1st Questionnaire Exemption Request Pyreos Ltd.

Exemption for „*Lead in thin film electronic sensor elements such as pyroelectric sensors or piezoelectric sensors*“

Document for Publication

Background

The Oeko-Institut and Fraunhofer IZM have been appointed within a framework contract[1] for the evaluation of an application for granting an exemption to be included in or deleted from Annexes III and IV of the new RoHS Directive 2011/65/EU (RoHS 2) by the European Commission.[1]

Pyreos has submitted the above-mentioned request for exemption, which has been subject to a first evaluation. As a result we have identified that there is some information missing and ask you a few questions to clarify concerning your request before we can start the online consultation.

Please answer the questions until 13 April 2015 latest, or otherwise let us know until when you can provide the answers.

Questions

1. It is not quite clear which of your submissions are confidential and which are public. Please let us know which of the documents you submitted can be published in the online consultation.
   Pyreos answer: the PDF-document with the Title “*RoHS_V_Application_Form-Pyreos_final 14112014 - publication.pdf*” submitted as part of the application is designated for publication.

2. Your thin film pyroelectric materials consist of PZT like piezoelectric ceramics. Exemption 7c-I in RoHS Annex III allows the use of lead in such ceramics including piezoelectric ceramics, as well as in glass and glass-ceramic matrix compounds in electrical and electronic components. You request, however, a new exemption. Please explain why you consider exemption 7c-I not to cover your use of lead in the sensors?
   Pyreos answer: Our primary request is for a new exemption as the quantity of lead and the technology used for thin film sensors as defined in our application and our answers below to question 4 and 5 is fundamentally different from the conventional technology covered by the existing exemption.

   We will however be willing to consider revising the scope of our application in support of an amendment of the existing exemption to include an explicit reference to pyroelectric

[1] Contract is implemented through Framework Contract No. ENV.C.2/FRA/2011/0020 led by Eunomia

applications. However as the primary option we prefer to include a new exemption specific to the thin film sensor technology due to the differences between the thin film sensors and the conventional technology in this field.

3. You present a table in your exemption request showing the various piezo-/pyroelectric properties of PZT-based and other materials. Please shortly explain the meaning of the various parameters.

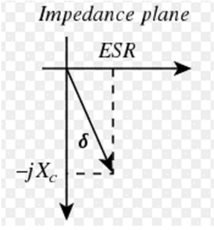
Pyreos answer: The parameter $\varepsilon/\varepsilon_0$ describes the relative permittivity of the sensor material with ε_0 being the permittivity of the vacuum which is by definition 1. The parameter ε describes the permittivity of the material system used in the pyro elecrtic sensors.
For more detailed information please see http://en.wikipedia.org/wiki/Relative_permittivity

http://www.physicshandbook.com/topic/topicr/relativep.htm

Tan δ in this context describes the dissipation of electrical potential energy. Electrical potential energy is dissipated in all dielectric materials, usually in the form of heat. In a capacitor made of a dielectric placed between conductors, the typical lumped element model includes a lossless ideal capacitor in series with a resistor termed the equivalent series resistance (ESR) as shown below.[1] The ESR represents losses in the capacitor. In a good capacitor the ESR is very small, and in a poor capacitor the ESR is large.

When representing the electrical circuit parameters as vectors in a complex plane, known as phasors, a capacitor's dissipation factor is equal to the tangent of the angle between the capacitor's impedance vector and the negative reactive axis, as shown in the diagram to the right. This gives rise to the parameter known as the loss tangent δ where

$$\tan\delta = \frac{\mathrm{ESR}}{|X_c|} = \mathrm{DF}$$



Since the DF in a good capacitor is usually small, δ ~ DF, and DF is often expressed as a percentage. DF approximates to the power factor when ESR is far less than X_c, which is usually the case. DF will vary depending on the dielectric material and the frequency of the electrical signals. In low dielectric constant (low-k), temperature compensating ceramics, DF of 0.1% to 0.2% is typical. In high dielectric constant ceramics, DF can be 1% to 2%. However, lower DF is usually an indication of quality capacitors when comparing similar dielectric material.

The parameter p is called the pyro coefficient. The pyroelectric coefficient may be described as the change in the spontaneous polarization vector with temperature:[12]

$$p_i = \frac{\partial P_{S,i}}{\partial T}$$

where p_i ($Cm^{-2}K^{-1}$) is the vector for the pyroelectric coefficient.

Ultimately it is a measure of the conversion efficiency of the sensor material to convert infrared radiative power into electrical power.

4. You claim that less than 1 g of lead only would be used under this exemption. Please substantiate this figure with a calculation showing how you arrive at this figure.

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5. Lead-free pyroelectric sensors are all single crystal based, such as lithium tantalate. You state that these types of materials are very expensive and therefore are not viable. Are there any technical reasons why they cannot be applied, taking into account that possible performance differences could be compensated electronically or by design changes in the devices where these sensors are applied?

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6. There seem to be other producers of such sensors using lead-free materials. What are your main competitors producing such sensors?
   The main competitors for pyro-electric sensors for lead free sensors using Lithium Tantalate are:
   Infratec,
   Excelitis,
   Panasonic
   Murata.

   To my knowledge there are no other lead free pyrosensors currently commercially available.

Please note that answers to these questions are to be published as part of the available information relevant for the stakeholder consultation to be carried out as part of the evaluation of this request. If your answers contain confidential information, please provide a version that can be made public along with a confidential version, in which proprietary information is clearly marked.

Pyreos answer: The answers provided to question 4 and 5 are confidential.