Assistance to the Commission on Technological Socio-Economic and Cost-Benefit Assessment Related to Exemptions from the Substance Restrictions in Electrical and Electronic Equipment:

Study to assess renewal requests for 29 RoHS 2 Annex III exemptions [no. I(a to e -lighting purpose), no. I(f - special purpose), no. 2(a), no. 2(b)(3), no. 2(b)(4), no. 3, no. 4(a), no. 4(b), no. 4(c), no. 4(e), no. 4(f), no. 5(b), no. 6(a), no. 6(b), no. 6(c), no. 7(a), no. 7(c) - I, no. 7(c) - II, no. 7(c) - IV, no. 8(b), no. 9, no. 15, no. 18b, no. 21, no. 24, no. 29, no. 32, no. 34, no. 37]

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07 June 2016

Report for The European Commission

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32.0 Exemption 32 “Lead oxide in seal frit used for making window assemblies for Argon and Krypton laser tubes”

Declaration

In the sections that precede the “Critical Review” the phrasings and wordings of stakeholders’ explanations and arguments have been adopted from the documents provided by the stakeholders as far as required and reasonable in the context of the evaluation at hand. Formulations have been altered in cases where it was necessary to maintain the readability and comprehensibility of the text. These sections are based exclusively on information provided by applicants and stakeholders, unless otherwise stated.

Acronyms and Definitions

Ion lasers	Gas lasers, i.e. argon and krypton lasers
SSL	Solid state laser(s)

32.1 Description of the Requested Exemption

Coherent[1808] and Lumentum[1809] (formerly JDSU) requested the renewal of Exemption 32 without changes for another five years:

> *Lead oxide in seal frit used for making window assemblies for Argon and Krypton laser tubes*

32.1.1 Background and History of the Exemption

The exemption was first reviewed[1810] in 2006, whereupon the Commission granted the exemption, and once again[1811] in 2010/2011. The exemption was renewed for the

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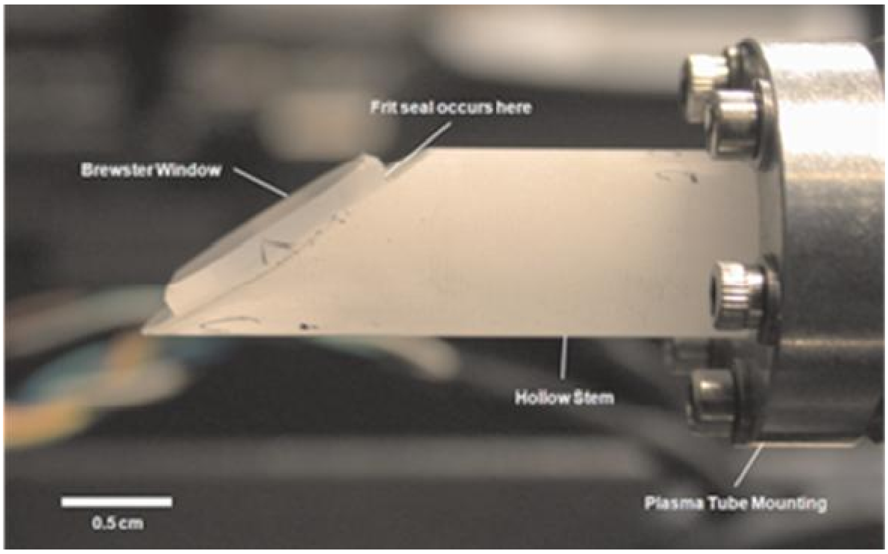
[1808] Coherent 2015a “Request for continuation of exemption 32, document "BR-_9849983-v3-Coherent_Exemption_request_form_update_after_comments___PG_with_redaction.pdf": Original exemption request,” http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_32/Coherent/BR-_9849983-v3-Coherent_Exemption_request_form_update_after_comments___PG_with_redaction.pdf

[1809] Lumentum 2015a 2015 “Request for continuation of exemption 32, document "32_JDSU_RoHS_Application_Exemption_32.pdf": Original exemption request,” http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_32/JDSU/32_JDSU_RoHS_Application_Exemption_32.pdf maximum four years allowed under Directive 2002/95/EC (RoHS 1) until 31 July 2014. This expiry date was systematically postponed to July 2016 when the exemption was transferred to Annex III of the recast Directive 2011/65/EU (RoHS 2).

