

Internal distribution code:

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

D E C I S I O N
of 10 November 2005

Case Number: T 1015/03 - 3.2.07

Application Number: 96308935.4

Publication Number: 0784104

IPC: C23C 30/00

Language of the proceedings: EN

Title of invention:

Nickel-base superalloy having an optimized platinum-aluminide coating

Patentee:

GENERAL ELECTRIC COMPANY

Opponent:

MTU AERO ENGINES GMBH

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56, 114(2), 123(2)

EPC R. 57a

Keyword:

"Claims - extending beyond content of the application as originally filed (no, after amendment)"

"Amendments caused by grounds of opposition (yes)"

"Request filed during oral proceedings (allowed)"

"Novelty (yes)"

"Inventive step (yes)"

Decisions cited:

T 0591/90

Catchword:

-



Case Number: T 1015/03 - 3.2.07

D E C I S I O N
of the Technical Board of Appeal 3.2.07
of 10 November 2005

Appellant: GENERAL ELECTRIC COMPANY
(Proprietor of the patent) 1 River Road
Schenectady, NY 12345 (US)

Representative: Tomlinson, Edward James
Frohwitter
Patent- und Rechtsanwälte
P.O. Box 86 03 68
D-81630 München (DE)

Respondents: MTU Aero Engines GmbH
(Opponent) Dachauer Strasse 665
D-80995 München (DE)

Representative: Söllner, Oliver
MTU Aero Engines GmbH
Intellectual Property Management
Postfach 50 06 40
D-80976 München

Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 23 July 2003
revoking European patent No. 0784104 pursuant
to Article 102(1) EPC.

Composition of the Board:

Chairman: H. Felgenhauer
Members: H. Hahn
E. Lachacinski

Summary of Facts and Submissions

- I. The patentee lodged an appeal against the decision of the Opposition Division to revoke the European patent No. 0 784 104.
- II. The opposition had been filed against the patent as a whole and was based on Article 100(a) EPC (lack of novelty and lack of inventive step).

The Opposition Division held that that the subject-matter of claims 1 and 7 as granted according to the main request was novel, particularly with respect to document D1 (Tawancy H.M. et al., "Effect of substrate composition on the oxidation behaviour of platinum-aluminized nickel-base superalloys", Surface and Coatings Technology, 54/55, 1992, pages 1-7) which does not disclose the claimed article and method in a direct and unambiguous manner. The subject-matter of claims 1 and 7 of the main request, however, was considered to lack an inventive step with respect to an obvious combination of document D2 (Connor J.A., "Evaluation of Simple Aluminide and Platinum Modified Aluminide Coatings on High Pressure Turbine Blades After Factory Engine Testing - Round II", The American Society of Mechanical Engineers, 92-GT-140, pages 1-11, presented at the International Gas Turbine and Aeroengine Congress and Exposition, Cologne, Germany June 1-4, 1992; enlarged figures of sample MDC-150 on DS alloy and of samples RT-22G on DS and SC alloy according to its figures 2 and 3 were provided by the respondent as "Anlage A2", "Anlage A3" and "Anlage A4", respectively) with D3 (Smith J.S., Boone D.H., "Platinum Modified Aluminides - Present Status"; The American Society of

Mechanical Engineers, 98-GT-319, pages 1-10, presented at the Gas Turbine and Aeroengine Congress and Exposition, Brussels, Belgium June 11-14, 1990). The same conclusion as for the main request was held to be valid for the subject-matter of claims 1 and 6 according to auxiliary requests I and II, which claims 1 to 12 correspond to the claims 1 to 12 of the auxiliary requests III and IV as filed with letter of 17 April 2003.

- III. With a communication dated 9 March 2005 and annexed to the summons to oral proceedings the Board presented its preliminary opinion with respect to the main request and the auxiliary requests 1 to 9 as filed together with the grounds of appeal on 2 December 2003.
- IV. As a response to the communication of the Board the appellant filed on 12 September 2005 with its letter of the same date a main request and auxiliary requests 1 to 7.
- V. Oral Proceedings before the Board were held on 10 November 2005. The amendments made to the requests filed on 12 September 2005 necessitated the Board to discuss new issues under Article 123(2) and Rule 57a EPC which had not been addressed previously. In applying its discretion under Article 114(2) EPC the Board gave the appellant the opportunity to file amended requests, namely a main request and auxiliary requests 1 to 3, in order to deal with these new issues and to overcome the objections raised. Although the respondent argued that the amended requests were filed too late the Board allowed these amended requests because the amendments made to the independent claims

of these requests were made to deal with the new issues and were, with respect to the previous claims of a converging nature. Moreover the subject-matter of claims 1 and 6 of the amended main request is very similar to those of auxiliary request 5 dated 12 September 2005, so that the respondent actually could not be surprised by the amendments made.

