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DECISION
of 2 October 1996

Case Number: T 0853/92 - 3.3.2

Application Number: 86303770.1

Publication Number: 0202899

IPC: C04B 35/58

Language of the proceedings: EN

Title of invention:
A silicon nitride sintered body and a method of producing the same

Patentee:
NGK INSULATORS, LTD.

Opponent:
Widia GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 100(b), 54, 56

Keyword:
"Inventive step: determination of the problem with respect to the closest prior art, surprising effect"

Decisions cited:
-

Catchword:

-

Case Number: T 0853/92 - 3.3.2

DECISION
of the Technical Board of Appeal 3.3.2
of 2 October 1996

Appellant: (Opponent)	Widia GmbH Münchener Strasse 90 45145 Essen (DE)
Representative:	Vomberg, Friedhelm, Dipl.-Phys. Schulstrasse 8 42653 Solingen (DE)
Respondent: (Proprietor of the patent)	NGK INSULATORS, LTD. 2-56, Suda-cho, Mizuho-ku Nagoya-shi, Aichi 467 (JP)
Representative:	Paget, Hugh Charles Edward MEWBURN ELLIS York House 23 Kingsway London WC2B 6HP (GB)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted 21 July 1992 rejecting the opposition filed against European patent No. 0 202 899 pursuant to Article 102(2) EPC.**

Composition of the Board:

Chairman: F. Antony
Members: M. M. Eberhard
R. E. Teschemacher

Summary of Facts and Submissions

I. European patent No. 0 202 899 based on application No. 86 303 770.1, filed on 19 May 1986 and claiming a priority date of 20 May 1985, was granted with effect from 22 August 1990 on the basis of 11 claims. Claim 1 as granted reads as follows:

"1. A silicon nitride sintered body consisting mainly of Si_3N_4 and a sintering aid and containing at least one compound of Mn, Co, Ni, Nb and Mo in the form of an oxide, oxynitride or nitride as a crystallization controlling agent and having a substantially crystallized intergranular phase."

II. The Appellant (Opponent) filed a notice of opposition on 11 May 1991, requesting the revocation of the patent on the grounds of lack of novelty and inventive step (Article 100(a) EPC). In the notice of opposition and in the course of the opposition proceedings, the Appellant relied on the following citations:

D1: EP-A-0 107 919
D2: DE-C-2 353 093
D3: JP-58-064 268 (English abstract thereof)
D4: US-A-4 264 550
D5: US-A-4 332 909
D6: US-A-4 407 970
D7: Journal of Materials Science 11, 1976, pages 1135, 1155 to 1156
D8: EP-B-0 124 199 (only EP-A-0 124 199 pre-published)
D9: "Fachberichte Sprechsaal", vol. 123, No. 11, 1990, pages 1102 to 1103 (post-published literature).

III. By a decision posted on 21 July 1992, the Opposition Division rejected the opposition. Regarding novelty, the Opposition Division held that D1 and D6 neither disclosed any crystallisation treatment, nor any data showing that the sintered bodies had a fully crystallised intergranular phase. D1 contained at best the desideratum of obtaining a substantially crystalline intergranular phase in sintered silicon nitride bodies, but did not teach how to achieve this. Concerning inventive step, the Opposition Division took the view that the cited documents did not suggest selecting at least one of the compounds recited in claim 1 in order to obtain the crystallisation control of the intergranular phase and to limit grain growth.

IV. On 16 September 1992, the Appellant lodged an appeal against this decision, paid the prescribed fee and on 21 November 1992 submitted a statement of grounds of appeal.

The Appellant criticised the fact that the Opposition Division had not taken into consideration his arguments concerning sufficiency of disclosure. It had been pointed out in the notice of opposition that claim 1 as granted did not mention the amounts of the individual components, which was inconsistent with the statement at page 3, lines 23 to 28, of the description. Moreover, claim 1 gave no information about the meaning of a "substantially crystallised intergranular phase" and as to how the said phase could be obtained.

