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**Datasheet for the decision
of 21 March 2019**

Case Number: T 0074/14 - 3.4.03

Application Number: 04747712.0

Publication Number: 1650812

IPC: H01L31/075

Language of the proceedings: EN

Title of invention:

Method for making a silicon based thin film solar cell

Patent Proprietor:

Kaneka Corporation

Opponent:

Digital Simplex Pte Ltd.

Headword:

Relevant legal provisions:

EPC 1973 Art. 56, 100(a), 100(b), 100(c)
EPC Art. 52(1)
EPC 1973 R. 71(2)
RPBA Art. 12(4), 13(1), 13(3), 15

Keyword:

Amendments - added subject-matter (yes)

Amendments of application - discretion of examining division

Inventive step - auxiliary request (yes)

Decisions cited:

G 0007/93, T 1002/92

Catchword:



Beschwerdekammern
Boards of Appeal
Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 0074/14 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 21 March 2019

Appellant: Digital Simplex Pte Ltd.
(Opponent) 105 Cecil Street
No. 03-02 The Octagon
Singapore 069534 (SG)

Representative: Leffers, Thomas
Schweiger & Partners
Intellectual Property Law Firm
Elsenheimer Strasse 1
80687 München (DE)

Respondent: Kaneka Corporation
(Patent Proprietor) 2-3-18, Nakanoshima,
Kita-ku,
Osaka (JP)

Representative: Vossius & Partner
Patentanwälte Rechtsanwälte mbB
Siebertstrasse 3
81675 München (DE)

Decision under appeal: **Decision of the Opposition Division of the
European Patent Office posted on 13 November
2013 rejecting the opposition filed against
European patent No. 1650812 pursuant to Article
101(2) EPC.**

Composition of the Board:

Chairman W. Van der Eijk
Members: S. Ward
 M. Papastefanou

Summary of Facts and Submissions

I. This is an appeal against the decision of the Opposition Division rejecting the opposition against European patent EP 1 650 812 B1.

The opposition had been filed against the patent in its entirety on the grounds of lack of inventive step, insufficient disclosure and unallowable extension of subject-matter (Articles 100(a), (b) and (c), 52(1) and 56 EPC)

II. The following documents are referred to in this decision:

D1: US 4 781 765

D2: US 4 776 894

D3: JP 2003 258279 A

D3a: English translation of D3

D8: JP 11 186574 A

D8a: English translation of D8

D10: US 5 738 732

D11: JP 62 65478 A

D12: US 5 021 100

D13: US 5 569 332

D14: JP 2001 028452 A

D15: JP 59 63774 A

D16: "Silicon Oxide (SiO_x , $0 < x < 2$): a Challenging Material for Optoelectronics", N. Tomozeiu.

III. The appellant-opponent (hereinafter, the opponent) requested in writing that the decision under appeal be set aside and that the patent be revoked.

At the end of the oral proceedings held before the Board the respondent-proprietor (hereinafter, the

proprietor) requested that the appeal be dismissed (hence, that the patent be maintained unamended), or failing that, that the patent be maintained according to one of the auxiliary requests 1-6 filed with the letter dated 19 February 2019.

The documents corresponding to auxiliary request 6 were:

- Claims 1-6 of auxiliary request 6, filed on 19 February 2019;
- Description as in the published patent specification;
- Drawings as in the published patent specification.

IV. Oral proceedings were held in the presence of the proprietor and in the absence of the opponent, the opponent's intention not to attend having previously been stated in writing.

V. (i) Claim 1 of the main request reads as follows:

"Method of forming a silicon based thin film solar cell, comprising disposing a photoelectric conversion layer on a translucent board, forming an n-type silicon based low refractive index layer on the photoelectric conversion layer, forming an n-type silicon based interface layer on the silicon based low refractive index layer, wherein the silicon based low refractive index layer has a refractive index not more than 2.5 at a wavelength of 600 nm, and wherein the silicon based low refractive index layer has a thickness of not less than 30 nm."

