

**Internal distribution code:**

- (A)  Publication in OJ  
(B)  To Chairmen and Members  
(C)  To Chairmen  
(D)  No distribution

**Datasheet for the decision  
of 19 August 2010**

**Case Number:** T 1555/07 - 3.2.07

**Application Number:** 98310415.9

**Publication Number:** 0926254

**IPC:** C23C 4/10

**Language of the proceedings:** EN

**Title of invention:**  
Thermal coating composition

**Patent Proprietor:**  
United Technologies Corporation

**Opponent:**  
SIEMENS AKTIENGESELLSCHAFT

**Headword:**

-

**Relevant legal provisions:**

EPC Art. 56, 123  
EPC R. 80, 139  
RPBA Art 13(1), 12(2)

**Keyword:**

"Allowability of amendments (main request - no; first to fourth auxiliary request - yes)"  
"New objections under Article 123(2) EPC - not admitted"  
"Inventive step (first to fourth auxiliary requests - no)"

**Decisions cited:**

G 0003/89

**Catchword:**

-



Case Number: T 1555/07 - 3.2.07

**D E C I S I O N**  
of the Technical Board of Appeal 3.2.07  
of 19 August 2010

**Appellant:** United Technologies Corporation  
(Patent Proprietor) United Technologies Building  
1 Financial Plaza  
Hartford, CT 06101 (US)

**Representative:** Leckey, David Herbert  
Dehns  
St Bride's House  
10 Salisbury Square  
London EC4Y 8JD (GB)

**Respondent:** SIEMENS AKTIENGESELLSCHAFT  
(Opponent) Postfach 22 16 34  
D-80506 München (DE)

**Representative:** -

**Decision under appeal:** Decision of the Opposition Division of the  
European Patent Office posted 4 July 2007  
revoking European patent No. 0926254 pursuant  
to Article 102(1) EPC.

**Composition of the Board:**

**Chairman:** H. Meinders  
**Members:** H. Hahn  
I. Beckedorf

## Summary of Facts and Submissions

I. The appellant (patent proprietor) lodged an appeal against the decision of the Opposition Division to revoke the European patent EP-B-0 926 254.

II. The following documents are cited in the present decision:

Of the opposition proceedings:

D7 = EP-A-0 707 091

D10 = US-A-4 055 705

Filed in the appeal proceedings:

D24 = "Thermal conductivity of Yttria-Zirconia single crystals, determined with spatially resolved infrared thermography", J. Am. Ceram. Soc. 83 (8), 2000, pages 1993-1998

E1 = "Thermal Conductivity of Zirconia", P.G. Klemens, Proceedings of 23<sup>rd</sup> International Thermal Conductivity Conference 1996

E2 = "Characterisation of yttria and rare earth-oxide doped zirconia materials for high temperature applications", J.F. Jue et al., Elevated Temperature Coatings, 1994, pages 125-134

E3 = EP-A-0 765 951

E4 = US-A-5 981 088

III. The opposition had been filed against the patent in its entirety under Article 100(a) EPC, for lack of novelty and inventive step, and under Article 100(c) EPC, that the patent extends beyond the content of the application as originally filed since the features

"**sand** seal" and "**sand** blade" of claim 4 as granted are not supported by the original specification.

The Opposition Division remarked that the objection under Article 123(2) EPC resulted from a clerical error made by the EPO during establishment of the "Druckexemplar" which resulted in a corrected patent specification published on 18 January 2006 in the Patent Bulletin 2006/03 so that the main request, was considered to meet the requirements of Articles 123(2) and (3) EPC. It further held that the subject-matter of claims 1 and 3 of the main request was novel, particularly with respect to D10 and D7, but lacked an inventive step over a combination of the teachings of D7 and D10. The Opposition Division considered that the claims of the first to fourth auxiliary request, all filed with fax dated 5 April 2007, met the requirements of Articles 123(2) and (3), and of Article 54 EPC. As claim 3 of the first and second auxiliary requests was identical with claim 3 of the main request it likewise lacked an inventive step. It further held that claim 1 of the second auxiliary request lacked an inventive step over a combination of the teachings of D7 and D10 which conclusion likewise applied to the identical claim 1 of the third auxiliary request and which also applied to the subject-matter of claim 1 of the fourth auxiliary request. As a result the patent was revoked.