VI. Requests

(a) The appellant requested that the decision under appeal be set aside and the patent be maintained on the basis of the claims 1 to 12 of the main request filed at the oral proceedings in combination with the description columns 5 to 8 of the patent as granted, the description columns 1 to 4 as filed at the oral proceedings, and with figures 1 to 4 of the drawings of the patent as granted.

(b) The respondent (opponent) requested that the appeal be dismissed.

VII. The aforementioned documents D1 to D3 and the further documents:

D5 = US-A-5 077 141 (which had been considered during the examination procedure of the application underlying the patent in suit)

D6 = Experimental report of the respondent dated 11 July 2005, exhibits A1 to A3 and B1 to B3

are relevant for this decision.

VIII. Independent claims 1 and 6 according to the main request read as follows (amendments compared to the claims 1 and 7 as granted are in bold):

"1. An article having a platinum-aluminide surface region, comprising:

a **substantially single crystal** substrate having a nickel-base **superalloy** substrate bulk composition, **with an aluminium content of from 5 to 16 weight percent and a rhenium content of from 1 to 8 weight percent**, and a substrate surface; and

a **single phase** platinum-aluminide surface region at the substrate surface formed by depositing a layer of platinum upon the substrate surface and diffusing the platinum layer into the substrate surface and thereafter providing a source of aluminium and diffusing aluminium into the substrate surface, the surface region having an integrated aluminium content of from 18 to 24 percent by weight and an integrated platinum content of from 18 to 45 percent by weight, balance **nickel and diffused** components of the substrate bulk composition, totalling 100 percent by weight, and wherein both the platinum and aluminium contents are relatively high adjacent to the substrate surface and decrease with increasing distance into the substrate from the substrate surface."

"6. A method of preparing an article having a platinum-aluminide surface region, comprising the steps of:

providing a **substantially single crystal** substrate having a nickel-base **superalloy** substrate bulk composition, **with an aluminium content of from 5 to 16 weight percent and a rhenium content of from 1 to 8**

weight percent, and a substrate surface; thereafter depositing a layer of platinum upon the substrate surface; thereafter diffusing platinum from the layer of platinum into the substrate surface; thereafter providing a source of aluminium; and thereafter diffusing aluminium from the source of aluminium into the substrate surface for a time sufficient to produce a **single phase** surface region at the substrate surface, the surface region having an integrated aluminium content of from 18 to 24 percent by weight and an integrated platinum content of from 18 to 45 percent by weight, balance **nickel and diffused** components of the substrate bulk composition **and wherein both the platinum and aluminium contents are relatively high adjacent to the substrate surface and decrease with increasing distance into the substrate from the substrate surface.**"

IX. The appellant argued essentially as follows:

The amendments of claims 1 and 6 are supported by the application as originally filed (see claims 1 and 6 or claims 7 and 12 in combination with page 5, lines 23 to 28; page 7, lines 13 to 26 and line 27 to page 8, line 1; page 9, lines 3 to 3 of the application as originally filed). Thus these amendments meet the requirements of Article 123(2) EPC and, since the corresponding independent claims 1 and 7 of the patent as granted have been limited, also of Article 123(3) EPC. All these amendments were made in order to overcome the grounds of opposition under Article 100a) EPC so that the requirement of Rule 57a EPC is met.

The article according to claim 1 and the process according to claim 6 are not only novel but also involve an inventive step for the following reasons. There is no indication that a combination of either the coating RT-22G or MDC-150 as specified in document D2 in combination with the single crystal nickel-base superalloy substrate according to document D5 would result in an article as defined in claim 1.