32.1.2 Technical Description of the Exemption

According to Coherent[1812], as illustrated in Figure 32-1 the lead oxide in the seal frit is located in a Brewster window assembly, i.e. an optomechanical assembly that provides a vacuum-tight seal and is optically transparent to the laser radiation.

Figure 32-1: Location of the seal frit in the laser tube assembly



Source: Coherent[1813]

Coherent[1814] classifies the Brewster window with the lead-containing seal frits as a critical optical interface that significantly affects the performance of the laser. A plasma tube can have either one or two of these assemblies based on its type. Lumentum[1815] explains that the lead oxide-based material in Argon and Krypton laser products provides a critical thermo-mechanically-stable and vacuum-tight seal between the optics and

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[1810] Gensch, Carl-Otto [Oeko-Institut e.V.], et al. 2006 “Adaptation to scientific and Technical progress under Directive 2002/95/EC: Final Report - final version,”; http://ec.europa.eu/environment/waste/weee/pdf/rohs_report.pdf; page 127 et seqq.

[1811] For details see report of Zangl, Stéphanie, Oeko-Institut e.V. 30 May 2011 Adaptation to Scientific and Technical Progress under Directive 2002/95/EC: Evaluation of New Requests for Exemptions and/or Review of Existing Exemptions. With the assistance of Otmar Deubzer, Fraunhofer IZM, and Ran Liu, Katja Moch, Oeko-Institut e.V., page 83 et sqq.

[1812] Op. cit. Lumentum 2015a

[1813] Op. cit. Coherent 2015a

[1814] Op. cit. Coherent 2015a

[1815] Op. cit. Lumentum 2015a

laser tube. The softening point of the lead-oxide material occurs at a narrow temperature range around 420 °C, and does not thermally damage the nearby fragile components being joined. Additionally the material has a coefficient of thermal expansion closely matched to the components for stress-free sealing. Lead-free glasses are not available for this application, and the continuation of exemption 32 is therefore required.

Coherent [1816] states that ion lasers are unique in that they generate a variety of wavelengths in the ultraviolet, visible and infrared regions of the electromagnetic spectrum. These lasers are capable of producing ultrapure spatial and temporal output. Lumentum[1817] explains that its 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. Coherent[1818] lists the following primarily scientific and light industrial applications for Argon and Krypton ion lasers in use in the EU today:

- Spectroscopy, e.g. examination of molecules or atoms by measuring effects of laser beam exposure;
- Microscopy, e.g. magnification of samples and objects using laser as light source; non-medical uses include examination of geologic materials; and
- Holography, e.g. using lasers to record and/or view optically stored information for applications such as data storage, security, art, engineering and communications.

Lumentum[1819] states that leading manufacturers of flow cytometers, DNA sequencers, and haematology equipment, incorporate Argon lasers into their products in both new production and in service of a large worldwide installed base. 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, again for both new installations and service business.

Further technical details related to Exemption 32 are available in the reports of the previous reviews.[1820, 1821]

[1816] Op. cit. Coherent 2015a
[1817] Op. cit. Lumentum 2015a
[1818] Op. cit. Coherent 2015a
[1819] Op. cit. Lumentum 2015a
[1820] Op. cit. Gensch, Carl-Otto [Oeko-Institut e.V.], et al. 2006; http://ec.europa.eu/environment/waste/weee/pdf/rohs_report.pdf; page 127 et seqq.

[1821] For details see report of (Zangl, Stéphanie, Oeko-Institut e.V. 30 May 2011) Adaptation to Scientific and Technical Progress under Directive 2002/95/EC: Evaluation of New Requests for Exemptions and/or Review of Existing Exemptions. With the assistance of Otmar Deubzer, Fraunhofer IZM, and Ran Liu and Katja Moch, Oeko-Institut e.V., page 83 et sqq.

32.1.3 Amount of Lead Used Under the Exemption

Coherent's[1822] 2014 shipments of replacement plasma tubes and new systems containing plasma tubes, in all non-exempt applications, EU-wide, contain less than 1g of lead, and the number of ion lasers in use for all applications is flat to declining, both in the EU and globally. There is no potential for emerging applications that would employ ion laser technology, and thus, the amount of Pb introduced per annum would be generally flat to declining in subsequent years. Lumentum[1823] indicates its total annual usage of PbO in the sealing glass in its lasers to be 230g, and with only 17g of PbO thereof entering the EU market direct shipments of argon lasers.

