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D E C I S I O N
of 30 April 2004

Case Number: T 0566/02 - 3.3.5

Application Number: 95907184.6

Publication Number: 0740644

IPC: C04B 35/81

Language of the proceedings: EN

Title of invention:
Silicon carbide whisker reinforced cutting tool material

Patentee:
SANDVIK AKTIEBOLAG

Opponent:
Kennametal Inc.

Headword:
Cutting insert/SANDVIK

Relevant legal provisions:
EPC Art. 100(a),(b), 83, 54, 56

Keyword:
"Sufficiency of disclosure (yes)"
"Novelty and inventive step (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0566/02 - 3.3.5

D E C I S I O N
of the Technical Board of Appeal 3.3.5
of 30 April 2004

Appellant: (Proprietor of the patent)
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 12 April 2002 revoking European patent No. 0740644 pursuant to Article 102(1) EPC.

Composition of the Board:

Chairman: M. M. Eberhard
Members: E. O. Wäckerlin
H. Preglau

Summary of Facts and Submissions

I. European patent No. 0 740 644 relating to a ceramic cutting insert comprising an alumina matrix and whiskers of silicon carbide was opposed on the grounds of insufficiency of disclosure (Article 100(b) EPC), lack of novelty and lack of inventive step (Article 100(a) EPC). The opponent (respondent) relied *inter alia* on the following documents in support of the opposition:

D1: US-A-5 238 334

D2: Letter from SILAG Operation, South Carolina, dated 13 January 1984, with enclosures: Brochure "SILAR" and price list.

D4: US-A-5 177 037

D5: Advanced Ceramic Materials 1 (1), 1986, 36 - 41

D6: EP-A-0 496 712

The single claim 1 as granted reads as follows:

"1. Ceramic cutting insert for chipforming machining of heat resistant alloys comprising an alumina matrix and 5 - 50 % by volume of homogeneously dispersed whiskers of silicon carbide, **characterized** in that the whiskers have an average length of 4 - 7 μm with a standard deviation of 3 - 5 μm, preferably about 4 μm."

II. The opposition division revoked the patent. It was held that the disclosure was sufficient. Novelty in respect of both D1 and D6 was acknowledged in view of the distribution of the lengths of the whiskers characterised by the specific selection of the range of (i) the average whisker length, and (ii) the standard deviation thereof.

With regard to the issue of inventive step the opposition division held that the specific distribution of the whisker length according to the patent in suit did not make a contribution to the physical properties of the claimed cutting tool material. Therefore the opposition division concluded that there was lack of inventive step.

III. The appellant (proprietor) lodged an appeal against the decision of the opposition division. He relied on additional documents in the course of the appeal procedure, in particular to D9

D9: J. Am. Ceram. Soc. 77 (11), 1994, 2828 - 2832

The respondent (opponent) also relied on further documents at the appeal stage, namely D7 and D8.

D7: Experimental Statistics. National Bureau of Standards Handbook 91, Washington D.C., 1966, p. 1-6 to 1-9

D8: Annals of the CIRP, 36 (1), 1987, 13 - 16

IV. The appellant argued, *in essence*, that the disclosure was sufficient, since the skilled person is able to perform the invention over the whole range of claim 1 as granted. Furthermore, it is well known in the art how to measure the length of the whiskers in the sintered composite and how to mix whiskers with an alumina matrix.

Novelty cannot be denied either. D1 discloses a ceramic cutting insert containing an alumina matrix and 10 to 40% by weight of single crystal whiskers and/or platelets of carbides, nitrides and/or borides of Si, Ti, Zr, Hf and/or Nb. The examples say nothing about the properties of the silicon carbide whiskers, especially nothing in respect of length, diameter or aspect ratio. Only the general description refers to the diameter and length of the whisker material. The range of length is 2.5 to 100 μm and, thus, much broader than the range of 4 to 7 μm according to the patent in suit.

Likewise the disclosure of D6 is not prejudicial to the novelty. Whereas the ranges of the diameter and of the whisker length are the same as in D1, the aspect ratio is even broader. D6 contains only one example relating specifically to silicon carbide whiskers, namely example 1 where whiskers of the type "SC-9" are used. According to D2 the length of "SC-9" whiskers is 10 to 80 μm. For this reason example 1 of D6 does not fall within the scope of claim 1 of the patent in suit.

