Comments related to the general and specific questionnaires of exemption 7.c

Japan Business Council in Europe

We expressly state the comments mainly concerning the necessity of continued application of exemptions and the difficulty of substitution for the consultation of RoHS exemption 7.c.

In this document, ceramics applied in electric and electronic equipment and parts are roughly grouped into “piezoelectric (pyroelectric)”, “semiconductor”, “dielectric”, and we explains our comments related to the questionnaires of exemption 7.c.

A. Piezoelectric ceramics
B. Semiconductor (PTC) ceramics
 (Abbreviation for Positive Temperature Coefficient.
 Characteristic in which resistance increases as the temperature rises)
C. Dielectric ceramics

General Questionnaire

1. For which substance(s) or compound(s) should the requested exemption be valid?

 Lead in electronic ceramic parts.

2. What is the application in which the substance/compound is used for and what is its specific technical function?

 Refer to the attached excel file.

3. What is the specific (technical) function of the substance/compound in this application?

 Refer to the attached excel file.

4. Please justify why this application falls under the scope of the RoHS Directive (e.g. is it a finished product?

 Refer to the attached excel file.

5. What is the amount (in absolute number and in percentage by weight) of the substance/compound in: i) the homogeneous material, ii) the application, and iii) total EU annually for RoHS relevant applications?

 Refer to the attached excel file.

6. Please check and justify why the application you request an exemption for does not overlap with already existing exemptions respectively does not overlap with exemption requests covered by previous consultations.

 Not applicable – this is only for new exemption requests

7. Please provide an unambiguous wording for the (requested) exemption.

 Lead in electronic ceramic parts.

8. Please justify your contribution according to Article 5 (1) (b) RoHS Directive whereas:

8-1. Substitution of concerned hazardous substances via materials and components not containing these or elimination or substitution of concerned hazardous substances via design changes is technically or scientifically either practicable or impracticable;

A. Piezoelectric ceramics

It is technically and scientifically impracticable.

The relationship between Curie temperature and the constant of piezoelectric material is important in applying the piezoelectric effect. An example of the piezoelectric material constant is found below.

Piezoelectric Strain Coefficient (d constant)	: If the value is high, it can generate displacement efficiently from a low electric field. Also, it makes the output larger for sensors and it can be used as good sensor material with high sensitivity
Electro Mechanical Coupling Coefficient	Coefficient to show the efficiency to transform and communicate electric alteration into the energy of mechanical alteration (or vice versa) due to the piezoelectric effect. In order to gain filter characteristics, materials with high values in this category are essential.
Mechanical Quality Factor	Coefficient to show the extent of mechanical loss near frequencies where the piezoelectric substance resonates. In resonators and oscillators, as the value becomes higher, the oscillator becomes more efficient and the fluctuation in the resonance frequency decreases.

We also find a piezoelectric effect in Barium titanate, although it lacks the characteristics of the piezoelectric material constant, applied in actuators, sensors, oscillators, filters and transformers etc. As a result we obtain the intended piezoelectric effect by incorporating lead into the crystal structure of ceramics to change the characteristics and by obtaining high performance coefficient of piezoelectric materials such as Curie temperature etc

As mentioned above, the piezoelectric material constant required for piezoelectric ceramic is the minimum required characteristic for application in electrical products application. This means that if this ceramic feature is not obtained, the application is not valid (example: it does not function as a filter or actuator). As it is not valid as application of piezoelectric ceramics, it does not make sense to lower the values of required specifications or standards.

We understand that some materials showing piezoelectric characteristics, such as bismuth/sodium titanates etc., have been proposed as substitute materials. However, even if these features of these ceramics are obtained on a mass-production scale, they can only be substituted in limited piezoelectric applications. Besides, according to the currently released report, the mass-production technology is not established and how to maintain the scheduled piezoelectric effect stably remains to be worked out.

B. Semiconductor (PTC) ceramics

It is technically and scientifically impracticable.

Intermediate functions which are not non-conductive like insulators but do not conduct electricity without resistance like conductors are called “semi-conductors“. Thermistor is a “temperature-sensitive resistor” which is achieved by applying the ceramics with those characteristics. A thermistor has the feature to increase or decrease resistance in response to slight changes in temperature.

PTC ceramics is a kind of thermistor with the characteristic of increasing resistance as temperature becomes higher. Adding small amounts of metallic oxide to Barium titanate generates various characteristics, which is applied as the element to control the relationship between temperature and resistance.

Thermistors using PTC ceramics can be widely applied in electric and electronic control circuits such as temperature control heater, overcurrent protection, thermosensors, and motor activation assistance, and are widely adopted in electric and electronic control circuits. In addition, they are used as overcurrent protection and current control in electronic circuits to limit a current to fixed value or higher by using the characteristic to dramatically increase resistance and curb current when electrical current is passed through PTC ceramics for heating to reach a certain temperature (Curie temperature). Because of following advantages; small size, high speed of response, a control circuit or relay contact is not required, and repeated usable ones unlike fuse, they are applied in overcurrent protector and current control elements which can save the space and replacement parts are not required.