Even though exact figures concerning the total amount of lead used under this exemption are not available, the consultants assume it is safe to say that less than 1 kg of lead is used in the EU under this exemption.

32.2 Applicants' Justification for the Continuation of the Exemption

32.2.1 Substitution of Lead

Lumentum[1824] mentions bismuth-based glass as an alternative to the lead-based sealing glass. The bismuth-based glasses have a significantly higher (540°C) melting temperatures than the lead-based glass (420°C). Lumentum has tested the initial suitability of bismuth-based alternatives. While the published melting temperature is 540°C, in trial builds processing temperatures in excess of 560°C did not produce good flow of the frit material. The coverage of the frit material should be complete as in the photo on the left in Figure 32-2. As seen in the photo on the right, the lead-free material did not flow to provide a complete seal (red arrow).

[1822] Op. cit. Coherent 2015a
[1823] Op. cit. Lumentum 2015a
[1824] Ibid.

Figure 32-2: Lead-based (left) and bismuth-based frit (right) after processing

Source: Lumentum[1825]

Lumentum[1826] says the potential of damage to the components, primarily the optics, restricts the processing temperatures. Because the optics utilize complex multilayer coatings (> 30 layers), the suppliers of the optics discourage the use of higher temperatures or longer processing times. The coating fabrication process only allows for stabilization of the key optical properties up to 500°C. Processing at temperatures above 500°C will cause failure of the coatings.

Lumentum[1827] concludes that bismuth oxide material is not considered a viable alternative at this time. The optics are not designed to be subjected to temperatures beyond 500°C. Testing of the bismuth oxide material even above the specified sealing times and temperatures did not provide the complete sealing needed.

Coherent[1828] as well considers bismuth- or phosphorous-based glasses as potential substitutes, which are, however, not sufficiently developed technically or commercially to be viable for Coherent; there is no experience or working history in industry with those materials and Coherentdoes not believe that such materials satisfy the exact technical requirements to form the window bonds. Coherent believes there are a

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[1825] Ibid.
[1826] Ibid.
[1827] Lumentum 2015b 2015 "Answers to clarification questionnaire, document "Exe_32_Questionnaire-1_JDSU_2015-08-31.pdf": Clarification questionnaire (questionnaire 1)," http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_32/JDSU/Exe_32_Questionnaire-1_JDSU_2015-08-31.pdf
[1828] Coherent 2015b "Answers to questionnaire 1, document "Coherent_Resp_August_2015_Exem_32_NC.pdf"," http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_32/Coherent/Coherent_Resp_August_2015_Exem_32_NC.pdf

number of fundamental unresolved difficulties with respect to the viability of lead-free alternatives for the fabrication of Brewster window assemblies: [1829]

- **Yield**

  The manufacturing process of the window bonds is multifaceted and complex. It has evolved incrementally over 40 years. There are extraordinarily stringent requirements for mechanical and optical performance. Despite Coherent's experience with the established process, current yields are only borderline acceptable. Any change to the established process will drive yield even lower. No lead-free frit exists that would allow Coherent to utilise its established processing envelope. Alternative frit materials have melting temperatures of 550°C. This is 125°C higher than the material used in the current processes with lead glass. These higher temperatures will place extreme stresses on both raw materials in the assembly, and the production tooling. A reduction in yield will severely compromise Coherent's ability to provide sufficient product for mission-critical applications in the semiconductor and microelectronics markets.

- **Performance**

  The performance of Coherent's plasma tubes are determined to a significant extent by their capability to resist optical degradation by vacuum ultraviolet (VUV) radiation emanating from the gas plasma. A proprietary optical coating on the vacuum side of the Brewster window confers this distinguishing characteristic. Deposition of this unique optical coating on the Brewster window occurs prior to fritting the window to the stem. The dimensions of the assembly and limitations of the coating process preclude the application of the coating after the window fritting process. Because of this process limitation, the coating must endure the high temperatures required to bring the frit to liquid state. The higher temperatures required by the lead-free material will compromise the integrity of this coating. Manifestations of this degradation are yield loss and premature field failure. Coherent is not aware of a coating that provides the required performance and confers resistance to the higher processing temperatures.