D4 concerns a completely different material and does not disclose the step of premilling the whiskers which would lead to a reduction of the standard deviation.

The whisker length of 5 to 15 μm given in Figure 3 of D8 was measured on polished sections of sintered materials. This method leads to values which do not represent the true whisker length, as confirmed by D9.

With regard to the issue of inventive step the appellant argued that the problem underlying the present invention was to provide a ceramic cutting tool material with a combination of good hardness, fracture toughness and fracture strength. The inventors have surprisingly found that using short whiskers having a length within a specified range results in cutting tool inserts having such improved "overall" properties.

Neither D1, nor any of the other prior art documents give the teaching that such a compromise between the different properties can be achieved by using silicon carbide whiskers having the specified narrow distribution of whisker lengths.

Even though D4 discloses the use of short whiskers, the skilled person would not combine D4 with D1 or D6, because D4 relates to a completely different technical problem, namely the provision of a ceramic composite material having a high electrical conductivity for electro-discharge machining.

Similarly, the technical problem underlying D5 is also completely different from the problem of the present invention. D5 deals mainly with the question of how to increase the flowability and homogeneous incorporation of fibres including whiskers, microfibres, mineral fibres, short metal fibres etc. into a matrix material.

Thus, no incentive is given to the skilled person to combine D1 or D6 with D4 and, optionally, D5.

V. The arguments of the respondent can be summarised as follows:

The patent in suit does not disclose the alleged invention in a manner sufficiently clear and complete for it to be carried out. The examples contained in the patent show that a person skilled in the art working along the teaching of these examples, and therefore within the scope of the claim, will not obtain improved cutting tools in any instance. Further, as the aspect ratio of the silicon carbide whiskers is not specified in the claim, it is also to be expected that no improvement of the cutting properties will be achieved if the diameter of the whiskers is very low. Moreover what is claimed in the present case is a final product, i.e. the ceramic cutting tool. However, the entire disclosure of the patent in suit relates to the milled material which has to be sintered in order to convert it into the final product. During the sintering step some breaking of the whiskers may occur. The distribution of the whisker lengths in the final product may therefore differ from the distribution in the milled material. There is no evidence that the average length and standard deviation of the whiskers of examples A, B, C and D of the patent in suit have been determined after the sintering step. Furthermore the patent in suit contains no information as to how the mixing step was carried out and how the length of the whiskers in the sintered composite was measured.

In respect of the issue of novelty the respondent submitted that the teaching of D1 anticipates claim 1 of the patent in suit. The patent in suit requires that the whiskers have an average length of 4 to 7 μm with a standard deviation of 3 to 5 μm. Assuming that the lengths are distributed according to a normal distribution, about 70% of the whiskers exhibit a length of 4 to 7 μm +/- 3 to 5 μm, i.e. between 1 to 12 μm. This range overlaps with the range of 2.5 to 100 μm disclosed in D1.

The skilled person would use a standard whisker preparation, e.g. "SILAR SC-9" or "SC-10", and an aspect ratio within the preferred range of 5 to 10 stated in D1. Consequently, the average length of the silicon carbide whiskers would be in the range of from 3 to 6 μm.

D4 is also novelty-destroying, because it discloses ceramic cutting inserts comprising an alumina matrix and 10 to 50% by volume of silicon carbide whiskers having an average length of less than 10 μm, typically 5.0 μm. It is immaterial that D4 is silent on the standard deviation of the length, since this is an inherent feature of the teaching of D4. It is also immaterial that the product of D4 contains a further component, namely an electro-conductive ceramic component like TiC, TiB_2, ZrB_2 or TiN.

A further document that destroys novelty is D6. According to D6 whiskers of a length of 2.5 to 100 μm and a length to diameter ratio of preferably 5 to 30 are used. D6 suggests the use of silicon carbide whiskers of the "SC-9" type which are known to have an

average diameter of 0.6 μm. This translates into an average length of the whiskers of between 3 and 18 μm, which overlaps with the average length according to the patent in suit. Using whiskers having an aspect ratio of about 5 to 10 leads to lengths within the range as claimed in the patent in suit.

