

**Internal distribution code:**

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

**Datasheet for the decision  
of 6 December 2021**

**Case Number:** T 0612/18 - 3.2.03

**Application Number:** 07253170.0

**Publication Number:** 1889940

**IPC:** C23C4/18, C23C28/00, C23C4/02,  
C23C28/04, C23C4/12

**Language of the proceedings:** EN

**Title of invention:**  
Thermal barrier coating with a plasma spray top layer

**Patent Proprietor:**  
Raytheon Technologies Corporation

**Opponent:**  
Siemens Aktiengesellschaft

**Headword:**

**Relevant legal provisions:**  
EPC Art. 56, 100(b)  
RPBA 2020 Art. 12(1)(a), 12(2), 13(2)

**Keyword:**

Amendment after summons - taken into account (yes)  
Grounds for opposition - insufficiency of disclosure (no)  
Inventive step - (yes)

**Decisions cited:**

T 0617/16, T 2603/18, T 0305/87, J 0014/19

**Catchword:**



**Beschwerdekammern**  
**Boards of Appeal**  
**Chambres de recours**

Boards of Appeal of the  
European Patent Office  
Richard-Reitzner-Allee 8  
85540 Haar  
GERMANY  
Tel. +49 (0)89 2399-0  
Fax +49 (0)89 2399-4465

Case Number: T 0612/18 - 3.2.03

**D E C I S I O N**  
**of Technical Board of Appeal 3.2.03**  
**of 6 December 2021**

**Appellant:** Siemens Aktiengesellschaft  
(Opponent) Werner-von-Siemens-Straße 1  
80333 München (DE)

**Representative:** PATERIS Patentanwälte PartmbB  
Markgrafenstrasse 22  
10117 Berlin (DE)

**Respondent:** Raytheon Technologies Corporation  
(Patent Proprietor) 10 Farm Springs Road  
Farmington, CT 06032 (US)

**Representative:** Dehns  
St. Bride's House  
10 Salisbury Square  
London EC4Y 8JD (GB)

**Decision under appeal:** **Decision of the Opposition Division of the  
European Patent Office posted on 10 January 2018  
rejecting the opposition filed against European  
patent No. 1889940 pursuant to Article 101(2)  
EPC.**

**Composition of the Board:**

**Chairman** C. Herberhold  
**Members:** G. Patton  
N. Obrovski

## Summary of Facts and Submissions

- I. European patent No. 1 889 940 B1 ("the patent") relates to a turbine engine component comprising a substrate, a thermal barrier coating deposited onto the substrate and a plasma sprayed sealing layer deposited onto the thermal barrier coating layer. It also relates to a method for forming a coating on a turbine engine component.
- II. An opposition was filed against the patent as a whole based on Article 100(a) EPC (lack of novelty and lack of inventive step) and Article 100(b) EPC (insufficiency of disclosure).

The Opposition Division held, *inter alia*, that:

- the ground for opposition based on Article 100(b) EPC did not prejudice the maintenance of the patent (claims 7 and 8)
- the subject-matter of independent claims 1 and 7 was novel in view of E3 and E5
- the subject-matter of independent claims 1 and 7 involved an inventive step starting from either E3 or E5 taken as the closest prior art

The opposition was rejected, and the patent was maintained as granted.

The opponent lodged an appeal against the Opposition Division's decision.

- III. In a communication pursuant to Article 15(1) RPBA 2020 annexed to the summons to oral proceedings dated 24 April 2020, the Board provided its preliminary, non-binding opinion to the parties that the subject-matter

of claim 1 of the main request could be seen as lacking inventive step starting from E5.

The patent proprietor reacted with the letter dated 20 August 2021, to which the opponent replied by letter dated 9 September 2021.

Oral proceedings were held on 6 December 2021. For matters that arose during the oral proceedings, in particular the issues discussed with the parties and their requests, reference is made to the minutes.

The order of the present decision was announced at the end of the oral proceedings.

- IV. The opponent (hereinafter the "appellant") requested that the decision under appeal be set aside and that the patent be revoked. It further requested that the eighth and ninth auxiliary requests as well as the contents of the respondent's submission dated 20 August 2021 not be admitted into the proceedings.

The patent proprietor (hereinafter the "respondent") requested that the appeal be rejected and that the patent be maintained as granted (main request) or, alternatively, on the basis of one of the first to ninth auxiliary requests filed with the reply to the statement of grounds of appeal dated 2 August 2018.

