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Datasheet for the decision of 29 September 2015

Case Number: T 1589/11 - 3.4.03

Application Number: 05255752.7

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Title of invention:
Piezoelectric actuator

Patent Proprietor:
Delphi Technologies, Inc.

Opponent:
Epcos AG

Headword:

Relevant legal provisions:
EPC Art. 52(1)
EPC 1973 Art. 54, 56, 100(a), 100(c)
RPBA Art. 13(1), 15(1)

Keyword:
Late-filed auxiliary requests - justification for late filing (yes)
Amendments - added subject-matter (no)
Novelty - (yes)
Inventive step - (yes)

Decisions cited:
T 0284/94, T 0398/00, T 0714/00, T 0025/03, T 0094/12

Catchword:

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Case Number: T 1589/11 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 29 September 2015

Appellant: (Opponent)	Epcos AG St.-Martin-Str. 53 81669 München (DE)
Representative:	Epping - Hermann - Fischer Patentanwaltsgesellschaft mbH Schloßschmidstraße 5 80639 München (DE)
Respondent: (Patent Proprietor)	Delphi Technologies, Inc. PO Box 5052 Troy, MI 48007 (US)
Representative:	Manitz, Finsterwald & Partner GbR Postfach 31 02 20 80102 München (DE)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 6 May 2011 concerning maintenance of the European Patent No. 1764844 in amended form.**

Composition of the Board:

Chairman G. Eliasson
Members: S. Ward
C. Heath

Summary of Facts and Submissions

I. This is an appeal by the opponent and sole appellant against the interlocutory decision of the Opposition Division concerning maintenance of European patent No. EP 1 764 844 in amended form according to the proprietor's then first auxiliary request.

II. The patent was opposed in its entirety. The cited grounds for opposition were lack of novelty, lack of inventive step and unallowable extension of subject-matter (Articles 100(a) and (c), 52(1), 54 and 56 EPC).

III. The following documents are cited in this decision:

D1: WO 2004/077583 A1

D2: WO 03/105246 A2

D4: M. Boaro, J. M. Vohs, R. J. Gorte: Synthesis of Highly Porous Yttria-Stabilized Zirconia by Tape-Casting Methods, J. Am. Ceram. Soc. 86, Pages 395-400 (2003).

D5: Keramik, H. Schaumburg (Editor), B. G. Teubner, Stuttgart 1994, Pages 124-125.

IV. At the end of the oral proceedings held before the Board the parties confirmed their requests as follows:

The appellant-opponent (hereinafter, the opponent) requested that the decision under appeal be set aside and that the patent be revoked; the respondent-proprietor (hereinafter, the proprietor) requested that the decision under appeal be set aside and that the patent be maintained as follows:

- Claims 1-3 of the Auxiliary claims as filed during oral proceedings;

- Description: page 2 as filed during oral proceedings, page 3 as filed on 7 April 2011 before the opposition division, pages 4 – 7 of the patent specification.
- Figures 1 – 11 of the Patent specification.

V. Claim 1 of the sole request (i.e. claim 1 of the "Auxiliary claims" filed during oral proceedings) reads as follows:

"A piezoelectric actuator comprising:
a co-fired stack (10) of piezoelectric elements (12) formed from a piezoelectric material,
a plurality of positive internal electrodes (14) interdigitated with a plurality of negative internal electrodes (16) throughout the stack (10) to define active regions (22) of the piezoelectric material which are responsive to a voltage applied across the internal electrodes (14), in use,
an external positive electrode (18) for connection with the positive internal electrodes (14), and
an external negative electrode (20) for connection with the negative internal electrodes (16),
each of the positive internal electrodes (14) extending from the positive external electrodes (18) across a width of the stack (10) to define a first gap with the negative external electrode (20), and each of the negative internal electrodes (16) extending from the negative external electrode (20) across the width of the stack (10) to define a second gap with the positive external electrode (18)
the stack (10) having a total of four side surfaces wherein the external electrodes (18,20) are provided on two facing side surfaces which define a full width of the stack (10) between each other,