(ii) Claim 1 of auxiliary request 1 is identical to claim 1 of the main request, except that "not less than 30 nm" has been amended to "not less than 30 to 90 nm" (auxiliary request 1 also comprises four other new independent claims).

(iii) Claim 1 of auxiliary request 2 (the sole independent claim) is identical to claim 1 of auxiliary request 1.

(iv) Compared to claim 1 of the main request, claim 1 of auxiliary request 3 (the sole independent claim) comprises the following additional features:

"wherein a most abundantly existing constituent element, excluding silicon, in the silicon based low refractive index layer is not less than 25 atomic %, and wherein the most abundantly existing constituent element is oxygen."

(v) Compared to claim 1 of the main request, claim 1 of auxiliary request 4 (the sole independent claim) comprises the following additional feature:

"forming a back electrode layer on the n-type silicon based interface layer".

(vi) Compared to claim 1 of auxiliary request 4, claim 1 of auxiliary request 5 (the sole independent claim) comprises the following additional feature:

"wherein the back electrode layer comprises a metal oxide layer".

(vii) Compared to claim 1 of auxiliary request 4, claim 1 of auxiliary request 6 (the sole independent claim) comprises the following additional feature:

"wherein the back electrode consists of a transparent reflective layer and a back-reflecting layer".

VI. With the summons to oral proceedings, the Board sent the parties a communication under Article 15(1) RPBA setting out its provisional views, which may be briefly summarized as follows: The arguments relating to the ground of Article 100(c) would be discussed at oral proceedings. It was doubtful whether a lack of disclosure within the meaning of Article 100(b) EPC had been demonstrated, and the plausibility of at least some of the inventive step attacks could also be doubted. In not admitting documents D10-D15 into the procedure, the Opposition Division appeared to have dealt with this matter in accordance with the right principles and in a reasonable way. No reasons had been given why D16 could not have been filed earlier.

VII. The opponent's arguments, in so far as they are relevant to the present decision, were essentially as follows:

(i) Although claim 1 of the main request was largely based on claims 1, 2 and 5 as originally filed, it also included disposing a photoelectric conversion layer "on a translucent board", and it defined the two silicon-based layers to be "n-type".

These features were disclosed in the application as filed only in connection with the particular embodiment described on pages 10 to 13 and illustrated in figure 2. The omission from the claim of other features of

this embodiment constituted an extension of subject-matter beyond the content of the application as filed.

In particular, the solar cell formed by the method of claim 1 might include any number of photoelectric conversion layers (e.g. one, three or more), each of which might be amorphous or crystalline. In the embodiment of Fig. 2, however, only one amorphous photoelectric conversion unit 3 and one crystalline photoelectric conversion unit 4 were disclosed.

Also the solar cell could not function without electrodes, and so the step of forming the electrodes, which was not claimed, must be essential.

In the arrangement originally disclosed in Fig. 2, the n-type silicon low refractive index layer and the n-type interface layer were positioned between the crystalline photoelectric conversion unit 4 and the back electrode 5 such that the back electrode is arranged on the n-type silicon-based interface layer. This feature was absent from claim 1.

The application failed to disclose a method including depositing a combination of layers in the claimed order, as on page 13, lines 6 to 9, it was disclosed that the layers could be disposed in the reverse order on a conductive board such as metal or on an insulated substrate.

(ii) In relation to the ground of Article 100(b) EPC, the method of claim 1 as granted included open ended ranges which comprised values which were not practically realizable, so that the invention could not be performed over the entire range claimed.

(iii) Concerning inventive step, although D1 did not disclose the claimed feature that the silicon-based low refractive index layer had a thickness of not less than 30 nm, the contested patent failed to disclose any particular technical effect associated with this feature. The skilled person would consider increasing the thickness of the layer 3n11 to at least 30 nm in order to improve the blocking of the diffusion of undesired elements from the back electrode, and would also increase the oxygen content to compensate for the correspondingly increased absorption, thereby ensuring that the refractive index would be no more than 2.5.