The definition "adjacent to the substrate surface" has the meaning of defining a position as "close as possible" to the substrate surface. According to the described measuring method for determining the concentration profile of aluminium (Al) and platinum (Pt) (see patent, column 6, lines 40 to 50) said term "adjacent" corresponds to a value of 2-3 μm . According to the electron microprobe analysis method referred to a small cross-sectional area and volume of the sample to be measured is analysed using an electron beam. Although the voltage in kV of the analysing system determines the area of the surface which is actually analysed this represents a routine method for the skilled person as shown by D2 which also mentions the use of a 5 μm square raster for measurements of this type (see page 3, right hand column, second paragraph). Thus this distance of 2-3 μm corresponds to the first position at which such a measurement can be carried out, this first position being "adjacent to the surface". Consequently, the measuring points of the composition profiles of the RT-22G and MDC-150 Pt-aluminide coatings according to document D2 (as shown on pages 3 and 4) do not have a maximum concentration of Al and Pt at the first measured distance at 5 μm and therefore do not meet the requirement of claim 1 "and wherein

both the Pt and Al contents are relatively high adjacent to the substrate surface and decrease with increasing distance into the substrate from the substrate surface". To the contrary, both coatings MDC-150 and RT-22G show concentration profiles in which the concentrations of Al and Pt rise from the first measuring point until a maximum is reached at a position of about 10 to 20 μm from the surface. This rise is particularly marked in respect of profiles measured on single crystal substrates.

Furthermore the concentration profile of the coating MDC-150 on DS alloy differs largely from that on SC alloy. The experimental results according to D6 provided by the respondent show, when comparing the concentration profiles of Al and Pt according to its exhibits A3 and B3, that if an intermediate anneal is performed prior to the aluminizing step, the effect is to cause the formation of a peak in Pt concentration at a point approximately 30 μm from the surface. Thus the evidence provided by the respondent confirms that an adaptation of the subject-matter of D2 to include an intermediate anneal would have an effect on the concentration profile, such that in all probability a peak in at least Pt concentration would be found away from a region adjacent the substrate surface. Accordingly, the respondent's allegation that the subject-matter of claim 6 is obvious in view of the disclosure of D2 combined with the disclosure of an intermediate anneal, for example as found in D3, is disproved by its own experimental results. No experimental results with respect to a single crystal substrate have been offered by the respondent.

Additionally the coating layers of exhibits A3 and B3 according to D6 are substantially different to those described in D2. The concentration profile of exhibit A3 with a depth of 64 μm for the point at which the Al content falls to 18 weight% has little resemblance to the figures in D2 where this point is reached at approximately 30 μm . Furthermore, D2 teaches the skilled person that the desirable form of coating is a two-phase coating comprising PtAl_2 in a $\beta\text{-Ni (Pt)Al}$ matrix (see page 2, right hand column, first paragraph).

The problem underlying the patent in suit with respect to document D2 is to provide a single phase surface region on a single crystal substrate having improved properties and a method of making the same.

The solution thereto is the article having the specific concentration profile as defined in the claims 1 and 6.

As indicated by figure 4 of the patent the rig burner life is improved by the specific Pt-aluminide coating on the specific Ni-base superalloy substrate so that a technical effect has to be acknowledged.

The method of claim 6 is further distinguished from the prior art by the additional Pt interdiffusion step which according to document D3 results in a two-phase structure (see page 2, left hand column, last paragraph).

Therefore the prior art according to D1 to D3 could not have lead to the subject-matter of product claim 1 and process claim 6, which therefore involve an inventive step.

X. The respondent argued essentially as follows:

The amendment made by adding the expression "superalloy" to claim 1 is in conflict with Rule 57a EPC since it only serves to remove a contradiction with the description.

The incorporation of the "concentration profile" feature into process claim 6 is objectionable under Article 123(2) EPC for being a generalisation since said profile is the result of specific process parameters which have not been incorporated into claim 6. It is also objectionable under Rule 57a EPC since the feature relates to the product and this feature is only incorporated for clarity reasons and is not required by the grounds of opposition. Furthermore, the wording "a single phase platinum-aluminide surface region" in claims 1 and 6 can be interpreted as meaning "a single phase of Pt-aluminide" in said surface region which is not supported by the application as originally filed, particularly not by the passage at page 9, lines 3 to 4, so that it contravenes Article 123(2) EPC.