wherein the stack (10) further comprises means (34) for deliberately creating artificial cracks (36) within the stack (10) at a location at which the artificial cracks do not give rise to a short circuit between the internal electrodes (14, 16) but serve to relieve stresses within the piezoelectric material, and wherein the means for deliberately creating artificial cracks (36) includes a plurality of intermediate layers (34) of non-conductive material extending across the full width of the stack and distributed throughout the stack (10);
characterised in that the or each of the intermediate layers (34) is formed from a material having a higher sintering temperature than the piezoelectric material."

VI. The opponent's arguments, in so far as they are relevant to the present decision, were essentially as follows:

(i) The new sole request ("Auxiliary claims") should not be admitted into the procedure as it was late-filed and unclear, especially in relation to the term "facing".

(ii) In relation to unallowable extension of subject-matter, the feature "extending across the full width of the stack" had been extracted from Fig. 2 while other features present in the figure had been omitted, in particular:

A). the intermediate layers 34 were located between electrodes of different polarity;
B). the intermediate layers 34 were located in respective zones of the stack in which the distance between internal electrodes was increased with respect to other zones of the stack;

C). the intermediate layers 34 were thicker than means for creating cracks in other examples and were also thicker than the internal electrodes; and
D). the intermediate layers 34 were not randomly distributed over the length of the stack.

This amendment was not allowable under Article 123(2) EPC, as the extracted feature had a clear structural and functional connection with the omitted features (see T 714/00, T 284/94 and T 25/03). All of these features were closely linked together, since they all contributed to the cracks being created at certain regions of the stack where there was no risk of short circuits.

Moreover, the incorporation into a claim of a feature only disclosed in a drawing could only be allowed under Article 123(2) EPC if it was clearly recognisable to a skilled person that the feature represented the result of technical considerations directed to the solution of the technical problem posed (see T 398/00). In the present case, the description gave no hint as to the contribution the above feature was supposed to make to the solution of the technical problem.

If it were the case that the "width" represented a direction defined in terms of the outer electrodes, then, since claim 1 of the granted patent did not specify the positions of the external electrodes, numerous configurations which were not originally disclosed fell within the ambit of the claim, contrary to the provisions of Article 123(2) EPC.

(iii) In relation to novelty, the only alleged difference between claim 1 and document D1 lay in the characterising feature. This was a product-by-process

feature, and inspection of the final product would not allow the skilled person to make any inferences about the sintering temperature used in the process. Such a feature could not establish the novelty of a product claim. The burden of proof for an allegedly distinguishing product-by-process feature lay with the proprietor (see "Case Law of the Boards of Appeal of the European Patent Office", 7th edition 2013, section III.G.5.1.2(a)).

A "higher sintering temperature" was not a simple parameter dependent on chemical composition. Sintering was a complex process in which many factors other than temperature played a role, for example pressure and particle size. This could be confirmed by reference to document D5. Hence a higher sintering temperature was not a verifiable characteristic of the finished product.

In any event, it was implicit that the sintering temperature would be higher for the breach layers in Document D1. Following decarbonisation (removal of the bonding agent) the porosity of the green films destined to become the breach layers was greater than that of the green films destined to become the piezoelectric ceramic layers. Subsequently the stack was raised to a temperature at which the piezoelectric ceramic layers reached 97-98% of the theoretical density. At this temperature the breach layers had only 90-95% of the theoretical density as a result of their greater initial porosity. To close the pores in these layers further to achieve the maximum 97-98% of the theoretical density, an even higher temperature would be required, this higher temperature being the sintering temperature of the breach layers, according to the definition of the term given in paragraph [0031]

of the contested patent. It was thus implicit that document D1 disclosed intermediate (breach) layers formed from a material having a higher sintering temperature than the piezoelectric material.