- V. The following documents considered in the opposition proceedings are relevant to the present decision:

E3: EP 1 340 833 A

E5: EP 1 559 811 A

E10: WO 01/83851 A

E19: Printout of slides, "Therm. Spritzen Einführung

Praktikum", Termische Verfahren der  
Oberflächenveredelung, Institut für  
Fertigungstechnologie keramischer Bauteile (IFKB),  
University of Stuttgart, 2004, 18 pages

VI. Claim 1 of the **main request** reads as follows with the  
feature numbering used by the parties:

"1. A turbine engine component (10) comprising: a  
substrate (12); and characterised by

- 1.1 a thermal barrier coating (14) deposited onto  
said substrate
  - 1.1.1 said barrier coating comprising one or  
more layers of a gadolinia stabilised  
zirconia material
    - 1.1.1.1 which consists of from 30 to 70 wt%  
gadolinia and the balance zirconia  
and
    - 1.1.1.2 having a porosity of from 10 to  
20%; and
  - 1.2 means (16) for sealing an outer surface of said  
thermal barrier coating (14) and limiting  
molten sand penetration deposited into said  
thermal barrier coating (14),
    - 1.2.1 wherein said sealing means comprises a  
plasma sprayed outer ceramic layer (16)  
deposited onto said thermal barrier  
coating (14),
      - 1.2.1.1 said outer ceramic layer (16)  
consisting of yttria stabilized  
zirconia and
      - 1.2.1.2 having a porosity in the range of  
from 2.0 to 30%."

Claim 7 of the **main request** reads as follows with the  
feature numbering used by the parties:

"7. A method for forming a coating on a turbine engine component (10) comprising the steps of:

- 7.1 depositing a thermal barrier coating (14) comprising
  - 7.1.1 one or more layers of gadolinia stabilized zirconia onto a surface of said turbine engine component (10),
  - 7.1.2 said coating (14) having a porosity of from 10 to 20% and
  - 7.1.3 wherein said gadolinia zirconia consists of 30 to 70 wt% gadolinia, balance zirconia; and
- 7.2 plasma spraying a sealing layer (16)
  - 7.2.1 composed of a yttria stabilized zirconia
  - 7.2.2 having a porosity of from 2.0 to 30% onto said thermal barrier coating (14),
  - 7.2.3 forming a plurality of splats of said yttria stabilised zirconia material and allowing said splats to build up and form defects including cracks, said porosity, and splat boundaries
  - 7.2.4 which act as a barrier to prevent the penetration of molten sand into said thermal barrier coating,
  - 7.2.5 wherein said plasma spraying step comprises depositing said sealing layer (16)
    - 7.2.5.1 using a plasma spray gun
      - 7.2.5.1.1 operating at from 30 to 70 volts
      - 7.2.5.1.2 and from 300 to 900 amps
      - 7.2.5.1.3 and a ceramic powder flow rate of from 30 to 70 grams per minute."

Dependent claim 8 of the **main request** reads as follows:

"The method of claim 7, wherein said thermal barrier coating step comprises depositing a ceramic material at a temperature of from 1700 to 2000°F (927 to 1093°C), a pressure of from 0.05 to 2.0 millitons (6.7 to 267 millipascal), and a feed rate of from 0.3 to 2.0 inches (7.62 to 50.8 mm) per hour."

In view of the outcome on the main request, there is no need to recite the wording of the claims of the auxiliary requests.

VII. The appellant essentially argued as follows (the arguments are discussed in more detail in "Reasons for the Decision" below where appropriate).

*Main request - sufficiency of disclosure*

Because of information missing from the patent, the skilled person was not able to perform the invention in accordance with claim 7 in view of the many parameters required for obtaining the claimed porosity from 2.0 to 30 % and the splats and defects of the sealing layer.

The skilled person was not able to carry out the invention in accordance with claim 8 because the undefined feature "*feed rate of from 0.3 to 2.0 inches per hour*" made no technical sense.

*Late-filed letter - admission of contents*

The respondent's letter dated 20 August 2021 was filed late, more than one year after the first notification of the summons to oral proceedings dated 24 April 2020. There were no exceptional circumstances pursuant to



Article 13(2) RPBA 2020 for admitting the respondent's new arguments submitted with the letter.

*Main request - claim 1 - inventive step*

Document E5, taken as the closest prior art, disclosed all the features of claim 1 of the main request, except for the porosity level of the thermal barrier coating (hereinafter "TBC", feature 1.1.1.2).