- **Usable lifetime**

  In highly accelerated testing, lead-free alternatives performed very poorly when compared to the currently used process. Figure 32-3 is illustrative of the significant differences Coherent encountered. The yellow data points represent the lead-free test. The blue line is the current process. (Due to the

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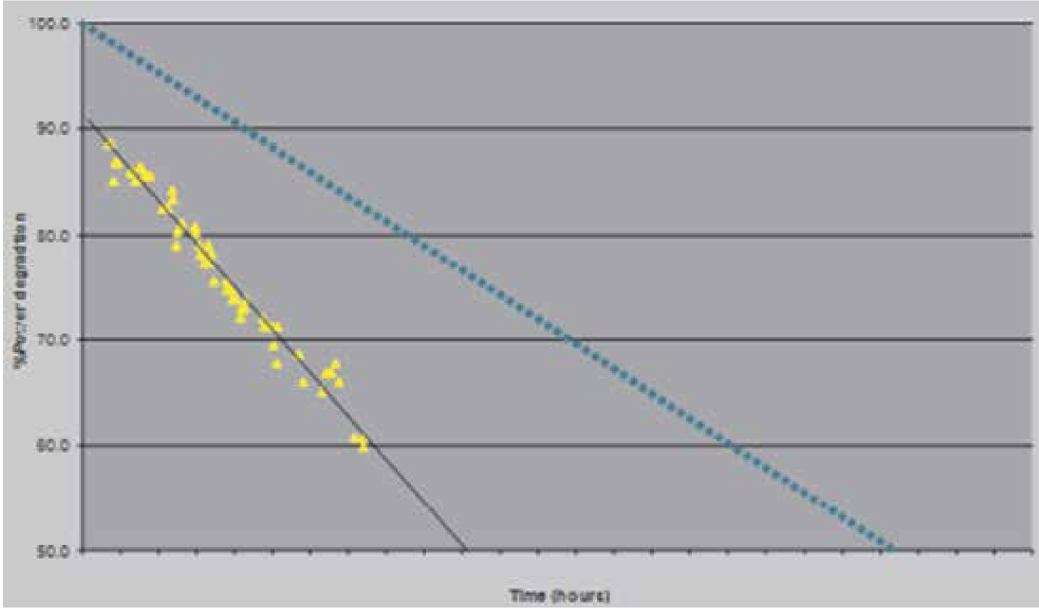
[1829] Coherent 2015b "Answers to questionnaire 1, document "Coherent_Resp_August_2015_Exem_32_NC.pdf","
http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_32/Coherent/Coherent_Resp_August_2015_Exem_32_NC.pdf

sensitive nature of the data, Coherent has removed the x-axis (hours) values). Coherent[1830] finds two things in the lead-free sample remarkable:

- there was an output power (usable light) reduction at the onset, and;
- it takes less than half the time to a 50 % drop in output.

The 10 % initial output loss notwithstanding, just a 10 % reduction in performance would be significant to Coherent's end-users. A 50 % reduction would be catastrophic. Coherent has neither a clear technology path nor a projected timetable that would allow to mitigate performance gaps of this magnitude.

Figure 32-3: Power degradation of lead-free plasma tubes (yellow) vs. historical average with lead (blue dotted line)



Source: Coherent[1831]

Coherent[1832] and Lumentum[1833] conclude that krypton and argon lasers cannot be manufactured without the use of lead oxide in seal frit of the window assembly, and without these lasers many applications would not be possible. That includes instruments used in healthcare and research like flow cytometers, DNA sequencers, haematology equipment as well as equipment for bioinstrumentation and semiconductor manufacturing.

[1830] Ibid.
[1831] Op. cit. Coherent 2015a
[1832] Ibid.
[1833] Op. cit. Lumentum 2015a

32.2.2 Elimination of Lead

Coherent[1834] explains that solid state laser technologies are replacing the argon and krypton type of lasers (ion lasers) that require the above requested exemption. New system shipments of such ion lasers have been in steady decline for five years. Ion lasers are, however, unique in that they generate a variety of wavelengths in the ultraviolet, visible and infrared regions of the electromagnetic spectrum. These lasers are capable of producing ultrapure spatial and temporal output. According to Coherent1835, the use of argon and krypton ion lasers will therefore persist only in those applications where their unique multi-wavelength performance is a necessity.

