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Datasheet for the decision of 5 February 2025

Case Number: T 1544/22 - 3.4.03

Application Number: 17152171.9

Publication Number: 3196945

IPC: H01L31/0224, H01L31/0747

Language of the proceedings: EN

Title of invention:
SOLAR CELL

Patent Proprietor:
Shangrao Xinyuan YueDong Technology Development Co. Ltd

Opponents:
Meyer Burger (Germany) GmbH
Strawman Limited

Relevant legal provisions:
RPBA 2020 Art. 13(1), 13(2), 12(4)
EPC Art. 54, 56, 83, 123(2)

Keyword:
Amendment to appeal case (no)
Late-filed argument (admitted - yes)
Amendments (intermediate generalisation - no)
Sufficiency of disclosure (yes)
Novelty - (yes)
Inventive step - non-obvious alternative (yes)

Decisions cited:
T 2329/15, T 1702/18, T 1108/16, T 0646/17, T 0247/20

Catchword:
Submissions, which are merely a refinement of arguments previously submitted and which further illustrate a party's position, must be allowed even if they are late filed. Otherwise, the parties could only repeat their arguments put forward in the statement of grounds of appeal and the reply thereto (see Reasons for the Decision, point 2.5.2).

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Case Number: T 1544/22 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 5 February 2025

Appellant: (Opponent 2)	Strawman Limited Orchard Lea Horns Lane Combe, Witney Oxfordshire OX29 8NH (GB)
Representative:	D Young & Co LLP 3 Noble Street London EC2V 7BQ (GB)
Respondent: (Patent Proprietor)	Shangrao Xinyuan YueDong Technology Development Co. Ltd NO. 3 Yingbin Road, Shangrao Economic and Technical Development Zone Shangrao, Jiangxi Province (CN)
Representative:	Global IP Europe Patentanwaltskanzlei Pfarrstraße 14 80538 München (DE)
Party as of right: (Opponent 1)	Meyer Burger (Germany) GmbH An der Baumschule 6-8 09337 Hohenstein-Ernstthal (DE)
Representative:	Krujatz, Jörg Martin Meyer Burger (Germany) GmbH An der Baumschule 6-8 DE-09337 Hohenstein-Ernstthal (DE)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 7 April 2022 concerning maintenance of the European Patent No. 3196945 in amended form.**

Composition of the Board:

Chairman	M. Stenger
Members:	J. Thomas
	E. Mille

Summary of Facts and Submissions

I. The present decision concerns the appeal filed by opponent 2 (appellant 2) against the interlocutory decision of the opposition division to maintain European patent No. 3 196 945 B1 in accordance with the then (and present) auxiliary request 2.

II. Oppositions by opponents 1 and 2 were filed against the patent as a whole.

Opponent 1 based its opposition on the grounds of lack of novelty and of inventive step (Article 100(a) EPC in combination with Articles 52(1), 54 and 56 EPC).

Opponent 2 based its opposition on the grounds of lack of novelty and of inventive step (Article 100(a) EPC in combination with Articles 52(1), 54 and 56 EPC), sufficiency of disclosure (Article 100(b) EPC in combination with Article 83 EPC) and extension of subject-matter beyond the content of the application as originally filed (Article 100(c) EPC in combination with Article 123(2) EPC).

III. Appeals against the interlocutory decision of the opposition division were originally filed by the patent proprietor (appellant 1) and opponent 2 (appellant 2). Opponent 1 did not appeal and is thus a party as of right to the proceedings as a respondent.

IV. The board summoned the parties to attend oral proceedings before the board and issued a communication under Article 15(1) RPBA.

V. Prior to the oral proceedings before the board, opponent 1 informed the board that it would not be attending the oral proceedings and requested "*a decision according to the state of the file*".

VI. Oral proceedings were held before the board in the presence of appellant 1 and appellant 2, and in the absence of opponent 1. At the end of the oral proceedings, appellant 1 withdrew its appeal and thus became a respondent.