Overcurrent protector is used in electronic equipment and it limits the overcurrent and protects circuit only in the case of abnormal circumstances. Temperature in electronic equipment is higher than ambient temperature and reaches up to 100 centigrade in general ones, and up to 85 centigrade in lighting equipment, for instance. PTC ceramics cannot be used as overcurrent protector on practical use when the ambient temperature becomes near Curie temperature, because resistance increases rapidly in that case. Therefore, Curie temperature should be higher than the ambient temperature by 30 centigrade or more. In addition, higher Curie temperature is needed in order to obtain an equal permissible current with miniaturized parts.

In fact, Curie temperature of overcurrent protector in whole electronic equipment should be 130 centigrade or higher.

The Curie temperature of the basic material of Barium titanate is around 120 centigrade. Lead raises this Curie temperature and is used as the metal oxide to ensure more than 130 centigrade which is current practical temperature (such metal oxides are called shifters).

In the use for PTC thermistor for overcurrent protector, solid solution of Barium titanate and lead titanate by substituting some of the Barium atoms of Barium titanate to lead, enables to raise the Curie temperature and realizes high-temperature operations.

But the solid-solution ceramics of Barium titanate and lead titanate is the only mass-produced material which can raise the Curie temperature of Barium titanate. Other than lead, there is no shifter which ensures mass-production and reliability available.

If the Curie temperature can be 120 centigrade or below, it can be produced by adding strontium to Barium titanate. However, the product life and withstand voltage is poorer than using lead and there are problems to be solved before practical application. Also, considering the time required for product development, assessment and substitution after completion of the material, it may require several years and is unlikely to be completed by 2012 when the next review is due to be held.

For a substitute material in case the Curie temperature of more than 130 centigrade is required as overcurrent protector, research and development of solid solution material of natrium and bismuth and Barium titanate is advocated. However, as the reliability and the mass-production technology is not ensured and there is no prospect of mass-produced supply of workable substitute material, the completion of substitution within several years is not in sight. Thus, the exemptions should continue at least until the next review of the exemptions.

PTC ceramics for overcurrent protector can be partially substituted by another methods, however, all of ones cannot be. For example, electronic parts which have overcurrent protection function are fuse, circuit breaker (Molded Case Circuit Breaker), and PTC element made of the resin. In the case of fuse, the overcurrent protection is a limit once, and it cannot be used more than once. Therefore, the loss accompanied by production and disposition will be increased. Moreover, circuit breaker can be used repeatedly, but electric and electronics equipments which use it will be limited because of problems such as size and noise. On the other hand, PTC element made of the resin can be used repeatedly, however, resistance increases at each use. Therefore, it is limited to the usage in which the number of use is limited.

C. Dielectric ceramics

It is technically and scientifically impracticable. But it will be practicable only for low voltage capacitors.

Most of electronic components applying dielectric ceramics do not contain lead any more. Some electronic components use lead-containing dielectric ceramics; however, there are potential substitutes for them. It is expected that the substitution can be promoted by appropriately setting the timing for development, evaluation and substitution of application.

However, even for dielectric ceramics including lead there are no material substitutes for high-voltage capacitors used with voltages exceeding 125 V AC or 250V DC. Some people have proposed the use of Barium titanate as a potential substitute material. However, it has the characteristic of being likely to distort when voltage is imposed and the lack of strength is a concern in the application of electronic components which are used under high voltage.

In order to obtain the function to withstand high voltage and to accumulate a large amount of electricity, a material which loses a small amount of accumulated electricity is required. Strontium titanate is appropriate for this. However, strontium titanate has a poor ability to accumulate electricity at room temperature. Thus, we ensure the ability to accumulate electricity containing the accumulated electric loss by adding lead as a shifter.

For high voltage capacitors using voltage exceeding 125 V AC or 250V DC, there is no prospect at present for substitution. Same degree of functionality cannot be assured for capacitors composed of dielectric materials other than ceramics either. The function of high voltage capacitors is guaranteed in safety standards and if we push for substitution, it is possible that functions to be guaranteed in safety standards will not guaranteed.

8-2. Negative environmental, health and/or consumer safety impacts caused by substitution are either likely or unlikely to outweigh environmental, health and/or consumer safety benefits thereof (If existing, please refer to relevant studies on negative or positive impacts caused by substitution).

１） Environmental load associated with manufacturing and refinement

We have found a report quantifying the environmental load of various metals with an index of “Total Materials Requirement (TMR)” produced by the Eco Material Center of the National Institute for Material Science.

Total Materials Requirement （TMR）: Total amount of global resources involved in production

“Efficient use of resources and influence on environment during the entire lifetime of the substance and material cycle”

http://www.lifecycle.jp/manual/coefficient_of_resources.pdf（P26）

According this report, bismuth and niobium indicated as a substitute material for lead are estimated to have a larger environmental load due to their scarcity.

Comparison of TMR

lead	95	(comparative criterion)
bismuth	150,000	(approximately 1500 times)
niobium	1,400	(approximately 14 times)

Also, as bismuth is obtained as a by-product of lead ore, if bismuth is to be obtained, lead is always produced. If it is not used, a corresponding amount of energy is required to dispose it.