D6 requires wet milling and mixing of the raw material. This corresponds to the method used in the patent in suit. As D6 and the patent in suit both use the same raw material in the same amount, and also use the same processing of the material, the resulting product must be the same, too.

D8 describes various tests of commercial ceramic cutting tools, including "composite A" which comprises an alumina matrix and 30% by volume of silicon carbide whiskers manufactured by "ARCO". According to D8 the length of the "ARCO" whiskers as obtained from the manufacturer was 10 to 80 μm, whereas in the cutting tool "composite A" a range of 5 to 15 μm had been found. This is in line with the teaching of D8 according to which the whiskers have to be broken before mixing them with the alumina particles. Furthermore D8 reveals that a regular whisker length is important. This implies that the standard deviation must be small. The respondent concluded that the teaching of D8, taken as a whole, is therefore prejudicial to the novelty of the ceramic cutting inserts according to the patent in suit.

With regard to the issue of inventive step the respondent submitted that document D1 or D6 may be used as the starting point.

Starting from D6 as the closest prior art, the problem to be solved would be to optimise the known cutting insert. The skilled person would realise that the background art as indicated in D6 corresponds, *in essence*, to the teaching of D4. Therefore he would consult D4 and find that short whisker lengths lead to improved thermal shock resistance. Further he would find that a low aspect ratio in the range of 10 to 20 and whisker lengths of 5 to 10 μm (for whiskers having an average diameter of 0.5 μm) give rise to increased resistance to critical crack formation and propagation as well as an increased fracture toughness. From Table 2 of D4 the skilled person would conclude that an average whisker length of 5.0 μm is suitable. Thus, by combining D6 and D4 the skilled person would arrive at the claimed subject-matter in an obvious manner.

Similar considerations apply to the combination of D1 and D4. D1 teaches that the whiskers should have a low aspect ratio in the range of 5 to 10 for good strength, toughness, thermal shock and wear resistance. Furthermore D5 discloses how whiskers having a low and controlled aspect ratio can be obtained, namely by pre-breaking the whiskers before mixing them with the matrix material.

The respondent submitted further that the alleged invention, if at all novel, is only an arbitrary selection from the prior art teachings. The appellant has not presented any evidence showing that the claimed standard deviation has any impact on the properties or performance of the cutting tool. On the contrary the test results given in Table 3 of the patent in suit

reveal that there are only slight and insignificant differences between the properties of the samples according to the invention, i.e. "Variant B" and "Variant C", and the sample according to the prior art, i.e. "Variant A".

As far as D8 is concerned, the respondent argued that the only difference, if any, between the tested cutting insert "A" of D8 and the cutting insert according to the patent in suit is another definition of the whisker length, with a clear overlap of the respective ranges. However, this difference is easily overcome by the expert skilled in the art in view of other statements in D8, namely that the volume, aspect ratio and length of the fibres must be controlled to get proper performance and good reliability of the tool.

The respondent concluded that the cutting insert according to the patent in suit lacks an inventive step in view of D8 or one of the following obvious combinations of documents: (i) D6 and D4, optionally together with D5; or (ii) D1 and D4, again optionally together with D5.

VI. The appellant requested that the decision under appeal be set aside and that the patent be maintained as granted (main request) or, alternatively, on the basis of one of the auxiliary requests I to V filed during the oral proceedings.

The respondent requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.

2. *Sufficiency of disclosure*

The respondent has raised an objection of insufficiency of disclosure under Article 100(b) EPC, but he did not contest that the examples contained in the description produce the results set out in Tables 2 to 4. He argued that the cutting tool "Variant C", although covered by claim 1, does not show improved properties over the comparative example "Variant A" in the cutting test. The skilled person is therefore unable to determine from the usual cutting tests whether he will get an improved cutting tool when working within the scope of claim 1.