The closest prior art is represented by document D2 and the examples made with MDC-150 on DS alloy and RT-22G on SC alloy (see page 3, figure 2 and page 4, figure 3). The only differences between the product of claim 1 and the coated nickel-base superalloy substrates of D2 reside in the concentration of the Al and rhenium (Re) contents of the substrate which is not specified in document D2 and in that a single crystal substrate is used. Such single crystal superalloy substrates containing Al and Re in the ranges of 5-16 weight% Al

and 1-8 weight% Re are known, for example from document D5 which originates from the examining procedure. This document discloses such nickel-base superalloys (see e.g. column 2, lines 41 to 55; column 4, lines 26 to 39) which can be coated with a MCrAlY alloy or with an aluminide coating (see column 4, lines 61 to 68 and column 7, line 48 to column 8, line 13).

The feature of claim 1 defining the concentration profile of Al and Pt is vague due to its definition "adjacent to the surface" which can be understood as meaning a point at a distance of e.g. 10 μm or 20 μm from the substrate surface. Since the voltage of the measuring system determines the area of the analysed surface, if this voltage is increased then a larger area of the surface is analysed so that the first point of measurement would be e.g. at 10 μm from the substrate surface.

The coating RT-22G on DS alloy is very similar to that on SC alloy so that the skilled person would therefore also apply the MDC-150 coating onto an SC alloy substrate. At least the concentration profile of the sample MDC-150 on DS alloy according to D2 should meet the requirement of the concentration profile feature of claim 1. The concentration profiles of the sample MDC-150 on DS alloy according to D2 show only a slight peak at 10 μm which is within the range of measuring uncertainty. A concrete value of said range of uncertainty is not known. The only difference between claim 1 and the article according to D2 resides in the single crystal substrate having a composition containing certain amounts of Al and Re which is, however, known. There is no explanation with respect to

differences of the concentration profiles of the coating MDC-150 on DS alloy and on SC alloy since not all of the parameters for making the same are known from D2.

The method according to D3 with the Pt diffusion heat treatment step does not result in a two-phase structure as alleged by the appellant since D3 also discloses a post coating heat treatment for a transformation into a single phase structure (see page 2, left hand column, last paragraph).

Thus in view of an obvious combination of documents D2 and D3 the subject-matter of claims 1 and 6 lacks inventive step.

Reasons for the Decision

1. *Admissibility of amendments (Rule 57a and Articles 123(2) and (3) EPC)*
 - 1.1 Both independent claims 1 and 6 were amended by introducing the additional features concerning the **"substantially single crystal"** substrate having a nickel-base **"superalloy"** substrate bulk composition **"with an aluminium content of from 5 to 16 weight percent and a rhenium content of from 1 to 8 weight percent"** and by defining that the produced Pt-aluminide surface region is a **"single phase "** which has a composition of Al, Pt with balance **"nickel and diffused components"** of the substrate bulk composition. All these amendments have a basis in the application as originally filed (see page 5, lines 21 to 29; page 6,

lines 21 to 23; page 9, lines 3 to 4; and claims 1 and 6, and claims 7 and 12).

Furthermore, the feature concerning the concentration profile "**and wherein both the platinum and aluminium contents are relatively high adjacent to the substrate surface and decrease with increasing distance into the substrate from the substrate surface**" was incorporated into process claim 6. This feature is also supported by the application as originally filed which discloses the same only in combination with said substantially single crystal substrate having the specific Al and Re contents and which after the processing results in the single phase surface region (see page 6, lines 21 to 23 in combination with page 5, lines 21 to 29; and with page 7, line 27 to page 8, line 1; and with page 9, lines 3 to 4).

Inclusion of these additional features leads to the subject-matter of claims 1 and 6 of the main request being restricted as compared to that of claims 1 and 7 as granted.

- 1.2 The respondent argued that the amendment resulting from the insertion of the term "**superalloy**" into claim 1 is in conflict with Rule 57a EPC since it only serves to remove a contradiction of claim 1 as granted, which defined a "nickel-base alloy", with the description. Furthermore, the incorporation of the "concentration profile" feature into process claim 6 would be objectionable under Rule 57a and Article 123(2) EPC for being a clarity amendment and for representing a generalisation since said profile is the result of specific process parameters which have not been

incorporated into claim 6. Finally the respondent argued that the wording "a single phase platinum-aluminide surface region" could be interpreted as meaning "a single phase of platinum-aluminide" in said surface region which has no basis in the application as originally filed, particularly not at page 9, lines 3 to 4, so that it contravenes Article 123(2) EPC.