IV. With a communication dated 28 April 2010 and annexed to the summons to oral proceedings the Board presented its preliminary opinion with respect to the claims of the main request and first to fourth auxiliary requests as filed with the grounds of appeal.

None of the five requests appeared to be formally allowable for contravening Rule 80 EPC.

With respect to the issue of inventive step the Board remarked amongst others that D7 appeared to represent the closest prior art for product claim 1 which appeared to be distinguished over the coated compressor blade tips of D7 in that it required an yttria content of 11-14 wt.% for stabilizing the zirconia. The same appeared to be valid for the gas turbine seal system according to independent claim 4.

Thus at the oral proceedings set it would be discussed whether or not the subject-matter of claims 1 and 4 would be rendered obvious by the available prior art documents and particularly by a combination of the teachings of D7 and D10 or whether the person skilled in the art would be prevented from adopting such a combination, e.g. due to a prejudice.

V. With letter dated 19 July 2010 the appellant submitted an amended main request and amended first to fourth auxiliary requests in combination with arguments concerning the allowability of the amendments made as well as the patentability thereof and supported by fresh evidence E1 to E4, partly taking account of the Board's comments in the summons.

VI. Oral Proceedings before the Board were held on 19 August 2010. To start, the formal allowability of the new requests was discussed. The respondent raised objections under Rule 80 EPC with respect to claim 2 and under Article 123(2) EPC with respect to claims 3-4 of the main request. The objections under Article 123(2)

EPC were also raised with respect to the claims of the first to fourth auxiliary requests containing the same amendments. Thereafter inventive step in respect of the subject-matter of claim 1 of the first auxiliary request was discussed. Both parties did not present further arguments concerning claim 1 of the remaining second to fourth auxiliary requests.

- (a) The appellant requested that the decision under appeal be set aside and that the patent be maintained in amended form on the basis of one of the sets of claims filed as main request or, alternatively, as first to fourth auxiliary requests, all filed with letter of 19 July 2010.
- (b) The respondent requested that the appeal be dismissed.

At the end of the oral proceedings the Board announced its decision.

VII. Claims 1 to 4 of the main request read as follows (amendments compared to the claims 1-4 as granted are in bold; emphasis added by the Board):

"1. A compressor blade having a tip with a thermal abrasive top coating consisting of from eleven to fourteen weight percent (11 to 14 wt.%) yttria and the balance essentially zirconia."

"2. The **compressor blade and** thermal top coating of claim 1, wherein the coating has a thermal conductivity not exceeding one point one five watts per meter kelvin (1.15 W/mK)."

"3. A coating system for gas turbine engines which comprises:

- a. a metallic substrate, **said substrate being a compressor blade having a tip;**
- b. an adherent bond coat on **said tip of** said substrate;
- c. an abrasive top coat layer plasma sprayed over said bond coat, said layer consisting of eleven to fourteen weight percent (11 to 14 wt.%) yttria and the balance essentially zirconia;

wherein said coating system includes microcracks essentially perpendicular to the bond coat which extend through the top coat to the bond coat."

"4. A gas turbine seal system comprising an abradable seal and a compressor blade which cooperates with said seal, said blade being a blade as claimed in claims 1 or 2."

VIII. Claim 1 of the first auxiliary request is identical with claim 1 of the main request and claim 2 of the first auxiliary request corresponds to claim 4 of the main request which has been further amended to recite "a blade as claimed in claim 1".

IX. Claim 1 of the second auxiliary request reads as follows:

"1. A gas turbine seal system comprising an abradable seal and a compressor blade which cooperates with said seal, said blade having a tip with a thermal abrasive top coating consisting of from eleven to fourteen weight percent (11 to 14 wt.%) yttria and the balance essentially zirconia."