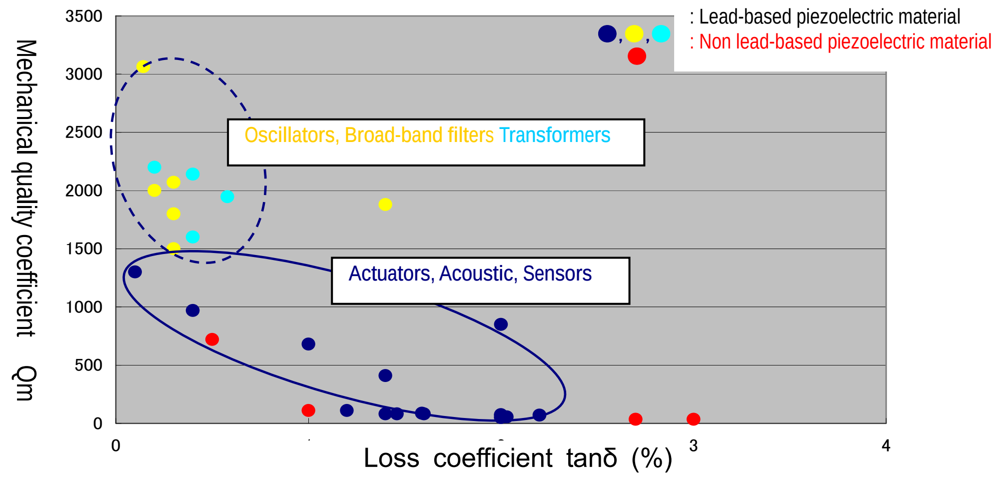
２） Environmental load associated with usage

A. Piezoelectric ceramics

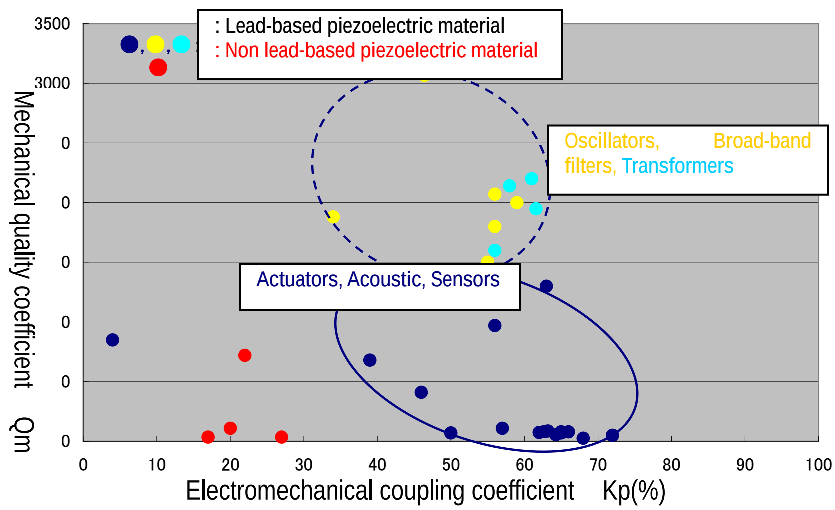
- Piezoelectric transformers

Based on the principle of piezoelectric transformers, the mechanical vibration is the resonance and it generates heat in parts which are joined. The heat alters the electric characteristics such as dielectric constant increasing the energy loss. Therefore, it is necessary that the mechanical quality coefficient (Qm) is high, that dielectic loss is small (tan δ), and that the electromechanical coupling coefficient (kp) is large for the material. If Qm is high, the deterioration of vibration becomes small and if tan δ is small, the thermal loss of electric energy is restrained and if kp is large, the conversion efficiency of electric energy and mechanical vibration energy becomes large, decreasing energy loss.

If we compare the characteristic value of Qm and tan δ for non lead-based material and lead-based material (conventional products), in non lead-based material the Qm is smaller and the tan δ is larger than conventional products as shown in 8-2-figure 1. If it is used as a piezoelectric transformer, the generated heat is larger than conventional products with larger deterioration of characteristics and energy loss. Also, 8-2-figure 2 shows the comparison result of Qm and kp. As mentioned previously, non lead-based material has a larger deviation than current material and in order to obtain similar characteristics, larger energy will be needed which increases the environmental load as a result.



8-2-Figure 1 Technology map of piezoelectric ceramics from the aspect of tanδ and Qm



8-2-Figure 2 Technology map of piezoelectric ceramics from the aspect of Kp and Qm

- Power saving liquid crystal backlight inverter adopting piezoelectric transformers
Introduction of report by Ricoh Keiki Co., Ltd.
(Ricoh Technical Report No.31 ; Dec. 2005)