Moreover the respondent criticised that the aspect ratio is not included as a feature in claim 1. Further he contended that, although cutting inserts are claimed, the whole disclosure of the patent in suit relates to a preliminary product, namely the milled material before the sintering step. Since it is known that some breakage of the whiskers occurs during the sintering operation, the distribution of whisker lengths in the cutting insert is not the same as in the milled material. Moreover the method for measuring the whisker length in the sintered composite is not given in the patent in suit. The patent is also silent with regard to the kind of mixing which is performed, i.e. whether it is a soft mixing or not. Therefore the disclosure of the final cutting insert is incomplete.

The board is not convinced by this argumentation. As far as the first argument is concerned, the board concurs with the opposition division that this is an issue of inventive step, not sufficiency of disclosure, since claim 1 is not restricted to cutting inserts having **improved** properties in the cutting test.

The board observes further that the absence of the aspect ratio as a feature of claim 1 is immaterial to the issue of sufficiency of disclosure. It has been consistent case law of the boards of appeal that sufficiency of disclosure must be assessed on the basis of the application as a whole - including the description and claims - and not of the claims alone. The aspect ratio is indicated in the description. The fact that no improvement of the cutting properties might be achieved for certain values of the aspect ratio has no impact on the issue of sufficiency of disclosure since claim 1 does not require that improved cutting properties be achieved.

With regard to possible differences of the distribution of whisker lengths in the milled material and the sintered product, respectively, it is stated in the description of the patent in suit that the aspect ratio of the whiskers is not very much affected by the mixing and hot pressing operations, and that the desired aspect ratio of the whiskers is adjusted by premilling the whiskers prior to mixing with alumina in order to avoid that at least the longer whiskers will be broken during said operations (see page 2, lines 28-30 of the description). As pointed out by the appellant and not disputed by the respondent, a growth of the alumina grains may occur during the sintering step, but not a

growth of the whiskers. Therefore it is considered, in the absence of evidence to the contrary, that the average whisker length and standard deviation in the final product do not substantially differ from those given for the milled material.

Although a method of measurement of the whisker length in the **sintered composite** is not given in the patent in suit, it belongs to the common general knowledge of the skilled person how to determine this length. As indicated by the appellant, the sintered composite is put into an acid to dissolve the matrix and subsequently the actual length of the whiskers is determined. This was not disputed by the respondent. A method of measurement of the whisker length by SEM before mixing them with alumina is described in the patent in suit (see page 2, lines 54 to 56).

It is indeed not indicated in the patent in suit how the mixing is performed, i.e. whether it is a soft mixing or not. According to the description, mixing of the whiskers with the alumina powder is carried out using any suitable mixing technique. In view of the further information in the patent in suit that the aspect ratio of the whiskers is not very much affected by the mixing technique and hot pressing operation (see page 2, lines 28 to 30), the skilled person would in particular use a soft mixing technique rather than a vigorous one. In any case, the respondent has provided no evidence that the average length of whiskers and the standard deviation as defined in claim 1 for the sintered composite could not be obtained starting from the milled whiskers as used in the examples of the patent in suit.

For all these reasons the board is satisfied that the invention is sufficiently disclosed within the meaning of Article 83 EPC.

3. *Novelty*

3.1 The question arises whether or not the claimed ceramic cutting insert is novel. According to claim 1 the cutting insert is characterized in that the whiskers have an average length of 4 to 7 μm with a standard deviation of 3 to 5 μm.

In this respect it is observed that the indication of the average length and the standard deviation does not define the specific shape of the distribution of the whisker lengths as such. According to the appellant the actual distribution may be approximated for practical purposes by a bell-shaped function which is slightly skewed towards larger lengths. This was not disputed by the respondent.

3.2 Turning now to the prior art, D1 discloses ceramic cutting tool inserts for chip-cutting machining. The ceramic material comprises an alumina matrix and 10 to 40% by volume of monocrystalline whiskers and/or platelets of carbides, nitrides, and/or borides of Si, Ti, Zr, Hf, Ta and/or Nb or solid solutions thereof (see abstract). Three examples of D1 relate to materials containing silicon carbide whiskers, namely examples 5, 6 and 7, respectively. In example 5 the amount of whiskers is 7.5% by weight, whereas in examples 6 and 7 it is 25% by weight. D1 is silent on the length of the whiskers in the examples. Only in the

general part of the description is it stated that the whiskers have a length of 2.5 to 100 μm, a diameter of 0.2 to 10 μm and a length/diameter ratio of preferably 5 to 10 (see D1, column 3, lines 49 to 56). Nothing at all is said about the **average** length and the **standard deviation**.