X. Claim 1 of the third auxiliary request reads as follows:

"1. A compressor blade having a tip with a thermal abrasive top coating consisting of from eleven to fourteen weight percent (11 to 14 wt.%) yttria and the balance essentially zirconia plasma sprayed over an adherent bond coat on said tip, wherein said compressor blade is metallic and wherein microcracks essentially perpendicular to the bond coat extend through the top coat to the bond coat."

Claim 2 of the third auxiliary request is identical with claim 2 of the first auxiliary request.

XI. Claim 1 of the fourth auxiliary request reads as follows:

"1. A gas turbine seal system comprising an abradable seal and a compressor blade which cooperates with said seal, said blade having a tip with a thermal abrasive top coating consisting of from eleven to fourteen weight percent (11 to 14 wt.%) yttria and the balance essentially zirconia plasma sprayed over an adherent bond coat on said tip, wherein said compressor blade is metallic and wherein microcracks essentially perpendicular to the bond coat extend through the top coat to the bond coat."

XII. The appellant argued essentially as follows:

The amendment of claim 2 of the main request represents a correction of claim 2 as granted under Rule 139, since it is obvious from the wording of claim 4 as



granted, referring to "a blade as claimed in claim 1 or 2", that claim 2 should have referred to the blade of claim 1 and not just to a thermal top coating thereof. In any event, this amendment is one occasioned by a ground of opposition under Article 100(a) EPC since a lack of inventive step objection had been raised against claim 2 as granted. The amendment of claim 3 is based on claim 3 as granted, corresponding to claim 4 and page 4, line 26 to page 5, line 10, and page 6, lines 24 to 29 of the application as originally filed. There is sufficient support for claim 4 in the original disclosure that the tip is in contact with an abradable seal (see e.g. page 2, line 29 to page 3, line 2).

The above arguments with respect to the main request likewise apply to the similar amendments made in the claims of the first to fourth auxiliary requests.

The patent provides a compressor blade with a thermal abrasive coated tip which is more durable, not only in its abrasive properties or qualities, and which attains a reasonable operable life. D7 represents the closest prior art document and discloses a compressor blade with a coated tip having a thermal barrier coating (TBC) of an yttria stabilized zirconia (YSZ) coating comprising 6.5-9 wt.% yttria (see page 3, lines 29 to 32 and page 4, lines 36 to 38). Therefore the objective problem to be solved is to provide a compressor blade with an improved durability. This problem is solved by a coating comprising 11-14 wt.% yttria which is not applied over the entire surface of the compressor blade. The definition of claim 1: "coating consisting of 11-14 wt.% yttria and the balance essentially zirconia" includes only unavoidable impurities and does not allow

to include other abrasive materials such as those mentioned in D7, let alone in amounts of from 10-40 wt.% as indicated therein (see page 3, lines 26 to 28 and claim 2). Although D24 shows that increasing the yttria content increases the durability of an YSZ-TBC coating by reducing or lowering the thermal conductivity thereof there exist a number of different ways to achieve this result as evidenced by e.g. E1 (see page 2, paragraph "introduction").

The TBC coating protects the substrate from the (air) gas flow. There is, however, no indication in D7 that the coating is intended to be an abrasive coating and the same holds true with respect to D10 (see column 2, lines 7 and 8). Additionally, D10 does not disclose the claimed specific blade, i.e. a compressor blade, but only mentions blades or vanes of turbines (see column 1, lines 65 to 68). Furthermore, there exists a prejudice against using a coating with a higher yttria content since the increase of the yttria content causes the coating to become softer, i.e. more abradable. This is proven by E2 which shows decreasing fracture strength and indentation fracture toughness with an yttria content increasing from 4.7 to 13.7 wt.% (see figures 4 and 5). It is admitted that the compressor section works at a lower temperature than the burner section, i.e. below 1200°C.

No further remarks are made with respect to E2 and the remark of the Board that all samples discussed in E2 have been heat treated at 2150°C, so as to be in the cubic phase region.

