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D E C I S I O N
of 17 January 2002

Case Number: T 0517/98 - 3.3.5

Application Number: 90905918.0

Publication Number: 0457851

IPC: C04B 35/00

Language of the proceedings: EN

Title of invention:
Oriented grained Y-Ba-Cu-O superconductors having high critical currents and method for producing same

Patentee:
UNIVERSITY OF HOUSTON

Opponent:
Siemens AG

Headword:
-

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

Keyword:
"Main request, first and second auxiliary request - sufficiency of disclosure (no), not enabling over the whole ambit of the claim); Third auxiliary request - sufficiency of disclosure
(yes) - Inventive step-(yes) non-obvious modification of a known process; unexpected improvement of the resulting product"

Decisions cited:
T 0409/91

Catchword:

If the disclosure of a patent in suit is limited to products which, when prepared by the method according to the invention, are characterised by distinctive parameters, then a claim which does not stipulate these parameters a priori encompasses embodiments which are not obtainable by the method disclosed.

Such disclosure of a single way of performing the invention will only be considered sufficient if it enables a person skilled in the art to carry out the invention within the whole ambit of the claim. If this is not the case, the claim does not meet the requirements of Article 83 and 100(b) EPC.

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0517/98 - 3.3.5

D E C I S I O N
of the Technical Board of Appeal 3.3.5
of 17 January 2002

Appellant: (Opponent)
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Representative:
-

Respondent: (Proprietor of the patent)
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Decision under appeal:
Interlocutory decision of the Opposition Division of the European Patent Office posted 23 March 1998 concerning maintenance of European patent No. 0 457 851 in amended form.

Composition of the Board:

Chairman: R. K. Spangenberg
Members: A. T. Liu
J. H. Van Moer

Summary of Facts and Submissions

I. European patent No. 0 457 851 was granted with a set of 21 claims.

II. A notice of opposition was filed against the patent on the grounds of Articles 100(a) and (b) EPC. Of the 15 prior art documents cited in support of the opposition, reference shall be made to the following in the present decision:

D10: EP-A-0 295 023

III. During the oral proceedings before the opposition division, held on 5 March 1998, the patent proprietor filed a new set of claims which differed from the granted claims only in the deletion of claim 9 as granted.

IV. The set of claims which formed the basis for the decision consisted of an independent claim 1 directed to a superconductive composition, with claims 2 to 9 depending thereon; an independent claim 10 directed to a process for preparing a superconducting metal oxide complex, with claims 11 to 16 depending thereon; an independent product-by process claim 17, with claims 18 and 19 depending thereon and an independent use claim 20. The independent claims read as follows:

"1. A bulk high-temperature superconductive composition comprising oriented grains of the formula

$L_1Ba_2Cu_3O_{6+\delta}$

wherein L is a rare earth element and δ has a number value from about 0.5 to about 1.0 and further wherein at 77°K said bulk composition has a current density greater than 70,000 amps/cm^2 at zero magnetic field and a current density greater than 37,000 amps/cm^2 under a 0.6T magnetic field.

10. A process for preparing a superconducting metal oxide complex comprising the steps of:

(a) sintering a compacted solid mass at a temperature between about 40°C to about 90°C below its melting point, wherein the solid mass is derived from compounds containing L, Ba, Cu and O, L being a rare earth element, and further wherein the amounts of said compounds are such to yield the formula $L_1Ba_2Cu_3O_{6+\delta}$ wherein δ has a number value from about 0.1 to about 1.0;

(b) heating the solid mass in a preheated chamber to a temperature of from about 80°C to about 190°C above its melting point for a time sufficient to partially melt and decompose said mass;

(c) rapidly cooling the mass to a temperature between about 10 °C to 40 °C above its melting point and then cooling the mass to a steady temperature between about 20°C and 40 °C below its melting point at a rate of approximately 1°C/hour;

(d) maintaining the mass at said steady temperature for a time sufficient for the entire mass to resolidify; and

(e) annealing the resolidified mass in an oxygen containing atmosphere for a time sufficient for the requisite amount of oxygen to diffuse into the mass.

17. A product prepared in accordance with anyone of claims 10 to 16 having a current density greater than 70,000 amps/cm^2 at 77°K and zero magnetic field.

