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PHOTONIK
im Deutschen Industrieverband
SPECTARIS

7. November 2019

Contribution to Stakeholder consultation under RoHS 2 (Pack 15)
Indium phosphide (CAS Number: 22398-80-7)

Dear consultants of the Oeko Institute,

The German Hightech Industry Association SPECTARIS hereby states that we fully support the attached contribution made by IMAT e.V. to the 2nd Stakeholder consultation on report No. 3 dated 25/09/2019 named "ROHS Annex II Dossier for Indium phosphide / Restriction proposal for substances in electrical and electronic equipment under RoHS."

With a membership of over 400 high-tech companies, SPECTARIS firmly believes that in light of the global opportunities and challenges, the careful and responsible use of key optoelectronic substances like indium phosphide in the photonics industry should be continued to the benefit and well-being of the European people and European economy regarding employment and growth.

We remain at your disposal for any questions regarding this matter.

Best regards,

Jörg Mayer
CEO, SPECTARIS

Dr. Wenko Süptitz
Head of Photonics Division, SPECTARIS

Contribution by IMAT
2nd Stakeholder Consultation – Substance Assessment of Indium Phosphide (InP)

RoHS Annex II Dossier for InP

Restriction proposal for substances in electrical and electronic equipment under RoHS

Report Nr 3 –6/11/2019

November 6, 2019

1. **Introduction**

We are grateful to the Öko-institute for having taken our contribution to the 1st stakeholder consultation (dated June 15, 2018) into consideration. IMAT, the German semiconductor industry, is pleased to read that indium phosphide (InP) is NOT recommended for restriction under the RoHS directive.
Please find attached the report including some comments directly in the text with track change mode for your convenience.
We hope our comments can help to further ameliorate some of the details in the report, and we remain at your disposal for any follow-up question.

2. **Growing use of InP by 2028**

The report concludes on page 19-20 that currently ~24 to 33 kg InP is placed on the European market (excluding the use of InP in display applications and lighting). IMAT agrees with that.
However, by the year 2028, the authors of the report expect a growth in use to ~600kg in display applications and ~256 kg in lighting applications.

Display
Despite all optimism, it is hard to believe that there is a technology that will show a constant growth of 28% CAGR in the display sector over 10 years, while the entire market is more saturated and is expected to hardly grow from 2020. Today only QLED contains InP. QLED is a technology that is associated with high manufacturing costs and is primarily used because the standard processes of LCD manufacturing can be maintained. We have seen how Samsung lost half of its market share because they chose QLED instead of OLED. (see https://www.stern.de/digital/homeentertainment/samsung-dominierte-den-tv-markt--nun-kam-der-absturz--schuld-sind-oled-fernseher-7659666.html)
According to research within the Fraunhofer Society, current OLEDs do not apply InP. It is a fact that displays that operate without colour filters and generate RGB directly from the LED are naturally much more energy efficient. Current MicroLED displays do not require quantum dots from InP and will be the next tough competitor to OLED technology. According to Nanosys, the market leader in the production of QD films, this technology can only be used in high-end televisions above $1000. This is just 8% of all televisions. How large the share of InP-based QD will be within this small market segment in 10 years' time, nobody can reliably predict, but based on our > 30 years experience in this sector, it will not grow by a factor of 10 (from the authors' assumed ~60 to ~600kg).

LED Lighting
OSRAM recently introduced its first LED with Quantum Dots. This LED addresses the market for high CRI LED (Colour Rendering Index) with high energy efficiency. It contains both fluorescent materials and quantum dots based on cadmium selenide. OSRAM provided the information that they are not aware of any LED containing InP in the market. They just started cooperation with the US Department of Energy (DOE) on research and development of InP based QD LED for solid state lighting. Products to be marketed are not expected to be available before 2025. Only on-chip QD-LED are suitable for energy efficient lighting products fulfilling the coming legal energy efficiency requirements.
Therefore, the current market is **0 kg** and will not grow in the next 5 years. The number assumed in the report is completely unrealistic for solid state lighting. It is also hard to predict for the years after 2025.
The fact that the current market is 0 kg, is also why no contributions from the lighting industry were made to the first stakeholder consultation. A completely hypothetical replacement of cadmium by InP multiplied by a completely hypothetical growth rate in the lighting sector can only lead to a completely hypothetical number.

Communication, Sensing and highspeed electronics

Reliable market data on the development of InP volumes are not available. On the basis of the sales development made with optical transceivers provided by Lightcount, it is possible to estimate orders of magnitude. In the past (2010-2019), market value growth in this area was 15% CAGR and, despite a downturn in 2019, is predicted to be 22% CAGR in the coming years. If one also takes into account that at least half of the growth is due to performance increases in the components, one can estimate volume growth at about half the growth rates.

Photovoltaic

Today, monocrystalline and polycrystalline silicon dominates the mass photovoltaic market. Multi-junction cells are used in very small niches where only efficiency and weight are important, and costs are irrelevant. Different wavelength bands are converted into electricity by different layers. InP can be used theoretically. InGaP or InGaAs are used with priority. The application would be limited to space applications. There are no figures available for this area. The quantities in space applications (which is a sector excluded from RoHS, as you know according to article 2, 4b of RoHS directive 2011/65EC), are certainly negligible.