VII. Given that the patent proprietor's legal status changed during the proceedings, the board will refer to the parties as follows:

- appellant 2 will be referred to as opponent 2,
- the previous appellant 1, who became a respondent at the end of the oral proceedings, will be referred to as the patent proprietor, and
- the respondent and opponent 1 will be referred to as opponent 1.

VIII. The parties' final requests at the end of the oral proceedings before the board were as follows.

Opponent 2 requested that the decision under appeal be set aside and that the patent be revoked.

The patent proprietor requested that the patent be maintained on the basis of auxiliary request 2, as decided by the opposition division in its interlocutory decision. It thereby (implicitly) requested that opponent 2's appeal be dismissed.

Opponent 1 had requested in writing that the patent proprietor's appeal be dismissed and that the patent be revoked in its entirety (main request), or subsidiarily

that the patent be maintained on the basis of the set of claims of the request underlying the interlocutory decision. It had further requested that auxiliary requests 3 and 6 to 9 not be admitted into the appeal proceedings.

IX. The following documents are cited:

D1: EP 2 682 990 A1
D2: EP 2 450 970 A1
D3: A. Luque and S. Hegedus, "Handbook of Photovoltaic Science and Engineering", 2003, ISBN 0-471-49196-9
D5: WO 2012/136586 A1
D9: US D658,119 S

X. Independent claim 1 of auxiliary request 2 has the following wording:

"*A solar cell, comprising:*
a crystalline semiconductor substrate (110) of a first conductive type;
a front passivation layer (120) located between the front doped layer and the semiconductor substrate,
a front doped layer (130) located on a front surface of the semiconductor substrate and forming a hetero junction with the semiconductor substrate;
a back passivation layer (160) located between the back doped layer and the semiconductor substrate,
a back doped layer (170) located on a back surface of the semiconductor substrate and forming a hetero junction with the semiconductor substrate;
a front transparent conductive layer (140) located on the front doped layer;

a back transparent conductive layer (180) located under the back doped layer,

a front collector electrode (150) located on the front transparent conductive layer; and

a back collector electrode (190, 190') located under the back transparent conductive layer,

wherein the front collector electrode (150) is not physically and directly in contact with the front doped layer (130),

wherein the back collector electrode (190, 190') is not physically and directly in contact with the back doped layer (170),

wherein one of the front doped layer and the back doped layer has a second conductive type opposite the first conductive type to form a p-n junction with the semiconductor substrate, and the other of the front doped layer and the back doped layer has the first conductive type, and

wherein a planar area of the front transparent conductive layer is larger than a planar area of the back transparent conductive layer,

characterized in that

the front passivation layer (120) and the back passivation layer (160) overlap each other on the side surface of the semiconductor substrate (110) and the front transparent conductive layer (140) is further located on the front passivation layer and the back passivation layer which overlap each other on the side surface of the semiconductor substrate,

wherein the front collector electrode (150) includes a plurality of first finger electrodes (150a) extending in a first direction, and at least one first bus bar electrode (150b) extending in a second direction and physically connected to the plurality of first finger electrodes,

wherein the back collector electrode (190, 190')
includes a plurality of second finger electrodes (190a) extending in the first direction and at least one second bus bar electrode (190b) extending in the second direction and physically connected to the plurality of second finger electrodes, or includes a sheet electrode (190') which covers entirely the back surface of a back transparent conductive layer,
wherein each of the front surface and the back surface of the semiconductor substrate includes an edge region (A1) that is continuously formed from an edge of the semiconductor substrate to an inside of the semiconductor substrate along the edge and a center region (A2) that is a remaining region except for the edge region,
wherein the front transparent conductive layer (140) is formed in the center region and a remaining edge region except for a non-formed portion (A3) formed discontinuously in a part of the edge region of the front surface,
wherein the non-formed portion (A3) is located at both ends of the at least one first bus bar electrode (150b), and a width (W1) in the first direction of the both ends of the first bus bar electrode (150b) is larger than a width (W2) in the first direction of a remaining portion of the first bus bar electrode (150b) located between the both ends along the second direction, and
wherein the back transparent conductive layer (180) is formed only in the center region except for the edge region of the back surface."