The respondent did not deny that these features are missing, but he asserted that they are implicitly disclosed. In his view the skilled person would use a standard whisker preparation, for example "SILAR SC-9" or "SILAR SC-10" when reproducing the examples of D1. To obtain the preferred aspect ratio of 5 to 10 as indicated in D1, the skilled person would have to pre-break the standard whiskers. Assuming that the diameter of the whiskers is 0.6 μm as disclosed in D2 for "SILAR SC-9" or "SILAR SC-10", the resulting average length would be 3 to 6 μm, which fits well into the claimed range of 4 to 7 μm.

Contrary to the opinion of the respondent, the board holds that neither the range of the average length nor the standard deviation is disclosed in D1 in an implicit manner. A feature can only be considered as implicitly disclosed if it is directly and unambiguously derivable from the prior art document under consideration. In the present case this condition is not met, because D1 contains no teaching that whiskers of the type "SILAR SC-9" or "SILAR SC-10" have to be used. As far as the respondents' argument is concerned according to which the range of the whisker lengths disclosed in D1, i.e. 2.5 to 100 μm, overlaps with the claimed range, the board observes that D1, while indicating the range of lengths of the whiskers,

is completely silent on the **average** length. An average length of 4 to 7 μm is not directly and unambiguously derivable from the said length range. Consequently the board concludes that the claimed cutting insert is novel over the disclosure of D1.

3.3 D6 discloses also ceramic cutting inserts for chip-forming machining (claim 1). According to page 2, lines 51 to 54 and 58, and page 3, line 1 the material comprises an alumina matrix and 5 to 50% by volume of homogeneously dispersed silicon carbide whiskers having a length of 0.2 to 100 μm, a diameter of 0.2 to 10 μm and an aspect ratio of 5 to 30. In example 1, "samples A to E", silicon carbide whiskers of the type "SC-9" are used. These whiskers are known to have a length distribution so that 80% by weight of the whiskers fall within the range of 10 to 80 μm (see D2, data sheet of SC-9). The average length must therefore be somewhere between the boundary values of 10 and 80 μm, respectively. This is far outside the range set out in claim 1 of the patent in suit.

The respondent has referred to the sentence on page 3, lines 6 to 7 of D6, according to which *"the cutting material according to the invention is made by wet milling and mixing of oxide based powder and whisker and/or platelets."* He derives from the sentence that the whiskers are milled before being incorporated in the oxide based powder, which means that their original length is not maintained.

The board cannot accept this interpretation. Although the sentence is somewhat ambiguous from a grammatical standpoint, its technical meaning is beyond any doubt.

What the sentence tries to express is that the matrix material is wet milled and subsequently mixed with the **untreated** whiskers. The alternative interpretation made by the respondent must be ruled out, because it is technically not meaningful. As pointed out by the appellant vigorous milling conditions, which are required for milling the matrix material (here: alumina) would lead to the destruction of the whiskers. One of the inventors of D6 who was present at the oral proceedings confirmed that no milling of the whiskers had been performed in D6.

The respondent’s argument that there exists an overlap of the whisker length between D6 and the patent in suit, which is prejudicial to the novelty, is not convincing. As in the case of D1 there is no explicit disclosure of the **average** length in D6. In order to overcome this gap the respondent has made calculations which are based on the assumptions that:

(i) the aspect ratio is from 5 to 30 or, more specifically, from "about 5 to 10", and

(ii) the diameter of the silicon carbide whiskers is 0.6 μm, i.e. the diameter given in D2 for "SC-9" type whiskers, "SC-9" whiskers being used in example 1 of D6. In the boards’ view these assumptions are based on hindsight for the following reasons: The aspect ratio of 5 to 30 is disclosed in the general part of the description in combination with a whisker length of 2.5 to 100 μm and a whisker diameter of 0.2 to 10 μm, but not with the specific diameter of 0.6 μm mentioned in D2, and the preferred range of 5 to 10 for the

aspect ratio is not disclosed in D6. It was selected by the respondent for the purpose of the calculation. Therefore the calculations do not demonstrate the alleged lack of novelty of the claimed average length, let alone of the associated standard deviation. It follows that, as in the case of D1, D6 does not disclose the features of the **average** length and the **standard deviation** set out in claim 1.