Based on > 30 years experience, the IMAT members support the following numbers for EU consumption of InP:

Year 2019:

- Optoelectronics;
  - Fibre-optic networks, wireless base stations and satellite communications: **10 kg**
  - Other laser and sensor applications, LiDAR autonomous driving, vehicle emissions testing, spectroscopy analysis for food, chemical analysis: **6 kg**
- High-speed electronics;
  - Electronic semiconductor applications:
    High speed (Terahertz) Hetero-junction Bipolar Transistors in measurement analysers and non- military radio frequency communications: **8 kg**
- Photovoltaic applications
  - Near to **0 kg**
- LED lighting
  - **0 kg**

TOTAL: ~24kg

<u>Year 2028:</u>

Based on the market forecasts for a typical component of optical communication technology, the future material deployment for InP can be estimated. This leads to the following estimates for 2028:

- Photonic applications:
  - Fibre-optic networks, wireless base stations and satellite communications: **24 kg**
  - Other laser and sensor applications, LiDAR autonomous driving, vehicle emissions testing, spectroscopy analysis for food, chemical analysis: **20 kg**
- High-speed electronics;
  High speed (Terahertz) Hetero-junction Bipolar Transistors in measurement analysers and non- military radio frequency communications: **19 kg**
- Photovoltaic applications
  - Near to **0 kg**
- LED lighting
  - **0-5 kg**

TOTAL: ~65 kg

3. <u>Hazard – exposure – risk of InP</u>

IMAT agrees with Öko-Institute that GaAs is at least as hazardous as InP (p36 of the current report). Considering the fact that:

a. GaAs and InP have a similar hazard profile (GaAs: H372/H350/H412 and InP: H350/H372/H361f)
b. Both are used in the semiconductor industry; for comparable applications, leading to the same exposure profile
c. Both GaAs and InP are not applied as a surface material but encapsulated in housings to protect the InP based optical component and quantum dots. There is no potential for emissions during the intended use of the substance.
d. Clean room environment is standard practice in the semiconductor industry to avoid contamination of the highly sensitive materials worked with.
e. Exposure scenarios are available in the REACH registration file of GaAs https://echa.europa.eu/nl/registration-dossier/-/registered-dossier/13885/3/1/4 Concluding in no risk for any of the identified uses.
f. Annual EU tonnage/year GaAs ~ 10-100T
   Annual EU tonnage/year InP ~0.03-0.06T

It can safely be assumed that the risk linked to the use of InP is currently negligible for humans and the environment. And even if – worst case, unrealistic, hypothetical assumption

– the quantities of InP would reach the same level of GaAs, the risk to humans and environment would still remain negligible.

4. <u>Alternatives for InP</u>

The semiconductor industry is extremely sensitive to cost. Whenever a cheaper alternative exists, industry will change its production immediately to remain competitive. As example:

InP quantities are so low that prices remain high. On average **InP wafers are a factor 5 more expensive than GaAs wafers** of the same size.

InP is used because of the necessity of its special characteristics and use profile and **despite** its higher cost. Industry does not see any problem related to the substance itself.

Worldwide companies and research institutes have been looking for viable alternatives to InP for more than 30 years now. If the future brings cost-saving alternatives, industry would make use of them.

5. <u>Summary</u>

IMAT, the German semiconductor industry, is pleased to read that indium phosphide (InP) is NOT recommended for restriction under the RoHS directive.

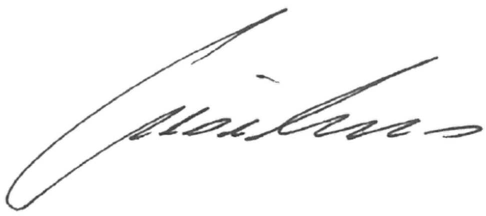
After thorough investigation of the InP semiconductor industry, it is our expert opinion that the EU yearly quantities of InP are currently ~ 24 kg. Quantities are expected to go up to ~ 63 kg/year by 2028. Öko-Institute estimates 600kg for displays and 256kg for the lighting sector. These estimates are not based on facts and are unrealistic.

IMAT agrees with the Öko-Institut that InP is at least as hazardous as GaAs. Considering the ‘no risk’ conclusions in the 10-100T REACH dossier of GaAs and the comparable use and toxicological profile of both substances, it can safely be assumed that the risk to humans and the environment, linked to the use of InP is also negligible (like for GaAs), even if the quantities of InP would go up unexpectedly to ~1T by 2028.

IMAT's contribution is limited exclusively to the environmental aspects of InP. But there is also a major impact on Europe's innovative strength. An ongoing and regular review of InP is a danger to research and development of key communication and digitisation components for industry 4.0 and 5G. If Europe continues to lose ground for fear of further restrictions in these areas, it is a risk to Europe's competitiveness, which in the end will not be compensated by any benefit to the environment.

We remain at your disposal for any follow-up question.

Yours faithfully,



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