This analysis was not inconsistent with document D4, a document which disclosed that the samples under discussion had the same onset temperature and behaved similarly up to the process temperature used (1823 K), but which did not disclose the behaviour at higher temperatures. In particular, document D4 did not disclose that the different samples would all reach their maximum density at the same temperature.

(iv) Even if the characterising feature were found not to be disclosed in document D1, no inventive step could be acknowledged. The problem would be merely to find an alternative material for the breach layers of document D1. In D2 it was disclosed that the weakened layers might be formed of ZrO_2, and it was undisputed that this material had a higher sintering temperature than the material of the piezoelectric layers.

Moreover, it was clear from document D2 that forming layers extending across the entire stack (as in document D1) comprising ZrO_2 (as disclosed in document D2) would not lead to complete delamination as suggested by the Opposition Division, but to the formation of cracks as required for stress relief. In this respect, document D2 clearly disclosed partial sintering (e.g. page 12, lines 5-18), in which case complete delamination would not arise.

Alternatively, starting from document D2, claim 1 differed only in that the intermediate layers extended across the full width of the stack. Either on the basis

of common general knowledge or having regard to document D1, the skilled person would understand the advantages of extending the crack sources across the entire cross section of the stack, for example to prevent short circuits in the inner regions.

VII. The proprietor's arguments, in so far as they are relevant to the present decision, were essentially as follows:

(i) The request based on the "Auxiliary claims" merely aimed to overcome the finding of the Board that the previous main request did not meet the requirements of Article 123(2) EPC, and did not introduce any lack of clarity.

(ii) Document D5 was late-filed and not relevant, and hence should not be admitted onto the proceedings.

(iii) The feature "extending across the full width of the stack" is not inextricably linked with any of the other features disclosed in Fig. 2, none of which are necessary for the complete solution of the technical problem provided for by the subject-matter of claim 1, namely to direct crack formation into regions of the actuator where there is no risk of crack formation.

The amendments made to claim 1 of the present request were clear and further defined the term "width" in a manner which unambiguously excluded any originally undisclosed embodiments alleged by the opponent to fall within the ambit of claim 1 as granted.

(iv) In relation to novelty, claim 1 was not a product-by-process claim. What was claimed was a co-fired stack in which the intermediate layers were formed from a

material "having a higher sintering temperature" than the piezoelectric layers. This represented a measurable relative feature of the two materials, not the temperature at which the sintering process was carried out. Hence the product-by-process arguments of the opponent were irrelevant.

It was not explicitly disclosed in document D1, nor was it implicit, that the sintering temperature would be higher for the breach layers. The sintering temperature was based only on the material properties of the ceramic constituent of the layers, and was independent of the quantity of organic binder or the porosity before sintering. In D1 the breach layers and the piezoelectric elements were made of one and the same material and hence would have the same sintering temperature. Sintering the breach layers of Dl at a higher temperature would not lead to any further closing of the pores or higher compaction.

Document D4 showed that shrinkage versus process temperature of various samples made from an identical ceramic material was the same, regardless of the amount and types of pore former.

(v) Furthermore, the characterising feature provided two technical advantages.

The first was to control shrinkage, since with "excess binder, as in Dl, shrinkage is necessarily higher in the intermediate layers". Secondly, the invention did not require high porosity intermediate layers as in D1, which could allow an improvement in compressive strength and a reduction of the electric field concentrations associated with large pores, improving the reliability of the actuator in use.

In Dl the intermediate layers formed a structural part of the stack between the piezoelectric layers. In D2, the purpose of the microdisturbances was to create a delamination between the adjacent piezoelectric layers. Since the intermediate layers of Dl and the microdisturbances of D2 had different technical purposes, a skilled person would not consider the materials used in D2 to be useful for substitution in the intermediate layers of Dl.

The skilled person starting from D2 would find no motivation to combine this document with Dl. To provide the stack of D2 with a breach layer extending across the whole width of the stack would mean that the skilled person would have to completely leave the clear teaching of D2, namely to provide a sintering at selected locations only.

