JBCE answer to Questionnaire 1 (Clarification)

Exemption 1c of RoHS Annex IV

1st September, 2020

As an applicant, JBCE would like to answer the questions dated on 24th August.

Please kindly find our answers in the attached.

If you have any further questions, please do not hesitate to contact to us.

We are looking forward to continued contribution during the consultation phase of evaluation.

Yours sincerely,

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ABOUT JBCE

Founded in 1999, the Japan Business Council in Europe (JBCE) is a leading European organisation representing the interests of over 85 multinational companies of Japanese parentage active in Europe.

Our members operate across a wide range of sectors, including information and communication technology, electronics, chemicals, automotive, machinery, wholesale trade, precision instruments, pharmaceutical, railway, textiles and glass products.

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Questionnaire 1 (Clarification) Exemption 1(c) of RoHS Annex IV

Wording of requested exemption:

Lead, cadmium and mercury in infra-red light detectors

Requested validity period: *7 years*

1. Acronyms and Definitions

InGa	indium gallium arsenide
LiTaO	lithium tantalum oxide
MCT	mercury cadmium telluride
PbS	lead sulphide
PbSe	lead selenide
TGS	triglycine sulfide

2. Background

Bio Innovation Service, UNITAR and Fraunhofer IZM have been appointed[1] by the European Commission through for the evaluation of applications for the review of requests for new exemptions and the renewal of exemptions currently listed in Annexes III and IV of the RoHS Directive 2011/65/EU.

Company JBCE has submitted a request for the renewal of the above-mentioned exemption, which has been subject to a first review. As a result we have identified that there is some information missing. Against this background the questions below are intended to clarify some aspects concerning the request at hand.

We ask you to kindly answer the below questions until September 1st 2020 latest.

3. Questions

1. You mention PbS and PbSe as lead constituents, as well as PZT.

   a. Are PbS and PbSe constituents of ceramics so that they would be covered by exemption 7(c)-I as well?

      PbS and PbSe are compound semiconductors[2].

[1] It is implemented through the specific contract 070201/2020/832829/ENV.B.3 under the Framework contract ENV.B.3/FRA/2019/0017

[2] Source: Opto-semiconductor Handbook Chapter 06 Compound semiconductor photosensors (Hamamatsu Photonics K.K.) https://www.hamamatsu.com/resources/pdf/ssd/e06_handbook_compound_semiconductor.pdf

b. PZT is a ceramic, the use of lead in the sensors therefore is covered by exemption 7(c)-1 of Annex III. Is this correct?

PZT is ceramic and the same material of exemption 7(c)-1 of Annex III.

c. We propose to exclude these forms of lead from the scope of this exemption to avoid overlapping scopes. Would you agree to this?

No. The exemption for infrared detectors is applied for measurement and analysis instruments of category 9, monitoring and control instruments. Table 50, the page 168 of "Review of Directive 2002/95/EC (RoHS) Categories 8 and 9 - Final Report" lists PbS, PbSe and PZT as materials of infrared detectors[3]. According to the description, PbS, PbSe and PZT shall be listed in 1c of Annex IV.

The feedback in Better Regulation in December, 2016 was that the numbering scheme of exemptions shall maintain consistency as far as possible to aid implementation[4]. The Official Journal was issued with reflecting the thought of the feedback in June, 2017[5]. Taking into the consideration on the event, we strongly believe that Infrared detectors mentioned in Final Report issued by European Commission shall be listed in Annex IV to maintain consistency as far as possible and to aid implementation.

2. About the graph 2 and the table 1,

a. why the MCT detectors can have different spectral responses (1-14; 1-17 and 1-25µm) and different detectivity at the same temperature (77K)?

The composition ratio of HgTe to CdTe decides the band gap of HgCdTe crystals. The production of infrared detectors having the maximum sensitivity at various wavelength is possible by changing the composition ratio.[6]

b. Why is it not the case for other quantum type detectors?

MCT is a mixed crystal semiconductor, and the composition ratio of HgTe to CdTe decides the band gap of HgCdTe crystals. The production of infrared detectors having the maximum sensitivity at various wavelength is possible by changing the composition ratio. There might be other variable band gap semiconductors that potentially can replace HgCdTe. However, those detectors with different band gaps are very limited available.

