

**Internal distribution code:**

- (A) [ ] Publication in OJ  
(B) [ ] To Chairmen and Members  
(C) [X] To Chairmen

**D E C I S I O N**  
**of 26 April 1999**

**Case Number:** T 1034/97 - 3.4.2

**Application Number:** 92117612.9

**Publication Number:** 0537730

**IPC:** H01L 31/0224, H01L 31/0392

**Language of the proceedings:** EN

**Title of invention:**  
Solar Cell

**Applicant:**  
Canon Kabushiki Kaisha

**Opponent:**  
-

**Headword:**  
-

**Relevant legal provisions:**  
EPC Art. 56  
EPC R. 67

**Keyword:**  
"Inventive step (yes)"  
"Reimbursement of appeal fee (no)"

**Decisions cited:**  
T 0013/84

**Catchword:**  
-





Europäisches  
Patentamt

European  
Patent Office

Office européen  
des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

**Case Number:** T 1034/97 - 3.4.2

**D E C I S I O N**  
**of the Technical Board of Appeal 3.4.2**  
**of 26 April 1999**

**Appellant:** Canon Kabushiki Kaisha  
30-2, 3-chome, Shimomaruko  
Ohta-ku  
Tokyo (JP)

**Representative:** Bühling, Gerhard, Dipl.-Chem.  
Patentanwaltsbüro  
Tiedtke-Bühling-Kinne & Partner  
Bavariaring 4  
80336 München (DE)

**Decision under appeal:** Decision of the Examining Division of the  
European Patent Office posted 15 May 1997  
refusing European patent application  
No. 92 117 612.9 pursuant to Article 97(1) EPC.

**Composition of the Board:**

**Chairman:** E. Turrini  
**Members:** A. G. Klein  
V. Di Cerbo

## Summary of Facts and Submissions

- I. European patent application No. 92 117 612.9 (publication No. EP-A-0 537 730) was refused by the Examining Division.

The reason for the refusal was that the subject-matter of claim 1 of the main request did not involve an inventive step within the meaning of Article 56 EPC.

The Examining Division in particular considered that cavities in the electrode material of a solar cell were undesirable because they increased the resistance of the electrodes, and that, accordingly, it was desirable that the volume of these cavities per gram of electrode material be as low as possible and preferably zero. Merely determining the limit for the acceptable volume of cavities as specified in claim 1 without indicating the means to achieve such a low cavity density could not justify an inventive step either (see point 2 of the reasons).

In respect of claim 1 of the auxiliary request, the Examining Division ruled that the additional limitation of the electrode material containing a conductive base substance having a solvent content of 18 wt.% or less extended beyond the content of the application as filed in contravention of the provisions of Article 123(2) EPC (see point 4 of the reasons). Moreover, the limitation could not confer patentability to the subject-matter of the claim, since it was disclosed in prior art document

D1: DE-C-3 804 831

(see point 5 of the reasons).

- II. The appellant (applicant) filed an appeal against the decision.
  
- III. Oral proceedings were held on 26 April 1999, at the end of which the appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of an amended set of claims 1 to 10.

Claim 1, the only independent claim of the valid set of claims, reads as follows:

"1. A solar cell having a photoelectric conversion semiconductor layer and an electrode made from a solventless conductive material containing a conductive base substance and a resin electrically connected to said photoelectric conversion semiconductor layer;  
wherein among cavities existing in said electrode, volume of said cavities having a diameter of 0.1  $\mu\text{m}$  or greater is 0.04  $\text{cm}^3/\text{g}$  or less."

The appellant also requested reimbursement of the appeal fee.

- IV. The appellant's argument in support of his requests can be summarised as follows.

The electrode of the solar cell disclosed in document D1 is obtained from a conductive base which contains substantial quantities of solvent (e.g. 27 wt.% in Example 1 as disclosed in the passage bridging columns 2 and 3). The evaporation of such solvent content in the curing step inevitably causes a large volume of cavities in the final electrode

material. Water entering these cavities when the solar cell is used outdoors may result in slow decomposition of the electrode material, and electrical shorting of the solar cell.

In contrast, the invention is based on the recognition that such degradation of the electrode does not occur when it is made from a solventless material in such a way as to keep the volume and the size of the cavities at a minimum.