20. A method for conducting an electrical current within a conductor material without electrical resistive losses, comprising the steps of utilizing as the conductor material a metal oxide complex of the formula

$L_1Ba_2Cu_3O_{6+\delta}$

wherein L is a rare earth element and δ has a number value from about 0.1 to about 1.0 and further wherein at 77°K the current density of said composition is greater than 70,000 amps/cm^2 at zero magnetic field and the current density is greater than 37,000 amps/cm^2 under a 0.6T magnetic field;

cooling said metal oxide complex to a temperature at or below that at which said metal oxide complex becomes superconductive; and

initiating a flow of electrical current within said metal oxide complex while maintaining said metal oxide complex at or below the temperature at which it becomes superconductive."

V. The opposition division held that the patent in suit satisfied the requirements of Article 100(b) EPC.

The 15 cited documents were not found to contain any information which beyond reasonable doubt disclosed a bulk type superconductive material as stipulated in claim 1. Furthermore, the performance of the composition according to claim 1 was accepted as being superior to that of the known compounds. An inventive step could be acknowledged since the prior art did not offer guidance as to how to achieve such high current densities.

VI. An appeal was lodged by the opponent who made reference inter alia to the following document for the first time at the appeal proceedings stage:

D16: Science, Vol. 241, pages 922 to 930, (August 1988)

VII. At the oral proceedings which took place on 17 January 2002, the respondent filed three new sets of claims which were to form the basis for a first, second and third auxiliary request.

The 20 claims of the first auxiliary request essentially corresponded to those of the main request, with the only difference that claim 1 had been amended to read as follows:

> "A bulk high-temperature superconductive composition comprising oriented grains of the formula
>
> $L_1Ba_2Cu_3O_{6+\delta}$

wherein L is a rare earth element and δ has a number value from about 0.5 to about 1.0 and further wherein at 77°K said bulk composition has a current density, measured by pulse current density measurement with a 1 ms pulse width, greater than 70,000 amps/cm^2 at zero magnetic field and a current density greater than 37,000 amps/cm^2 under a 0.6T magnetic field."

The second auxiliary request consisted of 18 claims, corresponding to claims 1 to 6 and 8 to 19 of the main request, with the essential difference in that claim 1 had been amended to read as follows:

"A bulk high-temperature superconductive composition comprising oriented grains of the formula

$$L_1Ba_2Cu_3O_{6+\delta}$$

wherein L is a rare earth element and δ has a number value from about 0.5 to about 1.0, wherein the grains are stacked parallel to each other in the a-b crystallographic basal plane, and further wherein at 77°K said bulk composition has a current density greater than 70,000 amps/cm^2 at zero magnetic field and a current density greater than 37,000 amps/cm^2 under a 0.6T magnetic field."

The third auxiliary request consisted of 10 claims which corresponded substantially to claims 10 to 19 of the main request.

VIII. The appellant's arguments submitted orally and in writing were essentially the following:

- The definition of the composition in claim 1 of

the main, first and second auxiliary requests was open ended and encompassed embodiments which could not be obtained according to the disclosure of the contested patent. Following the decision T 409/91, the requirements of Article 100(b) EPC were thus not met.

- The process according to claim 1 of the third auxiliary request lacked an inventive step in view of the prior art according to D16 and D10.

IX. The respondent's arguments may be summarised as follows:

- The appellant should have provided evidence in support of his objection of lack of sufficient disclosure.

- A broad protection for products with an unusually high conductivity was justified in the present case as such products were disclosed for the first time in the patent in suit.

- By stating that the obtention of a high current density was a major challenge but without providing any teaching as to how this may be achieved, D16 would point to the merits of the contested patent.

X. The appellant (opponent) requested that the decision under appeal be set aside and that the European patent No. 0 457 851 be revoked.

The respondent (patentee) requested that the appeal be dismissed and, in the alternative, that the patent be maintained on the basis of any of the first, second and third auxiliary requests filed during the oral proceedings.

Reasons for the Decision

1. *Main request*

1.1 Claim 1 is directed to a class of superconductor materials characterised by a lower limit of current densities ("at 77°K said bulk composition has a current density greater than 70,000 amps/cm^2 at zero magnetic field"). The Board observes that, although this is not explicitly stated in claim 1, the stipulated feature of "current density" in the claim is construed as meaning "critical current density", which is an intrinsic property of the material, and not merely any current density reflecting the voltage being applied to the material. This interpretation has not been contested by either party. For the purpose of this decision, the two expressions are therefore used interchangeably.