Plasma-spray was explicitly disclosed in E5 for the deposition of the outer ceramic layer. In any case, the structure of the resulting layer could not be differentiated from that obtained by other methods, such as PVD (physical vapour deposition) or EB-PVD (electron beam physical vapour deposition) explicitly mentioned in E5 for the outer ceramic layer. The process feature 1.2.1 could therefore not be a distinguishing feature over the disclosure of E5. In any case, it was not associated with any technical effect.

Nor was any technical effect associated with distinguishing feature 1.1.1.2 (porosity level of the TBC) in view of the patent as a whole. The problem to be solved could thus be seen as the provision of a suitable porosity for a TBC.

As the claimed porosity range of the TBC was either taught by E10 or part of the skilled person's routine work, the subject-matter of claim 1 lacked inventive step starting from E5.

Hence, the subject-matter of claim 1 of the main request did not involve an inventive step starting from E5.

Document E3, taken as the closest prior art, disclosed all features of claim 1, except for the claimed porosity ranges (features 1.1.1.2 and 1.2.1.2). Plasma-spray was the preferred technique for the deposition of the outer layer in the disclosure of E3.

Since according to claim 1 as granted the TBC and the outer layer could exhibit the same porosity or the TBC could even have a lower porosity than that of the outer layer, the alleged problem to be solved of providing a barrier to prevent the penetration of molten sand into the TBC was not solved over the whole range claimed.

In consequence, the technical problem to be solved was merely the provision of a coating system comprising a TBC and an outer layer with a certain porosity. As a merely arbitrary choice from a host of possible solutions, the subject-matter of claim 1 lacked inventive step starting from E3.

In any case, the claimed porosity of the outer layer (feature 1.2.1.2) did not have on its own a technical effect as many other unspecified parameters were necessary to prevent the penetration of molten sand into the TBC, such as a certain thickness of the layer or its exact composition.

Furthermore, no technical effect was associated with the claimed porosity of the TBC in view of the patent as a whole.

Hence, the subject-matter of claim 1 of the main request did not involve an inventive step starting from E3.

*Main request - claim 7 - inventive step*

Document E5, taken as the closest prior art, disclosed all features of claim 7, except for feature 7.1.2 (porosity of the TBC) and the specific process parameters of plasma spray (features 7.2.5.1.1, 7.2.5.1.2 and 7.2.5.1.3). E5, paragraphs 30, 31 and 32 disclosed the deposition of the outer ceramic layer by plasma-spray.

Feature 7.1.2 (porosity of the TBC) did not justify an inventive step for the same reasons given for claim 1 in view of feature 1.1.1.2.

According to the patent, the problem to be solved with respect to the plasma-spray process parameters could be seen as finding a suitable amperage, voltage and powder feed rate for obtaining the claimed porosity of the outer ceramic layer (feature 7.2.2).

However, it was doubted that every plasma-spray process with features 7.2.5.1.1, 7.2.5.1.2 and 7.2.5.1.3 yielded a coating with the claimed properties since many other parameters influenced the resulting coating properties (see for instance E19, pages 4, 5 and 8).

As the objective technical problem was not solved over the whole claimed range, the objective technical problem to be solved could be seen as providing process parameters for a plasma-spray process suitable for the deposition of an outer layer of a TBC system.

Whichever the technical problems to be considered, the subject-matter of claim 7 did not involve an inventive step with regard to E5 in combination with the

knowledge and routine work of the person skilled in the art.

E5, page 7, lines 15 to 16 disclosed a torch power overlapping the power range obtainable by using the voltage and amperage of features 7.2.5.1.1 and 7.2.5.1.2. E5, page 7, line 13 also mentioned powder feed rate as a relevant plasma-spray parameter. Thus, the person skilled in the art was prompted to adjust this parameter.

Since the claimed ranges for the plasma-spray gun parameters and the porosity were large, finding suitable parameters according to features 7.2.5.1.1, 7.2.5.1.2 and 7.2.5.1.3 did not go beyond the routine work of the person skilled in the art.

E3, paragraph 31 also disclosed the deposition of a ceramic top coat by an air plasma process using parameters falling within the claimed ranges.

Thus, the subject-matter of claim 7 also lacked inventive step starting from E5 in combination with the teaching of E3.

The subject-matter of claim 7 lacked inventive step also in view of E3 taken as the closest prior art for the same reasons as those given for claim 1 when starting from E3, taking into consideration the guidance given in E3 for the selection of the process parameters (features 7.2.5.1.1, 7.2.5.1.2 and 7.2.5.1.3).

VIII. The respondent essentially argued as follows (the arguments are discussed in more detail in "Reasons for the Decision" below where appropriate).