3.4 D4 discloses electro-conductive ceramic cutting tool inserts consisting of 35 to 60% by volume of alumina, 10 to 50% by volume of silicon carbide whiskers and 20 to 30% by volume of TiC (see D4, claim 14). Silicon carbide whiskers having an average length of less than 10 μm are mentioned in column 5, lines 33 to 36. Further it is stated in D4 that a whisker aspect ratio of about 10 to 20 is preferred, and that this low aspect ratio results in typical silicon carbide whisker lengths of 5 to 10 μm for whiskers having an average diameter of 0.5 μm (column 6, lines 31 to 37). On the basis of volumetric calculations D4 estimates that whiskers having an average length of 5.0 μm and an average diameter of 0.5 μm would lead to products with a mean free path length of 5 μm, compared to 100 μm in the case of whiskers having an average length of 100.0 μm and an average diameter of 1.5 μm (column 6, lines 53 to 60; columns 6 to 7, Table 2). Silicon carbide whiskers "having the small diameter and low aspect ratio utilized in the new ceramic composites" are said to be commercially available from the manufacturer Tokai Carbon Co., Tokyo (see column 7, lines 22 to 25).

It is questionable whether the indication of the average length of 5.0 μm in Table 2 of D4 relates to a real example. It may well be a purely theoretical assumption for the purpose of calculating the mean free path. Assuming in favour of the appellant that Table 2 relates, in fact, to a real example, then there is still a missing feature, namely the standard deviation of the whisker length.

The argument of the respondent that a standard deviation within the range of 3 to 5 μm is inherent to the whisker preparation and, thus, forms part of the implicit disclosure of D4, is not convincing. It could only be accepted if there was sufficient evidence that a skilled person, when carrying out the teaching of D4, would inevitably arrive at a standard deviation of 3 to 5 μm. However, D4 does not disclose the method of manufacturing the whiskers, and it is also not mentioned that a milling step is involved, which, according to the appellant , would inevitably lead to a reduction of the standard deviation. Furthermore the respondent has failed to bring forward such evidence. In particular he has given no details regarding the average length and the standard deviation of the commercial product of Tokai Carbon Co. referred to in D4.

In the absence of conclusive evidence to the contrary the board concludes that at least the range of the **standard deviation** according to claim 1 of the patent in suit is not disclosed in D4.

3.5 The respondent has also contested the novelty of the claimed cutting insert on the basis of D8, particularly with regard to the "composite A" described therein. The board observes that, according to Figure 3 on page 14 of D8, the length of the "Arco" silicon carbide whiskers of "composite A" is 5 to 15 μm, which does not correspond to the range of 10 to 80 μm given in Figure 2. In order to explain this difference the respondent took it for granted that the whiskers were not used in their original shape as manufactured, but that they had been broken in order to shorten their length. This explanation was contested by the appellant who pointed out that the whisker lengths set out in Figure 3 had been measured on polished sections of the sintered composite material. Therefore according to the appellant the range given in Figure 3 of D4 did not represent the true physical lengths of the whiskers, but the projection of the whiskers on a planar area of the polished sections. The appellant did not recognise that there was an inconsistency between the data set out in Figures 2 and 3 of D8, respectively, since on average the projection of a whisker was smaller than the true physical length.

