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D E C I S I O N
of 6 August 2002

Case Number: T 1086/97 - 3.4.3

Application Number: 92309428.8

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IPC: H01L 21/368

Language of the proceedings: EN

Title of invention:
Electrochemical process

Applicant:
BP SOLAR LIMITED

Opponent:

-

Headword:
Electrochemical process/BP SOLAR LIMITED

Relevant legal provisions:
EPC Art. 52(1), 56

Keyword:
"Inventive step (no)"

Decisions cited:
T 0002/83

Catchword:

-



Case Number: T 1086/97 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 6 August 2002

Appellant: BP SOLAR LIMITED
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 3 June 1997
refusing European patent application
No. 92 309 428.8 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: R. K. Shukla
Members: E. Wolff
M. B. Günzel

Summary of Facts and Submissions

I. This is an appeal against the decision of the Examining Division to refuse European patent application No. 92 309 428.8 on the ground that the independent device claim 1 lacked an inventive step over the combined teaching of the following two documents:

D1: Journal of the Electrochemical Society, Vol. 132, No. 11, November 1985, pages 2768 to 2771.

D2: Database WPIL, week 8918, AN 89-134 192 and JP-A-1 079 007.

The features of dependent claims 2 to 12 were considered not to add anything inventive to the subject-matter of claim 1.

The following documents were also referred to during examination but were not relied upon in the decision of the Examining Division:

D3: US-A-4 400 244.

D4: Patent Abstracts of Japan, Vol. 11, No. 176, C 426, 05-06-1987 and JP-A-62 004 239 (10-01-1987).

II. The notice of appeal was filed on 25 July 1997 and the appeal fee was paid on the same day. The statement setting out the grounds of appeal was filed on 1 October 1997.

The appellant requests that the decision of the Examining Division be set aside and the patent application be allowed on the basis of the main request or, alternatively, on the basis of the auxiliary request, both filed with the statement of the grounds of appeal.

III. Claim 1 of the main request reads as follows:

"1. Process for the formation of a thin film of a semiconductor containing Cd and Te which includes electrolytic deposition of material from a bath by passing current between an anode and a cathode, characterized in that

the anode is separated from the bath from which the semiconductor is deposited by an ion-exchange membrane so as to give an anolyte compartment and a catholyte compartment."

Claim 1 of the auxiliary request reads as follows:

"1. Process for the formation of a thin film of a semiconductor which includes electrolytic deposition of material from a bath by passing current between an anode and a cathode, characterized in that

the anode is separated from the bath from which the semiconductor is deposited by a cation-exchange membrane so as to give an anolyte compartment and a catholyte compartment, and the semiconductor compound is deposited on the cathode."

Claims 2 to 14 of both the requests are dependent claims.

IV. The arguments presented by the appellant in support of his requests can be summarised as follows.

The application relates to a process for making photovoltaic cells. The problem which the invention sets out to solve is to find a process for making photovoltaic cells with improved electrical performance, as witnessed by the fact that all the examples described in the application relate to the performance parameters of the finished devices.

Document D1 relates to the manufacture of Cd Te photovoltaic cells, but does not suggest how to obtain devices with improved performance characteristics. There is no indication of ultimate device performance. Document D1 furthermore refers only in passing to separating the anode and cathode compartments to avoid contaminants from the anodic process, and the separation is accomplished by means of a glass frit. A glass frit is not an effective barrier because it does not prevent but merely delays contaminants reaching the catholyte compartment, resulting in poor quality of the photovoltaic cell.

In contrast, the use of an ion-exchange membrane according to the invention provides a genuine separation between the anolyte and the catholyte bath. This separation brings with it several improvements. First, there is the greater purity of the deposited material, which is highly important in the case of photovoltaic devices. Secondly, because an ion-exchange membrane - unlike glass frit - is an effective block to the migration of unwanted impurities, it can be used in continuous processes of the kind employed in the manufacture of photovoltaic cells. Thirdly, because an

ion-exchange membrane can be crossed by H ions but not by Te ions, the presence of this barrier prevents the formation of telluric acid which has been found to occur in the absence of the barrier and which is a competing reaction removing from the bath Te ions which would otherwise be available for the deposition of Cd Te. This advantage, although not mentioned as such in the patent application, is referred to by the statement on page 6, line 12 of the published application that "the catholyte life is greatly extended".

Document D2 relates to a diffusion process, i.e., a process quite different from the electrolytic process employed in case of invention in suit. Moreover, it also lists several other membranes besides the cation exchange membrane "Nafion" (RTM, Du Pont Corp.), such as nylon, cellulose or Teflon, for example, which are not suitable for use in the process to which the present invention relates.

Following T 2/83, the question to be asked is not whether the skilled person could but whether, given the disclosure in the prior art documents, the skilled person **would** have arrived at the claimed invention. An ion-exchange membrane is only one of many choices and there is no indication in the prior art as to which of the many types of membrane available would in fact provide the desired degree of purity. The invention as claimed cannot be obvious if, in order to arrive at it, one would have to test every conceivable alternative.