XI. The patent proprietor's arguments may be summarised as follows.

The opposition division's decision with regard to Articles 123(2), 83 and 56 EPC is entirely concurred with. With regard to inventive step, it is not necessary to reformulate the technical problem such that a positive contribution over the prior art or an improvement is provided. Instead, it is sufficient to reformulate the problem such that an alternative solar cell as compared with existing solar cells is provided.

Further detailed arguments of the patent proprietor that are relevant to the decision are discussed in the "*Reasons for the Decision*" below.

XII. Opponent 2's arguments may be summarised as follows.

The subject-matter of claim 1 of auxiliary request 2 has been amended such that it now contains subject-matter which extends beyond the content of the application as filed. The claimed solar cell is not disclosed in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art over the whole scope of the claim. Moreover, the claimed subject-matter does not involve an inventive step since no positive technical contribution is provided and no technical problem has been solved, because the solar cell of claim 1 has only disadvantages with respect to existing solar cells, in particular those disclosed in documents D1 and D2.

Further detailed arguments of opponent 2 that are relevant to the decision are discussed in the "*Reasons for the Decision*" below.

XIII. Opponent 1's arguments may be summarised as follows.

Similarly to opponent 2, opponent 1 argues that the subject-matter of claim 1 of auxiliary request 2 extends beyond the content of the application as filed and is not disclosed in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art over the whole scope claimed. In addition, the subject-matter of claim 1 does not involve an inventive step since the differentiating features are obvious standard features well-known to the person skilled in the art. The "*non-formed portion (A3)*" does not present an essential feature and should be ignored in assessing inventive step.

Further detailed arguments of opponent 1 that are relevant to the decision are discussed in the "*Reasons for the Decision*" below.

Reasons for the Decision

1. Procedural issues

1.1 Opponent 1 requested "*a decision according to the state of the file*". Although this expression has a particular meaning in pre-grant examination proceedings (EPC Guidelines, C-V 15), this is not the case in post-grant opposition proceedings. Hence the board interprets opponent 1's request for "*a decision according to the state of the file*" as meaning that opponent 1 did not wish to submit any further observations or requests in the appeal proceedings, that it withdrew its request for oral proceedings, which it did not attend anyway, and that its supporting arguments were to be taken as they stood. Therefore opponent 1's final request was understood as presented above (see point VIII.).

1.2 The patent proprietor withdrew its appeal at the end of the oral proceedings before the board, and thereby became a party as of right as respondent (see point VI. above). The remaining appeal of opponent 2 was thus restricted to the request found by the opposition division to meet the requirements of the EPC, i.e. on which maintenance of the patent in accordance with the opposition division's interlocutory decision was based, namely auxiliary request 2, or any lower-ranked request if appropriate. Therefore the present decision does not relate to the requests ranked higher than auxiliary request 2, namely the main request and auxiliary request 1.

2. Admission of late-filed arguments

2.1 On Sunday 2 February 2025, the patent proprietor submitted a letter dated 31 January 2025 relating *inter alia* to auxiliary request 2. The letter comprised detailed arguments involving a number of figures in favour of inventive step of claim 1 of auxiliary request 2. This letter was sent to opponent 2 on Monday 3 February 2025, only two days prior to the oral proceedings before the board.

2.2 Opponent 2 requested that this late-filed letter not be admitted into the proceedings, under Article 13(2) RPBA, for the following reasons.

The letter contained a completely new set of arguments, which constituted an amendment to the patent proprietor's appeal case. This amendment would have necessitated contacting a technical expert, which was not possible due to the extremely late submission of the letter, in particular in view of the time needed to travel from England to Haar.

The very late filing of arguments representing a fresh case constituted an abuse of procedure. The letter could and should have been filed earlier.

The board's negative preliminary opinion on the subject-matter of claim 1 of auxiliary request 2 did not constitute a surprising turn in the proceedings, since it was always conceivable that a board would come to a different conclusion from the opposition division. No exceptional circumstances applied.

Opponent 2 referred to decisions T 2329/15, T 1702/18, T 646/17 and T 1108/16 to support its reasoning.

2.3 The patent proprietor submitted that the late-filed letter was a direct response to the board's preliminary opinion, which deviated from the impugned decision. The letter and the arguments contained therein should thus be admitted.