*Main request - sufficiency of disclosure*

The skilled person was well aware of the process parameters used in plasma-spray and how they influenced porosity. Splats and cracks were inevitably formed in plasma-spray.

The skilled person would immediately realise that the feed rate related to the feed ingot, i.e. the feedstock.

The skilled person was therefore able to carry out the invention according to claims 7 and 8.

*Late-filed letter - admission of contents*

The arguments put forward in the respondent's letter dated 20 August 2021 did not represent an amendment to the appeal case as they were already present in the reply to the statement setting out the grounds of appeal but just stated differently.

*Main request - claim 1 - inventive step*

Document E5, taken as the closest prior art, did not hint at gadolinia stabilised zirconia (hereinafter "GSZ") for the TBC material (features 1.1.1 and 1.1.1.1), nor did it hint at the process feature "plasma-spray" for the deposition of the outer ceramic layer (feature 1.2.1). A selection had also to be performed for the material of the outer layer (feature

1.2.1.1), and E5 did not disclose the porosity level of the TBC (feature 1.1.1.2).

Plasma spraying inevitably implied the formation of splats and cracks, making it possible to differentiate the claimed product from a product obtained by any other coating method, e.g. by EB-PVD, which typically led to a columnar structure of the layer. Given the technical effects associated with the splats and cracks, the problem to be solved could be seen as the provision of a coating to prevent the penetration of molten sand into the TBC.

The skilled person had no reason to select plasma-spray among the several possibilities described in E5 in view of the problem to be solved as E5 aimed at solving a different problem, namely that of high energy solid particles impacting and fracturing the TBC of airfoils, and favoured EB-PVD for obtaining outer layers with high fracture toughness.

E10 did not disclose yttria stabilised zirconia (hereinafter "YSZ") as a top coat for a TBC.

Hence, the subject-matter of claim 1 of the main request involved an inventive step starting from E5.

Document E3, taken as the closest prior art, did not disclose the materials of the TBC and the outer layer (features 1.1.1, 1.1.1.1 and 1.2.1.1), nor their respective claimed porosity ranges (features 1.1.1.2 and 1.2.1.2).

Given the technical effects associated with at least the porosity range of the outer ceramic layer (feature 1.2.1.2), the problem to be solved was to provide a

coating that prevents the penetration of molten sand into the TBC.

Since E5 aimed at solving a different problem (impact of solid particles), there was no motivation for the skilled person to select the combination of GSZ, YSZ and plasma-spray in the disclosure of E5.

Hence, the subject-matter of claim 1 of the main request involved an inventive step starting from E3.

*Main request - claim 7 - inventive step*

In addition to the distinguishing features in relation to claim 1, which were also present in claim 7, document E5, taken as the closest prior art, did not disclose the claimed plasma-spray technique either.

The technical effect associated with plasma-spray was to provide the porosity and sealing effect of the outer layer for protection against infiltration of molten sand.

The claimed solution was not disclosed nor suggested in any of the prior-art documents, which were not concerned with overcoming the problem of molten sand infiltration.

Plasma-spray was less preferred than PVD or EB-PVD in E5, motivating the skilled person to apply an outer layer by PVD or EB-PVD. A PVD or EB-PVD outer layer had, however, a columnar structure, which did not solve the problem posed, in contrast to the splats and cracks (feature 7.2.3) resulting from plasma-spray.

Although E3 mentioned plasma-spray, there was nothing in E3 to motivate the skilled person to select it for the outer coating with the expectation of solving the above given problem with respect to molten sand. Hence, the subject-matter of claim 7 of the main request involved an inventive step starting from E5.

The same arguments provided for claim 1 starting from E3 applied to claim 7.

## **Reasons for the Decision**

### **1. *Late-filed document E19***

Since late-filed document E19 was admitted by the Opposition Division and became part of the decision under appeal (see point II.2), the Board considers that this document is also subject to its review of the decision under appeal in the appeal proceedings (see T 617/16, point 1.1.1 of the Reasons; T 2603/18, point 1 of the reasons and Case Law of the Boards of Appeal, 9th Edition 2019, chapter V.A.3.5.4).

Furthermore, the Board concurs with the decision under appeal, uncontested by the respondent, that the content of E19 belonged to the skilled person's common general knowledge before the priority date of the contested patent.

### **2. *Main request - sufficiency of the disclosure***

The following was the Board's preliminary opinion provided to the parties in the communication dated 24 April 2020, point 5. It has not been subsequently commented on or contested by the parties. At the oral



proceedings, both parties referred to their written submissions. The Board, after reconsidering the parties' submissions, saw no reason to depart from its preliminary opinion.