The board considers that the explanation given by the appellant is plausible. Firstly this explanation is in agreement with the teaching of D9 which confirms that the determination of the whisker length in the composite by SEM may lead to erroneous (i.e. artificially reduced) whisker lengths due to the angular orientation of the whiskers in the composite (see page 2830, right hand column, last paragraph; D9 being post-published, its content is only regarded as an expert opinion). Furthermore, D8 contains no

indication that the silicon carbide whiskers have not been used in their original shape, apart from the statement on page 14 according to which "it is better to pre-break them before mixing" (page 14, right hand column, second paragraph). However, this statement is a simple reference to another document, namely D5, and does not relate specifically to the "composite A", which was the object of the investigation. According to the preceding sentence (in the same paragraph) which concerns the defects in "composite A" shown on Figure 4, "composite A has large areas of Al_2O_3 without any whiskers and many lines with no whiskers crossing. That may come from fibers - powders agglomerates formation during mixing or (and) from fibers breakage during hot pressing. These problems could depend on the initial length of the whiskers;" Then it is recommended to pre-break the whiskers "before mixing in order to get a controlled aspect ratio and a higher green density reducing movements during hot pressing", with the reference to D5. In the board’s view this teaching would rather suggest that the whiskers had not been milled or broken in another way before the hot-pressing step.

Moreover D8 does not disclose any specific standard deviation of the distribution of whisker lengths. It is true that D8 reveals the importance of what is called "a regular whisker length" (page 16, right hand column, line 26), but this statement does not provide a concrete teaching which range of the standard deviation is suitable. Therefore neither the average length, nor the standard deviation are unambiguously anticipated by the disclosure of D8.

For all these reasons the board concludes that the claimed cutting insert is novel in respect of D1, D4, D6 or D8. It is also new over the disclosure of the other prior art documents. This was not in dispute; therefore there is no need to discuss these documents here.

4. *Inventive step*

4.1 At the oral proceedings the parties agreed that D6 or, alternatively, D1 represents the closest prior art. The board can accept this approach. Both documents relate to ceramic cutting inserts for chip forming machining comprising an alumina matrix and homogeneously dispersed whiskers of silicon carbide. In order to be suitable in metal cutting, especially in the machining of heat resistant alloys, such inserts must possess a number of properties including high density, hardness, fracture toughness and fracture strength. Since these properties are to a certain extent mutually exclusive, the problem arises how to optimize the ceramic material, so that a good balance of properties is achieved.

Starting from the inserts as disclosed in D1 or D6, the technical problem underlying the patent in suit can be seen in providing an insert which exhibits an optimised balance of hardness, fracture toughness and fracture strength.

4.2 It is proposed to solve this problem by the cutting insert as defined in claim 1 which differs from the closest prior art by the specific ranges of the average length of the whiskers and the standard deviation. In practice the required short average length and the

narrow standard deviation are achieved by premilling the whiskers prior to mixing them with the alumina.

In view of the experimental results given in Tables 3 and 4 of the patent in suit, the board is satisfied that the technical problem stated above has actually been solved. Thus, examples B and C according to claim 1 show improved hardness and a slightly improved fracture strength compared to example A, which represents the prior art and relates to an insert having a larger average whisker length of 28,2 μm and a broader standard deviation of 23,1 μm. On the other hand the fracture toughness of examples B and C is only slightly reduced in comparison with example A (page 3, Table 3).

4.3 Neither D1 nor D6 contain information suggesting how to modify the cutting inserts disclosed therein in order to obtain the said optimised balance of properties.

4.4 As stated above, D4 discloses the use of short whiskers having an average length in the range of 5 to 10 μm in cutting inserts. However, it cannot be derived from the teaching of D4 that short and narrowly distributed whisker lengths give rise to the optimisation of the hardness, fracture strength and fracture toughness.

It cannot be derived from D4 either that the spread of lengths which is characterised by the standard deviation has a substantial impact on these critical properties. D4 is concerned with electro-conductive ceramic composites containing a significant amount of at least one electro-conductive component. It had been found that the addition of electrically conductive

components to the ceramic material compromised both fracture toughness and fracture strength of the material (column 3, lines 36 to 45). D4 suggests to compensate these detrimental effects by using whiskers averaging less than 10 μm in length (column 4, lines 15 to 50). But D4 provides no general technical teaching which goes beyond the specific problem caused by the addition of electro-conductive components.

According to D4 (see column 4, lines 54 to 59) the ceramic composites possess "significantly improved mechanical properties of fracture toughness, strength and hardness over previous electro-conductive ceramic composites **and non-electroconductive ceramic composites**" (emphasis added). In the respondent's view this statement must be understood as teaching that inserts containing silicon carbide whiskers having an average length in the range of 5 to 10 μm show improved fracture toughness, strength and hardness over non-electroconductive inserts with longer silicon carbide whiskers.