(iv) Alternatively, D2 (Fig. 10) disclosed a method of fabricating a solar cell including forming an n-type silicon based low refractive index layer 63 and an n-type silicon-based interface layer 64 on a photoelectric conversion layer 6.

Suitable materials for layers 63 and 64 included amorphous silicon alloys which should have an optically forbidden bandgap greater than 1.8 eV. This would induce the skilled person to select SiO_x , where x is greater than or equal to 0.5, which would have a refractive index of around 2.5 or less, as confirmed in document D16. In D2 the thickness of the layer 63 was 5 nm, but the skilled person would learn from D3 (which was prior art under Article 54(2) EPC due to the invalidity of the priority claim based on the earlier of the two priority applications) that the thickness of a low refractive index layer may be greater than 5 nm without undue absorption.

(v) D8 disclosed a solar cell including a low refractive index layer 116 and an interface layer 104. Layer 116 was a silicon oxide thin film which

inherently had a refractive index of not more than 2.5 and was implicitly n-type, as the oxidation of an n-type silicon layer (e.g. layer 104) would result in a silicon oxide also including the n-dopant. Even if the order of forming the layers in D8 was the reverse of that claimed, it was well known in the art that the order of stacking the layers of a solar cell may be reversed, the two arrangements being equivalent.

Inventive step might also be demonstrated by the combinations D11 and D15, D13 and D15 or D2 with any of D10, D11 or D12.

(vi) The Opposition Division was wrong not to admit documents D10-D15 into the procedure. D16 demonstrated the relationship between refractive index, bandgap and oxygen content for SiO_x .

VIII. The proprietor's arguments, in so far as they are relevant to the present decision, were essentially as follows:

(i) Those features of claim 1 which were not based on original claims 1, 2, and 5 could be derived from the description and drawings. In particular, an n-type silicon based interface layer was disclosed on page 13, lines 6-9. What was claimed was essentially a method of manufacturing an intermediate product, which represented a stage on the way to the manufacture of a final solar cell, but which did not itself have all of the layers of the final product. Hence, there was no need to specify the back electrode.

(ii) The opponent's position on Article 100(b) EPC was not reasonable, and would rule out any open-ended range in a European patent. The skilled reader was aware that

open-ended ranges were limited in practice and must be interpreted so that they made technical sense in combination with the remaining features and the technical field in question. In particular, the person skilled in the art understood that silicon based materials have a refractive index with a positive lower limit. For example, in the case of SiO_2 , the lower limit was about 1.45. Regarding the upper limit of the thickness of the low refractive index layer, it was not reasonable to assume a layer thickness of several mm in the present technical field, or even an infinite thickness as suggested by the opponent.

(iii) D1 failed to disclose that the silicon-based low refractive index layer had a thickness of not less than 30 nm, which, as shown in Fig. 6 of the patent, led to an improved conversion efficiency.

(iv) D2 also failed to disclose that the silicon-based low refractive index layer had a thickness of not less than 30 nm, and there was no reason why the skilled person would increase the thickness of the layer 63. The skilled person had no reason to combine D2 and D3.

(v) The skilled person was by no means prompted by the teachings in D8 to reverse the order of the layers, since then the preferred result and concept behind the teachings in D8 would be destroyed.

(vi) Documents D10 to D15 were late-filed and not highly relevant. The opponent did not provide any reasons for filing D16 only during the appeal. D10-D16 should not be admitted into the proceedings.

Reasons for the Decision

1. The appeal is admissible.
2. As announced in advance, the duly summoned opponent-appellant did not attend the oral proceedings. According to Rule 71(2) EPC 1973, if a party duly summoned to oral proceedings does not appear as summoned, the proceedings may nevertheless continue, the party then being treated as relying only on its written case. As the present case was ready for decision at the conclusion of the oral proceedings (Article 15(5) and (6) RPBA), the voluntary absence of a party was not a reason for delaying the decision (Article 15(3) RPBA).
3. *Main Request: Article 100(c) EPC 1973*
 - 3.1 Claim 1 of the main request is largely based on claims 1, 2 and 5 of the English translation of the PCT application as originally filed. The features which are not found in the originally filed claims are essentially as follows (in italics):
 - (a) *a method of forming a silicon based thin film solar cell (claim 1 as originally filed concerned a silicon based thin film solar cell);*
 - (b) *depositing a photoelectric conversion layer on a translucent board;*
 - (c) *an n-type silicon based low refractive index layer;*
and
 - (d) *an n-type silicon based interface layer.*
 - 3.2 In the statement of grounds of appeal the opponent does not raise any objection against the change of category

