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Datasheet for the decision of 20 October 2009

Case Number: T 1851/06 - 3.3.05

Application Number: 00102630.1

Publication Number: 1028098

IPC: C04B 35/80

Language of the proceedings: EN

Title of invention:
SiC-C/C composite material and uses thereof

Patentee:
NGK INSULATORS, LTD.

Opponent:
SGL Carbon SE

Headword:
SiC-C/C composite/NGK

Relevant legal provisions:
EPC Art. 56, 84

Keyword:
Main request and auxiliary requests 3, 4: "Inventive step (no): no improvement; redefinition of the problem; arbitrary alternative"
Auxiliary request 1: "Clarity (no): relative and/or ambiguous terms; feature having no well-recognised technical meaning in the technical field"
Auxiliary requests 2, 5, 6, 7: "Clarity (no): unclear parameter"

Decisions cited:
T 0197/86

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1851/06 **-** 3.3.05

D E C I S I O N
of the Technical Board of Appeal 3.3.05
of 20 October 2009

Appellant: (Patent Proprietor)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 13 October 2006 revoking European Patent No. 1028098 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: G. Raths
Members: J.-M. Schwaller
S. Hoffmann

Summary of Facts and Submissions

I. This appeal was lodged by the patentee (hereinafter "the appellant") against the decision of the opposition division which revoked European patent 1 028 098 in particular on the ground that claim 1 of the granted version (main request) did not involve an inventive step in the light of document

E3: DE 197 10 105 A1.

Claim 1 as granted reads as follows:

"1. An SiC-C/C composite material comprising silicon carbide, carbon fibers and a carbon component other than the carbon fibers and having a structure comprising a skeletal part and a matrix formed around the skeletal part, characterized in that at least 50% of silicon carbide is of β type, the skeletal part is formed of carbon fibers and a carbon component other than the carbon fibers, silicon carbide may be present in a part of the skeletal part, the matrix is formed of silicon carbide, the matrix and the skeletal part are integrally formed, and the composite material has a porosity of 0.5-5% and a two-peak type distribution of average pore diameter."

II. In the contested decision, the opposition division held in particular that:

- In view of the disclosure of E3, it was not plausible that the feature "a two-peak type distribution of average pore diameter" would solve a specific problem over its whole breadth.

– The terms "small" and "large", which were supposed to define a pore diameter, were unclear as they had no well-recognised meaning in the field concerned.

III. The further documents relied upon during the opposition proceedings included the following:

E8: Salmang-Scholze, "KERAMIK", pages 210 to 212 (1983)

E14: Photograph of a composite material prepared in accordance with E3

E15: ASTM D 4404-84 Standard Test Method

IV. In its statement setting out the grounds of appeal dated 23 February 2007, the appellant submitted arguments to support the different requests on which the contested decision had been based, as well as technical data intended to show that a bimodal pore distribution had a particular effect over a monomodal one (Annexes 1 and 2).

V. In response to the grounds of appeal, the respondent argued that the subject-matter of claim 1 of the main request lacked novelty and inventive step over E3.

It also filed the following document:

E19: "*Untersuchungen zur Herstellung und Charakterisierung von Kohlenstoffmembranen auf der Basis von Cellulose und Cellulosederivaten*", Dissertation, J. Pötzschke, pages 20 and 73 (July 2003),

in order to show that no standard method existed for characterising a porous substance and that the results regarding the determination of the pore size of a substance were strongly dependent on the measurement method and on the assumptions made by the person in charge of the measurement.

VI. Under cover of letter dated 18 September 2009, the appellant submitted three new sets of amended claims as auxiliary requests 1 to 3, respectively.

Claim 1 of auxiliary request 1 reads as follows:

"1. An SiC-C/C composite material comprising silicon carbide, carbon fibers and a carbon component other than the carbon fibers and having a structure comprising a skeletal part and a matrix formed around the skeletal part, characterized in that at least 50% of silicon carbide is of β type, the skeletal part is formed of carbon fibers and a carbon component other than the carbon fibers, silicon carbide may be present in a part of the skeletal part, the matrix is formed of silicon carbide, the matrix and the skeletal part are integrally formed, and the composite material has a porosity of 0.5-5% and a two-peak type distribution of average pore diameter, including pores of relatively large pore diameter formed inside the matrix."

Claim 1 of auxiliary request 2 differs from claim 1 of the previous request in that the diameter of the pores of relatively large pore diameter formed inside the matrix is defined as being of "*about 100 µm as a median*".

The appellant also filed two further documents:

E20: Description of the product Hexoloy ® SP Silicon Carbide, Saint-Gobain Ceramics

E21: Ronen et al., "*Friction-reducting surface-texturing in reciprocating automotive components*", Tribology Transactions, July 2001.