The above arguments concerning inventive step apply also to the claims of the second to fourth auxiliary requests.

XIII. The respondent argued at the oral proceedings essentially as follows:

The amendment made in dependent claim 2 of the main request contravenes Rule 80 EPC since it is not occasioned by a ground of opposition. A clarity objection does not represent a ground of opposition. Claim 3 of the main request was based on claim 4 as originally filed but does not comprise all features thereof and thus violates Article 123(2) EPC. Claim 4 of the main request has no basis in the application as originally filed since the abradable seal is only mentioned in the context of the prior art (see page 2, line 17 to page 3, line 2 of the application as originally filed). The application as originally filed does not disclose the abradable seal as a part of the invention and this is also not directly derivable for the person skilled in the art.

Since one of the independent claims of the first to fourth auxiliary requests is based on claim 4 of the main request these requests likewise do not comply with Article 123(2) EPC.

Although it is conceded that the objections concerning amendments made in the examination procedure resulting in claims 3 and 4 as granted have not been raised before, it is remarked that an Article 100(c) EPC objection has been raised in the notice of opposition so that these objections can now be raised in the

appeal procedure. Furthermore, there was a change of the representative before the present oral proceedings, with the result that these issues were noticed.

D7 represents the closest prior art for product claim 1 of the first auxiliary request. The difference between the subject-matter of claim 1 and the coated compressor blade according to D7 resides in the yttria content of the YSZ coating being 11-14 wt.% yttria. D10 discloses an YSZ coating comprising 12 wt.% yttria which value falls into the middle of the claimed yttria content range. This material has the required properties for the intended abrasive use of the TBC. It is not apparent as to why this zirconia material should be different from that of the patent in suit. It should also be considered that the term "abrasive" does not provide a clear distinction with respect to the prior art. Every coating can be abrasive if the corresponding seal is selected accordingly. This relative feature merely defines the purpose with respect to the undefined seal material, i.e. to be able to perform an abrading action.

Based on said single distinguishing feature the objective technical problem is defined as to improve the spallation resistance of the TBC which is the same problem as that mentioned in the patent in suit, namely the improved temperature stability of the top coating decreases the likelihood of spalling of the material (see patent, paragraph [0037]). It is, however, already known from the prior art D10 that the spallation resistance can be improved - compared to calcia stabilised zirconia material (see column 1, lines 28 to 35) - by using e.g. 12 wt% yttria stabilised zirconia

material which is insensitive to thermal shock cracking or barrier spallation (see column 2, lines 1 to 8; and example II). It is therefore obvious to the person skilled in the art, in order to solve that same problem, to use the YSZ material disclosed in D10 for coating the tips of the blades. Since D10 discloses the same YSZ material as the patent in suit this material should inherently have the same abrasive properties as that of the patent in suit. Furthermore, although D7 does not explicitly refer to an abrasive coating the property of abrasiveness is mentioned (see claim 2 and page 3, line 23) and thus the question arises as to why the person skilled in the art should not consider the material of D10.

The definition of the coating material "... balance essentially zirconia" according to claim 1 of the first auxiliary request allows for the presence of small amounts of further components which can be more abrasive.

A prejudice cannot be seen, particularly in view of the intended use as an abrasive as specified in claim 1 of the first auxiliary request since the seal material is undefined. Furthermore, the person skilled in the art knows the properties of the YSZ material (see e.g. E3, page 7, lines 2 to 4). From Table 2 of E2 it is known that above 6 mol% yttria (corresponding to 10.5 wt% yttria) no phase transformation takes place. YSZ with 12 wt% yttria is described to be fully stabilised so that the sample with 8 mol% yttria (corresponding to 13.7 wt% yttria) is also fully stabilised, but as it is stated to be suitable as an abrasive top coating the 12 wt% yttria material should likewise be suitable for

this intended purpose. Therefore, the person skilled in the art when considering improving the spallation resistance would substitute the zirconia material of the TBC coating according to D7 with the zirconia material comprising 12 wt.% yttria as disclosed in D10 and thus arrive at the compressor blade of claim 1 in an obvious manner.