Concerning the issue of novelty, the Appellant contended that the Opposition Division did not sufficiently consider the teaching of D9 about the drop in strength at high temperature. They compared different mechanical values at different temperatures and for bodies of different compositions. The flexural strength at 1200°C could not give any information about the strength at 1000°C. The subject matter of claim 1 as granted was not novel over D1, because the purpose stated at page 1 of D1, read in combination with the teaching of claims 1 and 6 thereof, would have led the skilled person directly to the claimed sintered body. The heat treatment referred to in claim 6 of D1 served to crystallise the glass phase so as to improve the thermomechanical properties. This was derivable from the article in "Sintered Metal-Ceramic Composites", 1984, pages 411 to 424 (hereinafter D10). It was irrelevant whether the oxides were termed crystallisation controlling agent or sintering aid since by using the same sintering process and the same starting powders, identical end products would necessarily be produced.

Concerning inventive step, the Appellant argued that the Opposition Division completely disregarded the teaching of D7 and D8. The subject-matter of claim 1 was obvious to the skilled person since, on the one hand, D1 disclosed the composition of the claimed product in conjunction with the desideratum of avoiding a glass phase resulting in low strength at high temperatures and, on the other hand, D7 or D8 taught how to achieve crystallisation of the intergranular phase, namely by cooling at a slow rate or by a subsequent heat treatment. The skilled person confronted with the problem of obtaining a high strength up to high temperatures would in view of D7 or D8 have used an appropriate cooling method, thereby arriving in an obvious way at the known crystalline intergranular phase.

V. The Respondent relied mainly on the following arguments:

The opposition ground of Article 100(b) was not raised in the notice of opposition, and was therefore a fresh ground not to be admitted at the appeal stage.

Concerning the issue of novelty, the Respondent disputed the Appellant's arguments in connection with D9. This document, which was not prior art, did not prove that the bodies of D1 had a substantially crystallised intergranular phase.

With regard to inventive step, the Respondent pointed out that the use of the oxides, oxynitrides and nitrides of Mn, Co, Ni, Nb and Mo in addition to a sintering aid had the surprising and beneficial effect of controlling the crystallisation of the intergranular phase so that fine crystal grains were obtained even when using a slow cooling rate to achieve crystallisation of the intergranular phase. The problems arising with crystallisation of the intergranular phase, namely insufficient crystallisation or formation of coarse crystals mentioned at page 2 of the patent in suit, line 38 onwards, were not discussed in the prior art. Following the teaching of the invention, a slow cooling rate could be employed throughout the body without fear of large-crystals growth at any part.

The additives recited in claim 1 as crystallisation controlling agents were not those preferred in D1 and were but five out of the sixteen identified there. The skilled person seeking to improve the products of D1 by crystallising the intergranular phase would naturally have started with the preferred components of D1. Following the specific examples of D1 he would in fact have found the problem of sensitivity of the crystallisation of the intergranular phase to the cooling rate, and also the problem of formation of coarse crystals. If he had instead switched to one of the combinations recited in claim 1 of the patent in suit, the discovery that a new problem, unsuspected in D1 or elsewhere in the prior art, was solved would have been a surprising one, justifying the grant of a patent. Nowhere in the prior art was it shown that the oxides, oxynitrides and nitrides of Mn, Co, Ni, Nb and Mo could serve to control the crystallisation of the intergranular phase. Thus, the prior art gave no incentive for the adoption of these materials in preference to any others.

The passages in D7 to which the Appellant referred were concerned with nitrogen-containing ceramic glasses and had nothing to do with a crystalline material such as silicon nitride. D8 dealt with the devitrification of a specific glass phase based on silica and said nothing about the technical effect of the devitrification sought or about strength at high temperatures resulting from a crystalline intergranular phase in silicon nitride.

VI. On 2 May 1996, the Respondent filed an amended set of two claims, by way of auxiliary request, reading as follows:

"1. A silicon nitride sintered body consisting mainly of Si_3N_4 and a sintering aid and containing at least one compound of Mn, Co, Ni, Nb and Mo in the form of an oxide, oxynitride or nitride as a crystallization controlling agent and having a substantially crystallized intergranular phase, wherein said compound or compounds of Mn, Co, Ni, Nb and Mo is or are present in a total amount of 0.05-3% by weight, calculated as MnO, CoO, NiO, Nb_2O_5 and MoO_3, and said sintering aid consists of 2-15% by weight calculated as Y_2O_3 of Y-compound, 1-10% by weight calculated as MgO of Mg-compound and 1-10% by weight calculated as CeO_2 of Ce-compound, based on the weight of the sintered body.