The arguments presented in the letter only elaborated in more detail arguments that had already been presented before. The aim of the letter was not to present a fresh case, but to facilitate discussing these arguments during the oral proceedings. Even if the letter had not been filed, its content could have been presented and discussed orally during the oral proceedings.

2.4 The board concurs with opponent 2 that a negative preliminary opinion of the board deviating from the impugned decision *per se* is not an unforeseeable development of the appeal proceedings and should not be considered as constituting exceptional circumstances within the meaning of Article 13(2) RPBA. Consequently,

such a deviation does not *per se* unconditionally justify an amendment to a party's appeal case.

2.5 However, contrary to opponent 2's view, the board is of the opinion that the arguments put forward in the late-filed letter do not represent a fresh case, in line with the submissions of the patent proprietor.

2.5.1 More particularly, the part of the late-filed letter relating to auxiliary request 2 (pages 3 to 24) explains in detail the technical effect of the shading of the "*non-formed portion (A3)*" and how its specific position in relation to the bus bar electrode is advantageous over the prior art.
These issues had already been addressed in section 4.3. of the patent proprietor's reply to the grounds of appeal and in sections 5.4, 6.1, and 10.2 of the patent proprietor's letter dated 18 July 2023. For instance, the first paragraph of page 38 of the latter reads "*The specific architecture and dimensions of the A3 regions thus allow for a reduction in the impact of shading losses and an improvement of the overall efficiency by balancing the effective area and the non-effective portion anyway required.*"
Moreover, these issues were also (albeit briefly) considered by the opposition division in the impugned decision when taking into account the "*reduc[tion of] the negative impact of these shaded regions*" due to the arrangement of the bus bar electrodes and finger electrodes in combination with the "*non-formed portion (A3)*" (Reasons for the Decision, point 4.2.1, last paragraph).

2.5.2 Thus at least the part referring to auxiliary request 2 of the late-filed letter relates to arguments considered in the decision under appeal that were

submitted by the patent proprietor during the written phase of the appeal proceedings with its reply to the grounds of appeal of opponent 2.
The late-filed letter merely elaborates these arguments in more detail, as submitted by the patent proprietor. The board holds that such a refinement of arguments previously submitted which further illustrates a party's position must be allowed, especially when, as in the case at hand, the refinement of arguments concerns points where the board's preliminary opinion differs from the impugned decision. Otherwise, the parties could only repeat their arguments put forward in the statement of grounds of appeal and the reply thereto.
In particular, oral proceedings, to which the parties have an absolute right under Article 116 EPC, would serve no purpose if such refinements were not allowed (see also decision T 247/20, Reasons point 1.3).

2.5.3 It follows from the above that the arguments discussed in the late-filed letter relating to auxiliary request 2 are not new arguments and do not represent a fresh case, contrary to opponent 2's submissions. Instead, they concern further refinements of arguments already addressed in the impugned decision (Article 12(2) RPBA) and previously presented during the appeal proceedings (Article 12(3) RPBA). Therefore they do not constitute an amendment to the appeal case as referred to in Articles 12(4) and 13(1) and (2) RPBA. Therefore the board concludes that these (very late) submissions are nevertheless to be admitted and considered in the case at hand.

2.6 Concerning the decisions cited by opponent 2 in relation to the late-filed letter, namely T 2329/15, T 1702/18, T 646/17 and T 1108/16, the board notes that

none of these decisions is comparable with the present case. In the first three decisions, the late-filed submissions did not relate to a refinement of an argument on file, but to a new set of claim requests which necessarily had to be treated differently from a refinement of existing arguments. In the last of the cited decisions, the late-filed submissions related to a new argument which was put forward for the first time in the whole proceedings and which therefore cannot be considered as a refinement of already-presented arguments either.