VIII. With the summons to oral proceedings, the Board sent the parties a communication under Article 15(1) of the Rules of Procedure of the Boards of Appeal (RPBA). The Board set out its provisional view that, *inter alia*, in the light of the submissions of the parties, claim 1 of the main request met the requirements of Article 123(2) EPC.

Reasons for the Decision

1. The appeal is admissible.

2. Admissibility of the sole request

2.1 The new sole request ("Auxiliary Claims") was filed during oral proceedings before the Board, and hence, according to Article 13(1) RPBA, is admissible only at the Board's discretion. The relevant procedural history which led to the filing of this request is summarised as follows:

2.2 In the statement of grounds of appeal, the opponent advanced two principal arguments in support of its case that claim 1 of the granted patent did not comply with Article 123(2) EPC (see Point VI(ii), above): firstly that it represented an inadmissible intermediate generalisation which did not meet the conditions set out in T 714/00 and T 284/94, and secondly that the amended feature did not represent the result of technical considerations directed to the solution of the technical problem posed (see T 398/00).

2.3 In the communication under Article 15(1) RPBA the Board indicated that (provisionally) it was not fully convinced by either of these arguments, and hence the provisional view of the Board was that claim 1 of the main request then on file appeared to comply with the requirements of Article 123(2) EPC.

The Board also noted that the term "width" is indicated in the application as filed as being in the plane of the paper in Fig. 2, extending from one external electrode to the other.

2.4 In the letter of 12 August 2015, and during the oral proceedings, the opponent developed a different line of argument: if the width were considered to extend in a direction from one external electrode to the other, then, since the claim did not specify the positions of

the external electrodes, numerous configurations fell within the ambit of the claim which were unlike anything actually disclosed in the application as filed, for example where both external electrodes were situated on the same side.

Ultimately the Board found this new line of argument convincing, and in the oral proceedings rejected claim 1 of the then main request for failure to comply with the provisions of Article 123(2) EPC.

2.5 The present request was filed in an attempt to address this finding by specifying more clearly *inter alia* the disposition of the external electrodes.

2.6 The Board raised no objection to the introduction by the opponent of new arguments not contained in the statement of grounds of appeal, even though new arguments may, in principle, also represent an amendment to a party's case within the meaning of Article 13(1) RPBA. Moreover, the fact that the Board found these new arguments convincing only became apparent to the proprietor during the oral proceedings. Under these circumstances the Board considered it equitable to allow the proprietor to formulate a response to this finding, especially as the new request cannot be seen as adding greatly to the complexity of the case.

The Board is not persuaded by the argument of the opponent that the amended features introduce a lack of clarity into the claim. In particular, the term "facing" has a well-recognized meaning, both generally and within the context of the granted patent, as may be seen in paragraph [0043] in combination with Fig. 10.

2.7 The request filed during oral proceedings ("Auxiliary claims") is therefore admitted into the procedure (Article 13(1) RPBA).

3. Admissibility of document D5

3.1 In the written proceedings the proprietor requested that document D5 should not be admitted into the proceedings on the grounds that it was late-filed and not relevant. During the oral proceedings the proprietor took the view that, since this document was in any event irrelevant, it could be left up to the discretion of the Board whether to admit it or not.

As the issue is no longer contested, document D5 is admitted into the procedure (Article 13(1) RPBA).

4. Article 123(2) EPC

4.1 The subject-matter of claim 1 is principally based on the combination of claims 1, 2 and 4 as originally filed. The features added to claim 1 during oral proceedings before the Board are based on page 5, lines 12-15 of the description as originally filed and Fig. 2.

The arguments in relation to the requirements of Article 123(2) EPC are focused on the feature "extending across the full width of the stack", which does not have any literal basis in the application as filed, but which, according to the proprietor, is principally based on Fig. 2. Although the arguments concerning Article 123(2) EPC were mainly raised in relation to claim 1 of the granted patent, they are equally relevant to claim 1 of the present request which also comprises the contested feature.