Lumentum[1836] adds that solid-state lasers are usually well suited for modern instrumentation designed specifically to accommodate their characteristic electrical and optical performance. For some applications, modern solid-state lasers do not provide the required optical characteristics necessary to achieve required results, e.g. specific wavelengths or groups of wavelengths combined with narrow linewidth. As an example, for some DNA sequencing and flow cytometry applications, three or more exotic (uncommon) wavelengths, often ultraviolet, are necessary. Solid-state sources may not be available for these wavelengths or are otherwise unreliable. Substituting solid-state sources for these applications would require several solid state lasers in place of a single gas laser and thus significantly increase the use of natural resources and the environmental impact of the equipment manufacturing in order to perform the same analyses with solid state lasers.

Coherent[1837] states that the use of ion lasers has been in steady and quite significant decline since well before the inception of RoHS. New installations of ion lasers came to a zenith in 2000, after which the markets for ion lasers collapsed rapidly and nearly completely. The applications declined, among others due to alternative laser technologies becoming available. Coherent[1838] thinks it is safe to say that ion lasers are in use today only in those applications that cannot apply a substitute, based on one or more of the following requirements:

- A specific, process-driven wavelength;
- Continuous wave radiation;
- Deep UV, 257 nm and less;
- Single longitudinal mode;
- Transverse mode quality that is not available in an alternative;
- Discrete tuning at a number of visible and/or UV wavelengths;
- Higher output power than is available with a substitute;

[1834] Op. cit. Coherent 2015a
[1835] Ibid.
[1836] Op. cit. Lumentum 2015b
[1837] Op. cit. Coherent 2015b
[1838] Ibid.

- Low output noise which is not available in an alternative;
- Known cost in an established market—in other words, the alternative is more than the market will bear; or
- A ‘copy-exactly’ process where the cost of risk retirement for any substitute would be prohibitive.

Coherent[1839] lists the following applications where, among others, ion lasers are still used due to the above described unique properties of ion lasers compared to alternatives (Coherent notes this is not a complete list):

- Photomask direct imaging;
- Flat panel display direct imaging;
- Photomask inspection;
- Patterned wafer inspection;
- Spectroscopy;
- Holography;
- Some types of computer-to-plate imaging;
- Some types of particle imaging velocimetry.

Coherent[1840] states there is no market growth today for ion lasers of any type. Many more ion lasers come out of service each year than go into service. The global market for ion lasers with an output of more than 500 mW is less than 75 per year, with nearly all of the demand in Asia. There is no market scenario, real or imagined, which will alter this trajectory. New installations in the EU are rare, and as is the case globally, many more ion lasers come out of service each year than are installed in the EU.

32.2.3 Environmental Arguments

Coherent[1841] claims that in the full calendar year 2014, ion lasers introduced less than 1 g of lead in all shipments to the EU, new devices or serviced devices, exempt, or non-exempt. The amount of new ion laser installations will continue to drop worldwide. Every year, the Pb mass shipped globally under Exemption 32 will decrease.

Coherent[1842] concludes that ion lasers make only a miniscule contribution to lead contamination, as the atmospheric Pb contamination in the EU already stood at around 1,200 tonnes/year in 2012, for industrial sources alone. Other sources such as transport, commercial, institutional, and household fuel combustion accounted for at least as much on top of that.[1843]

[1839] Ibid.
[1840] Ibid.
[1841] Ibid.
[1842] Ibid.
[1843] “Air Quality in Europe, 2014 Report”, EEA Report No5/2014, ESSN 1977-8499; source as referenced by Coherent

32.3 Roadmap for Substitution or Elimination of RoHS-Restricted Substance

32.4 Critical Review

32.4.1 REACH Compliance - Relation to the REACH Regulation

Appendix A.1.0 of this report lists various entries in the REACH Regulation annexes that restrict the use of lead in various articles and uses.

The exemption allows the use of lead.

Annex XIV contains several entries for lead compounds, whose use requires authorization:

- 10. Lead chromate
- 11. Lead sulfochromate
- 12. Lead chromate molybdate sulphate red

In the applications in the scope of the reviewed exemption, lead is used in electronic components that become parts of articles. None of the above listed substances is relevant for this case, neither as directly added substance nor as substance that can reasonably be assumed to be generated in the course of the manufacturing process.

Annex XVII bans the use of the following lead compounds:

- 16. Lead carbonates in paints
- 17. Lead sulphate in paints

Neither the substances nor the application are, however, relevant for the exemption in the scope of this review.