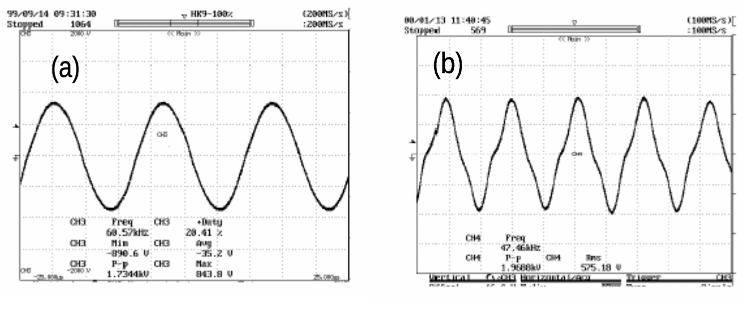
In order to ensure the reduction of size and weight and energy-saving (high-efficiency) which are always required of power sources installed in electric and electronics equipments, efforts have been made in the development of power sources. However, the existing power source circuit technology using wire-wound transformers (electromagnetic transformer) has reached its peak. Thus, a new “piezoelectric transformer“power device has been studied, and its driving and control method has been devised. A new power source technology using piezoelectric transformers has been built and put into commercial realization as a liquid crystal backlight inverter.

A comparison of piezoelectric inverters and wire-wound inverters is found in 8-2-Table 1 and 8-2-Figure 5. The piezoelectric inverter is a compact high-efficient optimal inverter.

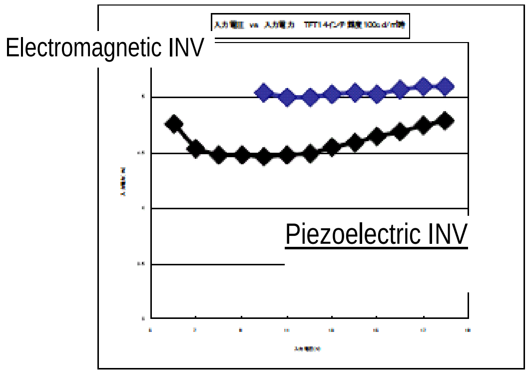
As piezoelectric transformer technology can be applied to high voltage power supplies used for copy machines and printers, fire-proof high voltage power supply with the size of less than half and the power consumption of less than half of the current power supply, which do not generate electromagnetic noise, and the wiring of high voltage electric power lines, is being developed based on these results.

8-2-Table 1 Comparison of piezoelectric inverter and wire-wound(electro-magnetic) inverter

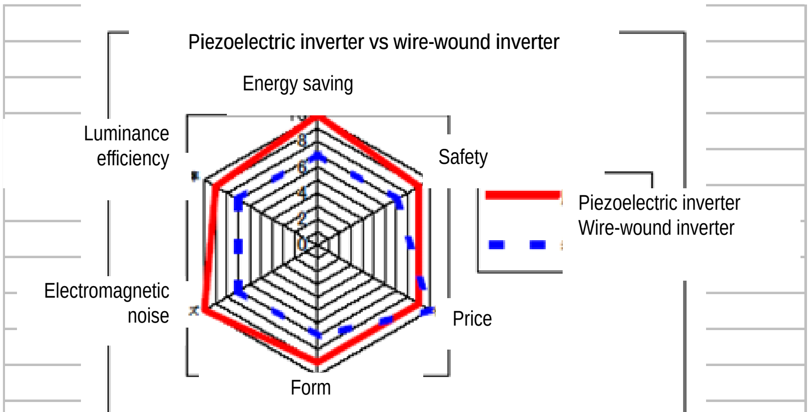
Item		Piezoelectric inverter	Wire-wound inverter
1	Volume	W13×L130×H5mm 8450 mm2	W19×L140×H10mm 26600mm2
2	Driving efficiency	90%	78%
3	Output waveform	Sine wave (8-2-Figure 3(a))	Triangle wave (8-2-Figure 3(b))
4	Output of identical luminance	Reduction of approximately 10% (8-2-Figure 4)	±0



8-2-Figure 3 Output waveform of inverters
(a) Piezoelectric INV, (b) Electromagnetic INV



8-2-Figure 4 Relationship of input electricity and output voltage
(TFT14inch luminance 100cd/m2 h)



8-2 Figure 5 Comprehensive evaluation of characteristics

B**.** Semiconductor (PTC) ceramics

-Overcurrent protector

Fuse is disposed at each overcurrent because it is not possible to use it more than once, and waste is generated. Therefore, more resources and energy will be needed for production and disposition. There are limitations also in the miniaturization, and it is very difficult to build it in small electronic equipment.

Overcurrent protection by circuit combined with semiconductors and relays is also possible, however, and parts number will be increased. Therefore, more resources and energy will be needed for production and disposition. Moreover, there is generation of the noise in the relay and the circuit breaker, and risk of glitch of electronic equipment will rise, too.

The loss accompanied by production and disposition will be increased. Moreover, circuit breaker can be used repeatedly, but electric and electronics equipments which use it will be limited because of problems such as size and noise. On the other hand, PTC element made of the resin can be used repeatedly, however, resistance increases at each use. Therefore, it is limited to the usage in which the number of use is limited.

C. Dielectric ceramics

Barium titanate, which is normally used as a material for ceramic capacitors, is available as a non-lead dielectric ceramic. However, the loss is dozens of times larger than the current lead-containing ceramics and becomes unstable at generating high heat when high voltage is imposed. Since barium titanate has the tendency to get distorted when voltage is imposed (electrostrictive strain property), it generates mechanical breakdown when high voltage impact is added and cannot be used.