4.2 The opponent argues essentially that extracting from Fig. 2 the isolated feature "extending across the full width of the stack", while omitting other features present in the figure (in particular features A) to D) listed under Point VI(ii), above) constitutes an inadmissible intermediate generalisation.

4.3 According to established case law of the boards of appeal, an amendment of this type is only allowable under Article 123(2) EPC under certain circumstances.

In T 714/00 (see Reasons, point 3.3) the relevant criterion was set out as follows:

- *"Extracting an isolated feature from an originally disclosed combination and using it for delimiting claimed subject-matter can only be allowable under the concept of Article 123(2) EPC if that feature is not inextricably linked with further features of that combination."*

Another (and in the opinion of the Board, broadly similar) criterion which is regularly applied is that such an amendment can only comply with the requirements of Article 123(2) EPC if there is no clearly recognisable functional or structural relationship between the extracted and the non-extracted features (see "Case Law of the Boards of Appeal of the European Patent Office", 7th edition 2013, II.E.1.2).

4.4 The Board is not persuaded that the opponent has demonstrated that there is an inextricable link or a clearly recognisable functional or structural relationship between the feature that the intermediate

layers extend across the full width of the stack and any one of the above-mentioned features A) to D).

In particular, the opponent appears to lay special emphasis on the feature C), i.e. that "the intermediate layers 34 are thicker than means for creating cracks in other examples and are also thicker than the internal electrodes". While the thickness of the intermediate layers would, no doubt, be an important design parameter, the purported link with the intermediate layers "extending across the full width of the stack" appears to be speculative and not derived from anything actually disclosed in the application.

Furthermore, the Board does not understand why extension across the full width of the stack is supposed to be linked not just to the thickness of the intermediate layers, but to their thickness relative to the internal electrodes, or why the thickness of the intermediate layers in other (non-claimed) embodiments of the patent is considered to be relevant.

It is plausible that varying the characteristics of the intermediate layers depicted in Fig. 2, for example the thickness or distribution, would have some influence on their ability to provide stress relief. However, the Board is not persuaded by the argument that this ability is based on an interaction between these characteristics and the extension of the intermediate layers across the full width of the stack.

4.5 The opponent also argued that for the amendments to claim 1 to be admitted pursuant to Article 123(2) EPC, it should be clear to the skilled person that incorporating the contested feature was the result of technical considerations directed to the solution of

the technical problem posed (see T 398/00 Reasons, Point 3.4), and that it was not apparent that this was the case here.

4.6 The relevance of any argument based on a prior decision of the boards of appeal must depend to a considerable extent on the degree of similarity between the two cases.

In T 398/00, which concerned a lifting truck, the appellant sought to derive, only from schematic drawings, the feature that the "major portion of the height of the engine contained in said housing is situated below a plane tangent to the top of the wheels" (see Reasons, point 3.4).

The present Board's assessment of the factual situation underlying T 398/00 is that while the schematic drawings appeared to show that a "major portion of the height of the engine" was "situated below a plane tangent to the top of the wheels", there was a genuine doubt whether this was deliberately intended and part of the invention, or whether it was simply an accidental and unconsidered artifact resulting from an arbitrary selection of concrete values for the wheel size, the engine size and the relative placement of the two, merely for the purpose of producing a drawing. It was in this context that the Board devised the test referred to under point 4.5, above.

In the opinion of the present Board, this test was devised to judge compliance with the requirements of Article 123(2) EPC within the specific context of a particular case, and cannot be applied in cases where the underlying facts are not comparable to those of

T 398/00. A similar conclusion was reached in T 94/12 (see Reasons, 4.1.3).