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[3] https://ec.europa.eu/environment/waste/weee/pdf/era_study_final_report.pdf

[4] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1005-Amendment-of-point-9-b-of-Annex-III-to-Directive-2011-65-EU-RoHS-/F943

[5] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32017L1010

[6] Source: Technical Information / Infrared detectors (Hamamatsu Photonics K.K.) P24 https://www.hamamatsu.com/resources/pdf/ssd/infrared_kird9001e.pdf

3. You present the below figure in your exemption request. You also state, that e.g. InGaAs detectors would require cooling to achieve the necessary detectivity. In the below table, there are hardly any detectors that work at room temperature, or their properties at room temperature are not included in the below figure. Even with cooling they are positioned in the lower detectivity range. Can you explain why the detectors requiring exemption 1(c) of Annex IV are superior in the light of the below table?

We did not mention that InGaAs requires cooling in in the page 18 of our exemption renewal request. We mentioned that “InAs” detectors would require cooling to achieve the necessary detectivity. Please kindly refer to the "PbS and PbSe" Paragraph of application Form 6 (A) in our application.

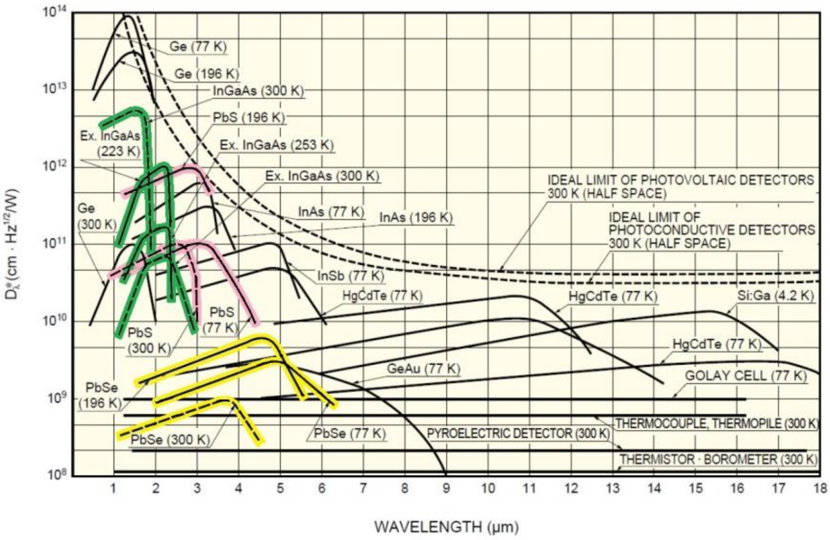
InAs and InGaAs are discussed as alternatives to PbS and PbSe in the in the page 18 to 19 in our application.

We explain the reason why we cannot choose InAs detectors as below.

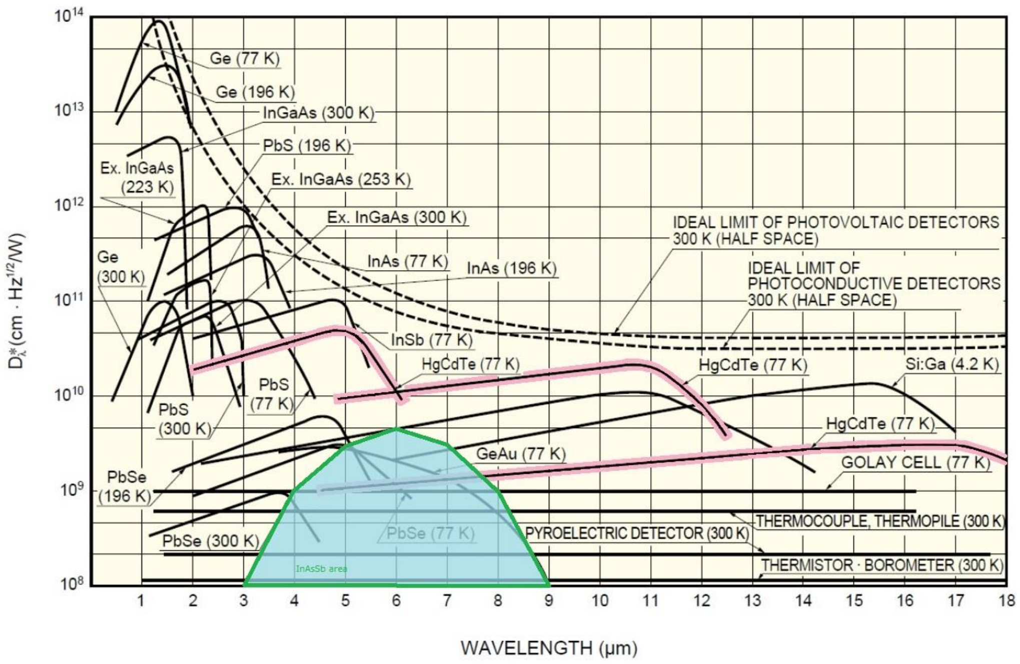
“…since the signal to noise ratio (S/N ratio) which is a measure of the useful signal produced, decreases at room temperature, this device cannot measure light accurately and cannot obtain the same sensitivity as PbS.”