VII. Oral proceedings took place on 20 October 2009.

After an initial discussion relating to the requests dated 18 September 2009 and concerning in essence Article 100(b), 56 and 84 EPC issues, the appellant decided to drop auxiliary request 3 then on file and filed five new sets of claims as auxiliary requests 3 to 7, with claim 1 of the different requests being defined as follows:

Auxiliary request 3:

"1. An SiC-C/C composite material comprising silicon carbide, carbon fibers and a carbon component other than the carbon fibers and having a structure comprising a skeletal part and a matrix formed around the skeletal part, characterized in that at least 50% of silicon carbide is of β type, the skeletal part is formed of carbon fibers and a carbon component other than the carbon fibers, silicon carbide may be present in a part of the skeletal part, the matrix is formed of silicon carbide, the matrix and the skeletal part are integrally formed, and the composite material has a porosity of 0.5-5% and a two-peak type distribution of

average pore diameter, wherein the skeletal part comprises a yarn assembly prepared by two-dimensionally arranging at least a plurality of yarns comprising carbon fibers and a carbon component other than the carbon fibers in nearly parallel with each other to form a yarn array element and laminating a desired number of the yarn array elements so that the yarns in the adjacent yarn array elements cross with each other."

Auxiliary request 4

Claim 1 of this request differs from claim 1 of the previous request in that the "*the yarns in the adjacent array elements cross at right angles with each other*".

Auxiliary request 5

"1. An SiC-C/C composite material comprising silicon carbide, carbon fibers and a carbon component other than the carbon fibers and having a structure comprising a skeletal part and a matrix formed around the skeletal part, characterized in that at least 50% of silicon carbide is of β type, the skeletal part is formed of carbon fibers and a carbon component other than the carbon fibers, silicon carbide may be present in a part of the skeletal part, the matrix is formed of silicon carbide, the matrix and the skeletal part are integrally formed, and the composite material has a porosity of 0.5-5% and a two-peak type distribution of average pore diameter, including large pores having a median of pore diameter of 100 μm and small pores having a median of pore diameter of 0.5 μm."

Auxiliary request 6

Claim 1 of this request differs from claim 1 of auxiliary request 5 in that it is further defined by "*the large pores being formed in protrusions formed along the matrix*".

Auxiliary request 7

In comparison with claim 1 of auxiliary request 6, claim 1 of this request is further defined in that "*the skeletal part comprises a yarn assembly prepared by two-dimensionally arranging at least a plurality of yarns comprising carbon fibers and a carbon component other than the carbon fibers in nearly parallel with each other to form a yarn array element and laminating a desired number of the yarn array elements so that the yarns in the adjacent yarn array elements cross with each other*".

VIII. The appellant requested that the decision under appeal be set aside and that the patent be maintained as granted (main request) or, in the alternative, on the basis of the claims according to the first or second auxiliary request filed with letter dated 18 September 2009, or according to one of the third to seventh auxiliary requests filed during the oral proceedings.

The respondent requested that the appeal be dismissed.

Reasons for the Decision

1. *Main request - Inventive step*

1.1 The patent in suit relates to a SiC-C/C composite material usable e.g. as braking members (paragraph [0014].

1.2 Both parties acknowledged E3 as representing the closest prior art.

1.3 E3 relates to a composite material containing carbon and a matrix of silicon carbide and silicon and reinforced with carbon fibers, which material has relatively high elongation at break (E3, page 2, lines 3 to 5). The composite can be used e.g. as friction material in brakes for high speed vehicles (E3, page 3, lines 25 to 28).

The composite material as defined in claim 1 of E3 is characterised by

(a) reinforcing short graphite fibers of a length of 0.1 to 5 mm homogeneously distributed throughout the composite material and associated with a shell of graphitised carbon partially converted into silicon carbide, which graphitised carbon has been obtained by coking of synthetic resins and subsequent graphitisation,

(b) a matrix consisting essentially of silicon carbide and containing up to 20 wt. % of elemental silicon, said matrix having been obtained by reaction of liquid silicon with a carbonaceous matrix obtained by coking of a carbon-containing binder,

(c) a breaking elongation in the range from 0.25 to 0.5%, and
(d) an open pore volume of maximum 5%.

In claim 3, the open pore volume is defined as being preferably of at most 1%.

The siliconisation operation by which liquid silicon is infiltrated into the porous carbonaceous matrix with simultaneous conversion of said matrix to silicon carbide is carried out in the temperature range of from 1450 to 2200°C, preferably in the range of from 1650 to 1750°C. In the sole example of E3, the siliconisation is carried out at a pressure of 3 mbar and a temperature of 1750°C.