4.7 The facts in the present case are not comparable. Fig. 2 clearly and unambiguously depicts an intermediate layer extending fully over the width of the stack between the external electrodes. It cannot be credibly maintained that this choice could have been inadvertent or unintentional. The present case is therefore markedly different from T 398/00, and hence the arguments of the opponent based on this case do not persuade the Board.

4.8 As mentioned above (point 2.4) the Board was persuaded by the argument that, as claim 1 of the granted patent did not specify the positions of the external electrodes, numerous configurations which were not originally disclosed fell within the ambit of the claim, contrary to the provisions of Article 123(2) EPC. In the opinion of the Board, this objection has been satisfactorily overcome by the amendments made to claim 1 of the present request.

4.9 Hence the Board judges that the subject-matter of claim 1 complies with the requirements of Article 123(2) EPC.

5. Novelty with respect to document D1

5.1 There appears to be general agreement that the preamble of claim 1 is disclosed in document D1, and hence the only point of dispute is whether document D1 discloses the characterising part:

- *"the or each of the intermediate layers (34) is formed from a material having a higher sintering temperature than the piezoelectric material."*

5.2 The Board is not persuaded by the argument that claim 1 is a "product-by-process" claim, and that the sintering temperature is a process parameter which would not be evident in the final product. The wording of the characterising part makes it clear that the subject-matter of the claim is defined in terms of a comparison of properties of the layers rather than in terms of a process temperature.

Moreover, within the context of the present invention, the meaning of the term "sintering temperature" is defined in paragraph [0031] as follows:

- *"Suitable materials for the additional layers may be ... a material that has a higher sintering temperature than the sintering temperature of the piezoelectric material (i.e. the sintering temperature at which the final dense structure is formed)."*

The Board's interpretation of this passage is as follows. Upon reaching an onset temperature, sintering (i.e. a process of densification involving a progressive elimination of the pores between the powder particles of the green body) commences, and further increasing the process temperature above the onset temperature results in greater densification. At a certain temperature, however, a maximum density is reached, and further rises in the process temperature will not result in further densification. The temperature at which this maximum density is reached is the "sintering temperature" within the context of the present invention.

5.3 It should be noted that claim 1 defines a co-fired stack, hence one in which all layers would have been subjected to identical firing conditions, and does not require an absolute determination of a sintering temperature, but merely whether the sintering temperature of the intermediate layers is higher than that of the adjacent layers.

5.4 The Board therefore sees the characterising part of claim 1 as a product feature which would allow a meaningful comparison between the claimed co-fired stack and a co-fired stack of the prior art, since a skilled person would be able to determine whether the temperature at which the intermediate layers reach their maximum density is or is not higher than the temperature at which the piezoelectric layers reach their maximum density, based on e.g. the known properties of the materials or on simple experimentation.

5.5 Hence the Board is not persuaded by the argument that the characterising feature cannot establish novelty as it would not allow a meaningful comparison with the prior art.

5.6 In the written procedure the opponent argued somewhat differently, asserting that the characterising part of claim 1 was in fact disclosed in document D1. In the preferred embodiment the breach layers ("Sollbruchschichten") are made from the same ceramic material as the adjacent layers, but with a higher porosity, and it was argued that it was implicit that the breach layers would have a higher sintering temperature than the adjacent layers (see point VI(iii), above).

5.7 Document D1 discloses that at a temperature at which the piezoelectric ceramic layers reach 97-98% of their theoretical density, the breach layers have only 90-95% of the theoretical density (page 5, fourth paragraph). The pertinent question is therefore whether, at an even higher temperature, the pores in the breach layers would close further to achieve the maximum 97-98% of the theoretical density, or whether the breach layers, as a result of their greater initial porosity, would only ever attain 90-95% of the theoretical density even at a higher temperature. In the first case the sintering temperature of the breach layers would be higher than the sintering temperature of the piezoelectric layers; in the second case the layers would have the same sintering temperature.

In the opinion of the Board, document D4 does not provide a definite answer to this question, and in the absence of any further relevant evidence, the Board is called upon to decide the matter based essentially on the opposing assertions of both parties.