The conclusion with respect to claim 1 of the first auxiliary request also applies to claim 1 of the second to fourth auxiliary requests which either concern a gas turbine seal system comprising the compressor blade of claim 1 or which additionally specify that the coating is applied to the compressor blade tip by plasma spraying and that microcracks are formed. Therefore that subject-matter claimed is also rendered obvious by the available prior art D7 and D10.

## **Reasons for the Decision**

1. *Allowability of amendments (Rules 80 and 139 and Article 123 EPC)*
  - 1.1 Claim 2 as granted according to the corrected version EP-B9-0 926 254 of the patent in suit, which only concerns the obvious clerical errors comprised in claim 4 as granted, reads:  
  
"2. The thermal top coating of claim 1, wherein the coating has a thermal conductivity not exceeding one point five watts per meter kelvin (1.15 W/mK)."

Claim 4 as corrected reads:

"4. A gas turbine seal system comprising an abradable seal and a compressor blade which cooperates with said seal, said blade being a blade as claimed in claims 1 or 2."

Claim 2 of the main request reads:

"2. The **compressor blade and** thermal top coating of claim 1, wherein the coating has a thermal conductivity not exceeding one point one five watts per meter kelvin (1.15 W/mK)."

- 1.1.1 The conditions an error in the claims has to fulfil to benefit from a correction are:
- it must be obvious that an error has occurred
  - it must be immediately evident what the correction should be (see G 3/89, OJ EPO 1993, 117, reasons 2 and 3). The Board considers that it may be obvious to the person skilled in the art that an error occurred in the granted claims, as claim 4 refers to the "blade being a blade as claimed in claims 1 or 2" whereas claim 2 is not for a compressor blade, but only for the thermal top coating of claim 1. Such a type of claim is not common, but not excluded either, taking its features from only a part of claim 1 and thus constituting in fact a further independent claim. However, the second condition is not fulfilled, as another solution to resolve this situation would be to delete the reference in claim 4 to claim 2.

Therefore the Board considers that the proposed correction under Rule 139 EPC of claim 2 as granted cannot succeed.

- 1.1.2 As is evident from a comparison of the bold typed parts of claim 2 of the main request and the underlined parts of claim 2 as granted (see point 1.1 above), claim 2 of the main request has been amended to make it a claim dependent on claim 1. However, adding dependent claims **cannot** overcome or deal with any ground of opposition (see Case Law of the Boards of Appeal, 6<sup>th</sup> edition 2010, chapter VII.D.4.1.3a).

Consequently, claim 2 of the main request also contravenes Rule 80 EPC and the main request is therefore not allowable.

- 1.2 The respondent raised objections under Article 123(2) EPC against claims 3 and 4 of the main request at the oral proceedings before the Board.

- 1.2.1 Article 12(2) RPBA requires the parties to present their complete case as early as possible, for the respondent this is the reply to the appeal. The Board notes that the reply of the respondent to the grounds of appeal does not contain any objections of added subject-matter.

- 1.2.2 The reasons for these new objections also do not lie either in the amendments made in appeal to claim 3 as granted (see point VII above) or in an amendment made to claim 4, since claim 4 of the main request is identical with claim 4 as granted, but are related to amendments made during the examination phase of the



application underlying the patent in suit. They also cannot be seen as a consequence of a direction of the Board (Article 12(2)(b) RPBA).

1.2.3 These objections under Article 123(2) EPC have also **not** been raised at any time during the opposition procedure, let alone in the notice of opposition which, with respect to Article 100(c) EPC, only objected to the features corrected as errors in claim 4 (see point III above).

1.2.4 These objections under Article 123(2) EPC are thus to be considered a new attack on the patent in suit with new facts and new arguments which represents an amendment of the respondent's case at a very late stage of the appeal proceedings. The change of the representative shortly before the oral proceedings before the Board cannot justify this very late amendment, either.