These arguments are not convincing for the following reasons.

- 1.2.1 The specific description, on which the said "concentration profile" feature of claim 1 is based (see the application as originally filed, page 7, line 27 to page 8, line 1), was only disclosed in the context of a nickel-base "**superalloy**" and not a nickel-base "alloy" (see page 5, lines 21 to 29 in combination with page 6, lines 21 to 23 of the application as originally filed). Therefore a generalisation to a not further qualified nickel-base alloy in claims 1 and 6, which without any doubt would be inconsistent with the disclosure of the patent in suit which is solely directed to the use of superalloy substrates (see e.g. patent, paragraph [0001]), would contravene Article 123(2) EPC. Consequently, it is evident that this amendment had to be made in order to meet the requirements of Article 123(2) EPC and not merely to remove an inconsistency between the claims and the description.
- 1.2.2 The process of claim 6 including the "concentration profile" feature has not been generalised by not defining further parameters such as the temperature

ranges for the diffusion treatment and the aluminizing treatment in this claim.

First of all, it is evident from the description that all specified temperature ranges represent only **preferred** temperature ranges since they are explicitly referred to as "preferred", (see page 7, line 2 and lines 24 to 26; and page 9, lines 10 to 12 of the application as originally filed). This applies in a similar manner to the thickness of the Pt layer which only "desirably" has a certain thickness (see page 6, lines 29 to 30). Secondly, it is clearly derivable from the description of the application that this "concentration profile" is the result of "the diffusion treatment", i.e. after the Pt has been diffused into the surface with the subsequent diffusion of Al (see page 6, line 31 to page 7, line 1 in combination with figure 3 of the application as originally filed). Therefore, although certain temperature ranges for the diffusion steps are necessary to be provided, it is evident for the skilled person that the temperature ranges taken in a particular case need not be identical with the ranges being described to be the "preferred" ones.

Furthermore, it is obvious that this amendment of process claim 6 was made in order to overcome a lack of inventive step objection with respect to a combination of documents D2 and D3 and that it was not made for clarity reasons, i.e. in order that both independent claims contain the same essential features, as argued by the respondent.

1.2.3 Both claims 1 and 6 define that the article has "a single phase platinum-aluminide surface region" and that "the surface region having an integrated aluminium content of from 18 to 24 percent by weight and an integrated platinum content of from 18 to 45 percent by weight, balance nickel and diffused components of the substrate bulk composition, totalling 100 percent by weight". It is evident from this definition that at least the three elements Al, Pt and Ni have to be present in the surface region so that the said single phase cannot be constituted of only the two elements Pt and Al as argued by the respondent.

1.3 The Board therefore concludes that the claims 1 and 6 of the main request meet the requirements of Rule 57a and of Articles 123(2) and (3) EPC.

2. *Novelty (Article 54 EPC)*

Novelty of the subject-matter of claims 1 and 6 of the main request was not disputed by the respondent. The Board is satisfied that none of the available prior art documents discloses an article or a process for making the same having all the features of either claim 1 or claim 6 (compare paragraph 3, below).

The Board therefore concludes that the subject-matter of claims 1 and 6 of the main request is novel.

3. *Interpretation of claims 1 and 6*

With respect to claims 1 and 6 the meaning of the expression "**adjacent** to the substrate surface" has been

extensively discussed in the written proceedings as well as the oral proceedings.

According to the decision under appeal this term has been understood as including peaks of Al and Pt in the concentration curves just below the surface (compare, grounds of decision, point 3.2, page 5, last paragraph).

The Board follows the opinion expressed by the appellant according to which the expression "adjacent to the substrate surface" has the meaning as defining a position which although being as close as possible to the substrate surface allows the contents of Pt and Al to be measured.