5.8 It is a fact that document D1 does not explicitly disclose that the breach layers have a higher sintering temperature than the piezoelectric layers, and hence it is up to the opponent to substantiate its assertion of a lack of novelty by demonstrating convincingly that this feature is implicitly disclosed in document D1.

This was pointed out in the communication under Article 15(1) RPBA, and it was open to the opponent to file further relevant evidence in this regard. In the present case, it must be considered that the opponent was in a particularly strong position to obtain further technical evidence in relation to the invention disclosed in document D1 (a PCT application), as the

applicant in that case and the opponent in the present case are one and the same (EPCOS AG).

Nevertheless, the only further evidence filed was document D5, which the Board does not see as being directly relevant to this question. Hence, for the reasons set out above, the Board is not persuaded that the characterising feature of claim 1 is implicitly disclosed in document D1.

5.9 Finally in relation to the question of novelty, the argument that paragraphs [0031] and [0032] of the contested patent explicitly state that arrangements similar to those of document D1 are intended to be covered by the invention is not found persuasive. These passages recite a series of possible alternatives and options, not all of which correspond to claim 1 as granted, or present claim 1. The use of a material with a higher sintering temperature for the intermediate layers is one option mentioned. Subsequently the choice of adding an excess of binder in regions where the weak layers are to be created (as in document D1) is mentioned in a passage starting: "Another option is..." (end of paragraph [0032]).

5.10 The Board therefore judges that the subject-matter of claim 1 is not disclosed in document D1.

6. Novelty with respect to document D2

6.1 Although the question of novelty with respect to document D2 was raised in the written proceedings, it is clear that this document does not disclose intermediate layers extending across the full width of the stack in the sense in which "width" is now defined in claim 1 of the present request. The opponent did not

raise any counter-arguments in this regard in the oral proceedings.

The subject-matter of claim 1 is therefore not disclosed in document D2, and consequently the Board judges that the subject-matter of claim 1 is new within the meaning of Article 52(1) EPC and Article 54 EPC 1973.

7. *Inventive step starting from document D1*

7.1 Starting from document D1 as the closest prior art, the distinguishing feature of claim 1 is that the intermediate layer or layers are "formed from a material having a higher sintering temperature than the piezoelectric material". In the light of the considerations under points 5.4 - 5.6, above, the Board considers that this means that the layers must be made of different materials, and not merely of the same material with differing levels of porosity, as in document D1.

7.2 The Opponent suggests that the problem solved by the distinguishing feature of claim 1 is to find an alternative material for the breach layers of document D1.

Since the claimed solution requires the intermediate layers and the piezoelectric layers to be of different materials (see point 7.1, above) and the starting point is a piezoelectric stack in which the breach layers 4 and the piezoelectric layers should advantageously be made from the same material (D1, page 5, penultimate paragraph), a problem defined in terms of finding an alternative material for the breach layers is clearly unsuitable, as it incorporates elements of the solution

(see Case Law of the Boards of Appeal, 7th edition 2013, section I.D.4.3.1).

7.3 The Board is also not persuaded by the suggestion of the proprietor (see point VII(v), above) that providing intermediate layers of a material having a higher sintering temperature than the piezoelectric material would control shrinkage, improve compressive strength and reduce electric field concentrations. The Board finds not so much as a hint in the description that the purpose of providing the claimed difference in sintering temperatures is to achieve any of these effects.

Moreover, the proprietor's arguments in this regard are based, to some extent, on the assumption that the intermediate layers of the invention will display low porosity, a characteristic which is not only not claimed, but which would run counter to the teaching of the opposed patent.

