1st Stakeholder Consultation – Compilation of initial substance information for indium phosphide (CAS 22398-80-7; EC 244-959-5)

Abbreviations

CdSe	Cadmium Selenide
CLP	Regulation (EC) No 1272/2008 on Classification, Labelling and Packaging
InP	Indium Phosphide
ITO	Indium Tin Oxide
LED	Light Emitting Diodes
REACH	Regulation (EU) No 1907/2006 on the Registration, Evaluation, Authorisation and restriction of Chemical substances

1. Legal status and other restrictions

Indium phosphide (InP) is classified under the CLP regulation (Regulation (EC) No 1272/2008 on Classification, Labelling and Packaging) as follows: [1]

- Carc 1B (Carcinogenicity)- H350 (May cause cancer)
- Repr. 2 (Reproductive toxicity) - H361f (Suspected of damaging fertility)
- STOT RE 1 (Specific target organ toxicity (repeated exposure)) - H372 (Causes damage to organs through prolonged or repeated exposure)

Indium phosphide is pre-registered under REACH.

Indium is listed on the 2017 list of Critical Raw Materials for the EU (COM(2017) 490 final)[2]. Materials appearing on this list have been identified as critical for the EU because possible risks of supply shortage (scarcity) and their impacts on the economy are higher than those of most of the other raw materials. Additional aspects (e.g. environmental, social) are not mentioned in the communication in this regard.

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[1] https://echa.europa.eu/de/information-on-chemicals/annex-vi-to-clp, last viewed 19.04.2018

[2] EU COM (2017), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the 2017 list of Critical Raw Materials for the EU, Brussels, 13.9.2017, COM(2017) 490 final, available under: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2017:0490:FIN, last viewed 19.04.2018, last viewed 19.04.2018

2. Uses and quantities

Based on a 2006 publication of IARC[3], indium phosphide is used as a semiconductor in electronics. Due to its semiconductor and photovoltaic properties, indium phosphide is primarily used in high power optoelectronic devices such as:

- Semiconductor in electronics (mainly in III – IV semiconductor compounds);
- Laser diodes for fibre optic communications;
- Light Emitting Diodes (LEDs), predominantly to optically transmit data and, to a lesser extent, in LED displays;
- Hetero-junction bipolar transistors for optoelectronic integration;
- Critical communications components (fiber optic internet);
- Solar cells and
- High-performance integrated circuits for microelectronics and optoelectronics (lasers and photo-detectors).

In the context of the RoHS directive, indium phosphide has been in the focus of discussions related to the application of quantum dot technologies in displays and in lighting. InP has been mentioned as a possible alternative for cadmium selenide in display lighting and in sold state lighting applications.[4] From past evaluations related to this application, it is further understood that the use of InP in quantum dot technologies in such products has increased[5].

Emerging technologies contribute to the increasing demand for the raw material. Indium is important for many emerging technologies, including thin-layer photovoltaic cells, displays and white LEDs. The demand for indium in these applications is expected to increase until 2030[6].

More than half of the global production of refined indium (723 tonnes metric in 2015) is produced by China (51%), followed by South Korea, Japan, where the extraction and production of primary indium takes place during the production of host metals in refineries (BGS 2017)[7]. Production of indium tin

3 IARC International Agency for Research on Cancer (2006): IARC Monographs on the Evaluation of Carcinogenic Risks to Humans; Cobalt in Hard Metals and Cobalt Sulfate, Gallium Arsenide, Indium Phosphide and Vanadium Pentoxide; Volume 86 (2006); http://monographs.iarc.fr/ENG/Monographs/vol86/mono86.pdf, last viewed 19.04.2018

4 Further information is available in the evaluation report of RoHS exemption requests 2013-2 and 2013-5, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_IX/20140422_RoHS2_Evaluation_Ex_Requests_2013-1-5_final.pdf, last viewed 19.04.2018

5 See Oeko-Institut (2016), Assistance to the Commission on Technological Socio-Economic and Cost-Benefit Assessment Related to Exemptions from the Substance Restrictions in Electrical and Electronic Equipment: Pack 10 Final Report, prepared for the European Commission, DG Environment, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/reports/20160602_Final_Report_RoHS_Pack_10_Cd_QDs_amended.pdf, last viewed 19.04.2018

6 Oeko-Institut (2014): Study for the Review of the List of Restricted Substances under RoHS 2. Analysis of Impacts from a Possible Restriction of Several New Substances under RoHS 2 by Gensch, C.-O., Baron, Y. Blepp, M., Bunke, D., Moch, K.; Revised Final Version 06.08.2014; http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Substance_Review/20140806_Substance_Review_revised_version_final_plus_Dossier.pdf, last viewed 19.04.2018

7 BGS (2017): British Geological Survey: World Mineral Production 2011-2015. Keyworth, 2017 . https://www.bgs.ac.uk/mineralsuk/statistics/worldStatistics.html, last viewed 19.04.2018

oxide (ITO) continued to account for most of global indium consumption as electrode material in flat screens (Oeko-Institut 2012)[8].

Indium combines with several non-metallic elements, including phosphorus, to form semiconducting compounds. Indium phosphide is prepared by direct combination of the highly-purified elements at elevated temperature and pressure under controlled conditions. Available information indicates that indium phosphide is produced by two companies in Taiwan (China) and one company each in Japan and the USA.[9]

Further sufficient information for indium phosphide quantities in use in the EU (per annum) is not available.

2.1. Substitution

- Gallium arsenide is understood to be a possible substitute for indium phosphide in solar cells and in many semiconductor applications.
- On the substance level, InP is a possible alternative for CdSe in quantum dot based technologies, applicable for lighting of displays as well as for solid state lighting. Though performance may differ in terms of energy consumption and/or spectral output, for both technologies alternatives are understood to be available and in development on the technological level (i.e., alternative display technologies, alternative LED technologies).

[8] Oeko-Institut (2012): Recycling critical raw materials from waste electronic equipment. https://www.oeko.de/oekodoc/1375/2012-010-en.pdf, last viewed 19.04.2018

[9] https://monographs.iarc.fr/ENG/Monographs/vol86/mono86-9A.pdf, last viewed 19.04.2018