2. A method of producing a silicon nitride sintered body which comprises molding a powder of Si_3N_4 blended with a sintering aid and at least one compound of Mn, Co, Ni, Nb and Mo as crystallization controlling agent, and firing or pressure sintering it, so as to produce a sintered body having a substantially crystallized intergranular phase, with the Mn, Co, Ni, Nb and Mo of said crystallization controlling agent present as oxide, oxynitride or nitride in the sintered body, wherein the Si_3N_4 is blended with 2-15% by weight of Y_2O_3 or Y-compound, 1-10% by weight of MgO of Mg-compound and 1-10% by weight of CeO_2 of Ce-compound as the sintering aid and 0.05-3% by weight in total calculated as MnO, CoO, NiO, Nb_2O_5 or MoO_3 of at least one compound of Mn, Co, Ni, Nb and Mo as the crystallization controlling agent, and the resulting blend is molded and fired in a nitrogen or inert gas atmosphere."

The Respondent pointed out that there appeared to be no statement in the prior art suggesting that a particular benefit might be obtained by the selection of a sintering aid consisting of compounds of Y, Mg and Ce. On page 3, lines 39 to 46, of the patent in suit, on the other hand, there was a suggestion of a cooperative effect with the other compounds used to control crystallisation. Furthermore, a specific advantage of the combination of Y, Mg and Ce compounds when used as sintering aid was stated at page 15, lines 18 to 20 of the patent in suit.

VII. Concerning the claims of the auxiliary request, the Appellant referred to his arguments put forward in the notice of opposition in connection with the corresponding dependent claims of the patent in suit. He further argued that the replacement of alumina by cerium oxide and magnesium oxide in the examples of D6 was obvious in view of the teaching of D6 and D5 (abstract).

VIII. In an annex to the summons for oral proceedings, the Board informed the parties of its provisional opinion that the product according to claim 1 as granted appeared to lack an inventive step. Oral proceedings were held on 2 October 1996 in the absence of both the Appellant and the Respondent, who had informed the Board on 31 August 1996 and 4 September 1996 respectively of their intention not to attend.

IX. The Appellant had requested in writing that the decision under appeal be set aside and the patent be revoked. The Respondent had requested in writing that the appeal be dismissed and that the patent be maintained as granted (main request) or alternatively that the decision be set aside and that the patent be maintained on the basis of claims 1 and 2 as submitted on 2 May 1996 and of the description submitted on 27 September 1996 (auxiliary request).

Reasons for the Decision

1. The appeal is admissible.

2. D7 and D8 were cited after expiration of the opposition term and D10 at the appeal stage. They are relevant in so far as they show that methods for crystallising an intergranular glassy phase in nitrogen ceramics (silicon nitride, sialons or related nitrogen ceramics) were known before the priority date. D10 is considered to be more relevant than D7 and D8 since it also discloses the effect resulting from the crystallisation of the intergranular glass phase in silicon nitride bodies, i.e. the improvement of their thermomechanical properties. Therefore, the Board has decided to take these documents into consideration.

Main request

3. The Appellant contended at the appeal stage that the requirement of sufficiency of disclosure was not fufilled, in particular because of the contradiction between the description and claim 1 as regards the amount of the crystallisation controlling agent, and he referred in this respect to his arguments in the notice of opposition. According to the latter, it was doubtful whether the teaching of claim 1 was complete, since this claim contained no limitation on the amount of crystallisation controlling agent; this was in contradiction to the passage at page 3, lines 23 to 28, of the description where it was explained that the limitation to an amount of 0.05 to 3 wt% appeared to be necessary to achieve a satisfactory crystallisation of the intergranular phase.

A contradiction between the description and the main claim or an objection against the broadness of the main claim with respect to the description might, in certain circumstances, raise the question of sufficiency of disclosure. However, in the present case, the notice of opposition contains neither an express reference to Article 100(b) or to insufficiency of disclosure, nor an indication that the skilled person would be unable, on the basis of the information given in the description, to perform the "invention" over the whole range of amounts of crystallisation controlling agent covered by claim 1, i.e. to achieve a substantially crystallised intergranular phase with amounts lying outside the range 0.05 to 3%. In these circumstances, the Appellant's objection in the notice of opposition cannot be construed as an objection under Article 100(b) all the more so as according to the cited passage of the description, the range 0.05 to 3% is the preferred range. Therefore, the Appellant's attack as to alleged lack of sufficiency at the appeal stage constitutes a fresh ground of opposition, which, in the absence of the Patentee's approval, cannot be taken into consideration (cf. G 10/91, OJ EPO, 1993, 420).

