable large-scale deployment of CIGS solar cells. The six energy scenarios, which were based on various sources, such as the International Energy Agency, included pessimistic, business-as-usual and optimistic assumptions of the photovoltaic share of global electricity generation. For example, photovoltaics produce around 1% of global electricity in 2050 in the business-as-usual scenario, rising to 17–21% in the optimistic scenario.

For each scenario, the researchers modelled the amount of indium needed to produce enough CIGS panels to meet the share of global electricity produced by photovoltaics. The model accounted for future technological improvements in design and reduction of indium lost through the manufacturing process. They also calculated the future demand for indium in other uses, particularly in liquid crystal displays (LCDs) and light emitting diodes (LEDs).

CIGS solar cells could potentially supply 12 to 387 gigawatts (GW) of renewable electricity in 2030 and 31 to 1401 GW in 2050 for the pessimistic and optimistic projected shares of the global energy market, respectively.

Under the pessimistic scenario, 485 tonnes of indium would be needed from 2000 to 2030, and for the most optimistic scenario 15 724 tonnes would be required. From 2000 to 2050, 789 to 30 556 tonnes would be needed for the pessimistic and optimistic scenarios, respectively. The researchers also estimated that between 17 000 tonnes and 39 000 tonnes of indium would be needed up to 2050 for non-CIGS uses.

The researchers calculated that improvements in CIGS solar cell technology could decrease demand for indium by 32% by 2050, compared with business-as-usual. Demand could fall by 43% by 2050 under the most optimistic technological improvements, combined with minimising losses through manufacture and recovery from production scrap and CIGS modules.

The researchers discuss four ways indium supplies could be increased to meet future demand:

1) Improve the overall extraction efficiency of indium from zinc throughout the mining, smelting and refining chain. The current overall extraction efficiency from mine to product is between 23% and 28%, but much indium does not enter the market

2) Increasing the production of zinc could also increase indium supplies. However, it is unlikely to be economically attractive to mine more zinc solely for the indium by-product, as global demand for zinc depends mainly on its use in the construction and automotive sector

3) Mine other indium-containing metal ores, such as copper, lead or tin

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4) Extract indium from historic wastes and residues, such as mine tailings. However, this would only be feasible if a kg of indium fetched US$ 1000 (€882). Recently, the price of indium has varied from $87 (€77)/kg in 2002 to $961 (€848)/kg in 2005. Furthermore, the wastes would need to be accessible, safe to process and contain sufficient quantities of indium to make extraction economically attractive.

The researchers estimate that the environmental impacts of increasing supplies of indium would not outweigh the benefits of renewable electricity generation from CIGS solar cells. The environmental impact, measured by Global Warming Potential (the ability to trap heat in the atmosphere) of greenhouse gases emitted by the supply chain providing indium would need to increase 330 times to be as damaging as the environmental impacts associated with electricity generation from the most advanced gas power plant.

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