Consequently, in view of the Board the expression "adjacent to the substrate surface" defines that position next to the substrate surface at which a concentration measurement is possible. Within the description of the patent in suit (see column 6, lines 40 to 50), a location starting within 2-3 μm of the outer exposed surface is referred giving an example for what is understood under the expression "adjacent". Such compositional measurements using wavelength dispersive spectroscopy with a 5 μm square raster are known in the art (see e.g. D2, page 3, right hand column, second paragraph). Furthermore, the Board considers that the person skilled in the art applies those known standard methods for making this compositional measurements as referred to in the patent (see column 6, lines 35 to 50). Consequently, the skilled person would apply a standard electron voltage suitable for this 5 μm square raster and not a much higher electron voltage for which no evidence has been

given and which would penetrate deeper into the surface and thereby analyse a much larger area of the surface, such that the first measurements would be more remote from the substrate surface, as argued by the respondent.

The definition of claims 1 and 6 "and wherein both the platinum and aluminium contents are relatively high adjacent to the substrate surface and decrease with increasing distance into the substrate from the substrate surface" is thus understood as defining:

- a) a certain position within the substrate as qualified by the term "adjacent to the substrate surface";
- b) the contents of Pt and Al at this position, where they are relatively high, and
- c) the decrease of the Pt and Al contents with increasing distance into the substrate. This understanding of the feature referred to above thus excludes any Al and/or Pt maximum concentration peaks which are not "adjacent" to the substrate surface and thereby differs from the Opposition Division's interpretation mentioned above.

4. *Inventive step (Article 56 EPC)*

4.1 *Document D1*

The disclosure of document D1, due to a discrepancy between the mentioned nominal Pt-Al-coating composition containing 20-25 wt.% Al and 35-55 wt.% Pt and the concentration profile of the sole sample revealing an Al concentration of only about 12-14 wt.% of the specimens (see page 1, right hand column, second paragraph; and page 4, figure 3), is considered not to

disclose an unambiguous teaching. It is unclear whether said nominal composition ranges are erroneous and the concentration values of Al and Pt given in figure 3 are correct or vice-versa. Consequently, this document will not be considered with respect to inventive step since the skilled reader is mainly interested in technical reality (see Case Law of the Boards of Appeal of the European Patent Office, 4th edition, 2001, chapter I.C.2.10; particularly decision T 591/90, not published). This condition is not fulfilled as D1 does not allow deducing which embodiment represents this technical reality. Therefore D1 is not further considered.

- 4.2 Document D2 is considered to represent the closest prior art for the article of claim 1 since it discloses the formation of Pt-aluminide coatings on directionally solidified (DS) and single crystal (SC) nickel-base superalloy turbine blades using three different aluminizing processes from different suppliers (namely pack cementation, chemical vapour deposition and above-the-pack aluminiding process; see page 1, abstract; and page 2, Table 1). It further discloses the resulting composition profiles of Pt and Al, which were determined using wavelength dispersive spectroscopy on a microprobe with a 5 μm square raster (see page 3, right hand column, second paragraph). The coatings of MDC-150 on DS alloy and of RT-22G on DS alloy (see page 3, figure 2) and RT-22G on SC alloy reveal a surface region having an integrated Pt content within 18 to 45 weight% and an integrated Al content within 18 to 24 weight% (see page 4, figure 3; see also "Anlage A2" to "Anlage A4"). Both coatings MDC-150 and RT-22G contain a single phase (see page 3, left hand

column, paragraphs "MDC-150 coating" and "RT-22G coating"). The composition profile of said coating RT-22G on DS alloy and on SC alloy shows steep peaks of the Pt concentration at 10 μm and 15 μm and flatter peaks of the Al concentration at 25 μm and 30 μm from the substrate surface, respectively (see page 3, figure 2 and page 4, figure 3). The composition profile of the coating MDC-150 on DS alloy shows a small peak of Pt at 10 μm from the substrate surface (see page 3, figure 2). Document D2, however, does nowhere specify the compositions of said DS and SC nickel-base superalloys. Furthermore, the coating process does not contain a Pt diffusion step between the Pt deposition and the aluminizing step.

The article according to claim 1 and the method according to claim 6 thus differ from the article and method according to document D2 in that a nickel-base superalloy with an Al content of from 5 to 16 weight percent and a Re content of from 1 to 8 percent is used as the substrate and in that said single phase platinum-aluminide surface region is formed by depositing a layer of Pt upon the substrate surface and diffusing the Pt layer into the substrate surface before diffusing the Al into the substrate surface, and in that both the platinum and aluminium contents in said surface region are relatively high adjacent to the substrate surface and decrease with increasing distance into the substrate from the substrate surface.