per se, and the Board also sees no reason to do so. In the arrangement of Fig. 2, the layers are formed in the order claimed, on an underlying translucent board 1, and so feature (b) is adequately based in the original application, even if various other deposition possibilities are mentioned in the description (see page 13, lines 6-13). Claim 1 as originally filed defined a "conducted type" silicon based low refractive index layer, which can only be taken to refer to silicon having a conductivity type (p or n), and the choice to limit to n-type, as disclosed in the arrangement of Fig. 2, does not introduce undisclosed subject-matter. The argument that only arrangements having precisely two photoelectric units are disclosed (an amorphous unit 3 and a crystalline unit 4) is contradicted by the description (page 13, lines 2-6).

3.3 The remaining objection concerns forming an "n-type silicon based interface layer". In claim 1 as originally filed this layer was simply a "silicon based interface layer". It is not disputed that the embodiment of Fig. 2 provides a basis for an "n-type silicon based interference layer" *per se* (page 12, line 9), but this is disclosed within the context of an arrangement in which other non-claimed features are also disclosed, in particular the interface layer being disposed between the low refractive index layer and the back electrode (page 9, lines 10-14; page 12, last paragraph; Fig. 2).

3.4 The proprietor argues that claim 1 should be seen as defining a method of manufacturing an intermediate product, which does not necessarily comprise all the features of a solar cell, in particular a back electrode, and there is therefore no requirement to include in the claim a back electrode or the

relationship of the interface layer to a back electrode.

The Board does not agree that claim 1 defines a method of forming an "intermediate product", it quite explicitly defines a method of "forming a silicon based thin film solar cell". However, in relation to the present discussion, what is at issue is not the nature of the final product, but whether it is permissible to import into claim 1 a first feature from the description (forming an *n-type* silicon based interface layer), while not importing a second feature (the location of the interface layer between the low refractive index layer and the back electrode), given that both features are disclosed in combination.

3.5 According to consistent case law of the Boards, such an amendment introduces subject-matter which extends beyond the content of the application as filed only if there is a clearly recognizable functional or structural relationship between the features, i.e. if they are inextricably linked (see *Case law of the Boards of Appeal of the European Patent Office*, 8th edition 2016, II.E.1.7).

3.6 In the present case, the function of the intermediate layer is described in the application as filed as follows:

"The n type silicon based interface layer 4n is used in order to improve a contact resistance between the n type silicon based low refractive index layer 4on and a back electrode 5" (page 12, lines 11-14).

It would be apparent to the skilled person that the resistance is reduced by the combination of the

material being n-type (a p-type or i-type interface layer or a layer of e.g. silicon oxide would not perform the intended function) and its position (an interface layer which was not located between the low refractive index layer and the back electrode would also not perform the intended function). These two features are therefore functionally related and inextricably linked.

3.7 As a result, the amendment in question constitutes an extension of the subject-matter of the European patent beyond the content of the application as filed, and hence the patent cannot be maintained according to the main request (Article 100(c) EPC 1973).

4. *Auxiliary requests: Admission into the proceedings*

4.1 Auxiliary requests 1-6 were filed approximately one month before the oral proceedings and may only be admitted and considered at the Board's discretion (Articles 13(1) and 13(3) RPBA).

4.2 In the case of auxiliary requests 1-3, the additional features of claim 1 are entirely unrelated to, and would not overcome, the Board's objection to the main request on the grounds of Article 100(c) EPC 1973. These requests therefore serve no useful purpose and are not admitted into the proceedings.