The citations brought to light in the Search Report do not hint at any correlation between the solvent content of the material from which the electrode is made, the total volume and size of the cavities and the resistance of the solar cell to environmental stresses.

Quite on the contrary, the electrode of the solar cell disclosed in document

D3: JP-A-63 185 071

is protected by a resin coating, in a well-known way.

With respect to the technical problem relied upon by the Examining Division of reducing the electrical resistance of the electrode, document D1 and the further citation

D2: JP-59 167 056

both concentrate on the provision of an intermediate contact layer between the electrode and the semiconductor material, in order to reduce the contact

resistance. The specific resistance of the electrode material itself does not pose any problem whatsoever, and there is no hint in the prior art that the total volume and size of the cavities might noticeably affect the conductivity of the electrodes.

Concerning his request of reimbursement of the appeal fee, the appellant submitted that the Examining Division failed to produce any document or reasoning in support of its allegation that the skilled person would have automatically achieved the claimed range for the total volume and size of the cavities. The refusal thus violated the principle laid down in Rule 68(2) EPC that the decisions of the European Patent Office shall be reasoned, whereby the conditions of Rule 67 EPC for reimbursement of the appeal fee were met.

### **Reasons for the Decision**

1. The appeal is admissible.
  
2. *Compliance of the amended claims with the requirements of Article 123(2) EPC*

Claim 1 corresponds in substance to claim 1 as originally filed, with the additional limitation that the material from which the electrode is made is "solventless". The use of a solventless material to form the electrode was disclosed as a most preferable option in the description as originally filed (see e.g. page 7, lines 20 to 26) and illustrated in conjunction with Example 2 (see page 15, line 17 to page 16,

line 16).

The subject-matter of dependent claim 2 was claimed originally in independent claim 7.

The non-single crystalline character of the semiconductor set out in dependent claim 3 was disclosed in the description as originally filed (see page 5, lines 22 to 27).

Dependent claim 4 corresponds to claim 3 as originally filed.

The features of dependent claim 5 was disclosed as a preferable range in the description as originally filed (see page 10, line 20 to page 11, line 1).

The transparent conductive layer of dependent claim 6 was disclosed in the paragraph bridging pages 6 and 7 of the original description.

Dependent claims 7 to 10 correspond to dependent claims 2 and 4 to 6 as originally filed, respectively.

Accordingly, the claims as amended do not in the Board's view contain subject-matter which extends beyond the content of the application as filed, in compliance with the requirement of Article 123(2) EPC.

3. *Sufficiency of the disclosure*

The description in conjunction with Examples 2 and 3 generally refers to an "epoxy type resin" as a suitable resin component of a solventless conductive paste for



forming an electrode. The Board has no reason to question the appellant's submission in the oral proceedings that the skilled person would have no difficulty to select an appropriate such epoxy type resin to work out the examples.

Accordingly, the invention set out in amended claim 1 in the Board's view is disclosed in the present application in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art, in compliance with the requirement of Article 83 EPC.

4. *Novelty*

Document D1 discloses a solar cell which, like the subject-matter of claim 1, has a photoelectric conversion semiconductor layer and an electrode made from a material containing a conductive base substance (silver powder) and a resin (a polyester resin) electrically connected to the photoelectric conversion semiconductor layer (see document D1, claim 1).

The material from which the electrode is made comprises from 10 to 45 wt.% solvent (see document D1, claim 1) and the document does not provide any detail of the total volume and shape of the cavities in the electrode material.

Thus, the subject-matter of present claim 1 is distinguished from the solar cell of document D1 in that the electrode is made from a solventless material and in that the volume of the cavities having a diameter of 0.1  $\mu\text{m}$  or greater is 0.04  $\text{cm}^3/\text{g}$  or less.

Concerning the feature of the electrode being made from a solventless material, the appellant at the oral proceedings convincingly submitted that the presence of a solvent in the electrode material and its evaporation during the curing step inevitably produces a characteristic structure in the final electrode, in particular a specific configuration of the cavities. Thus, the reference in present claim 1 to the electrode being made from a solventless material in the Board's view actually amounts to a structural limitation of the claimed solar cell, which distinguishes it from the solar cell of document D1.