4.3 *Problem to be solved*

The problem to be solved with respect to the platinum-aluminide coated nickel-base superalloy article described in document D2 is considered to be the provision of a single phase surface region on a substantially single crystal substrate having improved properties and a method of making such an article as indicated in the patent (see paragraph [0010] in combination with paragraph [0030]).

4.4 *Solution to the problem*

This problem is solved by an article as defined in claim 1 and by a process of preparing such an article as defined in claim 6. From the results of burner rig tests as shown in the patent in suit it is credible that the claimed measures provide an effective solution to the technical problem (see figure 4 and paragraph [0030]).

4.5 The Board considers that the subject-matter of product claim 1 and process claim 6 is not obvious to the person skilled in the art for the following reasons:

Claim 1

4.6 According to a first line of arguments of the respondent the only difference between the product of claim 1 and the coated SC nickel-base superalloy substrates of D2 having the RT-22G coating resides in the Al and Re contents of the superalloy substrate which are not specified in document D2. However, such SC nickel-base superalloy substrates containing Al and

Re in ranges of 5-16 weight% Al and 1-8 weight% Re, which can be coated with an MCrAlY alloy or with an aluminide coating, are known, for example from document D5 (see e.g. column 2, lines 41 to 55; column 4, lines 26 to 39 and lines 61 to 68; column 7, line 48 to column 8, line 13; claims 1 and 2). Therefore it would be obvious for the skilled person to combine the RT-22G coating from document D2 with the SC superalloy substrate according to D5.

- 4.7 According to a second line of arguments of the respondent at least the concentration profile of the sample MDC-150 on DS alloy according to D2 should meet the requirement of the "concentration profile" feature of claim 1 according to which "both the platinum and aluminium contents are relatively high adjacent to the substrate surface and decrease with increasing distance into the substrate from the substrate surface". The concentration profiles of said sample according to Anlage A2 show only a slight peak of Pt at 10 μm which lies within the range of measuring uncertainty. Thus the only difference between claim 1 and the article according to D2 resides in the SC substrate having a composition containing certain amounts of Al and Re which is, however, known. Since the concentration profile of the coating RT-22G on DS alloy is very similar to that on SC alloy, the skilled person would also apply the MDC-150 coating onto a different SC alloy substrate such as the one according to D5 and thereby arrive at the article according to claim 1.

- 4.8 These arguments cannot be considered as being convincing for the following reasons.

4.8.1 First of all, no evidence has been provided that a combination of either coating RT-22G or MDC-150 according to D2 with the SC nickel-base superalloy substrate according to D5 results in an article as defined in claim 1.

4.8.2 No reason is given for the skilled person to combine the coatings of document D2 with the substrate of D5. If, in accordance with the respondent's first line of arguments, such a combination is made it is to be expected that said RT-22G coating on the SC superalloy substrate according to D5 would then have the same concentration profile as shown in document D2 for the SC substrate.

However, as already referred to in paragraph 4.2 above, the coating RT-22G on DS and SC substrates according to D2 shows peaks in the concentration profiles of Pt and Al which thus cannot lead to the "concentration profile" as defined in claim 1 (compare paragraph 3 above). Consequently, such a combination would not lead to the article of claim 1 in an obvious manner.

4.8.3 Likewise the respondent has not shown that the formation of the MDC-150 coating on an SC superalloy substrate, let alone on the SC substrate according to D5, would lead to the article defined in claim 1.

As can be derived from document D2 itself, the concentration profile of the coating MDC-150 on DS alloy is different from that on SC alloy (see figures 2 and 3). The SC alloy sample has a much lower Pt content below about 18 weight% and the concentration of Pt rises from the first measuring point at 5 μm to a

maximum at a distance of about 25 μm from the substrate surface. The reasons for these differences of the concentration profiles on the two different substrates could not be explained by the respondent who argued that not all of the parameters for making these coatings are known from D2. This fact, however, holds also true for the RT-22G coating which concentration profiles remain about the same on said substrates. The Board considers that the conditions for making the coatings should have been the same for DS and SC substrates since otherwise no meaningful comparison would be possible. The skilled person taking account of the two different concentration profiles of the coating MDC-150 shown in D2 thus would not have expected to obtain the concentration profile of the DS sample on the SC substrate according to D5 since he did not obtain such a profile with the first SC substrate of D2.