1.2.5 The Board, in exercising its discretion according to Article 13(1) RPBA, taking account of the fact that these objections could have been raised much earlier in the proceedings, does not admit this amendment of the respondent's case.

1.3 Furthermore, the Board sees no reason to deviate from the Opposition Division's conclusion in the impugned decision that the claims 1-4 as granted, with the correction of claim 4, complied with Articles 123(2) and (3) EPC (see point 2 of the reasons).

The respondent did not raise any such objection with respect to the actual amendments made to the claims

during the appeal procedure in the first to fourth auxiliary request; the Board is satisfied that the claims according to the first to fourth auxiliary request are formally in order.

2. *Inventive step (Article 56 EPC)*

Taking account of the arguments presented by the two parties the Board considers that it has not been shown that the Opposition Division's was wrong in concluding that the subject-matter claimed in the patent in suit lacks an inventive step. The reasons are as follows:

*First auxiliary request*

2.1 D7 represents undisputedly the closest prior art for product claim 1 for disclosing a compressor blade having its tips coated with a TBC of zirconium-based oxide having a plurality of macrocracks extending at least 100 microns through the coating and a process to produce such a coating (see page 2, lines 5 to 8; and claims 1 and 5).

The object underlying D7 is the provision of a blade for a gas turbine engine whose tip segment is coated with a layer of zirconium-based oxide having a plurality of vertical cracks and which has good rub tolerance when contacting a seal material such as a bare cast superalloy, and of a stabilized zirconia coating for the tip portion of blades for a turbine engine (see page 2, line 57 to page 3, line 7). Said blades are made of a superalloy or a titanium alloy (see claim 3).

The zirconia can be partially stabilized by at least one stabilizing oxide selected from the group consisting of yttria, calcium oxide, cerium oxide, and magnesium oxide with yttria (YSZ) being the preferred one wherein yttria preferably is present in an amount of 6.5-9 wt.%. The stabilizing oxides can be used to partially or fully stabilize the zirconia so as to minimize or prevent any phase transformation that could occur otherwise in pure zirconia at elevated temperatures (see page 3, lines 29 to 32).

2.2 D7 additionally discloses that the YSZ tip coating material is foreseen as an **abrasive** top coating since it should have good rub tolerance when contacting the seal material (see e.g. page 2, lines 23 to 33 and lines 46 to 51). Furthermore, this abrasive property of 7 wt.% yttria YSZ tip coating material is proven by the dimensionless volume wear ratio (VWR), being the ratio of volume wear of the tip to the volume of the seal which ideally should be of the order of 0.05 or less, which value was met by the rub test results according to the examples A to C as presented in the table at page 5 (see page 5, lines 29 to 56). From the VWR value of 0.05 it can be concluded that the tip coating material is much more abrasive than the seal material, i.e. that the latter material is abraded by the former.

This abrasive property is likewise derivable from the statement in D7 that "the tip of the blade has a zirconium based oxide coating with embedded particles **more abrasive** than zirconia" (see page 3, lines 3 to 5 and lines 23 to 28) which implies that the zirconia material *per se* is already abrasive. This fact, however, in any case is part of the general knowledge of the

person skilled in the art since zirconia is used as an abrasive material, e.g. for making coated abrasives.

2.2.1 Consequently, the appellant's arguments to the contrary cannot hold.

2.2.2 It is, on the other hand, clear that the definition of claim 1 "... top coating consisting of from eleven to fourteen (11 to 14 wt.%) yttria and the **balance essentially** zirconia" excludes the presence of further abrasive components such as alumina, chromia, etc. as argued by the respondent and only includes unavoidable impurities. The respondent's arguments in this respect therefore cannot be accepted.

2.3 The subject-matter of claim 1 of the first auxiliary request is thus distinguished from the compressor blade having a tip with a thermal abrasive top coating of yttria stabilized zirconia according to D7 in that the content of the stabilizing yttria in the zirconia material is 11-14 wt.%, compared to either the general disclosure of using partially or fully yttria stabilized zirconia, or compared to the specific embodiments made with partially stabilized zirconia containing 6.5-9 wt.% yttria.