E3 does not indicate which silicon carbide type was obtained in the example, however, in view of the teaching of document E8 (page 210, item 7.2.1.) that the phase transition of the β type silicon carbide to the α type occurs at about 2100°C, the board has no doubt that the silicon carbide manufactured at 1750°C in the example of E3 is of the β type.

This has not been contested by the appellant, which argued that the SiC-C/C composite material according to claim 1 as granted was distinguished from the one of E3 by its "two-peak type distribution of average pore diameter".

1.4 The board observes that - as stated by the respondent - the feature "two-peak type distribution of average pore diameter" has no well-recognized technical meaning. However, in view of the description of the contested

patent (in particular page 6, lines 19 and 20; page 8, lines 12 and 13; page 9, line 53 to page 10, line 3; paragraph [0094]), which makes clear that the composite material claimed is meant to have two kinds of pores, in particular large pores with a diameter of about 100 µm as a median and small pores with a diameter of about 0.5 µm as a median, the board accepts appellant's interpretation that the above feature is to be understood as meaning that the claimed material is characterised by having a bimodal pore distribution.

1.5 With respect to the problem to be solved, the appellant stated that, starting from E3 as the closest state of the art, this might be seen in the provision of a SiC-C/C composite material having improved friction properties in comparison to the material known from E3. It contended in this respect that the Annexes 1 and 2 filed with the grounds of appeal - in which a comparison was made between a composite material A having a bimodal pore distribution ("two-peak") and a composite material B having a monomodal pore distribution ("single peak") - provided evidence of the alleged improvement in terms of friction properties.

1.5.1 The board is of the opinion that Annexes 1 and 2 are not convincing as evidence of the alleged improvement for the following reasons:

- First of all, since the Annexes provide no data at all regarding preparation and characterisation of the tested materials, in particular of the bimodal material A, and since the appellant's representative - after having been questioned on this issue at the oral proceedings - stated that he had no further

data to provide, there is a strong doubt whether material A falls under the wording of claim 1 at issue or not.

– According to the established case law of the boards of appeal, for a comparative test to demonstrate an inventive step with an improved effect over a claimed area, the nature of the comparison with the closest state of the art must be such that the effect is convincingly shown to have its origin in the distinguishing feature of the invention (see T 0197/86, point 6.1.3, OJ EPO 1989, 371). The board observes that the tests proposed in Annexes 1 and 2 do not fulfil this criterion, because although the tested materials have respectively a bimodal and a monomodal pore distribution, the single peak - at about 0.01 µm - of material B is not superposable with either of the two peaks - at about 0.1 µm and 1 µm - of material A, and so it cannot be concluded whether the effect shown in said Annexes is due i) to the distribution of the pores, ii) to the size of the pores, or iii) to both of these distinguishing features.

1.5.2 For the above reasons, and as furthermore no objective comparison between the SiC-C/C composite material claimed and the one of the closest state of the art E3 has been provided, an improvement over the latter cannot be recognised for the purpose of assessing the inventive step of the subject-matter claimed.

Under these circumstances, the problem has to be reformulated in less ambitious terms, namely as

providing another SiC-C/C composite material having friction properties.

1.6 As a solution to this problem, the patent in suit proposes the SiC-C/C composite material according to claim 1, which is in particular characterised by a "two-peak type distribution of average pore diameter".

1.7 It remains to be decided whether or not the proposed solution to that objective problem, namely the composite material according to claim 1 at issue is obvious in view of the state of the art.

1.7.1 Since the SiC-C/C composite material according to the closest state of the art document E3 is already disclosed as a friction material in brakes for high speed vehicles (page 3, lines 25 to 28) and since the friction properties of a material are closely related to its surface characteristics, the board is of the opinion that the skilled person faced with the problem of providing another SiC-C/C composite material having friction properties would inevitably be prompted to investigate the possibilities of modifying the composite's surface and while doing so would observe from document E14 - a photograph showing the porous texture of a material according to E3 - that the surface of the state of the art composite material contains a multitude of pores of different sizes, in particular "small" pores and "large" pores, as the respondent illustrated in E14 using circles and squares, respectively.

1.7.2 The appellant argued that the black areas or spots within the said circles and squares were not

necessarily pores, and so any conclusion which might be drawn from E14 as regards the porosity of the material of E3 would be speculative.

In the absence of evidence for this allegation and the appellant having itself confirmed at the oral proceedings that in the contested patent the identification of pores had also been made inter alia via photographs, in particular the one according to Figure 8 of the patent in suit, the above argument does not convince the board.