2.7 The preliminary opinion of the board was communicated to the parties more than four months prior to the oral proceedings. Given that the letter in question was submitted/received in practical terms only two days before the oral proceedings (i.e. on Monday 3 February 2025), the board agrees with opponent 2 that it was filed extremely late. In addition, the board is, and was already during the oral proceedings, of the opinion that the patent proprietor could and should have presented the arguments contained in the late-filed letter earlier in the proceedings. However, as set out above, the content of the late-filed letter pertains to a refinement of previously presented arguments and not to an amendment of the patent proprietor's case. Thus it could also have been presented for the first time orally in the oral proceedings, as submitted by the patent proprietor.

Nevertheless, such an oral presentation, possibly with the help of a flip chart, would most probably have lacked the detail of the arguments as contained in the letter, in particular in view of the figures presented therein. Thus, in view of the level of detail of the arguments in the letter, the board shared the opinion

of opponent 2 that it would have been beneficial to contact a technical expert to arrive at a better technical understanding of the arguments as contained in the letter. The board further accepted the submission of opponent 2 that this was rendered impossible by the extremely late filing of the letter, in particular taking into account the travel time of the representative from England to the premises of the boards of appeal in Haar.

Therefore the board was, already during the oral proceedings, of the opinion that by submitting late-filed arguments with such a high level of detail at such a short notice - two days before the oral proceedings - the patent proprietor had unfairly put opponent 2 in an unnecessarily unfavourable position.

In view of this particular situation, the board gave opponent 2 the opportunity to request an adjournment of the oral proceedings (see minutes of the oral proceedings before the board) and indicated that it was favourably disposed towards such a request. However, after having consulted with opponent 2, opponent 2's representative did not request an adjournment of the oral proceedings but preferred to continue them.

Since opponent 2 preferred to continue the oral proceedings, it is not necessary to discuss its original accusation of abuse of procedure.

3. Interpretation of claim 1 - auxiliary request 2

3.1 Opponent 2 interpreted the wording of claim 1 such that the "*non-formed portion (A3)*" did not necessarily have to be axially aligned with the bus bar electrodes. A slight perpendicular shift of the "*non-formed portion*

A3" with regard to the axial direction of the bus bar electrodes would still be covered by the wording of claim 1 as long as the "*non-formed portion A3*" was close to or touching the ends of the bus bar electrode(s).

3.2 However, the board understands the features of claim 1 relating to the bus bar electrode, the finger electrodes and the "*non-formed portion (A3)*" (claim 1, page 1, line 37 to page 2, line 2, and page 2, lines 12 to 19), as also presented by the patent proprietor, as follows.

3.2.1 Claim 1 defines "*a non-formed portion (A3) formed discontinuously in a part of the edge region of the front surface*, *wherein the non-formed portion (A3) is located at both ends of the at least one first bus bar electrode (150b)*".

Since the "*non-formed portion (A3)*" is defined in the singular, all discontinuous parts of the non-formed portion appearing in the edge region of the front surface are part of one single "*non-formed portion (A3)*". Thus, in each of Figures 4 and 5 of the granted patent, all six squares representing these discontinuous parts shown in the edge region relate to a single "*non-formed portion (A3)*".

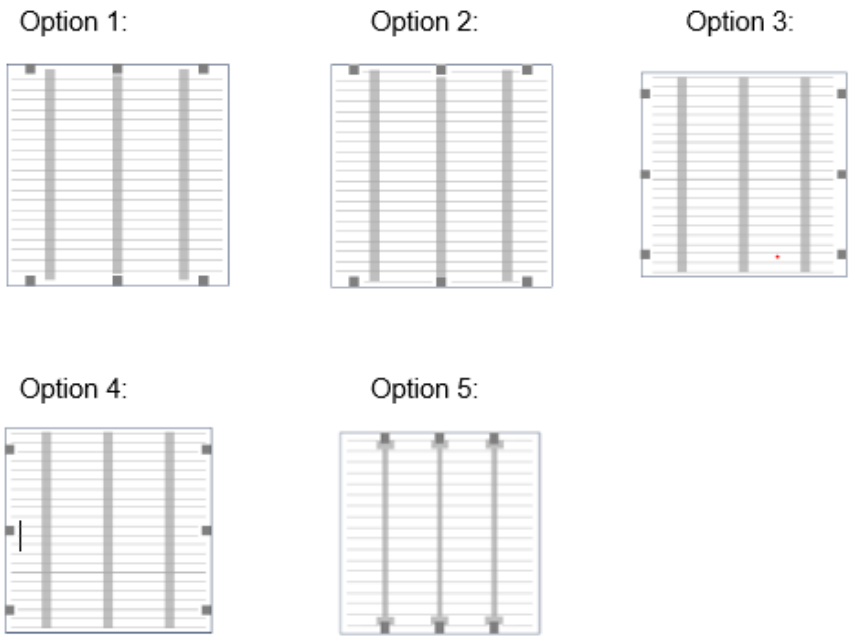
3.2.2 Further, since "*the non-formed portion (A3) is located at both ends of the at least one first bus bar electrode*", the "*non-formed portion (A3)*" and the "*bus bar electrode(s)*" are directly linked such that "*the non-formed portion (A3)*" (underlining by the board) coincides with the ends of the one or more bus bar electrodes. Therefore all discontinuous parts of the "*non-formed portion (A3)*" are located at both, i.e.