2.1 Claim 7

2.1.1 The appellant submits that because of information missing from the patent, the skilled person was not able to perform the invention in accordance with claim 7.

The skilled person had to consider a wide range of parameters as shown in E19, page 4, lower chart; page 8, upper chart and page 14, upper chart and confirmed by E5, paragraph 31, possibly with large ranges and interaction with each other. This did not enable them without undue burden to find suitable process parameters for obtaining the claimed porosity from 2.0 to 30 % for the sealing layer (feature 7.2.2). The same applied for obtaining the splats and defects of feature 7.2.3.

According to the appellant, the contested patent lacked an embodiment showing appropriate process parameters and was no more than an invitation to perform a research programme to identify such suitable process parameters.

2.1.2 The Board does not share the appellant's view.

The skilled person is well enough aware of the process parameters used in plasma-spray and how they influence porosity in one way or another to be able to obtain the claimed range. Furthermore, splats and cracks are inevitably formed in plasma-spray.

Hence, based on the disclosure of the contested patent, paragraph 14 and their common general knowledge, the skilled person is able to carry out the invention in accordance with claim 7 (see decision under appeal, point II.3.1).

2.2 Claim 8

2.2.1 In the appellant's view, the skilled person was not able to perform the invention in accordance with claim 8 because of the undefined feature "*feed rate of from 0.3 to 2.0 inches per hour*", which did not make sense.

2.2.2 The Board does not share the appellant's view.

The skilled person would immediately realise, based on their common general knowledge, that the feed rate relates to the feed ingot, i.e. the feedstock, making them able to carry out the invention in accordance with claim 8 (see decision under appeal, point II.3.2).

In addition, the objection raised by the appellant relates to clarity, which is not a ground for opposition.

3. *Late-filed letter - admittance of contents*

3.1 The appellant contests the admittance into the proceedings of the contents of the respondent's submission dated 20 August 2021, arguing that it was filed late, more than one year after the first notification of the summons to oral proceedings dated 24 April 2020. There were no exceptional circumstances

pursuant to Article 13(2) RPBA 2020 justifying the admittance of this new submission.

Asked at the oral proceedings before the Board about what in this submission went beyond the respondent's previous written submissions, the appellant referred to the mention of T 305/87 and the "two-lists principle" on page 3.

3.2 The Board does not share the appellant's view.

The term "two-lists principle" was indeed not explicitly mentioned in the respondent's previous written submissions, nor was T 305/87, which concerns this principle. In substance, however, the respondent's previous line of argument for inventive step already related to such a selection from two or more lists, as is apparent from the reply to the statement of the grounds of appeal, for instance from the following passage on page 4, third paragraph:

*"[T]he present invention solves this problem, i.e. improving the resistance to molten sand penetration into a thermal barrier coating so as to prevent distress to that coating, by (i) **selecting a GSZ layer** with the optimum amount of gadolinia and porosity for the afore-mentioned reaction, **in combination with (ii) an outer layer which has composition, deposition method and porosity selected** to slow down infiltration of the molten sand, thus allowing sufficient time for reaction of the molten sand with the GSZ to form the protective reaction product"* (emphasis by the Board).

Hence, the respondent's submission dated 20 August 2021 did not contain any new factual element which would

represent an amendment to the respondent's appeal case. Instead, the respondent only refined its previous line of argument in that submission (see J 14/19, Reasons 1.8).

3.3 In the absence of an amendment of the appeal case within the meaning of Article 13 RPBA 2020, the contents of the respondent's submission dated 20 August 2021 are taken into account.

4. *Main request - claim 1 - inventive step*

The appellant contests that the subject-matter of claim 1 of the main request involves an inventive step starting from either E5 or E3 as the closest prior art.

4.1 Starting from E5

The Board agrees with both parties that E5 can be regarded as a suitable closest prior art for claim 1 since it relates to the same technical field of turbine engine components comprising a TBC on a substrate (see, for instance, paragraphs 8 and 17; claims 8 and 9).

4.1.1 Disclosure of E5

E5 discloses a turbine engine component (10) comprising:

a substrate (14); and

a TBC ("ceramic thermal barrier coating", "inner layer" 26) deposited onto the substrate (14), optionally onto a bond coat layer (18) like in paragraph 13 and claim 2 of the contested patent;

and means ("protective outer layer" 30) for sealing an outer surface of the TBC (26) and *de facto* limiting any

environmental contaminants penetration deposited into the TBC (26), i.e. including molten sand, where the sealing means comprises an outer ceramic layer (30) deposited onto the TBC (26), the outer ceramic layer (30) consisting of yttria stabilised zirconia (YSZ) and having a porosity of 10 to 20%, i.e. falling within the claimed range of from 2.0 to 30% (paragraphs 8, 11, 17 and 26; claims 1, 4 and 5).