Strontium titanate is available as a non-lead dielectric ceramic without electrostrictive strain property with a small amount of loss. However, the dielectric constant is as small as one twelfth of the current lead-based material. Thus it becomes as large as ten times the current size if we are to make a high-voltage capacitor with it.（8-2-Tabel 2）

As mentioned above, non lead-based materials are not practical because we cannot impose high-voltage or the size becomes too large from the point of characteristics such as heat and damage. This means that the realization of current applications becomes impossible and the environmental load will be large as a result.

8-2-Table2: Comparison of material for high-voltage capacitors

	Relative permittivity	Dielectric loss (%)	DC breakdown voltage (kV/mm)	AC breakdown voltage (kV/mm)	Impulse breakdown voltage (kV/mm)
Current lead-based materials	2700	0.04	15.3	8.0	8.0
Barium titanate-based materials	3000	0.80	11.8	6.7	6.0
Strontium titanate	200				
Notes	Bigger is better	Smaller is better	Bigger is better	Bigger is better	Bigger is better

As shown in 1) and 2), we should not discuss focusing on the harmfulness of lead but find a measure which is friendly to environment and has a lower impact on the environment.

9. Please provide sound data/evidence on why substitution / elimination is either practicable or impracticable (e.g. what research has been done, what was the outcome, is there a timeline for possible substitutes, why is the substance and its function in the application indispensable or not, is there available economic data on the possible substitutes, where relevant, etc.).

A. Piezoelectric ceramics

(1) and (2) below are required of piezoelectric ceramics applied in electric and electronic equipment and parts.

(1) Securing of function （piezoelectric constant and dielectric constant etc）
(2) Securing of reliability (heat-resistance and environmental resistance etc)

Here we examined the relationship between the piezoelectric distortion constant d33 (hereinafter referred to as d constant for short) and the Curie temperature (hereinafter referred to as Tc for short) which is the index of heat resistance of lead-based currently commercially-available piezoelectric ceramics and non lead-based piezoelectric ceramics（Refer to 9- Figure 1）
As we described in 8-2-2), in the case of high power applications such as piezoelectric transformers and ultrasonic oscillators, with Kp equal or above 60 in order to restrain electrostatic capacity change by heat generation of the device itself, as the use within a small temperature change range is required, Tc of 250 centigrade or more becomes necessary. Moreover, for applications such as sound components, actuators, sensors, etc., for d constant equal or above 400～600pm/V, considering long term use, Tc equal or above 150centigrade is necessary.

〔d constant number required for in electric and electronic equipment and parts〕

Acoustic components, actuators, sensors	: 400～600pm/V or above (It depends on the application.)
Filters	: 100 pm/V～400pm/V
Resonators	: 100pm/V～200pm/V

〔Tc required for in electric and electronic equipment and parts〕

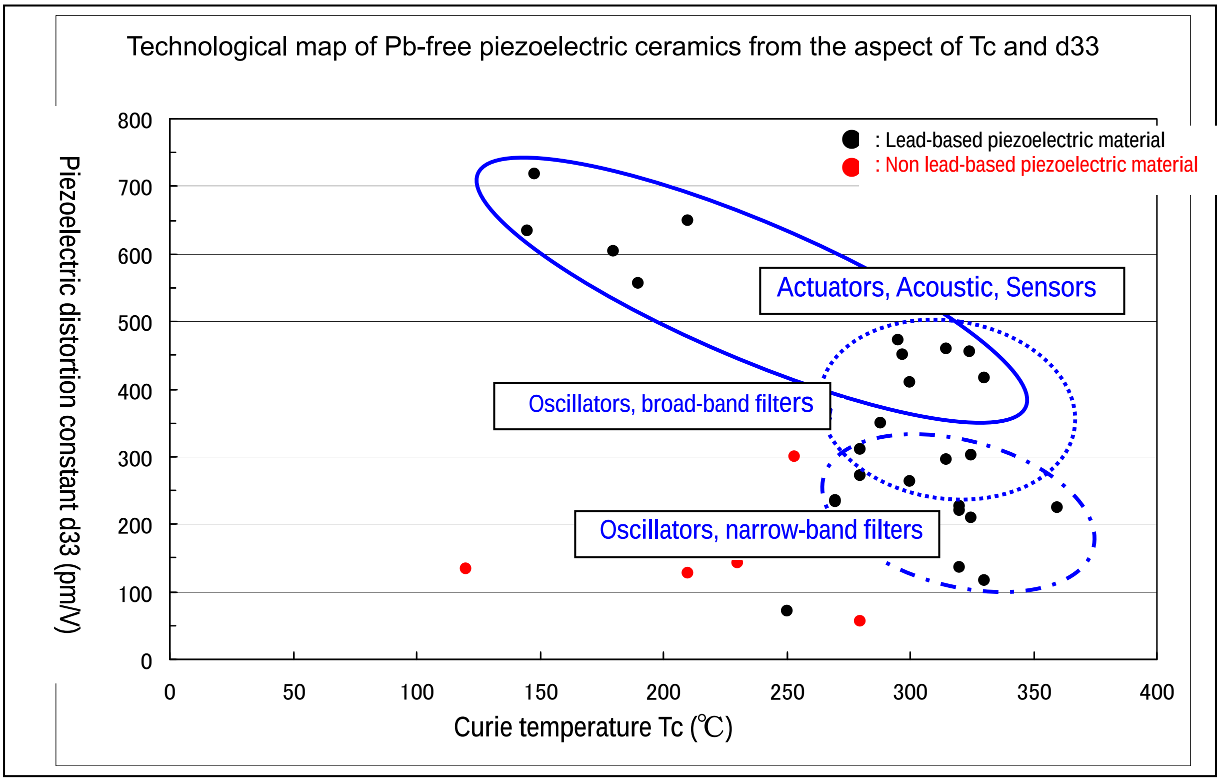
150centigrade～250centigrade or above (It depends on the application.)

