Commissioner=s Decision # 1335
Décision du Commissaire # 1335

TOPICS: B00, B20, B22, G00
SUJETS: B00, B20, B22, G00

Application No. : 558,106

Demande n^{o}. : 558,106

COMMISSIONER=S DECISION SUMMARY

C.D. 1335, Application No. 558,106

The subject application relates to ceramic-like layer-type crystalline metal oxide superconducting compositions having high superconducting transition temperatures.

The subject application was rejected by the Examiner on the basis that the claims were indefinite due to the misuse of various terms to define superconductivity, that the subject matter of the claims lacked utility and that the subject matter of the claims was not properly supported since the transition temperature was not defined with an upper limit.

The Commissioner of Patents agreed with the recommendations of the Board that the application be allowed provided a specified amendment is made and pending review of potential conflicts under section 43 of the *Patent Act*, as it read immediately before October 1, 1989.

IN THE CANADIAN PATENT OFFICE

DECISION OF THE COMMISSIONER OF PATENTS

Patent application number 558,106 having been rejected under subsection 30(3) of the Patent Rules, has been reviewed in accordance with subsection 30(6) of the Patent Rules by the Patent Appeal Board and the Commissioner of Patents. The findings of the Board and the ruling of the Commissioner are as follows:

Agent for the Applicant

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INTRODUCTION

[1] This Decision deals with a review of a Final Action dated August 15, 2006, on application 558,106. The application was filed on February 4, 1988 and is entitled ASUPERCONDUCTIVE COMPOUNDS HAVING HIGH TRANSITION TEMPERATURE AND METHODS FOR THEIR USE AND PREPARATION@. The inventors are Johannes G. Bednorz and Carl A. Mueller, and the current owner is IBM CANADA LTD.

BACKGROUND

[2] The invention relates to a new class of superconducting compositions having high superconducting transition temperatures. The compositions are metal oxides capable of superconductivity at a temperature of 26°K or higher. They have a ceramic-like layer-type crystalline structure, often perovskite-like, and include a transition metal, oxygen, and a rare earth and/or an alkaline earth element. The Nobel Prize in Physics 1987 was awarded to the above inventors for the discovery of these superconductive ceramic materials.

[3] The compositions are represented by the general formula RE-AE-TM-O, wherein RE is a rare earth or rare earth-like element (i.e., a group IIIB element), AE is an alkaline earth element (i.e., a group IIA element), TM is a non-magnetic transition metal, and O is oxygen. The rare earth element can be partially or completely substituted by the alkaline earth element. The ratio of (AE,RE):TM is generally approximately 1:1, but can vary. The amount of oxygen present in the final composition is such that the valence requirements of the system are satisfied.

[4] The compositions may consist of multiple Aphases@, which are local regions within the compositions that are uniform in chemical composition and physical state, but which differ physically and/or chemically from other regions. Some of these phases may not contribute to the superconductivity of the composition, but may in fact be insulating. The compositions may nonetheless be superconducting provided there is sufficient superconductive phase to impart this quality on the material as a whole.

[5] The field of high transition temperature superconductors is complex and specialised. A superconductor has a critical temperature (T_c) at which it becomes superconductive. This is observed by a sudden and sharp decline in electrical resistance of a superconductive

material when it is cooled below this critical temperature (T_c). When a material makes the transition between the normal and superconducting state, it actively expels its interior magnetic field (the Meissner effect). For the purposes of this Decision, it is the temperature of the onset of superconductivity, and not the temperature at which zero electrical resistance actually occurs, that is the focus for characterising the materials as superconductors.

PROSECUTION HISTORY

[6] The subject application was filed on February 4, 1988 under the provisions of the *Patent Act* as it read immediately before October 1, 1989 (henceforth: the *Patent Act*). The Examiner in charge of the application issued a Final Action on August 15, 2006 rejecting the application:

- claims 1-64, 66-72, and 75-89 were considered defective for lack of novelty under subsection 27(1) of the *Patent Act*;
- claims 1-89 were considered defective under section 2 of the *Patent Act* for lack of utility;
- claims 1-89 were considered defective under subsection 174(2) of the *Patent Rules* for lack of support;
- claims 1-32, 55, 56, 58, 59, 64, 65, 66-72, 77-80, and 83-89 were considered defective under subsection 34(2) of the *Patent Act* due to the Examiner=s finding that superconductivity above 26°K has no support in the present description;
- claims 1, 12, 24, 27, 55, 64-66, 69, 77, 83, 85, and 87 were considered defective under subsection 34(2) of the *Patent Act* for misusing various terms; and
- claim 1 was considered defective under subsection 34(2) of the *Patent Act* for claiming in terms of a desired result.

[7] On February 15, 2007, the Applicant replied to the Final Action and submitted a new set of 171 claims. The submission of the new claims resulted in the cancellation of claims 1 to 89. The Applicant argued that the newly submitted claims overcame all the defects identified in the Final Action and that the instant application was therefore in condition for allowance.

[8] In a Summary of Reasons submitted to the Patent Appeal Board, a copy of which was sent

to the Applicant on October 17, 2007, the Examiner indicated that the novelty and desired result issues had been overcome. However, the Examiner considered that the remaining issues had not been overcome. The Examiner also identified eleven new claim defects introduced in the response to the Final Action.

[9] Accordingly, the Applicant requested an oral hearing before the Patent Appeal Board. In advance of the Oral Hearing, the Applicant proposed a set of amended claims. The Hearing was originally scheduled for October 27, 2010, but was adjourned early and rescheduled for November 9, 2010 since the Applicant requested more time to further consider certain issues. It was agreed that the proposed amended claim set would not be pursued, and that only the claims amended in response to the Final Action would be considered. Submissions regarding the eleven new defects identified in the Summary of Reasons and questions raised by the Board were also presented at the Hearing and/or in corresponding written submissions. At both hearings, the Applicant was represented, via teleconference, by Bill Chan, Peter Wang and Daniel Morris of the Intellectual Property Department of IBM Canada Ltd.