4.3 In the case of auxiliary requests 4 and 5, the additional features of claim 1 of auxiliary requests 4 and 5 are focused on the relevant objection, but neither request corresponds precisely to the embodiment of Fig. 2, according to which the back electrode 5 consists of a transparent reflecting layer 5t, and a back reflecting layer 5m. The Board makes no comment on

whether this difference results in an extension of the subject-matter beyond the content of the application as filed, but merely notes that if these requests were admitted into the proceedings, this matter would have to be considered. The Board is not minded to admit requests filed at a late stage in the proceedings which raise such new issues, especially as the letter accompanying these requests contained no reasoning whatsoever indicating why these requests should be considered allowable. Hence, auxiliary requests 4 and 5 are not admitted into the proceedings.

4.4 The additional features of claim 1 of auxiliary request 6 have a basis in the application as filed (e.g. page 12, final paragraph), and this request is considered to overcome the Board's objections to the main request in relation to the ground of Article 100(c) EPC 1973, without raising any new issues. Auxiliary request 6 is therefore admitted into the proceedings.

5. *Auxiliary request 6: Article 123(2) EPC*

As noted in the previous paragraph, the subject-matter of claim 1 of auxiliary request 6 is found not to extend beyond the content of the application as filed. Dependent claims 2-6 are based on claims 3, 4 and 6-8 as originally filed. Auxiliary request 6 therefore meets the requirements of Article 123(2) EPC.

6. *Auxiliary request 6: Article 100(b) EPC 1973*

6.1 Although the opponent's objection under Article 100(b) EPC 1973 was raised in relation to the main request, it would apply equally to auxiliary request 6. The objection is that the claimed method includes open ended ranges (the low refractive index layer has no

lower limit for the refractive index and no upper limit for the thickness), and hence "the thickness may be infinite and the refractive index may be negative". However, "both an infinite thickness and a negative refractive index are not practically realizable so that the invention cannot be performed over the entire range claimed."

6.2 Conventionally, the absolute lower limit for the refractive index of any material is 1 (the refractive index in a vacuum), and for a low refractive index layer formed of an alloy of n-type silicon and silicon oxides (as disclosed in the description), the lower limit would be about 1.46, i.e. the refractive index of SiO₂ at 600 nm.

It is true that there has been interest in recent years in exotic materials (e.g. engineered arrays of micro-resonators or certain photonic crystals) displaying a negative refractive index. In the opinion of the Board, the fact that it may be theoretically (and even, to some extent, practically) possible to construct such materials does not mean that the term "refractive index" in a patent document must automatically be considered to extend to negative refractive indices. Where, as in the present case, it is abundantly clear that the invention concerns normal optical materials, the term "refractive index" is to be understood in its conventional sense, being restricted to positive values greater than 1. Hence, the fact that the patent does not disclose how to form an n-type silicon based low refractive index layer with a negative refractive index does not amount to a lack of disclosure within the meaning of Article 100(b) EPC 1973. The invention is simply not concerned with such materials.

6.3 Regarding the thickness of the low refractive index layer, a skilled person would not interpret claim 1 as being intended to extend, in practice, to "an infinite thickness", as suggested by the opponent.

This layer is disclosed as serving several functions (see passage bridging pages 7 and 8): it acts to generate a diffusion potential in the photoelectric conversion layer, it reflects light from its surface (hence the requirement for a low refractive index) and it should absorb as little light as possible (so that the transmitted light may be recycled by the reflective back electrode 5).

Thickness values for the low refractive index layer cited in the application are:

- in claim 1, "not less than 30 nm" ($\lambda/20$ at the claimed nominal wavelength of $\lambda = 600$ nm);
- in example 1 (page 15, lines 16-17), "600 Å" (60 nm) i.e. $\lambda/10$;
- on page 11, line 17, the preferable range is 500-900 Å (50-90 nm).

As silicon is well known to display significant absorption in the visible range, the skilled person would, in practice, understand that the thickness of the layer should be limited to sub-wavelength values of this order.