Appendix A.1.0 of this report lists Entry 28 and Entry 30 in Annex XVII of the REACH Regulation, stipulating that lead and its compounds shall not be placed on the market, or used, as substances, constituents of other substances, or in mixtures for supply to the general public. A prerequisite to granting the requested exemption would therefore be to establish whether the intended use of lead in this exemption request might weaken the environmental and health protection afforded by the REACH regulation.

In the consultants' understanding, the restrictions for substances under Entry 28 and Entry 30 of Annex XVII do not apply. The use of lead in this RoHS exemption in the consultants' point of view is not a supply of lead and its compounds as a substance, mixture or constituent of other mixtures to the general public. Lead is part of an article and as such, Entry 30 of Annex XVII of the REACH Regulation would not apply.

Entry 63 of Annex XVII stipulates that lead and its compounds

- shall not be placed on the market or used in any individual part of jewellery articles if the concentration of lead (expressed as metal) in such a part is equal to or greater than 0.05 % by weight. This restriction does not apply to internal components of watch timepieces inaccessible to consumers

- shall not be placed on the market or used in articles supplied to the general public, if the concentration of lead (expressed as metal) in those articles or accessible parts thereof is equal to or greater than 0.05 % by weight, and those articles or accessible parts thereof may, during normal or reasonably foreseeable conditions of use, be placed in the mouth by children. This restriction does, however, not apply to articles within the scope of Directive 2011/65/EU (RoHS 2)

The restrictions of lead and its compounds listed under Entry 63 thus do not apply to the applications in the scope of this RoHS exemption.

No other entries, relevant for the use of lead in the requested exemption could be identified in Annex XIV and Annex XVII (status February 2016). Based on the current status of Annexes XIV and XVII of the REACH Regulation, the requested exemption would not weaken the environmental and health protection afforded by the REACH Regulation. An exemption could therefore be granted if other criteria of Art. 5(1)(a) apply.

32.4.2 Environmental Arguments

The stakeholders' environmental arguments focus on the very small amounts of lead used under this exemption. Since the RoHS Directive does not specify minimum amounts of restricted substances as a criterion for an exemption, granting an exemption based on these environmental arguments would not be in line with RoHS Art. 5(1)(a).

32.4.3 Substitution and Elimination of Lead

The information submitted to the reviewers suggests that lead cannot be substituted in the seal frit used for making window assemblies for Argon and Krypton laser tubes. Solid state lasers can, however, replace krypton and argon lasers unless their unique characteristics are required. This would eliminate the use of lead. The applicants were therefore asked whether the scope of the exemption cannot be restricted to those applications where these ion lasers' unique properties are required so that solid state lasers cannot replace them.

Coherent[1844] answered that ion lasers are by their very nature the technology of last resort. They are most certainly powerful tools, but they are dinosaurs of the laser industry. They are bulky, inefficient at conversion of electrical energy to light output, and require dedicated infrastructure. Further, because they are relatively complex electro-optical devices, they typically require specialized training to install, maintain, and operate. That they remain in use today is a testament not only to their unique characteristics, and to the variety of performance improvements incorporated over four decades of use in science and industry, but more importantly, the lack of a complete suite of alternative technologies that sufficiently supplant the ion laser solution.

[1844] Ibid.

As a result, Coherent[1845] claims nobody buys an ion laser unless it is necessary. Ion lasers are massive, bulky, inefficient, and generally somewhat troublesome to operate relative to their solid-state alternatives. Moreover, they are expensive. The only customers for ion lasers today are those that require one or more of the unique attributes of the ion laser that are unavailable in a substitute, such as:[1846]

- One or more of the unique wavelengths that can only be obtained from Argon or Krypton plasma;
- The ability to tune between several of these unique wavelengths in a single laser platform;
- Continuous wave radiation;
- Many watts of output light;
- Spectral purity which cannot be matched by the alternative;
- Extreme coherence on the order of 10s of meters, which cannot be achieved by the alternative;
- Spatial characteristics of the output beam to deliver a nearly perfect circular beam cross-section, with a near perfect Gaussian distribution of intensity across the beam diameter (TEM_{00}, M_2<1.2);
- Extremely low output noise, typically <1%;
- Accessibility into the 351 to 413.1 nm range with multiple watts of output;
- Accessibility into the deep UV, specifically the wavelengths between 299nm and 257nm, that are provided by frequency-doubling of argon lasers;
- Proven longevity in commercial applications of more than 10,000 operating hours.