Lead-based piezoelectric ceramics achieve both d constant and Tc. As these functions are obtained, lead-based piezoelectric ceramics are often used in electric and electronic equipment and parts. On the other hand, non lead-based piezoelectric ceramics is currently under development with d constant at 50pm/V～300pm/V, Tc at 100～280centigrade and have not obtained the function to substitute lead-based piezoelectric ceramics . In order to use non lead-based piezoelectric ceramics in applications, we have to make efforts to enhance the d constant and Tc.

This can be summarized as below.

-At this stage, lead-based piezoelectric ceramics is necessary as the material for in electric and electronic equipment and parts. This is because the substitution of lead-based piezoelectric ceramics by non lead-based piezoelectric ceramics is not possible.

-In order to promote the shift from lead-based piezoelectric ceramics to non lead-based piezoelectric ceramics, we need to continue the development of non lead-based piezoelectric ceramics with the focus on enhancement of d constant and Tc.



9-Figure 1 Technological map of piezoelectric ceramics from aspect of Tc and d33

B. Semiconductor (PTC) ceramics

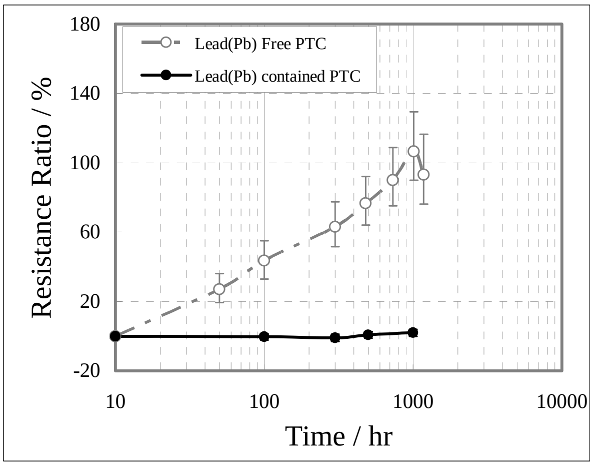
More than 130 centigrade Curie temperature(Tc) is required for overcurrent protector, and only lead contained PTC ceramics can make it possible like piezoelectric ceramics.

On the other hand, the following lead-free materials a) -d) are now proposed as alternative ones of PTC ceramics.

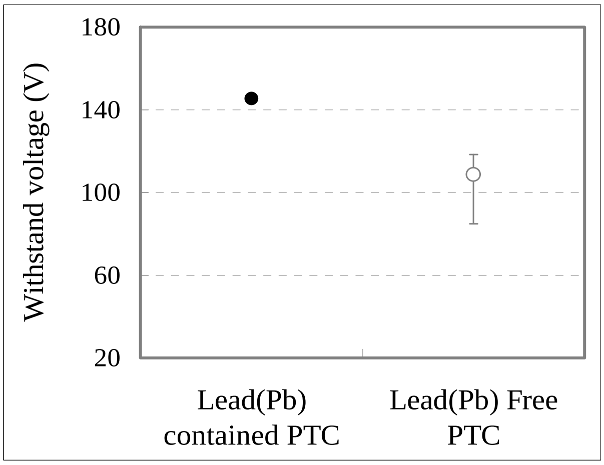
a) $BaTiO_3$-$(Ba_{1/2}Na_{1/2})TiO_3$ （BT-NBT）
b) $BaTiO_3$-$(K_{1/2}B_{1/2})TiO_3$ （BT-KBT）
c) $BaTiO_3$-$BaFeO_3$ （BT-BF）
d) $BaTiO_3$-NaNb O_3 （BT-NN）

However, the Curie temperatures of all these alternative ceramics are between 120 and 160centigrade, they cannot make enough performances for reliability and withstand voltage to replace PTC ceramics with lead.

Especially, it has been reported that the Curie temperature of item a) (BT-NBT) was improved up to 155centigrade but the mass production technology has not been established yet. Following figures are showing the comparison between lead contained PTC ceramic and lead-free one.



