

Consultation Questionnaire Exemption No. 32

Exemption for „Lead oxide in seal frit used for making window assemblies for Argon and Krypton laser tubes“

Abbreviations and Definitions

CTE	Coefficient of Thermal Expansion
EEE	Electrical and Electronic Equipment
Lumentum	Lumentum Operations LLC
Pb	Lead
PbO	Lead Oxide
RoHS	Directive 2011/65/EU on the Restriction of Hazardous Substances in Electrical and Electronic Equipment

Background

The Oeko-Institut has been appointed by the European Commission, within a framework contract¹, for the evaluation of applications for exemption from Directive 2011/65/EU (RoHS), to be listed in Annexes III and IV of the Directive.

Lumentum has submitted a request for the renewal of the above-mentioned exemption, which has been subject to an initial evaluation. A summary of the main argumentation for justifying the request is provided below. The applicant has been requested to answer additional questions and to provide additional information, available on the request webpage of the stakeholder consultation (<http://rohs.exemptions.oeko.info/index.php?id=367>).

For further details, please check the applicant's exemption request under the link available above.

The objective of this consultation and the review process is to collect and to evaluate information and evidence according to the criteria listed in Art. 5 (1) (a) of Directive 2011/65/EU (RoHS 2), which can be found under:

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32011L0065:EN:NOT>

If you would like to contribute to the stakeholder consultation, please read the summary of the argumentation provided and answer the questions that follow.

¹ The contract is implemented through Framework Contract No. ENV.B.3/FRA/2019/0017, led by Ramboll Deutschland GmbH.

1. Summary of argumentation of applicant on the justification of the exemption

1.1. Background

Lumentum applies for the renewal of Ex. 32 of Annex III of the RoHS Directive:

“Lead oxide in seal frit used for making window assemblies for Argon and Krypton laser tubes”

Lumentum (2020) applies for the exemption in its current formulation and requests it to be renewed for 5 years for RoHS Annex I categories 6, 8 and 9. In its application, it addresses only argon lasers and it is not clear if the exemption is still needed for krypton lasers or not. In a later communication, Lumentum (2021) admits that it is not aware whether the exemption is still needed for krypton lasers or not.

1.1.1. Volume of lead to be placed on the EU market through the exemption

The content of lead in the frit used for making window assemblies in argon lasers is >50% of the homogeneous material (% weight). The annual average of PbO used by Lumentum in the sealing glass frits of Argon lasers is about 200 g. However, only a fraction of that amount enters the EU. Based on Lumentum’s direct shipments, only 17g of PbO enters the EU market annually in argon lasers. This amount has not changed since Lumentum’s previous application for the renewal of RoHS exemption 32 in 2015. (Lumentum 2020)

Lumentum (2021) states that Coherent, Lexcel-Cambridge and LASOS also manufacture argon ion laser tubes as well as krypton lasers. All of the above manufacturers are likely selling and shipping either directly or indirectly around the globe, including to the EU. The consultants thus conclude that the volume of lead specified by Lumentum for its own portfolio is only indicative of part of the amount of lead placed on the market through this application.

1.2. Technical description

Argon laser products are used as coherent light sources in a broad range of critical applications, a majority of which are in research, bioinstrumentation and semiconductor manufacturing. This includes flow cytometers, DNA sequencers, and hematology equipment. Instruments are used internationally by both government and private sector agencies for health care, drug discovery, and research applications. In semiconductor manufacturing, argon lasers are used in inspection equipment. (Lumentum 2020)

1.3. Applicant’s justification for the requested exemption

The lead-oxide glass provides a critical thermo-mechanically stable and vacuum-tight seal between the optics and laser tube in applications of relevance to this exemption. Lead-oxide as a raw material lowers the melting temperature of the solder glass/glass frit. This glass frit joins glass of a mirror to the laser metal tube without thermally damaging complex coating layers of the mirror. The softening point of the lead-oxide based material occurs at a narrow temperature range around 420°C and does not thermally damage the nearby fragile components being joined. (Lumentum 2020)

The processing temperatures are restricted by the potential of damage to the components, primarily the optics. Because the optics utilize complex multilayer coatings (>30 layers) using higher temperatures or longer processing times is not advised by the supplier of the optics. The coating

fabrication process only allows for stabilization of the key optical properties to 500°C. Processing at temperatures above 500°C will cause failure of the coatings. (Lumentum 2020)

Additionally, the material has a coefficient of thermal (CTE) expansion closely matched to the components for stress-free sealing. The seal frit is required to have a thermal expansion coefficient at 7.0 to 8.0 $10^{-6}/K$ to match to the components for stress-free sealing. (Lumentum 2020)

1.3.1. Availability of alternatives (Substitution or Elimination, roadmap to substitution, reliability of substitutes)

Lumentum (2020) has not identified lead-free glass that meets the softening temperature and CTE requirements specified above.