2.4 This difference improves the resistance to corrosion and provides better temperature stability which decreases the likelihood of spalling of the top coating material, so that the substrate material remains protected from the corrosive effects of the sulfides and salts from the ambient environmental conditions (see patent in suit, paragraph [0037]).

- 2.5 Therefore the objective technical problem starting from the compressor blade having the coated tip according to D7, which requires the presence of a partially or fully YSZ abrasive thermal top coating, is the provision of an improved spallation resistance to the top coating on the tip of said compressor blade.
- 2.6 This problem is solved by the compressor blade as defined in claim 1 of the first auxiliary request.
- 2.7 The subject-matter of claim 1 of the first auxiliary request is, however, obvious for the following reasons:
- 2.8 From D10 it is known that the spallation resistance of a TBC can be improved - compared to calcia stabilised zirconia material (see column 1, lines 28 to 35) - by using 12 wt% yttria containing YSZ material which is insensitive to thermal shock cracking or barrier spallation (see column 2, lines 1 to 8; and example II).
- 2.8.1 The Board therefore considers that it is obvious to the person skilled in the art to use the YSZ material disclosed in D10 for coating the tips of the compressor blades of D7 in order to solve the aforementioned technical problem.
- 2.8.2 Since D10 discloses the same YSZ material as the patent in suit this YSZ material inherently has the same abrasive properties as that of the patent in suit and thus the question arises as to why the person skilled in the art would not consider the YSZ material of D10 having the higher yttria content of 12 wt.% as a solution to this problem. The Board could not find any reason, particularly when considering the more general

teaching of D7 that the TBC of the tip portion of the compressor blade may either be "partially or fully stabilized". "Partially yttria stabilized" means for example the 6.5-9 wt.% yttria disclosed in D7, while according to D10 zirconia with 12 wt.% yttria is stated to be "totally stabilized" (see example II) and thus to fall within the "fully stabilized" as defined in D7.

2.9 The appellant's arguments to the contrary cannot hold.

2.9.1 First of all, it is not credible that the person skilled in the art would refrain from using the 12 wt.% yttria containing YSZ material, for the reason that D10 discusses only turbine blades and not compressor blades as the substrate. The person skilled in the art can be expected to look for solutions to the posed problem, i.e. to improve the spallation resistance of the TBC on a metallic substrate, in all fields where this problem can occur, which in any case applies in like manner to compressor blades and turbine blades.

2.9.2 Secondly, the Board is unable to acknowledge a prejudice against using an YSZ material having an increased yttria content, which according to the appellant causes the coating to become softer and thus more abradable, on the basis of E2.

The YSZ material discussed in E2 contained 2.6 to 8.0 mol% yttria (corresponding to 4.7 to 13.7 wt.%) and was heat-treated at 2150°C in order to bring it into the cubic phase and then quenched to 1100°C to undergo the cubic to t' phase transformation, i.e. the **non-transformable tetragonal phase** which avoids the problems of material degradation in partially

stabilized zirconia (see E2, page 2, "Introduction", second and third paragraph; page 3, "Results and Discussion", first paragraph). Consequently, the fracture strength diagram and indentation fracture toughness diagram according to figures 4 and 5 of E2, respectively, which show a more or less linear decrease of the fracture strength or fracture toughness with an increase of the yttria content, does **not** apply to a non-heat treated YSZ material.

- 2.9.3 Even if one would consider E2 as being relevant then the YSZ sample with 13.7 wt.% yttria falls within the claimed range of from 11-14 wt.% according to claim 1 of the first auxiliary request which implies that the fracture strength and/or fracture toughness of this material is apparently sufficient, even though it is more abradable than that disclosed by the preferred embodiment according to D7, namely with 6.5-9 wt.% and which embraces the sample of E2 with 4.5 mol% yttria (corresponding to 7.9 wt.%).