9-Figure 2 Comparison between lead contained PTC ceramic and lead-free one (reliability)



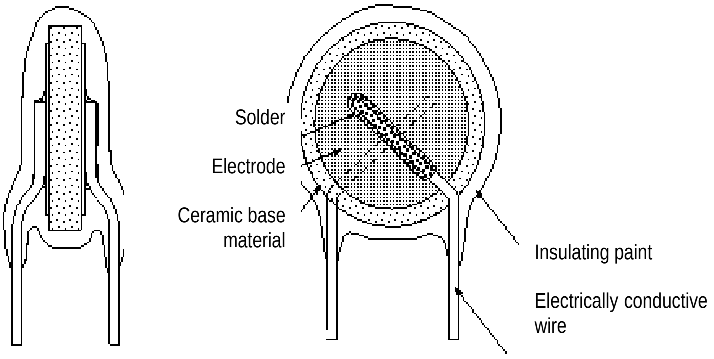
9-Figure 3 Comparison between lead contained PTC ceramic and lead-free one (withstand voltage)

C. Dielectric ceramics

As dielectric ceramics for capacitors not containing lead, there is barium titanate which is a material for usual ceramic capacitor, however there is a high dielectric loss(some tens of times that of the current ceramics including lead) and a large heat generation when voltage is applied making it unstable. Since barium titanate has the tendency to get distorted when voltage is imposed (electrostrictive strain property), it generates mechanical breakdown when high voltage impact is added and cannot be used.

Strontium titanate is available as a non-lead dielectric ceramic without electrostrictive strain property with a small amount of loss. However, the dielectric constant is as small as one twelfth of the current lead-based material. Thus it becomes as large as ten times the current size if we are to make a high-voltage capacitor with it（9-table 1）

As mentioned above, non lead-based materials are not practical because we cannot impose high-voltage or the size becomes too large from the point of characteristics such as heat and damage. This means that the realization of current applications becomes impossible and the environmental load will be large as a result.



9-Figure 4: Structure of a high-voltage capacitor

9-Table1: Comparison of material for high-voltage capacitors

	Relative permittivity	Dielectric loss (%)	DC breakdown voltage (kV/mm)	AC breakdown voltage (kV/mm)	Impulse breakdown voltage (kV/mm)
Current lead-based materials	2700	0.04	15.3	8.0	8.0
Barium titanate-based materials	3000	0.80	11.8	6.7	6.0
Strontium titanate	200				
Notes	Bigger is better	Smaller is better	Bigger is better	Bigger is better	Bigger is better

10. Please also indicate if feasible substitutes currently exist in an industrial and/or commercial scale for similar use.

A. Piezoelectric ceramics

We see no viable substitutes for piezo-electric ceramics at the present time. Therefore, feasible substitutes don't currently exist in an industrial and/or commercial scale.

B. Semiconductor (PTC) ceramics

The solid-solution ceramics of Barium titanate and lead titanate is the only mass-produced material which can raise the Curie temperature of Barium titanate. Other than lead, there is no shifter which ensures mass-production and reliability available.

If the Curie temperature can be 120 centigrade or below, it can be produced by adding strontium to Barium titanate. However, the product life and withstand voltage is poorer than using lead and there are problems to be solved before practical application.

For a substitute material in case the Curie temperature of more than 130 centigrade is required as in overcurrent protectors, research and development of solid solution material of natrium and bismuth and Barium titanate is advocated. However, as the reliability and the mass-production technology is not ensured and there is no prospect of mass-produced supply of workable substitute material, the completion of substitution within several years is not in sight.

C. Dielectric ceramics

Most of electronic components applying dielectric ceramics do not contain lead any more. Some electronic components use lead-containing dielectric ceramics; however, there are potential substitutes for them. It is expected that the substitution can be promoted by appropriately setting the timing for development, evaluation and substitution of application.

However, even for dielectric ceramics including lead, there is no substitute materials for high voltage capacitors using voltage exceeding 125V AC or 250V DC, and no appropriate shifter other than lead has been proposed so far.

11. Please indicate the possibilities and/or the status for the development of substitutes and indicate if these substitutes were available by 1 July 2006 or at a later stage.

    Refer to 8-1.

12. Please indicate if any current restrictions apply to such substitutes. If yes, please quote the exact title of the appropriate legislation/regulation.

    None

13. Please indicate benefits / advantages and disadvantages of such substitutes.

    Refer to 8-1 and 8-2.

14. Please state whether there are overlapping issues with other relevant legislation such as e.g. the ELV Directive that should be taken into account.

    ELV exemption no. 11 'Electrical components which contain lead in glass or ceramic matrix compound except glass in bulbs and glaze of spark plugs' are overlapping issues, so we should be taken into account it.

    Refer to the following webpage to check the consultation details of ELV exemption no. 11.

    http://circa.europa.eu/Public/irc/env/elv/library?l=/stakeholder_consultation/evaluation_procedure/reports/final_report/report_revision/_EN_1.0_&a=d

15. If a transition period between the publication of an amended Annex is needed or seems appropriate, please state how long this period should be for the specific application concerned.