all, ends of the bus bar electrode(s). Thus there are twice as many discontinuous parts as bus bar electrodes. Moreover, in view of the overall disclosure of the patent, in particular paragraph [0104] and Figure 4, all the discontinuous parts are aligned in the second direction with the ends of the bus bar electrode(s), i.e. in the longitudinal axis of the bus bar electrode, contrary to the submission of opponent 2.

3.2.3 The board notes that the interpretation of claim 1 as set out above in sections 3.2.1 and 3.2.2 was explicitly put forward by the patent proprietor in the oral proceedings.

3.2.4 It follows from the above that no discontinuous parts of the "*non-formed portion (A3)*" which are not aligned with an end of the at least one of the bus bar electrode(s) can be present. This means that all discontinuous parts of the "*non-formed portion (A3)*" are located on the two opposite edges along the first direction, which, according to claim 1, is perpendicular to the second direction of the solar cell (i.e. the direction in which the finger electrodes extend).
Therefore, considering options 1 to 5 as illustrated by the patent proprietor in its letter of 2 February 2025 and reproduced below, only option 5 falls under the wording of claim 1. In options 1 and 2, not all of the discontinuous parts of the "*non-formed portion (A3)*" coincide with the ends of the bus bar electrodes. In options 3 and 4, the discontinuous parts of the "*non-formed portion (A3)*" are not aligned along the edges which are perpendicular to the principal direction of the bus bar electrodes. A combination of option 1 or 2 with option 3 or 4 which would result in the presence

of discontinuous parts of the non-formed portion on all four edges is not encompassed by the wording of claim 1 either.



4. Amendments (Article 123(2) EPC) - auxiliary request 2

4.1 Claim 1 of auxiliary request 2 is based on a combination of claims 1, 2, 3, 8, 9, 10, 13 and 15 as originally filed. However, only a part of claims 13 and 15 as originally filed is included in the present claim 1.

4.1.1 The originally filed claim 13 specifies that "*a front passivation layer located between the front doped layer and the semiconductor substrate, and a back passivation layer located between the back doped layer and the semiconductor substrate, and the front passivation layer and the back passivation layer are formed of intrinsic amorphous silicon or a tunnel oxide*" (underlining by the board).

The features of the originally filed claim 13 underlined in the above citation and relating to the materials forming the passivation layers, namely intrinsic amorphous silicon or a tunnel oxide, have been omitted in the present claim 1.

4.1.2 The originally filed claim 15 specifies that "*the front transparent conductive layer is further located on the front passivation layer, the back passivation layer, the front doped layer, and the back doped layer, which overlap each other on the side surface of the semiconductor substrate*".
The features of the originally filed claim 15 underlined in the above citation, i.e. that the front doped and back doped layers also overlap on the side surfaces, have been omitted in the present claim 1.

4.2 In opponent 2's view, the omission of the features mentioned under points 4.1.1 and 4.1.2 above (omission of the underlined parts) constitutes two unallowable intermediate generalisations. Opponent 1 agreed with opponent 2 on that point.