6.4 In any event, Article 100(b) EPC 1973 requires that the patent should disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art, and the Board sees no reason to doubt that the skilled person would be capable of manufacturing the claimed low refractive index layer having essentially any thickness (i.e. any thickness which could reasonably be required within the

context of a method of forming a solar cell). Whether a particular thickness chosen would be optimal, sub-optimal or even poor has nothing to do with the ability of the skilled person to carry out the invention. The Board is therefore not persuaded by the opponent's arguments based on the ground of Article 100(b) EPC 1973.

7. *Auxiliary request 6: Inventive step starting from D1*

7.1 Document D1 discloses a photovoltaic device in which the layer 3n11 broadly corresponds to the n-type silicon based low refractive index layer of claim 1. Although no refractive index is disclosed for this layer, the stated provisional view of the Board was that, at least for some of the disclosed compositions (for example, SiO:H containing up to 25 at.%O - see Fig. 3B; claim 7), the refractive index would be less than 2.5 (in this regard, see claims 2 and 3 of the granted patent). This statement has not been challenged, and the Board sees no reason to deviate from this view.

7.2 The sole feature distinguishing claim 1 from D1 is therefore that the silicon based low refractive index layer has a thickness of not less than 30 nm.

As well as providing a light trapping function, the silicon based low refractive index layer "has a function to generate a diffusion potential in the photoelectric conversion layer" (paragraph [0016]). In a section describing such layers in general (paragraph [0005]) it is noted that they should be as thin as possible to reduce absorption, but must have sufficient thickness to generate an appropriate diffusion potential ("the conductivity type layers of the p type

and the n type are preferably maintained for a smallest possible thickness within a range for generation of a sufficient diffusion potential"). Fig. 6 shows that below about 300 angstroms the conversion efficiency drops, presumably due to an insufficient diffusion potential.

- 7.3 It therefore appears reasonable to proceed on the basis that the distinguishing feature of claim 1 solves the problem suggested by the proprietor, i.e. it serves "to provide a high-efficient silicon based thin film solar cell".
- 7.4 In D1, the thickness of the corresponding layer 3n11 is given in table 1 as 50-200 Å (5-20 nm), and specific values within that range (10 nm, 15 nm) are also disclosed.
- 7.5 The function of the n-type layer 3n11 in D1 is to block diffusion of undesired elements from the back electrode 4 into the i-layer 3i, thereby minimizing the thermal degradation of the conversion efficiency when the device is held at a high temperature for a long time. The opponent argues that the skilled person would consider increasing the thickness of this layer to increase the blocking effect to "further decrease the thermal degradation of the solar cell".
- 7.6 The argument of the opponent that the analysis of inventive step should be based on the problem of reducing thermal degradation is based on the contention that the patent itself fails to disclose any technical effect associated with the distinguishing feature. However, as explained above, the Board accepts that the patent makes it plausible that ensuring that the silicon based low refractive index layer has a

thickness of not less than 30 nm contributes to improving the efficiency, and no good reason can be seen why the problem should be shifted from one which is disclosed in the description to one which is nowhere mentioned or hinted at in the patent.

There is nothing in D1 suggesting that increasing the thickness of layer 3n11 would increase the efficiency, or provide a greater diffusion potential (or indeed that it would lead to any other benefit). For this reason alone, the opponent's argument from D1 fails.

- 7.7 For completeness, the Board does not find the arguments of the opponent persuasive even on the basis of the suggested problem of reducing thermal degradation. The disclosed layer 3n11 of SiN:H containing 25 at.%N and with a thickness of about 15 nm (column 3, lines 43-45) appears to substantially eliminate the problem of thermal degradation, as shown in Fig. 2. It is nowhere suggested in D1 that increasing the thickness of the layer would lead to a further improvement in this regard, and the opponent's contention that it would is essentially no more than speculation. In addition, to arrive at the claimed feature, the thickness of the layer would have to be doubled from 15 nm to 30 nm, which, as the skilled person would understand, would have a significant and undesirable effect on the absorption of the layer.