4. Turning to the issue of novelty, the Board cannot share the Appellant's opinion that D1 is novelty destroying to the subject matter of claim 1. D1 discloses silicon nitride ceramic bodies made by forming a compact containing silicon nitride and **one or more** sintering aids selected from the group comprising the oxides of Mg, Y, Cr, Mo, Fe, Mn, W, Co, V, U, Ni, Ti, Hf, Zr, Nb and Ta, and sintering the compact. The sintering is preferably carried out in a nitrogen-rich atmosphere at a temperature between 1200 and 1800°C, preferably about 1700°C, for a time of about twenty minutes to five hours. The resulting ceramic body is said to have high strength at elevated temperatures (see page 1, line 15 to page 2, line 5; page 3, lines 13 to 18; page 4, lines 1 to 4; claims 1, 2, 9, 10, 12 and 13). Therefore, D1 discloses starting compositions containing silicon nitride, one compound of Mn, Co, Ni, Nb or Mo in the form of an oxide, and a sintering aid. It also appears that the sintering process was performed under essentially the same conditions as in the patent in suit.

However, it is neither indicated in D1 that the sintered ceramic bodies so prepared have a substantially crystallised intergranular phase, nor that a devitrification treatment (i.e. cooling at a slow rate or a reheating treatment) was performed. It is indeed mentioned at page 1, lines 7 to 11, of D1 that a heat treatment of the sintered product is necessary to obtain good high temperature strength, but this treatment concerns ceramic bodies of the prior art to which D1 refers and not the ceramic bodies produced by the method claimed in D1. Therefore, this statement does not prove that the products of D1 contain a substantially crystallised intergranular phase. While the Appellant also made reference to heat treatment at a temperature of 1200 to 1400°C as stated in claim 6 of D1, this heat treatment in a nitrogen containing atmosphere is not applied to the sintered body mentioned above, but to a compact made from a mixture of **silicon** and one of the sintering aids, and it is performed in order to produce a reaction-bonded silicon nitride composite which is sintered afterwards; see claims 4 and 5 to which claim 6 is appended. Thus, the said treatment cannot result in the substantial crystallisation of an intergranular glassy phase. In the Board's view, it cannot be deduced from D9 that the intergranular phase in the bodies of D1 is substantially crystallised, because D9 shows that the degree of reduction in strength at high temperature and the temperature at which it first occurs vary greatly depending upon the additives to the silicon nitride body and their amounts, and none of the exemplified bodies of D1 was tested in D9 as pointed out by the Respondent.

In these circumstances and in the absence of convincing evidence to the contrary, the sintered bodies as defined in claim 1 are considered to differ from those of D1 by the presence of a substantially crystallised intergranular phase. Therefore, the subject matter of claim 1 is new over D1.

D6 discloses sintered bodies of ceramics produced from powdery starting mixtures comprising silicon nitride, a sintering aid (yttrium oxide and alumina), aluminium nitride and at least one of a number of oxides, representative of which are MnO_2, NiO, CoO, Nb_2O_5 and MoO_3: see Table 1, Examples 7, 11, 12, 14 and 15. The moulded compacts are sintered at 1750°C. As D6 is completely silent about the structure of the intergranular phase, and neither reports the cooling rate employed to cool these bodies after sintering, nor discloses that they were re-heated, it cannot be concluded that these sintered bodies have a substantially crystalline intergranular phase. This also applies to the sintered body of Example 20 obtained by reheating the sintered body of Example 11, since the reheating treatment is a second sintering treatment performed at the same high temperature as the first sintering treatment, i.e. 1750°C. Therefore, the claimed sintered bodies also differ from those of D6 by the presence of a substantially crystallised intergranular phase.

The subject matter of claim 1 is also novel with respect to the other citations. As this was not disputed by the Appellant at the appeal stage, it is not necessary to consider this point any further.