We also mentioned that “InGaAs, offers higher sensitivity and S/N ratio, however it cannot provide the desired measurable wavelength range as PbS or PbSe due to limitations in the substances inherent properties” in the page 19 in our application.

For clarification about the near- and mid-infrared range with wavelengths below 8 µm in this figure, we colored by detector material (PbS: Pink, PbSe: Yellow, InGaAs: Green), and we changed line by operating temperature (Super low temperature: Solid line, Room temperature: Dotted line). The detectors marked with colors of pink, yellow and green have higher detectivity and wider wavelength range with nitrogen cooling than that with electron cooling. PbS and PbSe covers a wide wavelength range at room temperature.



The quantum type detector other than the MCT detectors with pink in the table below cannot cover the wavelength range and detectivity of the long wavelength range of 8 µm or more. For your better comparison, we added the range of the wavelength and the detectivity of InAsSb detector with green in the graph below.



4. In figure 2 of your request, you present the lead-, cadmium- and mercury-free LiTaO and TGS detectors together with PZT detectors as thermal type pyroelectric detectors. While you list the properties of various materials for quantum type detectors in table 1 of your exemption request, this comparison is missing for the different pyroelectric materials.

   a. Could you please complete table 1 with the properties of PZT, LiTaO and TGS?

	Detector	Spectral response (μm) Typ.	Operating temperature (K) / (℃) Typ.	Detectivity D* (cm • Hz$^{1/2}$ /W) Typ.
Thermal Type	**PZT**	1-20 *1	300/27	3.2×10^{8}
	TGS	1-20 *1	300/27	1.1×10^{9} *4
	$LiTaO_3$	1-20 *1	300/27	2.0×10^{8} *5
	PbS	1-2.8	298/25	5.0×10^{10}
	PbS	1-3.2	263/-10	1.0×10^{11}
	PbSe	1-4.8	298/25	2.5×10^{9}
	PbSe	1-5.1	263/-10	5.0×10^{9}
	MCT (PC)*2	1-14	77/-196	4.0×10^{10}

Quantum Type	**MCT (PC)*2**	1-17	77/-196	1.3×10^{10}	*1
	MCT (PC)*2	1-25	77/-196	1.0×10^{10}	
	MCT (PV)*3	1-13.5	77/-196	3.0×10^{10}	
	Type-II superlattice infrared detector	?-14.3	77/-196	1.6×10^{10}	
	InAsSb	2-6	243/-30	5.0×10^{9}	
	InAsSb	2-5.9	77/-196	8.0×10^{10}	
	InAs	1-3.5	298/25	4.0×10^{9}	
	InAs	1-3.5	263/-10	1.8×10^{10}	
	InGaAs	0.7-1.7	300/27	5.0×10^{12}	
	Ex InGaAs	1.2-2.55	253/-20	2.0×10^{11}	

Thermal types have little peaks of wavelengths.
Window materials are chosen according to the wavelengths required.
*2 PC : Photoconductive detector
*3 PV : Photovoltaic detector
*4 The source of data from Table1 of YAMAKA Eiso, 1972, "Recent Development of Pyroelectric Infrared Detector", in 41(6), 640-642 of Oyo Buturi [7]
*5 The source of data from a company of JBCE members

Source: Technical Information / Infrared detectors (Hamamatsu Photonics K.K.)[8]

b. It seems that both LiTaO and TGS infrared detectors are already used. Can they not replace the PZT-based ones?

No. We explain the reasons in "PZT" in 6(A), the page 19 in our application.

c. You state in your exemption request that "The development of substitute detectors is on the way [...]". Could you please specify this and provide more details about the approaches and their current status?

We explain the result of making an effort to find candidate alternative materials of PZT of infrared detectors for gas/liquid analyzers in "PZT" in 6(A), the page 19 in our application. Even though we have been continuing to strive for finding suitable performance alternatives, we have not found any suitable ones for gas/liquid analysers.

Please note that answers to these questions will be published as part of the evaluation of this request. If your answers contain confidential information,

[7] https://www.jstage.jst.go.jp/article/oubutsu1932/41/6/41_6_640/_article/-char/ja
[8] https://www.hamamatsu.com/resources/pdf/ssd/infrared_kird9001e.pdf

please provide a version that can be made public along with a confidential version, in which proprietary information is clearly marked.