1.2 The appellant has pointed out that the subject-matter of claim 1 is characterised by an open-ended range of current densities. However, only a particular method for preparing a particular superconductor composition with specific properties is disclosed in the patent in suit (Examples 1 and 2 and Table 1). Neither the disclosed method nor an alternative method is described which would enable the skilled person to obtain the whole class of materials as claimed. The invention is therefore not disclosed in a manner sufficiently clear and complete for it to be carried out by the skilled person.

1.3 According to the patent in suit, **when prepared in accordance with the process of the invention** (emphasis added), the oxide materials exhibit a J (defined as the amount of current carried by a 1 cm^2 cross-section of material) in zero magnetic field at 77°K, of from about

30,000 to 85,000 amps/cm^2 . These oxide materials are comprised of plate shape grains of distinctive dimensions and stacked in a distinctive manner. The shape, length and orientation of the grains are described as being primarily responsible for the enhanced conductivity of the material (page 5, line 58 to page 6, line 12). In the Board's judgment, the disclosure of the patent in suit is thus restricted to a class of superconductors having a distinctive structure and a current density within a limited range. A claim which does not stipulate such restrictions a priori encompasses embodiments which are not described as being obtainable by the sole method disclosed in the patent specification.

1.4 The respondent has argued that, to demonstrate an insufficiency of disclosure, the appellant has to provide a concrete example of a material which would fall within the definition of claim 1 but could not be obtained following the teaching of the patent in suit.

The relevant question here is, however, not whether it is possible to obtain a product falling within the wide range as claimed, which can clearly be answered in the positive. Rather, the question is as to whether, by applying the method disclosed in the patent in suit, it is possible for the skilled person to prepare a material which is within the ambit of claim 1 but has a different structure than the one described and/or a current density (well) beyond the upper limit of 85,000 amps/cm^2 indicated in the description. The respondent has not argued, let alone proved, that such embodiments could be obtained according to the method of the patent in suit.

1.5 The respondent has also advanced the argument that, since a superconductor material could be made for the first time with a high current density as indicated,

the inventor(s) should be entitled to a broad protection, including protection for subject-matter which is not yet made available to the skilled person in the art.

In principle, the Board concurs with the respondent insofar as it is only fair for the inventor(s) to get the broadest protection possible, **provided that it is in accordance with his original disclosure** (emphasis added). This provision would imply that the disclosure of one way of performing the invention will be considered sufficient if, and **only if** it enables a person skilled in the art to carry out the invention within the whole ambit of the claim. As is stated in point 1.4 above, this condition is not met in the present case.

When examining the facts of the case, the Board notes that, ever since the discovery of superconductivity at high temperatures in copper oxide-based systems, there has been a constant effort in the art to improve the critical current density for bulk superconductor materials (see for example D16, page 928, right hand column last paragraph). On the other hand, the patent in suit has only shown the way of achieving this goal to some extent and within set limits but certainly not within the whole ambit of the claim (see point 1.3 above). In the Board's judgment, a broad protection as claimed is therefore unjustified in the present case since such a claim encompasses speculative subject-matter which could not be produced by the skilled person without the application of inventive ingenuity (see also T 409/91, OJ EPO 1994,653, points 2 and 3 of the reasons).

1.6 As corollary of the above, the main request must fail because the subject-matter of claim 1 does not meet the requirements of Articles 83 and 100(b) EPC.

2. *First auxiliary request*

2.1 The subject-matter of claim 1 differs from that of claim 1 of the main request in that it further incorporates the stipulation that the current density is "measured by pulse current density measurement with a 1 ms pulse width".

2.2 The Board observes that the definition of the method of measurement does not bring in any new aspect susceptible of changing the above reasoning. The finding for claim 1 of the main request therefore applies mutatis mutandis to claim 1 of this request.

3. *Second auxiliary request*

3.1 The subject-matter of claim 1 of this request differs from that of claim 1 of the main request in that it further incorporates the stipulation that the grains of the superconductor material "are stacked parallel to each other in the a-b crystallographic basal plane".

3.2 The Board concurs with the respondent in that the added feature is crucial and expressly disclosed as being obtained by the method of the invention. It is thus true that speculative materials not showing the stipulated grains orientation are now outside the scope of the claim.

As is indicated in point 1.3 above, the materials disclosed in the patent in suit are, however, not only characterised by the orientation of the grains but also by the shape and dimensions of the grains and, last but not least, by an upper limit of current density obtainable. The Board therefore holds that the incorporation of the grains orientation into the subject-matter of claim 1 is not sufficient for changing the reasoning with respect to the lack of

disclosure. As a consequence, the finding for claim 1 of the main request also applies to claim 1 of this request.