5. Both D1 and D6 disclose a silicon nitride body made from a starting composition containing silicon nitride, one compound of Mn, Co, Ni, Nb or Mo in the form of an oxide, and a sintering aid. Furthermore, D1 - in contrast to D6 - deals with the problem of degradation of strength at high temperature. In these circumstances, the Board considers that D1 represents the closest prior art. As pointed out above, the sintered bodies disclosed in D1 contain an intergranular phase which is not substantially crystallised.

Starting from this prior art, the technical problem underlying the patent in suit can be seen in providing high density silicon nitride bodies having an improved mechanical strength at high temperatures (1000°C). The patent in suit proposes to solve this problem by the product as defined in claim 1, i.e. a sintered body which differs from those of D1 by the presence of a substantially crystallised intergranular phase. In view of the examples and comparative examples of the patent in suit and in the absence of evidence to the contrary, the Board has no reason to doubt that this problem has indeed been solved by the claimed sintered body.

5.1 The Respondent has referred to the problems arising with crystallisation of the glassy intergranular phase discussed in the patent in suit at page 2, lines 39 onwards, namely insufficient crystallisation if the cooling is fast or formation of coarse crystals if the cooling is slow. The problems stated in that passage are those arising with silicon nitride bodies containing predetermined amounts of yttrium oxide, magnesium oxide and cerium oxide but no compound of Mn, Co, Ni, Nb or Mo, as described in JP-B-59-186 287 (priority document of EP-A-0 174 153). However, as this document was not published before the priority date it does not belong to the prior art. Moreover, if it had been pre-published, it would not have represented the closest prior art since D1 is closer to the product as defined in claim 1. For these reasons, the said Japanese document is not an appropriate starting point for the definition of the problem to be solved. The Board is not convinced that the problem of formation of coarse crystals also exists with respect to the closest prior art, namely the silicon nitride bodies of D1 which contain one of the oxides of Mo, Mn, Co, Ni or Nb and a sintering aid, since, as indicated in the patent in suit and emphasised by the Respondent himself, the intergranular phase is crystallised into fine crystal grains when these oxides are used in addition to a sintering aid. The Respondent's arguments that the skilled person would have been faced with the problem of formation of coarse crystals with the preferred components of D1 are also not convincing, since they are not consistent with the statement in the application as filed that chromium oxide also acts as a crystallisation controlling agent. For the preceding reasons, the further partial problem of avoiding formation of coarse crystals cannot be taken into consideration when determining the technical problem with respect to the closest prior art.

5.2 It remains to be examined whether or not it was obvious to the skilled person to achieve the substantial crystallisation of the intergranular glassy phase present in the products of D1 in order to solve the technical problem stated in point 5 above, i.e. to improve the high temperature strength.

The skilled person was aware of the fact that the presence of an intergranular glass phase in nitrogen ceramics, in particular in sintered silicon nitride bodies, had a harmful effect on the strength at elevated temperatures. This fact was not contested by the Respondent and is acknowledged in the introduction of the patent in suit and in prior art documents, for example in D10 (cf. the discussion of the prior art at page 2 of the patent in suit, or D10, page 414, 4th paragraph, and page 418). In particular, D10 emphasises that the grain boundary glassy phase present in silicon nitride sintered bodies containing sintering aids degrades the thermomechanical properties, in particular the mechanical strength at high temperatures. In this context it is suggested in D10 to perform a post-sintering heat treatment of the glassy phase to bring about its crystallisation and improvements of the thermomechanical properties (see page 418, page 421, last paragraph, page 423, conclusion). The problem of degradation of the strength at high temperatures owing to the presence of an intergranular glass phase in sintered ceramic bodies is also mentioned in D1 itself, where it is also proposed to heat treat the sintered body to obtain good high temperature strength (see page 1). In these circumstances, the skilled person faced with the problem stated above would obviously have been encouraged to eliminate as much of the intergranular glassy phase as possible in the products of D1 and, thus, to achieve substantial or complete crystallisation of the said phase in order to improve the high temperature strength of these sintered bodies. By doing so, the skilled person would have arrived in an obvious way at the product of claim 1 since methods for devitrifying a glass such as cooling the liquid at a sufficiently low cooling rate or reheating the glass were well-known before the priority date and furthermore the heat treatment of silicon nitride sintered bodies in order to bring about crystallisation of the intergranular glass phase is disclosed in D10.