Lumentum[1847] confirms that due to the specific characteristics of ion lasers, it is unmanageable to replace them by solid state lasers where their characteristic properties are required. For example, most of diode laser-based products exhibit a linewidth that is substantially broader than a linewidth of a gas laser. Narrow linewidth is needed to achieve the required sensitivity of the equipment. Another example is the ability of one gas laser source to generate several specific wavelengths at the same time (i.e. 488 nm, 514 nm and 558 nm) critical for some applications. Equipment that requires a multi-line ion laser cannot be replaced with a single solid state laser. Several solid state lasers would be required to perform the same function.

[1845] Coherent Inc. 2016: “Stakeholder document "Letter to O_Deubzer02092016.pdf", received by Dr. Otmar Deubzer, Fraunhofer IZM, via e-mail from Paul Ginouves, Coherent Inc., on 10 February 2016” unpublished manuscript,

[1846] Ibid.

[1847] Lumentum 2016 “Answers to questionnaire 2, document "Exe_32_Questionnaire-2_Lumentum_2016-02-01.docx", received via e-mail by Dr. Otmar Deubzer, Fraunhofer IZM, from Gabriela Janusz-Renault, Lumentum Inc., on 13 February 2016”

According to Coherent[1848], some of the strongest incentives to choose any alternative to an ion laser are electrical and water consumption. The average mid-power ion laser consumes 25 kW and three gallons (around 11.4 liters) of water per minute for cooling. A high-output device consumes 50 kW and 6 gallons (around 22.7 liters) of cooling water per minute. Ion lasers are inefficient. They convert just 0.1 % of the incoming power to light. The rest is converted to waste heat. A solid-state alternative will be roughly two orders of magnitude more efficient.

Coherent states[1849] that with every passing year, there are more varied alternatives for ion lasers. In addition, every year, the sales of ion lasers decline as a result. The ion laser has become, by its very nature, the laser of last resort. The few remaining customers resign themselves to the purchase, knowing that they truly have no alternative, while hoping for a different solution in the future.

32.4.4 Conclusions

Solid state lasers can in principle replace ion lasers. The above information suggests that for economic and technological reasons, krypton and argon lasers are only used where their unique properties are required, whereas otherwise solid state lasers will be used.

Working out the characteristic features of ion lasers that require their use instead of solid state lasers would result in a complex exemption wording with more than 10 criteria due to the various unique properties of ion lasers, which may have to be further specified and quantified to clearly demarcate the application fields of ion lasers from those of solid state lasers.

In this situation, the reviewers recommend to renew exemption 32 without changes for another five years.

32.5 Recommendation

The information submitted by the stakeholders suggests that substitution of lead in exemption 32 is technically impracticable. While the elimination using solid state lasers instead of ion lasers is possible in some cases, the applicants plausibly explain that argon and krypton lasers for technical and economic reasons are only used where their unique properties are required so that solid state lasers cannot replace them. In this situation, RoHS Art. 5(1)(a) in the reviewers opinion justifies the renewal of the exemption.

The reviewers therefore recommend continuing the exemption for another five years with its current scope and wording:

[1848] Op. cit. (Coherent Inc. 2016)
[1849] Ibid.

Exemption n. 32	Expires on
Lead oxide in seal frit used for making window assemblies for Argon and Krypton laser tubes	*21 July 2021 for* · *EEE of categories 1-7 and 10* · *medical equipment in category 8, and* · *monitoring and control instruments in category 9 of Annex I*
	21 July 2023 for in vitro diagnostic medical devices in category 8 of Annex I
	21 July 2024 for industrial monitoring and control instruments in category 9 of Annex I

32.6 References Exemption 32

Coherent 2015a Request for continuation of exemption 32, document "BR-_9849983-v3-Coherent_Exemption_request_form_update_after_comments___PG_with_redaction.pdf". http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_32/Coherent/BR-_9849983-v3-Coherent_Exemption_request_form_update_after_comments___PG_with_redaction.pdf.

Coherent 2015b Answers to questionnaire 1, document "Coherent_Resp_August_2015_Exem_32_NC.pdf". http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_32/Coherent/Coherent_Resp_August_2015_Exem_32_NC.pdf.

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