[10] Subsequently, the Applicant was invited to propose amendments to the claims, in line with all their submissions. If accepted, the amendments would form the basis of a formal directive from the Commissioner under section 31 of the *Patent Rules*. A proposed amended claim set was submitted by the Applicant on January 14, 2013.

CLAIMS

[11] The claims under consideration include 107 independent claims. Several representative claims are reproduced below:

> 1. An apparatus comprising a composition exhibiting superconductivity at superconducting onset temperatures greater than or equal to 26°K, said composition being:
>
> a ceramic-like material in the RE-AE-TM-O system, where RE is a rare earth or near rare earth element, AE is an alkaline earth element, TM is a multivalent transition metal element having at least two valence states in said composition, and O is oxygen, the ratio of the amounts of said transition metal in said two valence states being determined by the ratio RE : AE;
>
> a source of current for passing a superconducting electric current in said transition metal oxide, and
>
> a cooling apparatus for maintaining said transition metal oxide below said onset temperature and at a temperature greater than or equal to 26°K.
>
> 2. A combination, comprising:

a mixed copper oxide composition including an alkaline earth element (AE) and a rare earth or rare earth-like element (RE), said composition having a layer-like crystalline structure and multi-valent oxidation states, said composition exhibiting a substantially zero resistance to the flow of electrical current there through when cooled to a superconducting state at a temperature greater than or equal to 26°K, said mixed copper oxide having a superconducting onset temperature greater than or equal to 26°K, and

a current source for passing an electrical superconducting current through said composition when said composition exhibits substantially zero resistance at a temperature greater than or equal to 26°K and less than said onset temperature

7. An apparatus comprising:

a composition including a transition metal, a rare earth or rare earth-like element, an alkaline earth element, and oxygen, where said composition is a mixed transition metal oxide having a non-stoichiometric amount of oxygen therein and exhibiting a superconducting onset temperature greater than or equal to 26°K,

a temperature controller for maintaining said composition to said superconducting state at a temperature greater than or equal to 26°K and less than said superconducting onset temperature, and

a current source for passing an electrical current through said composition while said composition is in said superconducting state.

9. A superconductive apparatus for causing electric-current flow in a superconductive state at a temperature greater than or equal to 26°K, comprising:

a superconductor element made of a superconductive composition, the superconductive composition comprising a copper-oxide compound having a layer-type perovskite-like crystal structure, the composition having superconductor transition temperature T_c of greater than or equal to 26°K;

a current source for maintaining the superconductor element at a temperature greater than or equal to 26°K and below the superconductor transition temperature T_c of the superconductive composition; and

a temperature controller for causing an electric current to flow in the superconductor element.

19. A device comprising a superconducting oxide composition having a superconductive onset temperature greater than or equal to 26°K, said superconducting copper oxide being at a temperature less than said superconducting onset temperature and having a superconducting current flowing therein, said composition comprising at least one each of rare earth, an alkaline earth, and copper.

53. A structure comprising:

a composition exhibiting a superconductive state at a temperature greater than or equal to 26°K;

a temperature controller maintaining said composition at a temperature greater than or equal to 26°K at which temperature said composition exhibits said superconductive state;

a current source passing an electrical current through said composition while said composition is in said superconductive state; and

said composition including a copper oxide, a Group II A element, at least one element selected from the group consisting of a rare earth element and a Group III B element.

170. An apparatus comprising a superconductor having a superconducting onset temperature greater than or equal to 26°K, said superconductor being made by a method comprising:

preparing powders of oxygen-containing compounds of a rare earth or rare earth-like element, an alkaline earth element, and copper,

> mixing said compounds and firing said mixture at a temperature between 500°C and 1200°C for between one and eight hours to create a mixed copper oxide composition including said alkaline earth element and said rare earth or rare earth-like element,
> pressing said mixed copper oxide composition to form pellets; and
> annealing said mixed copper oxide composition pellets at temperature between about 500°C and 950°C for a period of approximately one half hour to three hours for sintering in an atmosphere including oxygen to produce superconducting composition having a mixed copper oxide phase exhibiting a superconducting onset temperature greater than or equal to 26°K, said superconducting composition comprising a crystalline structure comprising a layered characteristic after said annealing.

[12] Even though the claims are directed to an apparatus, a device or a structure, the analysis focuses on the compositions mentioned in each claim. Any findings, in respect of the above independent claims may be extended to the other narrower independent claims and all claims dependent thereon.

THE ISSUES

[13] Having regard to the claims submitted in response to the Final Action, the Board must address the following three issues:

1. Indefiniteness: The misuse of various terms to define superconductivity is confusing and therefore contrary to subsection 34(2) of the *Patent Act*.

2. Utility: Utility of the invention cannot be soundly predicted across the entire scope of the claims, contrary to section 2 of the *Patent Act.*

3. Support: The claims are not fully supported by the description, contrary to subsection 174(2) of the *Patent Rules*, since T_c has not been defined with an upper limit.

ISSUE 1: INDEFINITENESS

Legal Framework

[14] The statutory authority for this defect is subsection 34(2) of the *Patent Act*:

> The specification referred to in subsection (1) shall end with a claim or claims stating distinctly

> and in explicit terms the things or combinations that the applicant regards as new and in which he claims an exclusive property or privilege.

[15] The Exchequer Court has provided guidance with respect to subsection 34(2) of the *Patent Act* in *Minerals Separation North American Corp. v. Noranda Mines Ltd.*, [1947] ExCR 306 at 352, 12 CPR 99 (*Minerals Separation*):

> By his claims the inventor puts fences around the fields of his monopoly and warns the public against trespassing on his property. His fences must be clearly placed in order to give the necessary warning and he must not fence in any property that is not his own. The terms of a claim must be free from avoidable ambiguity or obscurity and must not be flexible; they must be clear and precise so that the public will be able to know not only where it must not trespass but also where it may safely go.

The Examiner=s Position

[16] The Examiner has identified two defects under subsection 34(2) of the *Patent Act* that relate to claim terminology. Although one defect, according to the Examiner, related to the concept of Asupport@, the underlying issue is best addressed under subsection 34(2) of the *Patent Act*. Therefore, both defects will be treated together. The source of the defects stems from the Examiner=s view that certain terms used in the claims, such as Asuperconductivity@ and Acritical temperature@, find Asupport@ in the description and relate to the *complete loss* of resistivity in a material (i.e., bulk superconductivity). The Examiner=s position can be summarized as follows:

- The claimed characteristic of being superconductive above 26°K has no Asupport@ in the present description. The data presented in the figures show that zero resistivity was not achieved above 13°K. *(Defect 1)*
- The accepted definition of T_c (critical or transition temperature) in the art is Athe temperature below which a material loses its resistance@ (quote taken from Final Action; Source: McGraw-Hill Encyclopedia of Science & Technology, 6th edition, copyright 1987, page 609 and Encyclopedia of Physical Science and Technology, Vol 13 (Academic Press Inc) copyright 1987, page 493). The terms Asuperconducting@, Acritical temperature@, Atransition temperature@, and Asuperconductivity@ are therefore misused, as they are used to denote the onset temperature of superconductivity, as opposed to the Aart accepted@ temperature of zero resistance. *(Defect 2)*

The Applicant=s Arguments

[17] In the response to the Final Action the Applicant submitted, in part, the following:

> [...] support for the claimed invention is present in the description of record. In particular on page 18 is stated the results obtained form [sic] various mixtures of the compounds in the composition of the claimed invention. Specifically it is taught that Awith a barium content of x = 0.15, the resistivity drop occurs at T_c = 26K.@ In this example the ratio RE,AE : TM is 2:1 whereas in the previous example the value x = 0.1 and the ratio RE,AE : TM is 1:1 produced different results. In the initial example of page 18 it is stated that the described composition does not exhibit superconductivity. These examples in conjunction with other information given in the description provide information enabling one skilled in the art to make and use the claimed invention. As explained in the description the Aresistivity drop@ represents the onset of superconductivity indicating the presence of superconducting properties and is in agreement with the statement on page 3 of Athis temperature is often called the critical temperature T_c and is the temperature above which superconductivity will not exist.@ For example it is further explained on page 22 Aits resistivity decreases by at least three orders of magnitude giving evidence for the bulk being superconducting below 13K with an onset around 35K...@ showing that a transition into superconducting occurs around 35K demonstrating the existence of superconducting characteristics as claimed.
>
> [...]
>
> Applicant has provided amended claims herewith to more clearly claim the subject matter of the instant invention for which protection is sought. For example in amended claim 1 there is more clearly claimed Aa composition exhibiting superconductivity at superconducting onset temperatures greater than or equal to 26°K [...] maintaining said transition metal oxide below said onset temperature and at a temperature greater than or equal to 26°K.@ A further example may be found in amended claim 162 in which the term Azero-bulk-resistivity@ adds further clarification regarding the temperature significance within the phrase Athe composition having a superconductive/resistive transition defining a superconductive/resistive-transition temperature range between an upper limit defined by a transition-onset temperature T_c and a lower limit defined by an effectively-zero-bulk-resistivity intercept temperature Tp=0, the transition-onset temperature T_c being greater than or equal to 26°K.@ Amended claims as provided herewith clearly and distinctly set forth the subject matter of the instant claims in clear language specifically stating the respective significant temperatures and therefore do not create any unnecessary or troublesome language for readers of the claim.

[18] The Applicant further provided the following arguments (both at the Oral Hearing and by written submission):

> The Applicant submits that there is support for the claimed elements of a composition exhibiting superconductivity/a superconducting state/transition onset temperature/etc. at temperatures greater than or equal to 26°K. The data shows the T_c (temperature at the onset of superconductivity) being equal to or above 26°K. The data example at p. 22 of the specification shows that the bulk of a substance being superconducting was below 13°K, but the example at p. 22 of the specification shows that the bulk of a substance being superconducting was below 13°K but still shows that the onset of superconductivity is 35°K, consistent with the aspects of the

> claims noted above. This data is consistent with the claimed temperature for exhibiting superconductivity/a superconducting state/etc. As noted during the discussion on October 27, 2010, there can be the onset of superconductivity in a region at a particular temperature, without the entire composition being superconductive. This is consistent with the limitations in the claims. The Applicant submits that even though there is data that shows that the bulk of a substance being superconducting is below 26°K, there is still support for the aspect that the onset of superconductivity/a superconducting state/etc. is at or above 26°K. The Applicant respectfully requests withdrawal of the Examiner's objection.

Analysis and Findings

[19] The defect of indefiniteness in relation to the misuse of various terms to define Asuperconductivity@ is linked to the defect of lack of Asupport@ (subsection 34(2) of the Act). The Examiner is of the opinion that the Applicant defined superconductivity incorrectly because, contrary to Applicant=s view, the terms Asuperconductor@ and Acritical temperature@ are used to denote complete (i.e., bulk) superconductivity, a state in which no electrical resistivity is present in a material. The Examiner further asserts that the Applicant was never in possession of the invention.

[20] On the other hand, Applicant defines superconductivity as the sudden decline of electrical resistivity in a material below a so-called transition temperature (T_c). From page 3 of the description, it is shown that Applicant intended to use this temperature to denote the onset of superconductivity:

> This temperature is often called the critical temperature T_c and is the temperature above which superconductivity will not exist.

[21] Applicant also made a clear distinction, on page 22, between the onset of superconductivity and zero-bulk-resistivity/bulk superconductivity:

> Its resistivity decreases by at least three orders of magnitude, giving evidence for the bulk being superconducting below 13°K with an onset around 35°K, as shown in FIG. 4 on an expanded temperature scale. (emphasis added)

[22] The Board agrees with the Applicant. Nowhere in the application, is complete superconductivity attained at the claimed temperature of 26°K or higher. The only instance of zero resistivity/complete superconductivity is depicted in Figure 4 at 13°K. We find that the description clearly defines all the allegedly indefinite terms identified by the Examiner to mean the *onset of superconductivity*, and we do not agree that the claims are

indefinite. The characteristic of the composition being superconductive above 26°K finds support throughout the application. The skilled person would therefore understand the claims to be definite since their terminology does not relate to compositions exhibiting bulk superconductivity.

Conclusion - Subsection 34(2)

[23] In view of the foregoing, the Board finds that the claims on file are definite, and therefore compliant with subsection 34(2) of the *Patent Act*.

ISSUE 2: UTILITY

Legal Framework

[24] Section 2 of the *Patent Act* includes the requirement that an invention be Auseful@, or have utility. Section 2 defines Ainvention@ as follows:

> Ainvention@ means any new and useful art, process, machine, manufacture or composition of matter, or any new and useful improvement in any art, process, machine, manufacture or composition of matter.

[25] The inventor must be in a position to establish utility as of the date the patent is applied for, on the basis of either demonstration or sound prediction; *Apotex Inc. v. Wellcome Foundation Ltd.*, 2002 SCC 77, [2002] 4 SCR 153, 29 CPR (4^{th}) 499 (*Wellcome*).

[26] The soundness of a prediction of utility is a question of fact and must pass a three-part test established by the Supreme Court in *Wellcome*. The three elements of the test are:

1. There must be a factual basis for the prediction;

2. The inventor must have at the date of the patent application an articulable and Asound@ line of reasoning from which the desired result can be inferred from the factual basis; and

3. There must be proper disclosure.

[27] In the present case, there is no dispute that the claims rely on a prediction. However, even when sound, Aa prediction does not need to amount to a certainty@; *Lundbeck Canada Inc.*

v. Ratiopharm, 2009 FC 1102 (*Lundbeck*). There is no requirement for testing and proving the invention in all its claimed applications.

The Examiner=s Position

[28] The Examiner=s position is outlined as follows:

1. The specification is unclear as to which exact compositions were prepared and tested, and those which were not.
2. The description implies, but does not state, that certain compositions were tested and form part of the factual basis. These compositions include (i) those with rare earths such as La, Ce, and Nd; (ii) those with alkaline earths such as Ca, Sr, and Ba; and (iii) those with transition metals such as Cu, Ni, and Cr.
3. It has been established through testing that a composition of the formula $La_{5-x}Ba_xCu_5O_{5(3-y)}$ has zero resistance at about 13°K and that it has an onset of superconductivity in the range of 26°K and 35°K depending on preparation conditions.
4. It has been demonstrated that Ce, Nd, Ca, Sr, Cu, and Ni, in the proper places and ratios, exhibited the stipulated result and this forms the factual basis for the determination of utility.
5. The factual basis for the prediction of the different classes of elements of the compositions (i.e., rare earths, alkaline earths, and transition metals) is based on the statement that three elements of each class of elements are useful, and therefore that other elements in that class are also useful. However, there is no reason to believe, based on accepted scientific principles, that these other elements would also be useful. The elements tested from each class are in the lower quartile and that the difference in atomic volumes and weights between the tested and untested elements is large enough to cast doubt on the utility of all the elements.

[29] The Examiner concludes, in part, with the following:

> The Examiner is of the opinion that not only is the test data not extensive enough to form a factual basis for the prediction of utility of the group, but also the sound reasoning supporting the prediction is not present.
>
> The range of Atomic Volumes and Atomic Weights is quite large. Test data at both ends of

> the ranges would have provided the factual basis on which to predict utility of the intervening elements.
>
> [...]
>
> The steps and variables involved in producing superconducting ceramics are so many and the useful ranges of each variable so different that an unimaginative person skilled in the art would not be led unerringly and without undue experimentation to a useful result.

[30] To summarize the Examiner=s position, utility for the entire scope of the claims has not been established by demonstration or by sound prediction. The basis for the lack of sound prediction defect emanates from the Examiner=s view: (i) that the number of different elements used to make the superconducting compositions of the invention is not extensive enough, especially since the different elements tested in each group are not representative of the entire scope, as they fall at the lower end of the relevant group and do not account for the large ranges of atomic volumes and weights present within the groups; and, (ii) that the steps and variables involved in the production of the superconductive ceramics are so diverse that an unimaginative person skilled in the art would not be able to operate the whole of the claimed invention without undue experimentation.

The Applicant=s Arguments

[31] In the response to the Final Action the Applicant submitted the following with respect to the size difference between elements from one end of the periodic group to the other:

> [...] Applicant has addressed such issue on page 25 of the description in which is taught AAs the ionic radius of Sr^{2+} nearly matches that of La^{3+} it seems that the size effect does not cause the occurrence of superconductivity. On the contrary it is rather adverse as the data on Ba^{2+} and Ca^{2+} indicates.@ Applicant teaches that better results were obtained through smaller atomic elements and not that larger elements fail as suggested by the Examiner. Therefore Applicant does provide required teaching to practice the claimed invention and in particular point towards a Abest mode@ to direct one skilled in the art of ceramic fabrication toward Auseful@ results.

[32] The Applicant further provided a written submission prior to the Oral Hearing regarding the lack of utility defect:

> The Applicant submits that there is sound prediction in respect of the aspects of the invention where there is a material composed a rare earth or near rare earth element, alkaline earth element, and a transition metal element, as well as oxygen. The specification shows data or support in respect of two rare earth elements (lanthanum and cerium), three alkaline earth elements (barium, calcium, and strontium), and two transition metals (copper and nickel). The data presented showed that various combinations of these elements exhibited superconductivity at temperatures greater than or equal to 26°K. The specification notes that transition metals that are multi-valent

> are particularly suitable (with the specific example of copper being shown), and that the compositions of the invention have a layer-like crystalline structure.
>
> The Applicant submits that the person skilled in the art would recognize that the rare earth elements and rare earth-like elements, grouped in the periodic table, were grouped and categorized as such, because these elements exhibited similar properties. In the same way, alkaline earth, transition metals, and group IIIb elements are similarly grouped because the elements in the group exhibit similar properties. Thus, there is sound line of reasoning that these elements can be used as intended.
>
> The Applicant submits that there is a factual basis for the prediction, based on the several different compositions disclosed that used different rare earth, alkaline earth, and transition metal elements, as well as resistivity data (see fig. 4) showing the composition in question exhibiting superconductivity at temperatures greater than or equal to 26°K. As well, there was an articulable and sound line of reasoning as noted about the compositions in question having a layer-like crystalline structure, the similarity in properties of rare earth, alkaline earth, and transition metals as known by chemists, among other aspects. Lastly, there was proper disclosure in the specification that gave a full, clear and exact description of the nature of the invention and the manner in which it can be practiced. Thus, the Applicant submits that there is sound prediction for the use of rare earth metals, alkaline earth metals, and transition metals, in addition to those specifically disclosed in the specification, for use in the composition.

Analysis and Findings

[33] Although we accept the Examiner=s summary of the factual basis as taught in the description (see points/positions 2 to 5 above), the Examiner did not consider all of the relevant facts data. Because of this, reconsideration of all three elements of the *Wellcome* test is required.

<u>FACTUAL BASIS</u>

[34] The Applicant has prepared various compositions having the general formula RE-AE-TM-O and demonstrated the utility of specific embodiments as superconductors at temperatures greater than or equal to 26°K. The compositions of the invention that were actually prepared by the Applicant are described in the specification. Compositions of the formulae $La_{2-x}Ba_xCuO_{4-y}$ and $La_{5-x}Ba_xCu_5O_{5(3-y)}$ were prepared and tested for different values of x (Figure 2), various current densities (Figure 4) and/or different annealing conditions (i.e., process conditions)(Figure 3). As exemplified on page 18 for $La_{2-x}Ba_xCuO_{4-y}$, with x = 0.15 and a 2:1 starting ratio ((RE-AE):TM), the resistivity drop (i.e., onset of superconductivity) occurs at 26°K whereas with a 1:1 starting ratio and x = 0.1, the resistivity drop occurs at 35°K. The onset of superconductivity for

$La_{5-x}Ba_xCu_5O_{5(3-y)}$ and x = 0.75 occurs at 35°K (page 22).

[35] The drawings provide further data on the onset of superconductivity of compositions of the invention. Figure 2 deals with $La_{5-x}Ba_xCu_5O_{5(3-y)}$ with x = 1 and 0.75, and shows that the composition has an onset of superconductivity between 26°K and 33°K. Figure 3 shows that $La_{5-x}Ba_xCu_5O_{5(3-y)}$ with x = 1 has an onset of superconductivity between 10°K and 30°K depending on the experimental conditions used to make the superconducting compositions. Figure 4 shows that at different current densities, $La_{5-x}Ba_xCu_5O_{5(3-y)}$ with x = 0.75 exhibits an onset of superconductivity between 30°K and 35°K.

[36] The specification also shows different compositions having cerium in place of lanthanum as the rare earth element; calcium and strontium as alkaline earth element(s) instead of barium; and nickel as a substitute to copper as transition metal element. The data presented showed that various combinations of the above elements according to the invention exhibited superconductivity at temperatures greater than or equal to 26°K. The Applicant also noted that the size (i.e., atomic volume) of the various elements within each group did not cause the occurrence of superconductivity (page 25).

[37] The Examiner is of the opinion that the relevant data is not sufficient to form a factual basis for all the compositions that are embraced by the claims. We disagree.

[38] The Applicant has indeed taught many different superconducting compositions. Various combinations of the three groups of elements (using 2 to 3 different elements for each one) of the composition were demonstrated to be superconductive at a temperature greater than or equal to 26°K. These compositions were prepared using known principles of ceramic fabrication by mixing powders containing the rare earth, alkaline earth, and transition metal elements, coprecipitating and heating in oxygen or air. The Alevel@ of superconductivity of the compositions of the invention could be varied by using different current densities and/or changing the reaction conditions for their preparation.

[39] Based on the above, we are satisfied that the data presented in the application is adequate to form a factual basis for the prediction.

SOUND LINE OF REASONING

[40] At the time of filing, it was generally known in the art that certain metallic oxides exhibit

superconductivity, due basically to the fact that these materials possess multiple crystallographic phases, one of which accounts for the high T_c (Johnston *et al.*, *Mat. Res. Bull.* **1973**, *8*, 777). Other metallic oxides having a perovskite structure were known to exhibit superconductivity due to high electron-phonon coupling in mixed valent compounds (Binnig *et al.*, *Phys. Rev. Lett.* **1980**, *45*, 1352; and Sleight *et al.*, *Solid State Communications* **1975**, *17*, 27).

[41] The superconductive materials of the invention are characterized as mixed transition metal oxides that can exhibit multivalent behaviour. These compositions have a layer-type crystalline structure, often perovskite-like, and contain a rare earth and/or alkaline earth elements.

[42] The elements used in the Applicant=s compositions fall into one group and two blocks of the periodic table of the elements. The alkaline earth elements are part of the group 2 (or group IIA) of the table. The transition metals are part of the d-block and comprise elements of groups 3 to 12, whereas the rare earth elements or lanthanides fall into the f-block of the periodic table.

[43] Elements of a group have very similar properties and exhibit a clear trend in properties down the group. The different regions of the periodic table referred to as periodic table blocks are named after the subshell (i.e., outermost electronic orbital) in which the Alast@ electron resides, namely *f*-electron and *d*-electron. The person skilled in the art is well aware that the periodic table illustrates recurring or periodic trends in the properties of the elements, and would, in the absence of evidence to the contrary, reasonably expect that elements grouped in a recognized fashion, as above, behave similarly. It is the very reason for the groupings into groups and blocks.

[44] Common physical structure of the compositions of the invention to known superconductors, and well-known similarities in the property of each element that composed the compositions, namely rare earth, alkaline earth and transition metal, are all factors showing that the Applicant has an articulable and sound line of reasoning. Since the size of the different elements in a group/period of elements was demonstrated to be a non-factor to the occurrence of superconductivity, the Examiner=s position that there was insufficient testing across the entire period cannot be accepted. This further shows that the Applicant=s reasoning is sound. A sound line of reasoning would therefore be apparent to the person skilled in the art in view of the common general knowledge.

[45] Based on the above, we are satisfied that the Applicant had at the date of the patent application an articulable and sound line of reasoning from which the desired result can be inferred from the factual basis.

PROPER DISCLOSURE

[46] As for proper disclosure, this requirement of the test is that the factual basis and the sound line of reasoning be found in the description. In the present case, all the compositions forming the factual basis were taught, as was the information used to establish a sound line of reasoning. Consequently, the Board concludes that the proper disclosure criterion has been satisfied.

Conclusion - Sound Prediction

[47] In view of the foregoing, the Board finds that there are insufficient grounds for concluding that there can be no sound prediction of utility for compositions falling within the scope of the claims. For these reasons, we cannot agree with the Examiner=s assessment that claims 1 to 20, 22 to 57, 59 to 68, 70 to 100, 102 to 123, and 125 to 171 do not comply with section 2 of the *Patent Act*.

ISSUE 3: SUPPORT

Legal Framework

[48] The statutory authority for the lack of support defect, subsection 174(2) of the *Patent Rules*, reads as follows:

> Every claim must be fully supported by the description.

[49] Subsection 174(2) of the Rules should be read in conjunction with subsection 34(1) of the *Patent Act* which reads as follows:

> (1) An applicant shall in the specification of his invention
> (a) correctly and fully describe the invention and its operation or use as contemplated by the inventor;

> (b) set out clearly the various steps in a process, or the method of constructing, making, compounding or using a machine, manufacture, or composition of matter, in such full, clear, concise and exact terms as to enable any person skilled in the art or science to which it appertains, or with which it is most closely connected, to make, construct, compound or use it;
> (c) in the case of a machine, explain the principle thereof and the best mode in which he has contemplated the application of that principle;
> (d) in the case of a process, explain the necessary sequence, if any, of the various steps, so as to distinguish the invention from other inventions; and
> (e) particularly indicate and distinctly claim the part, improvement or combination that he claims as his invention.

[50] Canadian courts have provided little judicial interpretation of subsection 174(2) of the Rules or any of its equivalents. However in *Re Application of Ciba* (1974), Commissioner's Decision No. 208, the Board stated B after noting that it may be possible for a single sentence in the disclosure to provide sufficient support to warrant claims to some inventions B that the overriding principle was that an inventor may not validly claim what he has not described (citing *Radio Corporation of America v. Raytheon Manufacturing Co.* (1957), [1956-1960] ExCR 98 para 28, 27 CPR 1 [*RCA*.]).

[51] The equivalent of subsection 34(1) has been interpreted in *Minerals Separation* (pp. 316-317) to demand the following:

> Two things must be described in the disclosures of a specification, one being the invention, and the other the operation or use of the invention as contemplated by the inventor, and with respect to each the description must be correct and full. The purpose underlying this requirement is that when the period of monopoly has expired the public will be able, having only the specification, to make the same successful use of the invention as the inventor could at the time of his application. The description must be correct; this means that it must be both clear and accurate. It must be free from avoidable obscurity or ambiguity and be as simple and distinct as the difficulty of description permits. It must not contain erroneous or misleading statements calculated to deceive or mislead the persons to whom the specification is addressed and render it difficult for them without trial and experiment to comprehend in what manner the invention is to be performed. It must not, for example, direct the use of alternative methods of putting it into effect if only one is practicable, even if persons skilled in the art would be likely to choose the practicable method. The description of the invention must also be full; this means that its ambit must be defined, for nothing that has not been described may be validly claimed. The description must also give all information that is necessary for successful operation or use of the invention, without leaving such result to the chance of successful experiment, and if warnings are required in order to avert failure such warnings must be given. Moreover, the inventor must act *uberrima fide* and give all information known to him that will enable the invention to be carried out to its best effect as contemplated by him.

The Examiner=s Position

[52] The lack of support defect as worded in the Final Action is outlined as follows:

> Claims 1 to 89 do not comply with subsection 174(2) of the PATENT RULES. These claims define subject matter that is not fully supported by the description. He claims products and methods relating to materials which are superconductive above 26°K, whereas he does not disclose any material showing any superconductive tendencies above about 40°K, let alone showing superconductivity above this temperature.
>
> The Applicant has claimed all compounds of the defined composition that are superconductive above 26°K. For support of this breadth of claim, he points on page 4 paragraph 2 of his letter of 25 April 2006 to the description which either shows data for or talks about compositions that have indications of superconductivity. However the highest temperature that the Applicant can find in his description is "around 40±1°K" on page 23 line 11, and that is not even the temperature at which the composition becomes superconductive. There is not even a mention of any temperature higher than that. Consequently there is no support for any temperature higher than around 40°K.
>
> There is no line of reasoning whatsoever for anything above that temperature. The Applicant has included within the scope of his claim things which he has not reduced to practice or soundly predicted and so has not invented.

[53] Essentially, the Examiner contends there is a lack of support when the claims refer to compositions exhibiting superconductivity at any temperature above 40°K. Applicant has not shown any composition exhibiting superconductivity above 40°K.

The Applicant=s Arguments

[54] In the response to the Final Action the Applicant submitted, in part, the following with respect to the lack of support defect:

> Applicant respectfully submits that the claims as amended are in compliance with the Patent Act. Applicant has provided factual evidence in the description and drawings of record to practice the invention as claimed; namely to produce ceramic oxides that exhibit superconducting behavior at temperatures above 26K. Apparently after the release of the Applicant's teaching large scale research was initiated within the respective scientific community leading to the discovery of additional high temperature superconducting compositions. The teaching thus meant the Applicant was in possession of the claimed invention and such enablement meant those coming after the Applicant could and did benefit by those teachings. Applicant is not required to test all possible combinations but is required to teach how to practice the claimed invention. One skilled in the art may use the teaching of the invention to construct and use superconducting compositions having temperatures higher than 26K. In fact on page [sic] 21 and 22 is stated that compositions annealed in air Aindicated by the minimum in resistivity in the 80K range was not found to be very pronounced@ based on assertions of the Applicant that annealing was a significant factor in the outcome and that higher temperatures were possible with additional

> experimentation. Such additional experimentation was carried on by Astudents@ of the Applicant's claimed teachings. There was sound prediction of higher temperatures based on the documented teaching of the Applicant. Had the teaching of the Applicant provided a dead end there would not have been the flurry of activity to duplicate and extend the Applicant' s work within the respective scientific community. Applicant therefore respectively submits that there is sufficient support in the description and drawings of record to support the claims as amended and to demonstrate to those skilled in the art sufficient detail to practice the invention as claimed.

[55] Further, the Applicant submitted, in part, the following written submission with respect to the lack of support defect:

> R. 174(2) states that every claim must be fully supported by the description. The claims speak to aspects, for example, where the superconducting onset temperatures are greater than or equal to 26°K. The Applicant submits that the claims are supported by the description at pages 18, 22, and 23.
>
> The Applicant is not aware of any case law, nor requirement under the Rules or Act, to provide data for a range of temperature points and to delineate an upper range, when the claim language does not specify a temperature range. The Applicant respectfully submits that the claim language is fully supported by the specification.

Analysis and Findings

[56] The lack of support defect identified by the Examiner stems from the fact that the Applicant never made a superconductor having an onset temperature greater than 40°K.

[57] The specification, on page 1 lines 5-11, generally describes Applicant=s invention as follows:

> This invention relates to a new class of superconducting compositions having high superconducting transition temperatures and methods for using and preparing these compositions, and more particularly to superconducting compositions including copper and/or other transition metals, the compositions being characterized by a superconducting phase and a layer-like structure.

[58] Under the heading, Summary of the Invention, the Applicant describes the compositions as being able to carry electrical currents in a substantially zero resistance state at temperatures greater than 26°K. The compositions are described on pages 7-8 as follows:

> [p.7] In general, the compositions are characterized as mixed transition metal oxide systems where the transition metal oxide can exhibit multivalent behavior. These compositions have a layer-type crystalline structure, often perovskite-like, and can contain a rare earth or rare earth-like element. [...] An example [of a rare earth-like element] is a group IIIB element of the periodic table, such as La. Substitution can be found in the rare earth (or rare earth-like) site or in the transition metal sites of the compositions. For example, the rare earth site can also include

> alkaline earth elements selected from group IIA of the periodic table, or a combination of rare earth or rare earth-like elements and alkaline earth elements. Examples of suitable alkaline earths include Ca, Sr, and Ba. The transition metal site can include a transition metal exhibiting mixed valent behavior, and can include more than one transition metal. A particularly good example of a suitable transition metal is copper.
>
> [p.8] An example of a superconductive composition having high T_c is the composition represented by the formula RE-TM-O, where RE is a rare earth or rare earth-like element, TM is a nonmagnetic transition metal, and O is oxygen. [...] If an alkaline earth element (AE) were also present, the composition would be represented by the general formula RE-AE-TM-O.

[59] Specific examples of superconductive compositions have already been discussed in paragraphs [34] and [35] above. In the Description of the Preferred Embodiments section of the specification, the Applicant has described in detail various superconductive compositions having i) transition metals of different oxidation states; ii) substitution (partial and with different degree of substitution) of the rare earth for an alkaline earth; and iii) different stoichiometry of the elements, and the effect that these have on the superconductive compositions of the invention.

[60] The specification in the paragraph bridging pages 8-9 teaches that known principles of ceramic fabrication can be used to prepare the inventive superconductive compositions. More specifically, the specification, on page 16, discloses the following manufacturing steps:

> - Preparing aqueous solutions of the respective nitrates of barium, lanthanum and copper and coprecipitation thereof in their appropriate ratios,
> - adding the coprecipitate to oxalic acid and forming an intimate mixture of the respective oxalates,
> - decomposing the precipitate and causing a solid-state reaction by heating the precipitate to a temperature between 500 and 1200°C for one to eight hours,
> - pressing the resulting product at a pressure of about 4 kbar to form pellets,
> - re-heating the pellets to a temperature between 500 and 900°C for one half hour to three hours for sintering.

[61] Temperature and time of both the decomposing and sintering steps (Figure 3), and the oxygen content of the final compound (pages 17-19), are noted to have an effect on the T_c. Even though these materials are highly process dependent, the specification explains how to proceed with the reaction for the formation of the desired product.

[62] It is evident that these materials were the products of a monitored well-defined synthetic protocol that the person skilled in the art is instructed to follow. The teaching thus meant that the Applicant had enabled the claimed invention. Further, the Applicant is not

required to test all possible combinations but is required to teach how to practice the claimed invention. A person skilled in the art, supplemented by common general knowledge, while allowing routine experimentation would have been able to use the teaching of the invention to construct superconducting compositions having a T_c greater than or equal to 26°K. The Applicant=s compositions are therefore enabled over the entire scope of the claims.

[63] The present claims are directed to a vast number of possible embodiments that can be prepared and which have been soundly predicted to be superconductive. Since each embodiment has its own inherent T_c, there is necessarily a range of T_c=s. However, it would be inappropriate to limit the scope of the claim by requiring an upper limit since the upper limit is effectively dictated by the generic formula, i.e., the highest possible T_c is inherent to one of the many possible compositions. It would also be unreasonable to expect that the present inventors have discovered the best embodiment (i.e., with the highest T_c), nor does the law require this. All that is promised by the claim is that the recited compositions will be superconductive at or above 26°K. Indeed, this is what the inventors have discovered. There is no requirement that the claimed compositions be extraordinarily superconductive, i.e., at a temperature far in excess of 26°K.

[64] Prior to Applicant=s discovery, there were no superconductors known to exhibit superconductivity at a temperature greater than or equal to 26°K. They abandoned old materials in favour of the claimed family of ceramics, found to be superconductive. Even though some of the Applicant=s superconductive compounds having the general system Ba-La-Cu-O had been described in the art (Michel *et al.*, *Rev. Chim. Min.* **1984**, *21*, 407 and Michel *et al.*, *Mat. Res. Bull.* **1985**, *20*, 667), none were found, known or even suspected to be superconductive.

[65] To require an upper critical temperature limit would unnecessarily restrict the claims.

[66] All of the compositions recited in the claims are defined by the atoms/elements present in the material. In addition, these claims include a limitation by specifying that the compositions exhibit superconductivity at a temperature greater than or equal to 26°K. Consequently, we believe that the description is sufficient to support the claims.

Conclusion - Support

[67] In view of the foregoing, the Board finds no lack of support with the claims not specifying an upper limit for the onset temperature T_c. For these reasons, we do not agree with the Examiner=s assessment that claims 1-171 do not comply with subsection 174(2) of the *Patent Rules*.

DEFECTS INTRODUCED IN THE RESPONSE TO THE FINAL ACTION

[68] In the Summary of Reasons submitted to the Board, the Examiner identified eleven defects introduced by the Applicant in the claims amended in response to the Final Action.

[69] The Applicant mentioned that they were amenable to making changes to the defective claims, except for the alleged defective claims where the Applicant has provided successful arguments as to why these claims are compliant. Subsequently, the Applicant submitted, on January 14, 2013, a proposed set of amended claims reflecting the changes agreed upon.

[70] We turn now to the Applicant=s proposed claim amendments. The proposed claim set consists of 170 claims and is based on the claim set currently on file, with the claims identified as defective (New Defects 2-9) in the Summary of Reasons being amended. After reviewing the proposed claim set, we have come to the conclusion that the defects identified in the Summary of Reasons would be remedied through the Applicant=s proposed amendments.

AOLD ACT@ CONSIDERATIONS

[71] Since this application was filed under the auspices of the *Patent Act* as it read immediately before October 1, 1989 (i.e. the AOld Act@), there remains the requirement that otherwise allowable claims be evaluated under section 43 to determine whether conflict proceedings are warranted. Such an evaluation is made by an Examiner charged with the task. The potential involvement of, and impact on, third parties necessitates this two-stage approach. The application will therefore be returned to the Examiner for this determination, subsequent to the completion of the required Rule 31(*c*) amendments in accord with this Decision.

RECOMMENDATION AND RULE 31(*C*) AMENDMENTS

[72] In view of the above findings, it is our recommendation that the rejection of the application be reversed.

[73] We further recommend that the Commissioner invite the Applicant, in accordance with paragraph 31(*c*) of the *Patent Rules*, to delete the claims submitted in response to the Final Action and to agree to the formal entry of the amendments proposed on January 14, 2013 within three months from the date of this decision. Failure to do so would result in the application being not compliant with the *Patent Act* and *Patent Rules*, since some claims would be broader in scope than the invention.

[74] Finally, we recommend that:

(*i*) the Applicant be invited to make only the above amendment within three months from the date of the Commissioner's Decision;

(*ii*) the Applicant be advised that, if the above amendment and only the above amendment, is not made within the specified time, the Commissioner intends to refuse the application; and

(*iii*) the Applicant be advised that, if the above amendment and only the above amendment, is made within the specified time, the Commissioner intends to return the application to the Examiner for allowance, unless proceedings under section 43 of the *Patent Act* are required.

Serge J. Meunier	Mark Couture	Ed MacLaurin
Member	Member	Member

COMMISSIONER=S DECISION

[75] I concur with the findings and recommendation of the Patent Appeal Board. Accordingly,

(*i*) I invite the Applicant to make the above amendments, and only the above amendments, within three months from the date of this decision, failing which I intend to refuse the application; and

(*ii*) If these amendments, and only these amendments, are made within the specified time, the Examiner=s rejection will be considered to have been overcome. The application will then be returned to the Examiner for possible proceedings under section 43 of the *Patent Act*.

Sylvain Laporte
Commissioner of Patents

Dated at Gatineau, Quebec
this 19th day of February, 2013