1.7.3 The appellant further argued in support of inventive step by relying on the above differentiating feature, stating that the specific friction properties of the composite claimed were due to the fact that the two types of pores characteristic of a bimodal pore distribution each had a specific function, the small pores accumulating lubricant or dust in order to reduce wear, the large pores contributing to increasing the coefficient of friction.

1.7.4 While the board observed at the oral proceedings that no support for this alleged dual function was to be found in the contested patent, the appellant referred to documents E20 and E21, which disclose that the pores act as "fluid or lubricant reservoirs helping to promote the retention of a fluid film at the interface of sliding component surfaces" (E20), or as "micro hydrodynamic bearings to enhance hydrodynamic lubrication" (E21).

1.7.5 The board observes that neither E20 nor E21, however, discloses a material having a bimodal pore distribution,

or a material with pores having different sizes with different functions, let alone a material having small pores accumulating lubricant or dust in order to reduce wear and large pores contributing to increasing the coefficient of friction. Therefore the appellant's argument is not accepted.

1.7.6 For the sake of argument, the board observes that even if the above dual function of the small and large pores had been credibly demonstrated, claim 1 at issue is worded so broadly that it covers any pair of pores - in particular pairs having both peaks in the range of the "small" pores or, conversely, pairs having both peaks in the range of the "large" pores - and it is difficult, not to say impossible, to believe that the alleged dual function of the small/large pores - likewise the friction properties of the claimed composite - would remain the same over the whole scope of protection of claim 1 at issue, whatever the distance between the two peaks in the distribution chart and whatever the kind of pores under consideration (nano-, micro-, meso- or macropores).

1.7.7 It follows that since no technical improvement results from the bimodal pore distribution, also defined as a "two-peak type distribution of average pore diameter", the SiC-C/C composite material according to claim 1 is simply to be regarded as an alternative. It remains to be decided whether the latter is just an obvious variation of the state of the art or whether it can only be derived therefrom in a non-obvious way.

In the present case, the bimodal pore distribution in fact is to be regarded as being merely one of several

straightforward ways of modifying the porous structure of a given material among which the skilled person looking for a product different from the one known from E3 would choose without exercising any inventive skill, or in other words make an obvious arbitrary choice, as it does not give rise to any advantageous effect in comparison to other currently well-known pore distribution modes (monomodal or polymodal).

1.8 Therefore, for the reasons indicated above, the board is not convinced that the subject-matter of claim 1 involves an inventive step (Article 56 EPC).

2. *Auxiliary request 1 - Clarity*

2.1 The subject-matter of claim 1 of this request is distinguished from claim 1 of the main request in that the composite material includes "pores of relatively large pore diameter formed inside the matrix".

2.2 The board observes that the feature "pores of relatively large pore diameter" is characterized by the terms "relatively" and "large", which render the scope of the claim vague and undefined. As the feature "pores of relatively large pore diameter" furthermore has no well-recognized meaning in the present technical field, in the sense that the skilled person reading the feature would not know from the outset which pore size is meant, the subject-matter of claim 1 is not considered to meet the requirements of clarity pursuant to Article 84 EPC.

2.3 The appellant's argument that said feature would be clear for a skilled person in the context of the

description is not accepted, as the feature "pores of relatively large pore diameter formed inside the matrix" now in claim 1 has its sole origin in the description (page 6, lines 18 to 19) of the contested patent, and said claim thus concerns a specific object which as such was not already claimed in the patent as granted. According to the jurisprudence, in such a situation, the subject-matter of the claim at issue is supposed to be clear without the need to resort to information derived from the description, and it is therefore objectionable under Article 84 EPC.

3. *Auxiliary request 2 - Clarity*

3.1 The subject-matter of claim 1 of this request is distinguished from that of claim 1 of the previous request in that the diameter of the pores of relatively large pore diameter formed inside the matrix is defined as being of "*about 100 µm as a median*".

3.2 The board observes - as established by document E19 - that no standard method exists for the characterisation of porous substances and that the results obtained using the different existing methods generally differ from one another and furthermore depend on the assumptions made by the operator.

The appellant stated that the characterisation of the pores had been made by using optical methods and by using mercury intrusion porosimetry. The board notes that none of these characterisation methods, however, has been disclosed in the patent in suit and, as furthermore indicated in E15, the mercury intrusion porosimetry method only covers the pore range of about

100 µm to 2.5 nm, larger pores having to be measured by another method (E15, page 1, left-hand column, paragraph 1.1).