- 4.1.2 The respondent argues that the skilled person had to make a selection among the long list of possible materials in paragraphs 23 to 25 of E5 for the material of the protective outer layer, suggesting that feature 1.2.1.1 was not disclosed in E5.

The Board does not share this view since the claimed material of the outer layer as well as the corresponding porosity correspond to a preferred embodiment of E5 as is apparent from the combination of claims 1, 4 and 5 (see also paragraphs 23 to 27; Table 1; Figure 2).

- 4.1.3 The respondent also contests that E5 discloses:  
a barrier coating comprising one or more layers of a gadolinia stabilised zirconia (GSZ) material which consists of from 30 to 70 wt% gadolinia, the balance zirconia and having the claimed porosity (features 1.1.1, 1.1.1.1 and 1.1.1.2)

It argues that E5 provided a long list of more than one hundred options in paragraphs 11 to 13 of possible materials for the inner layer, with no particular emphasis on GSZ. The skilled person had to make a selection from the long list in light of their knowledge of suitable candidates for the TBC materials. They would not have selected GSZ since YSZ was

disclosed in E5, page 2, lines 20 to 21 and 29 to 30 as being the conventional TBC material at the priority date of the patent, as it also was in E10, page 1, lines 16 to 17. GSZ was not a well-established TBC material at that time and, hence, had not been considered as equally suitable. Thus, YSZ would have been selected by the skilled person as the suitable material instead of GSZ. The combination of GSZ as the TBC material with YSZ as the outer layer material was neither disclosed nor suggested in E5.

The Board agrees with the respondent that no specific emphasis is made in E5 on any of the compositions listed for the inner layer in paragraphs 11 to 13. However, contrary to the respondent's view, E5, page 3, lines 43 to 50 explicitly discloses that GSZ ("gadolinium-zirconate") is a suitable TBC material. The passages of E5 referred to by the respondent, allegedly presenting YSZ as the preferred TBC material and GSZ as not equally suitable, concern the prior art of E5, not the disclosure of the invention of E5.

As discussed under point 4.1.2 above, the invention of E5 focuses on the material of the outer protective layer (30), more particularly on YSZ (see also paragraphs 6 to 8). This implies for the skilled reader that any of the compositions given in the single list of E5 for the inner layer is equally suitable, i.e. including GSZ (gadolinium-zirconate), in combination with the material of the outer protective layer of the invention of E5, page 3, line 46. In this respect, the two-or-more-lists principle invoked by the respondent does not apply.

As a result, the combination of GSZ material for the inner layer and YSZ material for the protective outer material is disclosed in E5.

- 4.1.4 The appellant contests the finding of the decision under appeal, point II.4.2, that E5 does not disclose that the outer ceramic layer deposited onto the TBC is plasma sprayed (feature 1.2.1).

The appellant refers to paragraph 32 of E5 disclosing that the outer protective layer (30) "*can be applied, deposited or otherwise formed on inner layer 26 by any of the techniques previously described*".

This encompasses *de facto* all the techniques described from paragraph 28 to 31, i.e. not only those of paragraph 31 as suggested by the appellant mentioning plasma-spray. Taking this into account, it appears, as argued by the respondent, that physical vapour deposition (PVD) or electron beam physical vapour deposition (EB-PVD) are the methods applied and preferred in E5 for the deposition of the outer protective layer since they are further described in paragraph 32 (see also claim 11). Hence, the Board considers that the skilled person would not directly and unambiguously derive from E5 that the outer layer would be obtained by plasma-spray.

In addition, the Board concurs with the respondent that plasma-spray inevitably leads to the creation of splats and cracks in the layer (see the patent, paragraph 15; E5, page 6, lines 46 to 47 and E3, paragraph 29). Hence, the outer ceramic layer of the product of claim 1 inevitably comprises splats and cracks as a result of this process feature.

The appellant has not convincingly proven that one of the other processes mentioned in E5, in particular PVD or EB-PVD, would lead to such structural features for the applied coating. On the contrary, such processes are known to provide columnar structures (see E5, page 6, lines 45 to 49 and E3, paragraphs 6 and 7). This would enable unambiguously distinguishing the outer ceramic layer of the claimed product from those obtained by other techniques such as PVD or EB-PVD. Paragraph 12 of the patent referred to by the appellant, in which several methods are mentioned for the TBC, does not contradict this view.