4. *Third auxiliary request*

The appellant has not raised the objection of lack of disclosure against the claims of the present request. Indeed, there is no doubt that claim 1 defines by its essential features a process which can be carried out by the skilled person. In claim 8, the product features such as structure and upper limit of current density achievable are implicitly restricted by the process parameters (see also point 1.3 above). The Board is therefore convinced that the requirements of Article 83 and 100(b) are met.

4.1 Claim 1 of this request is directed to a process for preparing a superconducting metal oxide complex of the formula $L_1Ba_2Cu_3O_{6+\delta}$.

4.1.1 Novelty

The Board is satisfied that the claimed process is novel. This has never been disputed. This point would also be clear from the discussion on inventive step below.

4.1.2 Inventive step

(a) The Board can accept the appellant's submission that the closest prior art is represented by D16 which reviews the processing techniques for the $Ba_2YCu_3O_7$ superconductors (see title and page 922, left hand column, first paragraph).

(b) With respect to D16, the technical problem can be seen in the production of superconductors having a reduced field dependence of current density.

(c) To solve the above technical problem, the patent in suit proposes in claim 1 a process which is particularly characterised in that, after the compacted solid mass is sintered then heated above its melting point for a time sufficient to partially melt and decompose, it is

> **rapidly cooled to a temperature between about 10°C to 40°C above its melting point and then cooled to a steady temperature between about 20°C and 40°C below its melting point at a rate of approximately 1°C/hour** (emphasis added).

(d) It is undisputed that the stated technical problem is solved by the claimed process (see patent in suit, page 7, lines 24 to 39; Examples 1 and 2; and also point 4.2 below). The only question is therefore as to whether the proposed solution can be derived from the available prior art in an obvious way.

(e) In D16, it is indicated that the same technical problem is solved by the application of a new technique called melt-textured-growth (page 926, left hand column, penultimate paragraph). Such process is disclosed in details in D10.

In the known process, after having been heated to a temperature in the two-phase field (solid + liquid) of the phase diagram, the samples are cooled at rates between 10 and 300 °C/hour (D10, column 17, lines 23 to 32). From the further explanation given in D10, it is clear that the heating step results in partial or complete melting. The cooling rate is then chosen such

that phase separation is substantially avoided or minimized. Typically, the cooling rate is suggested to be greater than 100°C/min and preferably greater than 200°C/min (column 9, lines 5 to 8 and lines 32 to 47). It is thus undisputed that the cooling regime of D10 completely deviates from that of claim 1.

The appellant has also conceded that the two-step cooling regime as stipulated in claim 1 is not suggested in any other available prior art document.

As a consequence, the Board must conclude that the process of claim 1 involves an inventive step.

4.2 Claim 8 of this request is directed to a product prepared in accordance with a process of the invention and further characterised by "a current density greater than 70,000 amps/cm^2 at 77°K and zero magnetic field".

In view of the description, the Board interprets the stipulated current density as being measured using a pulse current with a pulse width of 1 ms (page 8, line 22 to page 9, line 15). The Board has not overlooked the fact that, by not stipulating these test conditions, the subject-matter of claim 8 lacks clarity. However, since this deficiency has not been introduced by an amendment to the claim after grant, an objection under Article 84 EPC is not appropriate at this stage of the proceedings.

4.2.1 The Board is satisfied that the product according to claim 8 is novel. This has not been queried (for more details, see the discussion on inventive step below).

4.2.2 For the assessment of inventive step, the Board also accepts D16 as comprising the closest prior art, in respect of which the technical problem remains essentially the same as above, namely the provision of superconductor materials exhibiting a high current density with a reduced field dependence.

It is common ground that the data shown in the patent in suit prove that the stated problem is solved by the materials as stipulated in claim 1 (see page 6, lines 13 to 21 and page 9, Table 1). Furthermore, the claimed materials have an improved current density of at least 70,000 amps/cm^2 at 77°K and zero magnetic field, as compared to the superconductors disclosed in D10, for which the highest current density, at 77°K and zero magnetic field is 7400 amps/cm^2 (example X). The Board therefore acknowledges that the claimed product involves an inventive step.

Order

For these reasons it is decided that:

- The decision under appeal is set aside.

- The case is remitted to the first instance with the order to maintain the patent with the following documents:

1. claims 1 to 10 submitted as third auxiliary request

2. a description to be adapted accordingly

3. Figures as granted.

The Registrar: The Chairman:

U. Bultmann R. Spangenberg