V. Oral proceedings were held on 6 August 2002.

Reasons for the Decision

1. The appeal is admissible.

The main request

2. *Inventive step*

- 2.1 In the words of claim 1, document D1 discloses a process for the formation of a thin film of a semiconductor containing Cd and Te which includes electrolytic deposition of material from a bath by passing current between an anode and a cathode, wherein the anode is separated from the bath from which the semiconductor is deposited. The only difference between the invention as claimed and the prior art process disclosed in document D1 is that instead of the glass frit in document D1 the invention employs an ion-exchange membrane to separate the bath into an anolyte and a catholyte compartment.

- 2.2 The appellant submitted that the problem to be solved by the invention is that of providing a photovoltaic cell with improved technical properties. The Board cannot accept this argument for the following reasons.

- 2.2.1 The appellant has not alleged improvement in the electrical properties in relation to document D1 devices, but on the basis of comparative tests with processes where no membrane was used to isolate the cathode from the anodic process (see, for example, "Comparative Test B", page 4, lines 31 to 53).

- 2.2.2 In accordance with the established case law of the Boards of Appeal, the objective problem solved by an

invention is to be determined by reference to the nearest prior art which in this case is document D1. Document D1 discloses cathodic deposition of thin film CdTe (page 2969, left-hand column) in which the anode and cathode compartments are separated by glass frit. The glass frit is employed to avoid contaminants from the anodic process page 2768, left-hand column, last paragraph)

2.3 The objective problem defined by the difference between the prior art and the invention as claimed can be seen to lie in providing, in an electrolytic deposition process for CdTe, a suitable barrier as an alternative to the glass frit barrier between anode and cathode compartments such that contaminants are less likely to reach the cathode compartment. The skilled person would be aware that a glass frit acts merely as a mechanical barrier which can only delay but not prevent unwanted ions from passing through, and would therefore have a genuine incentive to look for alternative barriers.

2.4 As to the choice of a suitable barrier, document D2 discloses the use of cation exchange membranes, like Nafion (RTM, Du Pont Corp.) in connection with the deposition of thin metallic chalcogen films such as CdSe, CDS or PbS as photosensitive material for electro-optic devices such as solar cells and the like, i.e., similar types of devices to those of the application in suit.

2.5 In common with the Examining Division, the Board considers that the skilled person would be aware of the general properties of ion exchange membranes and also know about commercially available types of membranes, including Nafion. Knowing which types of membrane are

available, it is then a matter of mere routine experimentation to establish the suitability of Nafion and like ion-exchange membranes for separating the anolyte bath from the catholyte bath and preventing impurities from the anodic process from reaching the cathode. Moreover, the description itself acknowledges the availability of the "material sold by Du Pont under the trade name Nafion" as well as its use "as a separator in electrochemical applications" (published application, page 3, lines 16 and 17).

2.6 The appellant submitted that the skilled person would not have considered document D2 as relevant to solving the problem which, in his view, the invention addressed. However, the question is not whether the skilled person would have considered the disclosure in document D2 to be of assistance in improving electro-optic devices formed by deposition of CdTe but, according to the definition of the objective problem whether he would have considered the information in document D2 to be of assistance in deciding which membranes would prove useful in improving the separation between anolyte and catholyte bath. The Board has no doubt that for this latter purpose the skilled person would have considered the content of document D2 as providing a list of candidates worth trying, even if, as argued by the appellant, some of the membranes listed proved useless for the purposes of the invention.

2.7 As to the appellant's argument that an invention cannot be obvious if in order to arrive at it it is necessary to test every possible alternative, the Board considers this to be so only where the prior art offers an unacceptably large list of alternatives. However,

document D2 lists a mere five types of membranes in addition to the cation exchange membrane Nafion, few enough alternatives for the skilled person to be expected to eliminate by experiment those less useful. The need for experiment is, moreover, acknowledged by the appellant's argument that membranes "will differ in effectiveness depending on the identity of the species it is intended to filter or separate: there is no universal order of effectiveness" (statement of grounds, page 2, second paragraph)

- 2.8 For the reasons set out, the Board concludes that solving the objective problem as defined by employing an ion-exchange membrane does not involve an inventive step, and therefore that the invention according to the main request is obvious.

Auxiliary request

3. *Inventive step*

- 3.1 The auxiliary request differs from the main request in that

- (I) it is not restricted to materials containing Cd and Te,
- (ii) in that the claim specifies that the ion-exchange membrane is a cation-exchange membrane and
- (iii) in that the semiconductor compound is deposited on the cathode.

- 3.2 As discussed in relation to the main request, document

D1 discloses the formation of a thin film of semiconductor material (i.e. Cd and Te) as well as deposition of the semiconductor compound on the cathode ("Cathodic deposition", page 2769, left-hand column, "results and discussion"). Therefore, the only difference between the prior art document D1 and the invention as claimed is that the anode and cathode compartments are separated by a cation-exchange membrane rather than, as in document D1 by a glass frit.

3.3 Since document D2 discloses that Nafion is a cation exchange membrane, the use of a cation exchange membrane was obvious to the skilled person for the reasons given in respect of the main request.

3.4 For the foregoing reasons, the subject-matter of claim 1 of the auxiliary request does not involve an inventive step within the meaning of Article 56 EPC.

Order

For these reasons it is decided:

The appeal is dismissed.

The Registrar:

The Chairman:

M. Beer

R. K. Shukla