5.3 The Board cannot follow the Respondent's arguments that the use of at least one of the compounds of Mn, Co, Ni, Nb or Mo in addition to a sintering aid led to a surprising effect which would justify the maintainance of the patent. The use of these compounds is not the solution of the problem defined above in the second paragraph of point 5 with respect to the closest prior art D1, but the solution to the problem of formation of coarse crystal grains encountered when cooling the products of the post-published document JP-B-59-186 287 (cf. patent in suit, page 2, lines 39 onwards). A surprising effect resulting from the addition of the said compounds into the products of the Japanese document cannot render inventive the obvious solution to the problem defined with respect to the closest prior art, namely the substantial crystallisation of the intergranular phase in order to improve the high temperature strength.

5.4 It follows from the above that the subject matter of claim 1 does not meet the requirement of inventive step set out in Articles 52(1) and 56 EPC. For this reason the Respondent's main request cannot be allowed.

Auxiliary request

6. The amended claims 1 and 2 of the auxiliary request meet the requirements of Article 123(2) and (3) EPC . Claim 1 is based on a combination of claims 1, 2 and 6 of the application as filed, and it is disclosed at page 13, lines 14 to 16, of the original application that the compound of Mn, Co, Ni, Nb and Mo is in the form of an oxide, oxynitride or nitride. Claim 2 corresponds essentially to a combination of the original claims 7, 11 and 1 with the features disclosed at page 13, lines 14 to 16, of the description as filed. Claims 1 and 2 clearly do not broaden the scope of protection with respect to the granted claims.

7. The product and the process according to claims 1 and 2 are new with respect to the cited prior art. This was not disputed by the Appellant so that further comments in this respect are not necessary.

8. D6 discloses sintered bodies which appear to have a composition closer to the claimed composition than those of D1, but D6 does not deal with the problem of degradation of strength at high temperature (1000°C), contrary to D1. In these circumstances, D1 is also taken as starting point for the definition of the technical problem to be solved by claim 1 of the auxiliary request.

8.1 With respect to D1, this technical problem can be seen in providing high density silicon nitride sintered bodies exhibiting an improved high temperature strength and improved high temperature fatigue properties. It is proposed to solve this problem by the product as defined in claim 1, i.e. a sintered body in which the compound(s) of Mn, Co, Ni, Nb and Mo is (are) present in a total amount of 0.05-3% by weight (calculated as MnO, CoO, NiO, Nb_2O_5 and MoO_3) and the sintering aid consists of 2-15 wt% of Y-compound, 1-10 wt% of Mg-compound and 1-10 wt% of Ce-compound (calculated as Y_2O_3, MgO and CeO_2), based on the weight of the sintered body, the intergranular phase being substantially crystallised. In view of the examples and comparative examples of the patent in suit, the Board is satisfied that this problem has indeed been solved by the claimed product.

8.2 The Appellant has argued that the composition as defined in claim 1 of the auxiliary request lacked an inventive step over the disclosures of D1, D2, D4, D5 and D6, since the sintering aids used in the claimed sintered body are the usual ones and the amount of crystallisation controlling agent is disclosed in some of these documents (cf. arguments concerning claims 1, 2 and 6 as granted in the notice of opposition and in the letter dated 29 August 1996). Reference was made in particular to D1 and D6 for the amounts of magnesium oxide and yttrium oxide and to the abstract of D5 for the use of cerium oxide. The Board cannot follow the Appellant's arguments for the following reasons:

D1 itself discloses the use of yttrium oxide, magnesium oxide and chromium oxide as preferred combination of sintering aids, these oxides being preferably present in an amount of 4-12 wt%, 0.1-5 wt% and 0.1-3 wt%, respectively (cf. page 3, lines 5 to 12). Neither cerium oxide, nor another metal oxide of the lanthanide group is mentioned or suggested in D1 as possible component of the sintering aid. Thus, from D1 alone the skilled person would not have arrived at the claimed subject matter.