8. *Auxiliary request 6: Inventive step starting from D2*

- 8.1 The argument starting from D2 is based on the described embodiments corresponding to Fig. 10, and identifies layer 61 with the claimed photoelectric conversion layer, layer 63 with the claimed n-type silicon based low refractive index layer and layer 64 with the

claimed n-type silicon based interface layer (similar identifications could be made in the case of Fig. 12).

- 8.2 Claim 1 differs from D2 in that the silicon based low refractive index layer has:
- a thickness of not less than 30 nm; and
 - a refractive index not more than 2.5 at a wavelength of 600 nm.

In D2, the layer 63 is disclosed as having a thickness of 50 Å (5 nm) and no refractive indices for the layers are quoted.

- 8.3 As explained above (point 6.3), the Board finds it reasonable to proceed on the basis of the objective technical problem suggested by the proprietor ("to provide a high-efficient silicon based thin film solar cell").

- 8.4 To arrive at the claimed thickness (not less than 30 nm) the thickness of the layer 63 in D2 (5 nm) would have to be increased by a factor of at least six. There is nothing in D2 which would motivate such a measure in order to increase the efficiency, or to provide a greater diffusion potential or for any other reason.

- 8.5 In the statement of grounds of appeal it is argued that D3 discloses:

"a silicon based thin film solar cell having a low refractive index layer of a greater thickness, from around 10 nm to 20 nm in, for example, paragraph 27."

The opponent goes on to argue that, from this, D3 would provide the necessary motivation to arrive at the claimed subject-matter:

"Therefore, the skilled person learns from D3 that the thickness of a low refractive index layer may be greater than the 5 nm. Therefore, the skilled person would not have been dissuaded from investigating the effect of the thickness of the layer 63 in D2."

8.6 This argument fails for two reasons. Firstly paragraph [0027] of D3 is concerned with the properties of a layer of amorphous $\text{Si}_x\text{O}_{1-x}$, whereas in D2, the only concrete example of the material of layer 63 is amorphous $\text{Si}_{0.9}\text{N}_{0.1}$ (tables 6 and 7), and so it cannot be seen why any conclusions drawn in D3 should be considered pertinent. Secondly, as stated by the opponent, the thickness of the layer referred to in D3 ("around 10 nm to 20 nm") is also below the claimed lower limit of 30 nm, and hence the Board does not see how this document (even if it were to be considered as prior art according to Article 54(2) EPC) would incite the skilled person to increase the thickness of the layer in question to 30 nm or greater.

8.7 The opponent has failed to demonstrate that it would be obvious, starting from D2, to arrive at the claimed feature that the silicon based low refractive index layer has a thickness of not less than 30 nm, and it is therefore not necessary to investigate whether the second difference (a refractive index not more than 2.5 at a wavelength of 600 nm) is obvious.

9. *Auxiliary request 6: Inventive step starting from D8*

9.1 In the argument starting from D8, layer 105 is identified with the claimed photoelectric conversion layer, layer 116 is identified with the claimed n-type silicon based low refractive index layer and layer 104 is identified with the claimed n-type silicon based

interface layer. During manufacturing, the surface of n-type silicon layer 104 is oxidized (by exposure to oxygen or using plasma CVD) to form the silicon based oxide thin film 116 (paragraphs [0013]-[0017]), and the photoelectric conversion layer 105 is then formed on oxide layer 116 (paragraph [0018]).

9.2 The term "n-type silicon based low refractive index layer" in claim 1 implies that the layer comprises a certain amount of n-type silicon, i.e. elemental silicon doped with donor impurities. According to the contested patent, this layer is formed from an alloy layer comprising (n-type) silicon and other elements, such as oxygen, typically as silicon oxides (paragraph [0017]). The skilled person would understand that it is the n-type silicon that provides the layer's contribution to the generation of the diffusion potential in the photoelectric conversion layer, while the other components (e.g. silicon oxides) serve to reduce the refractive index to facilitate light trapping (paragraph [0016]).