Therefore, the Board considers that the structure of the outer protective layer obtained by feature 1.2.1 enables distinguishing the product of claim 1 from that disclosed in E5.

The Board concurs with both parties that E5 does not disclose feature 1.1.1.2.

4.1.5 In view of the above, E5 does not disclose the following feature of claim 1 (see also decision under appeal, point II.4.2):

- the TBC has a porosity of from 10 to 20% (feature 1.1.1.2)
- the sealing means comprises a plasma sprayed outer ceramic layer deposited onto the TBC (feature 1.2.1)

4.1.6 The Board shares the respondent's view that the distinguishing feature 1.2.1 (plasma-spray) results in a structure of the outer ceramic layer with splats and cracks acting as a barrier to prevent the penetration of molten sand into the TBC below due to its more tortuous path (see patent, paragraph 15). Hence,



contrary to the appellant's view, this feature is linked to a technical effect.

- 4.1.7 The problem to be solved on the basis of this distinguishing feature can then be seen as providing a coating preventing the penetration of molten sand into the TBC (see patent, paragraphs 3, 5 and 16).
- 4.1.8 The skilled person would have no reason to select plasma-spray among the several possibilities described in E5 (see paragraph 28, first sentence) when facing the problem to be solved set out above. As a matter of fact, the problem as such is not mentioned in E5, which deals with the impact of small particles and sand (see paragraph 4, last sentence and paragraph 5), i.e. not the penetration of molten sand. Furthermore, E5 discourages applying the claimed solution by referring to the sponge-like porous structure of open pores obtained by plasma-spray in contrast to coatings obtained by the "useful" PVD or EB-PVD techniques in forming TBCs having strain-tolerant columnar structure (see paragraph 28, lines 45 to 49 and paragraph 32).

Document E10 discloses plasma-spray of YSZ coatings. However, it does not disclose depositing an outer YSZ layer by plasma-spray onto a GSZ TBC as claimed (see examples I to V on pages 7 to 10, claim 1). Hence, should the skilled person think of combining D10's teaching on the outer layer with that of E5, they would not arrive at the claimed subject-matter.

The same applies with respect to E3, which neither directly and unambiguously discloses nor suggests, contrary to the appellant's view, YSZ for the outer layer (see E3, paragraphs 28 to 34). Claim 13 of E3, referred to by the appellant, is a general disclosure

of stabilised zirconia, and paragraph 4 of E3, also referred to by the appellant, concerns the prior art of E3 with no specific emphasis on yttria within the given list. In addition, this paragraph 4 does not seem to specifically relate to the outer layer as claimed. Finally, as stated above, E10 cited by the appellant as another prompt for the selection of YSZ in E3 cannot be used for changing or complementing the disclosure of E3.

4.1.9 In view of the above, the subject-matter of claim 1 of the main request involves an inventive step starting from E5 on the basis of feature 1.2.1 alone (Article 56 EPC).

4.2 Starting from E3

The Board agrees with both parties that E3, like E5, can be regarded as a suitable starting point for claim 1 since it relates to the same technical field of turbine engine components comprising a TBC on a substrate (see for instance paragraph 1 and claims 8, 9, 10 and 13).

4.2.1 Disclosure of E3

E3 discloses a turbine engine component such as a turbine blade comprising:  
a substrate (18);  
a TBC (24) deposited onto the substrate, via a bond coat layer (20) like in paragraph 13 and claim 2 of the contested patent, the barrier coating comprising one layer of GSZ material, see paragraphs 28 and 34; and means (26) for sealing an outer surface of the TBC (24), where the sealing means comprises a plasma sprayed outer ceramic layer (26) deposited onto the TBC

(24) (paragraphs 13, 28 to 34; claims 10 and 13; Figure 1).

- 4.2.2 The Board agrees with the parties that E3 does not disclose **at least** the claimed porosity ranges of the TBC and the outer ceramic layer (features 1.1.1.2 and 1.2.1.2) (see decision under appeal, point II.4.3 and point 4.1.8 above, last paragraph).
- 4.2.3 The Board considers that, like for the discussion starting from E5 in view of plasma-spray, the porosity range of the outer ceramic layer (feature 1.2.1.2) results in a barrier to prevent the penetration of molten sand into the TBC below (see patent, paragraph 15). It might well be, as argued by the appellant, that other parameters, e.g. the thickness of the outer layer or its exact composition, influence the penetration of molten sand. This, however, does not change the fact that the patent convincingly teaches that the porosity of the outer layer achieves such an effect on its own, i.e. independently from other unspecified parameters.
- 4.2.4 The appellant further contests the technical effect of distinguishing feature 1.2.1.2, arguing that the range of 10-20 % for the porosity of the TBC was completely contained in that of 2.0-30 % for the outer layer. The TBC and the outer layer could then exhibit the same porosity, or the TBC could even have a lower porosity than the outer layer. Moreover, there was not a single example mentioning exact porosity values leading to the alleged effect.