7.4 According to paragraph [0031] of the opposed patent, making the intermediate layer from a material having a higher sintering temperature than that of the piezoelectric material achieves the following result:

- *"During the sintering process to bond the whole structure together, the weaker layers are created within the structure because the additional layers 34 remain porous and poorly bonded at a temperature for which the remainder of the structure becomes densified and well bonded."*

Hence, according to the present invention, weakened porous layers are produced by using a material having a higher sintering temperature than that of the

piezoelectric material, whereas in document D1, weakened porous layers are produced by including an increased content of organic binder in the green films that are to become the breach layers. In the opinion of the Board, therefore, the problem is to find an alternative means of providing the required weakness in the intermediate layers.

7.5 Document D2 discloses a multilayer actuator which incorporates structural impairments which act as a crack source 7 extending a short distance into the body of the stack. By this means, internal mechanical stresses can be reduced in such a manner that no further crack formation is observed in the portions between the crack sources.

The crack sources may be implemented by applying in the predetermined areas a layer of an organic binder to which may be added either organic particles with a diameter of <200 nm, or (page 12, lines 20-26) inorganic particles with a diameter <1 µm which do not react with the piezoelectric material, such as ZrO_2 or sintered PZT.

The opponent essentially argues that document D2 provides an alternative means of forming weakened layers, which the skilled person would consider using to form the breach layers in D1 to solve the above-mentioned problem. Since it is undisputed that ZrO_2 has a higher sintering temperature than PZT, in adopting this alternative the skilled person would be led to a piezoelectric actuator corresponding to the subject-matter of claim 1.

For at least the following reason, the Board does not agree. The structural impairments in document D2 are

intended to prevent sintering so that there is local delamination (page 6, lines 8-9). This means that no tensile stress is possible at the delaminated areas (page 9, lines 27-32). Applying this teaching to the stack of document D1, in which the weakened layers extend across the entire cross-section of the stack, would lead to an unstable device which, as pointed out by the Opposition Division, would simply fall apart.

The Board accepts that partial sintering is also envisaged in document D2 (e.g. page 12, lines 5-18), but this is in connection with the embodiment using organic particles. In this case, since the particles are relatively small (<200 nm) and burn off during sintering, it is plausible that partial sintering of adjacent layers would occur, implying only partial delamination and, presumably, some structural coherence under tensile forces.

However, in the relevant embodiment of document D2, larger (<1 µm) particles of ZrO_2 are added to the binder, which do not burn off during sintering, but remain in the final product. In this case the particles prevent sintering, and the weakened areas, although being able to stand up to compression forces as a result of the particles, have no resistance to tensile stress (page 9, line 16-32). Providing such layers over the entire cross-section of the stack, would, as noted above, lead to a completely unstable product.

Hence, starting from document D1 as the closest prior art, the Board does not believe that the skilled person would incorporate the teachings of D2 in the manner suggested by the opponent.

8. Inventive step starting from document D2

8.1 Starting from the embodiment of document D2 in which ZrO_2 particles are used, the claimed subject-matter differs in that the intermediate layers extend across the full width (in the sense defined in claim 1) of the stack.

8.2 The opponent argues that the skilled person, either on the basis of common general knowledge or having regard to document D1, would appreciate that it would be advantageous to extend the crack sources 7 of document D2 across the entire cross section of the stack, for example to prevent short circuits in the inner regions of the stack.

However, for the reasons given above, the Board has already reached the conclusion that a skilled person would not contemplate extending the layers comprising ZrO_2 particles across the entire cross section of a stack, as the resulting structure would be completely unstable under tensile stress. Hence, the skilled person would not arrive at the subject-matter of claim 1 starting from document D2.

The Board therefore concludes that the subject-matter of claim 1 involves an inventive step within the meaning of Article 52(1) EPC and Article 56 EPC 1973.

Claims 2 and 3 are dependent on claim 1.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to maintain the patent as follows:

   - Claims 1 – 3 of the Auxiliary claims as filed during oral proceedings;
   - Description: page 2 as filed during oral proceedings, page 3 as filed on 7 April 2011 before the opposition division, pages 4 – 7 of the patent specification.
   - Figures 1 – 11 of the Patent specification.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated