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D E C I S I O N
of 22 July 1994

Case Number: T 0802/92 - 3.4.1

Application Number: 87309322.3

Publication Number: 0265251

IPC: H01L 31/06

Language of the proceedings: EN

Title of invention:

Heterojunction p-i-n-photovoltaic cell

Applicant:

Colorado School of Mines Foundation, Inc.

Opponent:

-

Headword:

Photovoltaic cell/COLORADO

Relevant legal norms:

EPC Art. 84, 123(2)

EPC R. 29(1), (3)

Keyword:

"Omission of a feature in a new category of claim - allowed"
"Technical features which achieve one of several "objects of
the invention" - not necessary for the definition of the
claimed subject-matter"

Decisions cited:

G 0001/93

Headnote/Catchword:

The removal from a claim of a feature which "does not provide
a technical contribution to the subject-matter of the claimed

invention" within the meaning of Decision G 1/93, and whose removal merely broadens the protection conferred by the claim, does not contravene Article 123(2) EPC.

Case Number: T 0802/92 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 22 July 1994

Appellant: Colorado School of Mines Foundation, Inc.
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Decision under appeal: Decision of the Examining Division of the European Patent Office dated 10 April 1992 refusing European patent application No. 87 309 322.3 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: G. D. Paterson
Members: R. K. Shukla
U. G. O. Himmler

Summary of Facts and Submissions

- I. European patent application No. 87 309 322.3 was refused in a decision of the Examining Division on the ground that independent Claim 17 contained subject matter extending beyond the content of the application as filed (Article 123(2), EPC). In its decision, the Examining Division also stated that independent Claim 1 did not contain all the features essential to the invention (Article 84 and Rule 29(1) and (3), EPC).
- II. Independent Claims 1 and 17, filed on 21 October 1991 and forming the basis of the above decision were as follows.

Claim 1

"A double heterojunction p-i-n photovoltaic cell (10) having at least three different semiconductor compound layers (12, 14, 16,) composed together of at least four different elements, comprising a p-type semiconductor layer (12), a high resistivity intrinsic semiconductor layer (14) having a band gap less than the p-type layer, used as an absorber of light radiation, an n-type, semiconductor layer (16) having a wider band gap than the intrinsic layer, said intrinsic layer being in electrically conductive contact on one side with said p-type layer (12) and on an opposite side with said n-type layer (16), and first and second ohmic contacts (20, 22) in electrically conductive contact with said p-type layer (12) and said n-type layer (16,) respectively."

Claim 17

"A method of making a double heterojunction p-i-n photovoltaic cell (10) having at least three layers, (12, 14, 16) of different semiconductor compound materials, composed together of at least four different elements, comprising the steps of: (A) forming as a first layer an n-type semiconductor layer (16) on a substrate (28); (B) forming on the n-type layer (16) and as a second layer (14), a high resistivity intrinsic semiconductor layer having a band gap less than the n-type layer, used as an absorber of light radiation; and (C) forming on the intrinsic layer (14) and as a third layer a p-type semiconductor layer (12) having relatively wider band gap than the intrinsic layer (14) being in electrically conductive contact on one side with the p-type layer (12) and on an opposite side with the n-type layer (16)."

III. The reasons given in the above decision can be summarized as follows.

Claim 17 - Article 123(2) EPC:

The application as originally filed did not contain any method claims. The description only discloses methods of forming a photovoltaic cell comprising a specific combination of compounds, namely a cell comprising CdS/CdTe/ZnTe. Claim 17 and the corresponding amendment of the description introduce a fabrication method for a cell which was not disclosed in the application as filed. In particular, Claim 17 does not specify the compounds used for the photovoltaic cell and is therefore more general than the methods disclosed in

the application as filed. Since no basis can be found in the application as filed for a generic fabrication method as specified in Claim 17, the subject matter of this claim extends beyond the content of the application as filed.

Claim 1 - Article 84 and Rule 29(1) EPC:

On page 5, lines 7 to 18 of the application as filed, it is stated that the composition of the semiconductor layers is such that a common anion is used for the intrinsic and p-type layers and a common cation is used for the intrinsic and n-type layers. This feature is essential in order to achieve the object of the invention stated on original page 4, lines 9 to 13, where it is stated that it is also an object of the invention to provide a cell utilizing materials at each junction which minimize the presence of discontinuities or spikes in the energy band which is designed to carry charge carriers out of the absorber layer. Since Claim 1 does not contain this feature essential to the invention, it does not fulfil the requirement following from Article 84 taken in combination with Rule 29(1) and (3).

- IV. The Applicant lodged an appeal against this decision and requested cancellation of the decision and the grant of a patent on the basis of Claims 1 to 41 filed on 21 October 1991 forming the basis of the decision under appeal. As auxiliary requests, the Applicant filed three sets of amended claims.

In support of his requests, the Appellant has argued essentially as follows:

Claim 17 - Article 123(2) EPC:

Although the specific examples of the production of the device in the description mention a combination of semiconductor compounds CdS/CdTe/ZnTe, the originally filed independent device claim is not limited to these compounds. It would therefore be logical to allow a method claim with a scope which is as broad as that of the independent device claim. Furthermore, it is stated in the original application (page 9, line 11) that the semiconductor layers are preferably formed of II to VI compounds. It is therefore clear that the method of production should not be limited to the particular compounds mentioned above.

Claim 1 - Article 84 EPC:

The statement "It is also an object of the present invention to provide such a cell utilizing materials at each junction which minimize the presence of discontinuities or spikes ..." on page 4, line 9 of the originally filed description does not imply a restriction to the sole purpose of minimizing discontinuities or spikes. Instead the statement should be interpreted to relate only to a particular embodiment of the invention. Furthermore, the originally filed independent device claim does not contain the feature concerning common anions and cations, and in the original description it is stated that the scope of the invention should be limited only by the appended claims. There is therefore support in the original application for the broader claim without the feature concerning the common anions and cations, and since the inventiveness of Claim 1 has not been

questioned, the applicant should be allowed to claim protection corresponding to the support in the original application.

V. The Appellant has requested the grant of a patent on the basis of Claims 1 to 41 filed on 21 October 1991 and the application including the following further amendments :

(i) in Claim 1, "three different semiconductor compound layers (12, 14, 16) "to read" three layers (12, 14, 16) of different semiconductor compound materials" ; and

(ii) on page 4, line 16, insert "preferred" before "embodiment" .

Reasons for the Decision

1. *Article 123 (2)*

As a result of the amendments filed during the examination proceedings, the amended application contains a new category of claims (Claims 17 to 41) relating to a method of making a photovoltaic cell. In the independent Claim 17 the method steps per se (steps A to C) consist merely of **formation** of three semiconductor layers, the semiconductor layers formed having the same conductivity types, the bandgaps and their arrangement as in the photovoltaic cell according to Claim 1 as filed. However, whereas the photovoltaic cell as set out in Claim 1 and all the embodiments of the photovoltaic cell described in the application as filed include first and second ohmic contacts,

formation of such ohmic contacts is not specified in Claim 17. In other words, Claim 17 defines a method of making the photovoltaic cell according to Claim 1 but without requiring the presence of ohmic contacts. The question therefore arises whether such a method of making a cell without forming ohmic contacts formed part of the content of the application as filed. This appears to be one of the reasons why the Examining Division considered that Article 123(2) EPC was contravened.

2. The Enlarged Board of Appeal in its Decision G 1/93 (to be published in OJ EPO) has recently interpreted the requirements of Article 123(2) EPC, in the specific context of a referred question concerning the so-called "conflict" between Article 123(2) and (3) EPC in a case where a "European Patent as granted contains subject-matter which extends beyond the content of the application as filed and also **limits** the scope of protection conferred by the claims".