For the appellant it seemed therefore questionable whether the problem of establishing a barrier to prevent the penetration of molten sand into the TBC was solved over the whole claimed range since according to

paragraph 15 of the patent, the barrier function of the outer layer was due to the lower porosity and the more tortuous path for the outer layer, i.e. the lower porosity than the TBC. In consequence, the alleged technical effect, if any, was only present for some of the claimed components and thus had to be disregarded when determining the objective technical problem underlying the invention and when assessing inventive step.

4.2.5 The Board does not share the appellant's view.

The passage of paragraph 15, lines 12 to 16 relating to the technical effect states that:

*"[S]pray parameters can be adjusted to yield a very dense or porous coating depending on the application. The **resulting structure of the outer plasma-sprayed layer** acts as a barrier to prevent the penetration of molten sand into the thermal barrier coating below due to its lower porosity and more tortuous path"* (emphasis by the Board).

Hence, the passage specifically concerns the structure of the outer ceramic layer obtained by plasma-spray. It does not relate to a teaching with respect to relative porosity ranges between the inner and the outer layers as suggested by the appellant.

The subsequent sentence of paragraph 15 does not refer to any relative porosity ranges between the layers either:

*"The average porosity for the EB-PVD coating layer 14 can be **anywhere** from 10 to 20%, while the porosity of the plasma-sprayed coating layer 16 **can be from 2.0 to 30%** depending on the parameters used"* (emphasis by the Board).

On the contrary, it teaches unambiguously that the porosity levels can be anywhere within the respective claimed ranges, unconditionally from one another.

The last sentence of paragraph 16 of the patent also confirms that the technical effect is due to the outer layer being independent from the TBC:

*"The outer plasma sprayed layer seals the surface of the thermal barrier coating to limit molten sand from penetrating therein."*

- 4.2.6 As a consequence, starting from E3, the problem to be solved on the basis of the porosity range of the outer ceramic layer (feature 1.2.1.2) can be seen as the provision of a coating that prevents the penetration of molten sand into the TBC (see patent, paragraphs 3, 5 and 16).
- 4.2.7 The Board does not share the appellant's view that the claimed porosity range of the outer ceramic layer would be an arbitrary choice as it relates to a mere allegation. To the contrary, the selected range enables obtaining a technical effect as discussed under points 4.2.3 and 4.2.5 above.

Furthermore, neither E3 as discussed nor E5 or E10 discloses or hints at depositing an outer YSZ layer with the claimed porosity level by plasma-spray onto a GSZ TBC as claimed (see point 4.1.5 above for E5; E10, examples I to V on pages 7 to 10, claim 1). The combination of the teaching of E3 with that of E5 or E10 would therefore not lead to the claimed subject-matter in an obvious manner.

4.2.8 In view of the above, the subject-matter of claim 1 of the main request involves an inventive step starting from E3 on the basis of feature 1.2.1.2 alone (Article 56 EPC).

5. *Main request - claim 7 - inventive step*

Like for claim 1, the appellant contests that the subject-matter of claim 7 of the main request involves an inventive step starting from either E5 or E3 as the closest prior art.

Since claim 7 comprises the distinguishing features discussed above for claim 1 (feature 7.2 corresponding to feature 1.2.1 with respect to E5 as the closest prior art and feature 7.2.2 corresponding to feature 1.2.1.2 with respect to E3 as the closest prior art), the same reasoning and conclusion as for claim 1 apply *mutatis mutandis* for claim 7, taking into consideration that the parties' arguments were similar in this respect.

Hence, the subject-matter of claim 7 of the main request also involves an inventive step starting from either E5 or E3 as the closest prior art (Article 56 EPC).

6. *Auxiliary requests 1 to 9*

In view of the Board's conclusion on the main request, there is no need to discuss auxiliary requests 1 to 9.

**Order**

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

The appeal is dismissed.

The Registrar:

The Chairman:



C. Spira

C. Herberhold

Decision electronically authenticated