9.3 In D8, however, layer 116 is formed by oxidization of the surface of the silicon layer 104 (which may be n-type), and hence layer 116 would be a thin layer entirely composed of silicon oxide (apart from small numbers of dopant phosphorus atoms, but without any n-type elemental silicon). The complete oxidation of layer 116 is confirmed in paragraph [0022], where it is described as "a typical insulator film". Layer 116 in D8 is not, therefore, an "n-type silicon based low refractive index layer" as defined in claim 1 of the patent, but an insulating layer.

If the skilled person decided to reverse the order in which the layers were deposited, as suggested by the

opponent, presumably the oxide layer 116 would be formed by fully oxidizing the surface of the underlying photoelectric conversion layer 105, and the resulting oxide layer would still not be an "n-type silicon based low refractive index layer".

- 9.4 Hence, contrary to the submissions of the opponent, layer 116 cannot be identified with the claimed n-type silicon based low refractive index layer. Consequently, the argument of the opponent fails, and no obvious route is apparent by which the skilled person would be led to the claimed subject-matter starting from D8.
10. For the reasons given above, the Board judges that the subject-matter of claim 1 of auxiliary request 6 involves an inventive step within the meaning of Article 52(1) EPC and Article 56 EPC 1973.
11. *Documents D10-D16: Admission into the proceedings*
- 11.1 Documents D10-D15 were not admitted into the proceedings before the department of first instance, and D16 was filed for the first time with the statement of grounds of appeal. The admission of these documents into the appeal proceedings is therefore at the discretion of the Board (Article 12(4) RPBA).
- 11.2 The Opposition Division found (Reasons, point 5.2) that documents D10-D15 were not *prima facie* relevant, in the sense of being likely to prejudice the maintenance of the patent (citing T 1002/92). In the statement of grounds of appeal, the opponent challenged this decision, arguing that these documents were relevant to support inventive step arguments starting from documents cited in the notice of opposition (D1, D2 and D8), and also in new combinations which were not

presented in the first instance proceedings. No reasons were given why such combinations could not have been included in the notice of opposition.

- 11.3 Where a Board of Appeal is requested to review a discretionary decision of a department of first instance not to admit late-filed submissions, it is generally accepted that:

"it is not the function of a Board of Appeal to review all the facts and circumstances of the case as if it were in the place of the first instance department, in order to decide whether or not it would have exercised such discretion in the same way as the first instance department ... a Board of Appeal should only overrule the way in which a first instance department has exercised its discretion if it comes to the conclusion either that the first instance department in its decision has not exercised its discretion in accordance with the right principles ... or that it has exercised its discretion in an unreasonable way, and has thus exceeded the proper limits of its discretion." (G 7/93, Reasons, point 2.6.)

- 11.4 To successfully challenge the decision of an Opposition Division not to admit documents into the proceedings on the grounds of lack of relevance *prima facie*, it is not enough merely to argue that they should in fact be considered relevant or that they could be used in an inventive step attack. Rather, it would be necessary to demonstrate that these documents are so manifestly relevant, and that the failure to recognise this was such an egregious misjudgement on the part of the Opposition Division, that the decision not to admit them constituted an unreasonable exercise of the Opposition Division's discretion.

- 11.5 As the opponent has not demonstrated this - or even attempted to demonstrate it - the Board sees no reason to deviate from the preliminary opinion expressed in the communication pursuant to Article 15(1) RPBA that the Opposition Division dealt with this matter in accordance with the right principles and in a reasonable way. The Board therefore confirms the decision of the Opposition Division that documents D10-D15 are not admitted into the proceedings.
- 11.6 No reasons were given by the opponent why D16, filed with the statement of grounds of appeal, could not have been filed earlier. Moreover, admitting this document (filed to establish common general knowledge concerning silicon oxide) would not change any of the conclusions drawn above. D16 is therefore not relevant and is not admitted into the proceedings.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the department of first instance with the order to maintain the patent on the basis of the following documents:
 - Claims 1-6 of auxiliary request 6, filed on 19 February 2019;
 - Description as in the published patent specification;
 - Drawings as in the published patent specification.

The Registrar:

The Chairman:



S. Sánchez Chiquero

W. Van der Eijk

Decision electronically authenticated