Furthermore, also the concentration profile of the MDC-150 coating on DS alloy shows a rise of Pt from the first point at 5 μm to a maximum at the second point at 10 μm from the substrate surface.

The respondent argued that taking account of the measuring errors this concentration profile would be considered as having a decreasing Pt concentration with increasing distance from the substrate surface. The respondent questioned by the Board then admitted that neither concrete values of said measurement errors nor their distributions are known. As a consequence thereof, it remains open whether or not the shape of the concentration profiles shown in D2 would be modified and in case it applies in which direction it would be modified, if such measuring errors were actually taken

into account. Document D2 is silent in this respect and neither mentions that the content of Al and Pt should decrease from the substrate surface into the inner region of the substrate nor that any regression curve fitting to the measuring points of said profile should be calculated and how it would look like. Moreover, the Board considers the profiles of D2 as being - at least in their general outline - representative regardless of the fact that individual values given are subject to measurement errors.

Claim 6

4.8.4 With respect to process claim 6, in addition to the arguments considered with respect to product claim 1, it has also to be considered that document D2 does not mention any Pt diffusion step between the deposition of Pt and the aluminizing step. The same holds true with respect to document D5 which suggests only the formation of conventional aluminide or MCrAlY coatings (see column 4, lines 4 to 9; column 7, line 48 to column 8, line 38).

4.8.5 Furthermore, the experimental results of comparative tests made with a DS substrate show, when comparing the concentration profiles of Al and Pt according to exhibits A3 and B3 (the sample according to A3 is stated to have been made in accordance with the teaching of D2 without an Pt interdiffusion step while the sample B3 was made with such an Pt interdiffusion step), that if an intermediate Pt diffusion anneal is performed prior to the aluminizing step, the effect is to cause the formation of a peak in Pt concentration at a point approximately 30 μm from the surface (see D6,

exhibits A3 and B3). Thus the evidence provided by the respondent confirms that an adaptation of the subject-matter of D2 to include an intermediate Pt diffusion anneal would have an effect on the concentration profile such that it has to be expected that a peak in at least Pt concentration would be found away from a region adjacent the substrate surface. Accordingly, the respondents allegation that the subject-matter of claim 6 is obvious in view of the disclosure of D2 combined with the disclosure of an intermediate Pt diffusion anneal, for example as found in D3, is disproved by its own experimental results. In this context the Board additionally remarks that according to these arguments a combination of three documents, namely D2, D5 and D3 would be necessary for which no indication is given.

The coating layers of exhibits A3 and B3 according to D6, are furthermore substantially different to those described in D2. The concentration profile of exhibit A3 with a depth of 64 μm for the point at which the Al content falls to 18 weight% has little resemblance to the figures in D2 where this point is reached at approximately 30 μm . Finally, document D3 does nowhere describe a Pt diffusion step at 1080°C for four hours, which formed the basis for the respondent's experimental results. These conditions are described in D3 only in the context of a **post** aluminizing heat treatment cycle (see page 2, Table 1), i.e. an anneal which is carried out **after** the deposition of Al and not before.

4.8.6 Taking account of the reasons given in paragraphs 4.6 to 4.8.5 above the teaching of document D2 even when combined with D5 and D3 cannot render obvious the subject-matter of claims 1 and 6.

4.9 The subject-matter of claims 1 and 6 thus involves an inventive step (Article 56 EPC).

The same applies to the subject-matter of the dependent claims 2 to 5 and 7 to 12 which define further preferred embodiments of the article according to claim 1 and the process according to claim 6.

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 in amended form according to the main request in the following version:
 - claims:
1 to 12 as filed at the oral proceedings,
 - description:
columns 1 to 4 as filed at the oral proceedings,
columns 5 to 8 of the patent as granted,

- drawings:
figures 1 to 4 of the patent as granted.

The Registrar:

The Chairman:

G. Nachtigall

H.-P. Felgenhauer