Commercially available alternatives to the leaded glass sealing material (frits) are bismuth based. Bismuth based glasses have significantly higher (540°C) melting temperatures than the Pb based frits. In trial builds² the lead-free frit did not produce a consistent good flow of the frit material (see illustration photo's in application). To further substantiate this, Lumentum provides a comparison of the coefficients of thermal expansion and sealing temperature of leaded and bismuth based lead-free sealing glass and sealed components in the argon lasers in Table 1 of the application. Thus, the bismuth-oxide based material (frit) is not considered a viable alternative at this time. (Lumentum 2020)

When asked as to alternatives based on other materials, Lumentum (2021) explains that bismuth-based frits are typically used as a replacement for leaded frits due to their lower melting temperatures compared to other type of glass material. Bismuth-free frits are used by the industry for other type of applications but their sintering or firing temperatures are already above 700°C, and their actual melting point is even above 900°C.

1.3.2. Environmental and health arguments

Environmental arguments were not raised as the main justification for this exemption.

1.3.3. The scope of the exemption

Lumentum was asked as to other exemption in the RoHS annexes that refer to frit materials and possible overlaps with Ex. 32. Lumentum (2021) answered that gas laser tubes are optical components that depend on electric current in order to function. If exemption 7(c)-I³ of Annex III covers glass used for this type of components, Lumentum would welcome to consolidate exemption 32 within exemption 7(c)-I.

As for exemption 4 of Annex IV for “lead in glass frit binder for assembly of gas lasers” seems to be suitable to cover our application however, it would limit it only for medical devices, monitoring and control instruments. It would not cover the use of argon laser tubes in other tool applications.

² Lumentum (2021) states that the trial builds with bismuth-oxide based frits were performed at different temperatures starting at 480°C. A good melting, per visual inspection, was only obtained starting from 540°C.

³ Ex. 7(c)-I of Annex III is currently formulated as follows: “Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound.”

2. Questions for stakeholders

1. The applicant has requested an exemption, proposing the following wording formulation:

“Lead oxide in seal frit used for making window assemblies for Argon and Krypton laser tubes”

- a. Do you agree with the scope of the exemption as proposed by the applicant?
 - b. Please suggest an alternative wording and explain your proposal, if you do not agree with the proposed exemption wording.
 - c. Please explain why you either support the applicant’s request or object to it. To support your views, please provide detailed technical argumentation / evidence in line with the criteria in Art. 5(1)(a) to support your statement.
2. Lumentum only provides justification of the exemption for argon lasers. If you contend that the exemption is also needed for krypton lasers, please provide justification for this statement on the basis of Article 5(1)(a) of the RoHS Directive.
 3. Lumentum states that assuming that exemption 7(c)-I of Annex III covers glass used for this type of components, it would welcome a consolidation of exemption 32 within exemption 7(c)-I. Do you agree or disagree with this proposal? Please explain why.
 4. Please provide information concerning possible substitutes or developments that may enable reduction, substitution or elimination, at present or in the future, of *“Lead oxide in seal frit used for making window assemblies for Argon and Krypton laser tubes”*;
 - a. In this regard, please provide information as to alternatives that may cover part or all of the applicability range of *“seal frit used for making window assemblies for Argon and Krypton laser tubes”*;
 - b. Please provide quantitative data as to application specifications to support your view.
 5. Please provide information as to research initiatives which are currently looking into the development of possible alternatives for some or all of the application range of *“seal frit used for making window assemblies for Argon and Krypton laser tubes”*.
 - a. Please explain what part of the application range is of relevance for such initiatives (in what applications substitution may be possible in the future).
 - b. Please provide a roadmap of such on-going research (phases that are to be carried out), detailing the current status as well as the estimated time needed for further stages.
 6. Please provide any further information and/or data that you think is of importance to substantiate your views.

In case parts of your contribution are confidential, please provide your contribution in two versions (public /confidential). Please also note, however, that requested exemptions cannot be granted based on confidential information!

Finally, please do not forget to provide your contact details (Name, Organisation, e-mail and phone number) so that Oeko-Institut can contact you in case there are questions concerning your contribution.

3. References

Lumentum (2020): Exemption Request Form for Ex. 32, RoHS Annex III. Lumentum Operations LLC (ed.), 20 Jan 2020.

Lumentum (2021): Answer to clarification questions regarding Ex. 32 of Annex III. Lumentum Operations LLC (ed.), 12 Mar 2021.