Table 2 of E2 teaches the person skilled in the art that no further phase transformation takes place after a high temperature annealing treatment at 1600°C for 20 hours of the YSZ material when the yttria content is 6.0 mol% (= 10.5 wt.%) or above and thus clearly also suggests to work in the range of from 10.5-13.7 wt.% yttria.

- 2.9.4 Thirdly, although it is true that there exist many ways of reducing the thermal conductivity of YSZ as mentioned in e.g. E1 (see page 1, paragraph "Introduction") the person skilled in the art is looking for a solution to the spallation problem. The

skilled person additionally uses his general knowledge that increasing the yttria content of an YSZ-TBC increases the durability of a turbine component by lowering the thermal conductivity from the TBC to the substrate (see e.g. D24, Tables I and II).

- 2.9.5 Furthermore, it also belongs to the knowledge of the person skilled in the art, as admitted by the appellant in its letter dated 19 July 2010 (see page 4, sixth paragraph), that the partially stabilized 7 wt.% yttria containing YSZ, being in the tetragonal and cubic phase (see in this context the phase diagram of zirconia and yttria in E4, figure 3) is a strong, effective erosion resistant material while the 20 wt.% yttria containing fully stabilised YSZ is only in the cubic phase and is thus much softer and abradable (see E3, page 6, line 57 to page 7, line 5). Thus it is clear that the person skilled in the art when looking for an abrasive YSZ material would consider only those materials comprising the tetragonal phase and not those comprising only the cubic phase, thus working in the claimed range.
- 2.9.6 Therefore the subject-matter of claim 1 of the first auxiliary request lacks an inventive step. The first auxiliary request is therefore not allowable.

*Second auxiliary request*

3. The above conclusion of point 2.9.6 applies *mutatis mutandis* to the subject-matter of independent claim 1 of the second auxiliary request - being directed to a gas turbine seal system comprising an abradable seal and the tip coated compressor blade according to claim 1 of the first auxiliary request (see point IX



above) - since the compressor blade of D7 inherently is used in such a gas turbine seal system with an abradable seal (see D7, page lines 23 to 45 in combination with page 3, lines 6 and 7, and page 5, lines 39 to 42).

The subject-matter of claim 1 of the second auxiliary request therefore likewise lacks an inventive step and the second auxiliary request is thus not allowable.

*Third auxiliary request*

4. Claim 1 of the third auxiliary request differs from claim 1 of the first auxiliary request in that it additionally defines plasma spraying of the YSZ over an adherent bond coat on the metallic substrate and that microcracks essentially perpendicular to the bond coat extend through the top coat to the bond coat (see point X above).

4.1 According to D7 the compressor blade is made from a superalloy or a titanium alloy and a MCrAlY bond coat is disposed between the YSZ TBC layer and the substrate (see claims 1 and 3). Furthermore, the TBC is applied on the compressor blade tip by plasma spraying the YSZ material which results in vertical macrocracks through the deposited layer (see e.g. page 4, lines 7 to 20), i.e. perpendicular to the bond coat.

The appellant has never argued that these macrocracks according to D7 do not correspond to the microcracks according to claim 1 of the third auxiliary request.

4.2 The subject-matter of claim 1 of the second auxiliary request therefore likewise lacks an inventive step and the second auxiliary request is thus not allowable.

*Fourth auxiliary request*

5. The above conclusion of point 4.2 applies *mutatis mutandis* to the subject-matter of independent claim 1 of the fourth auxiliary request - being directed to a gas turbine seal system comprising an abradable seal and the tip coated compressor blade according to claim 1 of the first auxiliary request (see point XI above) - since the compressor blade of D7 inherently is used in such a gas turbine seal system with an abradable seal (see D7, page lines 23 to 45 in combination with page 3, lines 6 and 7, and page 5, lines 39 to 42).

The subject-matter of claim 1 of the fourth auxiliary request therefore also lacks an inventive step and the fourth auxiliary request is thus not allowable, either.

**Order**

**For these reasons it is decided that:**

The appeal is dismissed.

The Registrar:

The Chairman:

G. Nachtigall

H. Meinders