In addition to the above, the appellant has not convinced the board that the skilled person would know from the outset which method and conditions would have to be employed in the present case to determine the pore diameter of the composite material claimed, or that all the methodologies known in the relevant technical field for determining the said pore diameter would yield the same result within the appropriate limit of measurement accuracy.

3.3 Bearing these points in mind, the board considers that the feature "*pores of relatively large pore diameter formed inside the matrix of about 100 µm as a median*" characterising the composite defined in claim 1 is not clear for the person skilled in the art. Claim 1 of this request therefore does not meet the requirements of Article 84 EPC.

4. *Auxiliary request 3 - Inventive step*

4.1 The subject-matter of claim 1 of this request differs from that of claim 1 of the main request in that the skeletal part comprises a yarn assembly prepared by two-dimensionally arranging at least a plurality of yarns comprising carbon fibers and a carbon component other than the carbon fibers in nearly parallel with each other to form a yarn array element and laminating a desired number of the yarn array elements so that the yarns in the adjacent yarn array elements cross with each other.

4.2 In the one and only example of E3 (page 5, line 35 to page 6, line 11), the skeletal part of the SiC-C/C composite is produced using a twill weave fabric ("*Gewebe in Köperbindung*" in the original text in German) consisting of graphite fiber rovings made from 3000 individual filaments. The woven fabric is impregnated with a phenolic resin and placed in a compression mould, with release papers being laid between the individual layers. Once the mold has been filled, the stack of layers is cured for 3 hours at 140°C under a pressure of 5 N/mm^2. After removal from the compression mould, the compacted and cured stacks are carbonised and graphitised, and ground in a chopping mill with a screen pack having apertures with a clear opening of 5 mm. The ground material is then mixed with a binder, transferred into a compression moulding press and heated under 15 bar and at 150°C. After being carbonised under protective gas to 900°C within 144 hours, the article is finally graphitised under argon at 2200°C for 15 minutes.

4.2.1 There is no doubt that in the compression mould of the above example the yarns in the adjacent layers "cross with each other" and that during the compression operation in the mould, the different layers have been "laminated" in the sense of present claim 1.

The appellant argued that in the above prior art, the compacted and cured stacks were ground to particles, whereas in the patent in suit this was not the case, as the skeletal part was defined as being a macro-body and was not constituted of chopped pieces, as in E3. It further contended that during the milling operation, the milled pieces were inevitably deformed, so that the

skeletal arrangement as claimed would not be found in the pieces of E3.

4.2.2 The board observes that claim 1 at issue does not define any size for the skeletal part or for the carbon fibers, let alone any lower dimension, nor does claim 1 require that the skeletal part be constituted of only one macro-body which has not been previously milled. Since the wording claim 1 furthermore encompasses the word "comprising", the board observes that the configuration wherein the "yarn assembly" be the one found in a single chopped particle of E3 can be read as the "skeletal part" defined in claim 1 of the present request. The board is furthermore convinced that in the individual chopped pieces the twill weave structure of the fabric is to a certain extent preserved and not totally destroyed during the milling operation, as argued by the appellant.

4.3 Accordingly, the sole feature distinguishing the subject-matter of claim 1 of the present request from the disclosure of E3 is the "two-peak type distribution of average pore diameter", which for the reasons indicated in items 1.7 to 1.7.7 supra is not considered to contribute an inventive step. For the same reasons, the subject-matter of present claim 1 does not meet the requirements of Article 56 EPC.

5. *Auxiliary request 4 - Inventive step*

The subject-matter of claim 1 of this request differs from that of claim 1 of auxiliary request 3 in that the adjacent yarn array elements cross "at right angles" with each other. As explained at the oral proceedings

by the respondent - and not disputed by the appellant - the expression "in Köperbindung" means that the yarns are perpendicular to one another and thus cross "at right angles" with each other, as in claim 1 at issue.

For the same reasons as those indicated in item 4.3 supra, claim 1 of the present request does not meet the requirements of Article 56 EPC.

6. *Auxiliary requests 5, 6, 7 - Clarity*

The SiC-C/C composite material being characterised in claim 1 according to each of these requests by features relative to pores and their diameter - namely "*large pores having a median of pore diameter of about 100 µm*" and "*small pores having a median of pore diameter of 0.5 µm*" - which the board considered in items 3.2 and 3.3 supra as not being clear for the person skilled in the art, for the same reasons, none of the claims 1 according to auxiliary requests 5, 6 and 7 meets the requirements of Article 84 EPC.

7. In conclusion, as none of the claims 1 that the appellant proposed meets the requirements of the EPC, none of the requests is allowable.

Order

For these reasons it is decided that:

The appeal is dismissed

The Registrar: The Chairman:

C. Vodz G. Raths