The other documents on the file do not disclose the use of a solventless resin material for the manufacturing of a solar cell electrode either, nor do they provide any indication of the total volume and size of the cavities in such electrode.

Accordingly, the subject-matter of present claim 1 in the Board's view shall be considered to be new within the meaning of Article 54 EPC.

5. *Inventive step*

The technical problem addressed by the invention as put forward in the description is to provide a solar cell which is less sensitive to environmental stress, in particular to the degradation of its conversion efficiency caused by permeation of water through the electrode and the resulting diffusing of the metal ions solved out of the electrode (see page 2, line 27 to page 5, line 1).

In the light in particular of the experimental data provided in the description with reference to Figures 5 to 7, the Board has no reason to question the appellant's submission that the use of an electrode made from a solvent free material actually improves the resistance of a solar cell to environmental influences by reducing the number and size of the cavities which otherwise result from the evaporation of the solvent in the curing process.

The prior art documents on the file do not in any way hint at the advantages of using a solventless material to form the electrode. Neither do they establish the existence of any link between the presence of a solvent in the material used to form the electrode and the occurrence of cavities, nor between the volume and size of such cavities and the weatherproofness of solar cells.

On the contrary, document JP-A-1 057 762, which like document D1 explicitly teaches the use of a solvent in the material from which the electrode is formed, addresses the interest of controlling the particle size of the metal powder to a size sufficient to prevent such metal powder to enter the pin holes **in the photoelectric conversion semiconductor**, which would result in short circuit (see the two sentences at the end of the abstract). This document thus points at a solution which is quite different from the claimed controlling of the cavities in the electrode material itself.

Document D3 does not specify the solvent content of the material used for forming the electrodes. Deterioration

of the characteristics of the solar cell is overcome there by using a particular resin (phenol resin) and by providing a coating of a protecting resin to cover the electrode (see the abstract).

The Examining Division in its decision only considered the technical problem of reducing the specific electrical resistance of the electrode. This problem in its view was solved in an obvious manner by reducing the volume and size of the cavities at a minimum.

The claims refused by the Examining Division did not however comprise the present limitation of the electrode being made from a solventless material. The citations available on the file do not hint at the use of such material for any purpose whatsoever. Those citations which address the problem of reducing the series resistance of a solar cell also consistently concentrate on reducing the contact resistance between the electrode and the photoelectric conversion semiconductor layer, rather than on reducing the bulk resistance of the electrode itself (see document D1, column 2, lines 38 to 44; document D2, the first paragraph of the abstract; document JP-A-59 167 057, penultimate sentence of the abstract).

For these reasons, the subject-matter of claim 1 is considered to involve an inventive step within the meaning of Article 56 EPC.

6. The description no longer being fully consistent with claim 1 as amended, it may still need to be adapted for compliance with the requirements of Rule 27 EPC. The appellant in this respect at the oral proceedings

agreed that the case should be remitted to the Examining Division for this purpose.

7. *Reimbursement of the appeal fee*

In support of his request for reimbursement of the appeal fee under Rule 67 EPC, the appellant submitted that the decision of the Examining Division violated the principle let down in Rule 68(2) EPC that decision of the European Patent Office shall be reasoned.

The Board could not however in the handling of the case by the Examining Division recognise any procedural violation which could justify reimbursement of the appeal fee. In particular, the grounds for refusal were set out clearly both in the appealed decision and in the communications issued earlier by the Examining Division, so that the appellant had an adequate opportunity to present his comments. The fact that the decision was based on a definition of the objective technical problem different from the definition put forward in the application is not objectionable per se (see for instance the decision T 13/84; OJ EPO 1986, 253). Neither was there in the present circumstances any need for the Examining Division to support its argument to the effect that it was generally desirable that the volume of cavities in a conductive electrode material be as small as possible, which appears quite trivial, by any concrete citation.

In this respect it is also stressed that, as explained above, only during the appeal procedure the appellant amended the claims in a way to render them allowable.

## Order

### For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the Examining Division with the order to grant a patent as follows:
  - claims 1 to 10 presented at the oral proceedings of 26 April 1999;
  - description and drawings to be adapted where necessary.

The request of reimbursement of the appeal fee is rejected.

The Registrar:

The Chairman:

P. Martorana

E. Turrini