A. Piezoelectric ceramics

Although we have never found the lead-free ceramics to replace the lead contained ones so far, if ceramics with substitute function is supplied on a mass-production basis, it is estimated that it will take quite a few years to develop an application which can be employed to replace in electric and electronic equipment and parts.

B. Semiconductor (PTC) ceramics

If the Curie temperature can be 120 centigrade or below, it can be produced by adding strontium to Barium titanate. However, the product life and withstand voltage is poorer than using lead and there are problems to be solved before practical application. Also, considering the time required for product development, assessment and substitution after completion of the material, it may require several years and is unlikely to be completed by 2012 when the next review is due to be held.

For a substitute material in case the Curie temperature of more than 130 centigrade is required as in overcurrent protector, research and development of solid solution material of natrium and bismuth and Barium titanate is advocated. However, as the reliability and the mass-production technology is not ensured and there is no prospect of mass-produced supply of workable substitute material, the completion of substitution within several years is not in sight. Thus, the exemptions should continue at least until the next review of the exemptions.

C. Dielectric ceramics

Capacitors with potential substitute materials will be developed, evaluated and substituted in sequence. However, due to the wide usage and the large number of units used, it may generate confusion in the market unless an appropriate transition period is provided. We expect the EU Commission to conduct a survey on the setting of a transition period and the setting of an appropriate time limit. JEITA is prepared to willingly cooperate with this survey.

Specific Questionnaire

1. What are the different applications of lead in electronic ceramic parts?

   Refer to the attached excel file.

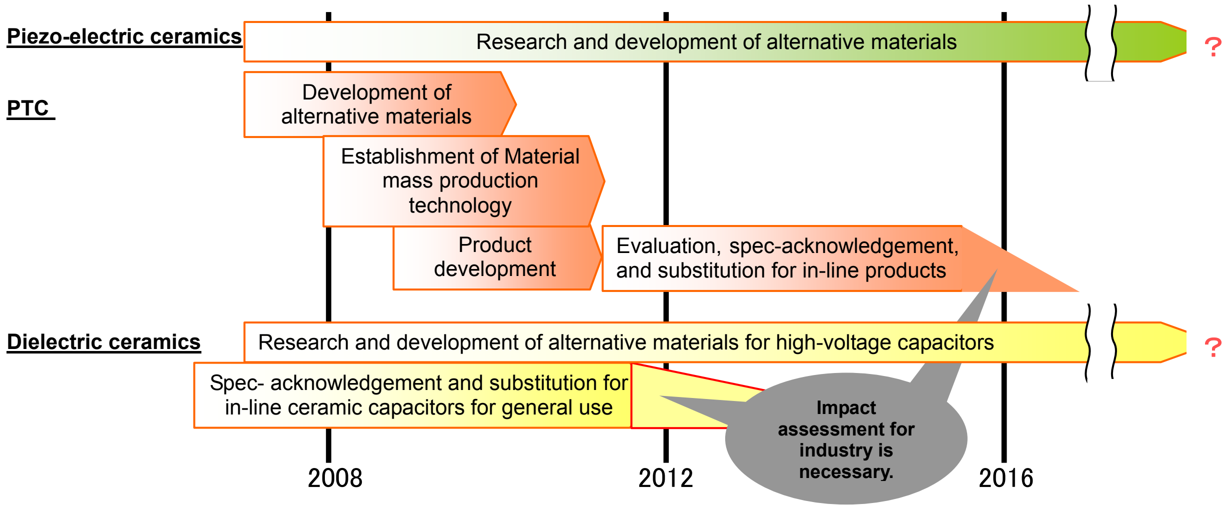
2. What is the amount of lead per application, the lead content in the homogeneous material, the annual production volume as well as the number of applications related to exemption 7(c) put on the EU market annually.

   Refer to the attached excel file.

3. Please explain whether and how lead can be substituted in the different applications in ceramics.

   Refer to the general questionnaire 8 and 9

4. Please provide a roadmap or similar evidence with activities, milestones and timelines towards the replacement of lead in these applications.



We don't have any prospects in order to draw the road map for research and development of alternative materials for Piezo-electric ceramics and high-pressure capacitor at all at this moment.

On the other hand, PTC ceramics and dielectric ceramics with potential substitute materials will be developed, evaluated and substituted in sequence. However, due to the wide usage and the large number of units used, impact assessment (reserve of the alternatives, transportation methods, price and so on) for industry is necessary in order to draw the road map for them.

5. Do you consider thickfilm applications to be covered by the current wording of exemption 7(c)?

The intermediate joint layer gets completed in the boundary of the ceramic part and the electrode part as some of the constituents of the both parts penetrate into the layer. Consequently, this intermediate joint layer gets integrated with the ceramic and the electrode part and they cannot be separated. Thus these three layers form one homogeneous material. (Refer to the figure below).

The lead, which penetrated from the ceramic part into the electrode part in jointing, may be detected in this homogenous material part after all. This lead constituent is originally from the ceramic part. ***Does the proposed wording assume that such lead is under the exemption?*** If so, such joint using the thick film absolutely accompanies this phenomenon. Therefore we propose that the content of the lead should be exempted from the RoHS directive because such joint is one homogeneous material that the ceramics and the thick film are integrated.