Some of the sintered bodies of D6 are produced from starting compositions comprising silicon nitride, yttrium oxide, alumina, aluminium nitride and at least one of the oxides of Mn, Ni, Co, Nb, Mo (cf. column 4, 5 and 6, Table 1, examples 7, 11, 12, 14 and 15). According to D6, alumina and AlN are mandatory and this document does not mention the use of a cerium compound or another lanthanide compound as sintering aid in addition to yttrium oxide. Furthermore, D6 does not deal with the problem of improving the mechanical strength and the static fatigue, both at 1000°C. In these circumstances, the skilled person could not have inferred from D6 that the use of the claimed amounts of cerium, yttrium and magnesium compounds as sintering aid in the silicon nitride bodies of D1, together with the claimed amount of at least one oxide of Mn, Co, Ni, Nb or Mo might result in a substantially crystallised intergranular phase at the cooling stage and lead to a sintered body having improved strength and static fatigue at 1000°C.

The silicon nitride sintered body of D5 is produced from a powder mixture containing silicon nitride, at least one oxide of yttrium, scandium, cerium, lanthanum and the metals of the lanthanide series, and at least one metal or metal oxide of iron, nickel and cobalt. A sintering aid such as aluminium oxide, magnesium oxide, silica, boron oxide, lithium oxide and the oxide spinels may also be present (cf. abstract, claims 1, 7, 8, 15 and 16). Alumina is used as a sintering aid in six of the eleven examples and none of the examples contains both yttrium oxide and cerium oxide. The problem addressed in D5 is to provide a sintered product where at least one of the following properties has been improved: strength at room temperature, impact resistance, toughness or self-lubrication. D5 is completely silent as to the high temperature strength and the static fatigue at 1000°C. This document contains no additional indication which could have given the skilled person an incentive to incorporate a cerium compound, in addition to the claimed amounts of yttrium and magnesium compounds, into those silicon nitride bodies of D1 containing an oxide of Mn, Co, Ni, Nb or Mo, in order to achieve substantial crystallisation of the intergranular phase at the cooling stage and to solve the problem defined above.

The Appellant has relied on D2 and D4 only to prove that the amount of nickel oxide or crystallisation controlling agent was already known. The sintering aid used in D4 consists of alumina and yttrium oxide, while the starting compositions of D2 contain a spinel or oxide mixtures which are converted to a spinel by heating, for example $MgAl_2O_4$ or MgY_2O_4. D2 and D4 do not suggest to use an oxide of the lanthanide group, let alone cerium oxide, as a sintering aid or as a component of the sintering aid; thus, they could not hint at the claimed solution even in combination with D1, D5 or D6.

8.3 If D6 had been taken as starting point instead of D1, the problem to be solved would have been the same, and this would not have changed the outcome of the present decision. Contrary to the Appellant's contention, the fact that MgO is mentioned in D5 and D6 and that the sintered bodies of D5 may contain cerium oxide would not have prompted the skilled person to replace the alumina contained in the starting composition of D6 by the claimed amounts of magnesium oxide and cerium oxide. This is because a great number of other possible oxides are also disclosed in D5 and D6, and it could not be expected that the use of these two oxides, in the claimed amounts, instead of alumina might lead to the substantial crystallisation of the intergranular phase at the cooling stage and to the sought improvement. The Appellant's allegation that this substitution was obvious to the skilled person is considered to be based on an ex post facto analysis.

8.4 The Appellant's arguments denying inventive step are based on the combinations of some or all of D1, D2, D4, D5 and D6 without use of the remaining documents. The Board has equally come to the conclusion that the subject matter of claim 1 would not have been obvious to the skilled person in view of the remaining documents taken separately or in combination with the preceding ones.

8.5 The preceding reasons concerning the product claim 1 apply analogously to process claim 2 which relates to the preparation of a product having the composition and characteristics recited in claim 1.

It follows from the above that the claims of the auxiliary request meet the requirement of patentability set out in Article 52(1)EPC.

9. The Respondent filed an amended description on 27 September 1996, i.e. five days before the oral proceedings. As, on the one hand, there is no evidence that the Appellant actually received this amended text before the hearing and, on the other hand, it seems that further amendment is necessary at least at page 3, line 46, in order to bring the description into agreement with the claims of the auxiliary request, the Board finds it appropriate to remit the case to the Opposition Division for adaptation of the description.

Order

for these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the Opposition Division with the order to maintain the patent on the basis of Claims 1 and 2 submitted as auxiliary request on 2 May 1996 and a description yet to be adapted.

The Registrar:

P. Martorana

The Chairman:

F. Antony

M.Eb
Te