Although the referred question was concerned with a case where a feature has been **added** to a claim before grant, so as to limit its scope of protection, in the present Board's view the principles which underlie the interpretation of Article 123(2) EPC by the Enlarged Board as set out in paragraph 16 of the Decision and paragraph II of the Headnote are not confined in their application to cases where a feature has been added to a claim, but are also equally applicable to cases where (as in the present case) a feature is **removed** from a claim, so as to broaden its protection.

Thus, in the Board's view, the removal from a claim of a feature which does not provide a technical contribution to the subject-matter of the claimed invention, whose removal merely broadens the protection conferred by the claim, does not offend the requirements of Article 123(2) EPC.

3. In so far as the method according to Claim 17 specifies **formation** of three semiconductor layers of unspecified materials, in the Board's view such a formation was clearly implicit in the application as filed having regard to the description of the basic embodiments of a photovoltaic cell according to the invention (see page 6, line 26 to page 7, line 6; page 13, line 9 to page 15, line 15 and Figures 2 to 4) and the description on page 16, line 26 to page 17, line 8.

As mentioned earlier in section 1 above, all the embodiments of the invention as described and claimed in the application as filed include ohmic contacts to the p-type layer and n-type layer, respectively. Nevertheless, it is evident from the description on page 3, lines 19 to 26 and page 4, line 21 to page 5, line 4 that according to the description as filed one of the primary aims of the invention is to provide a heterojunction p-i-n photovoltaic cell combining the ability to choose materials with appropriate properties with the ability to field assist charge carriers towards their respective regions, and that in contrast to the prior art heterojunction devices using two semiconductor materials, in the present invention this aim is achieved by the use of three different semiconductor layers formed of at least four different elements, the semiconductor layers including a p-type

relatively wide band gap semiconductor layer, a high resistivity intrinsic semiconductor layer, used as an absorber of light, and an n-type relatively wide band gap semiconductor layer. Thus, in the Board's view, it follows from the description that the presence of such ohmic contacts "does not provide a technical contribution to the subject-matter of the claimed invention" within the meaning of the Decision G1/93, in that the presence or absence of such ohmic contacts does not affect the carrying out of the described invention since they are not an essential part of it.

4. For the foregoing reasons, in the Board's judgment, the amendments in the form of Claim 17 do not contain subject-matter which extends beyond the content of the application as filed, and do not therefore contravene the requirements of Article 123(2) EPC.

Features necessary for the definition of the claimed subject-matter (Article 84 EPC)

5. There is a clear statement in the originally filed description that **an object of the invention** is to provide a cell utilizing materials at each junction which minimize the presence of discontinuities or spikes in the energy band which is designed to carry charge carriers out of the absorber layer (page 4, lines 9 to 13). On page 5, lines 7 to 18 the measures required to achieve this object are stated (i.e. the use of semiconductor materials for the intrinsic and p-type layers having a common anion and use of semiconductor materials for the intrinsic and n-type layers having a common cation). Thus the description makes it clear that minimising the presence of

discontinuities or spikes was not an object of the invention in its broadest aspect as claimed in Claim 1, and in the Board's judgment, the objection raised by the Examining Division under Article 84 EPC was misconceived.

In any event, the amendment referred to in paragraph V(ii) above now makes it clear that discontinuities or spikes in the energy band are minimized in a **preferred** embodiment of a photovoltaic cell according to the invention.

6. The amendments to Claim 1 referred to in paragraph V(i) during the appeal proceedings clarify the wording "three different semiconductor compound layers", and are supported by Examples I to V in the description as filed. These amendments therefore comply with the requirements of Article 123(2) EPC.
7. Since the main request is allowable, there is no need to examine the auxiliary requests.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to grant a patent on the basis of

Claims 1 to 41 filed on 21 October 1991;

pages 1 to 6, 16, 18, 20, 21 and 24 filed on 2 May 1991; pages 7 to 15, 17, 19, 22 and 23 as originally filed; and

drawings 1/3-3/3 as originally filed,

with the amendments to Claim 1 and on page 4 as in paragraphs V(i) and V(ii) above.

The Registrar:

The Chairman:

M. Beer

G. D. Paterson