The board is not convinced by this argument. In fact D4 does not disclose any comparison with a non-electroconductive ceramic composite comprising longer SiC whiskers, which could support the respondent's interpretation. In the experimental section set out in column 5, Table 1, five different ceramic materials, four of which without any whiskers, are compared with each other. Furthermore according to D4 the small size of the SiC whiskers is believed to contribute to the thermal shock resistance of the electro-conductive ceramic composites (column 5, lines 34 to 88). This

teaching cannot be regarded as a pointer to the present solution of the technical problem.

As pointed out by the appellant and not disputed by the respondent, it was well-known in the art that, generally, long whiskers give rise to increased fracture toughness and fracture strength. Therefore the skilled person could not expect that shortening the whisker length and narrowing down the standard distribution would lead to a slight increase of the fracture strength, whereby the decrease of fracture toughness is only minimal.

Therefore the board holds that the skilled person would not be prompted to combine D4 either with D1 or D6.

4.5 As far as document D5 is concerned, the board does not concur with the respondent’s view that the skilled person would combine D5 optionally with either D1 and D4 or, alternatively, D6 and D4.

In D5 the impact of the aspect ratio of whiskers on various properties of composite materials is discussed. It is stated that "short short fibers", i.e. whiskers having an aspect ratio of 10 to 20, produce "the best ceramic composites" (page 41, right hand column, first paragraph). Moreover it is stated that short fibers with an aspect ratio of 10 to 30 flow and behave like powder, so that the shorter they are, the easier they are to work with (page 37, right hand column, lines 2 to 3). On that basis it is concluded that reducing the aspect ratio is "not all bad if it is done before mixing", and that it is "better to pre-break the fibers

before mixing to a controlled aspect ratio" (page 40, right hand column, lines 6 to 7 and 11 to 15).

The board holds that the teaching of D5 is not specific enough to provide the skilled person with an incentive to combine D5 with either D1 and D4 or D6 and D4. In fact D5 does not specifically deal with composites comprising silicon carbide whiskers and an alumina matrix. Furthermore it does not concern ceramic cutting inserts for chipforming machining of heat resistant alloys. It also does not deal with the problem of achieving an optimised balance of hardness, fracture toughness and fracture strength which is required for such inserts. For these reasons the skilled person would not have contemplated combining the teaching of D5 with those of D1 and D4 (or D6 and D4), when trying to solve the present technical problem.

4.6 The respondent has also argued that D8 is prejudicial to the inventive step of the patent in suit. He submitted that the only difference between the insert according to claim 1 and the "composite A" which was tested in D8 consists in a different definition of the whisker length. On the basis of the statement in D8 according to which the volume and the aspect ratio must be controlled in order to get a proper performance and good reliability, the skilled person would have an incentive to modify the "composite A" of D8 and, thus, arrive at the invention in an obvious manner.

These arguments are not convincing. The statement in D8 that it is better to pre-break the whiskers before mixing in order to get a controlled aspect ratio and a higher green density (page 14, right hand column, last

sentence of second paragraph) is a simple repetition of what is already expressed in D5. D8 is silent about the effect of pre-breaking (i.e. shortening) of the whiskers on the desired combination of properties of the sintered composite material, namely fracture strength, fracture toughness and hardness. Taking into account the general knowledge about the influence of the whisker length on the fracture toughness and fracture strength of the composite (see above, point 4.4, second last paragraph) the teaching of D8 and in particular the conclusions set out on page 16 (right hand column, paragraph 7) provide no specific teaching how the present technical problem can be solved.

4.7 The other documents referred to by the parties are clearly less relevant. They contain no further information which, in combination with the teaching of the preceding documents, would point towards the claimed cutting insert.

5. It follows from the above that the subject-matter of claim 1 is novel over the cited prior art and involves an inventive step. Thus, claim 1 meets the requirements of patentability set out in Articles 52(1), 54 and 56 EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is maintained as granted.

The Registrar: The Chairwoman:

A. Wallrodt M. M. Eberhard