4.3 With regard to the amendments, the board does not share the opponents' view.

4.3.1 Claim 13 as originally filed is a dependent claim, so the features of this claim as a whole are optional features with regard to the independent claim 1 as originally filed. Opponent 2's understanding that all the features of claim 13 are linked together and that materials of the passivation layers other than the two alternatives disclosed in claim 13 are excluded in the original application is not shared by the board.

The skilled person will understand that the wording of claim 13 comprises three separate feature groups relating to three different aspects:

- the location of the front passivation layer
- the location of the back passivation layer
- the material of the front and/or back passivation layers.

The last feature group is independent of the other two groups. This is consistent with the originally filed description, paragraphs [0031] and [0066], where the two materials of the front and back passivation layers mentioned in the original claim 13 are referred to, but only as examples ("*may be formed*"). Other suitable materials are thus not excluded, contrary to opponent 2's submission. This understanding is also in agreement with the EPC Guidelines F-IV, 4.3 (iii), as pointed out by the patent proprietor (patent proprietor's first reply, dated 2 January 2023).

Therefore the inclusion of only a part of the original claim 13 in the independent claim 1 does not constitute an unallowable intermediate generalisation.

4.3.2 With regard to the omission of features defined in claim 15 as originally filed, namely the omission of the doped layers in the overlapping layers arranged on the side surfaces, the board does not share opponent 2's understanding that a front transparent conductive layer is only disclosed in the presence of a front passivation layer, a front doped layer, a back passivation layer and a back doped layer where all these layers overlap on a side surface.

Paragraphs [0073] and [0074] of the description as originally filed serve as a basis that doped layers may

be formed only on the front and back surfaces. The presence of a doped layer at the side surfaces is not disclosed as mandatory, and if there is no doped layer at the side surfaces no overlapping can occur.
In addition, paragraph [0032] of the description as originally filed teaches that either one, two, three or four of the above-mentioned doped or passivation layers might extend to the side surface. Only the layer(s) extending to the side surface can overlap with the front transparent conductive layer on this side surface. Therefore the stacking of the doped layer(s) on the side surfaces is an optional feature.

Furthermore, the embodiment presented from paragraph [0063] of the description as originally filed onwards shows the extension of the front and back passivation layers to the side surfaces (paragraph [0067]) without mentioning any transparent conductive layer and without mentioning the front and back doped layers. In the following paragraphs, the doped layers are discussed independently of the transparent conductive layer. These doped layers may only optionally extend to the side surface (paragraph [0073]), where they would then overlap with the passivation layers (paragraph [0074]). Paragraph [0074] does not mention a transparent conductive layer either. The discussion of the "*transparent conductive layer*" starts in paragraph [0076] with the words "*In this embodiment*", thereby referring back to the previous paragraphs relating to the same embodiment, which is still continued. Paragraph [0078], still referring to the same embodiment, mentions the possible extension of the front transparent conductive layer to the side surface. The arrangement of the front transparent conductive layer, the two passivation layers and the two doped layers is then presented in paragraph [0079]. Thus

paragraphs [0063] to [0079] all refer to the same embodiment presenting several alternative arrangements of the overlapping layers at the side surfaces.

The board therefore concludes that the teaching of paragraph [0079] is only one exemplary arrangement. The presence of the transparent conductive layer does not necessarily require that the doped layers extend to the side surfaces, as this would be contrary to the teaching of paragraphs [0073] and [0074].

4.4 Hence the board concludes that claim 1 as amended meets the requirements of Article 123(2) EPC, since the disputed omissions of features defined in claims 13 and 15 as originally filed do not constitute unallowable intermediate generalisations.

5. Sufficiency of disclosure (Article 83 EPC) - auxiliary request 2

5.1 The following three different objections under Article 83 EPC were raised by opponent 1 and/ or opponent 2:

5.1.1 (i) The invention is insufficiently disclosed because the application does not provide detailed information as to how the layers can be realised on the front, back and side surfaces.

5.1.2 (ii) The subject-matter cannot be realised over the whole scope of protection, because the specific type of the semiconductor material, i.e. a silicon hetero junction, is not defined in the claims. In the description, only a solar cell realised from a silicon hetero junction is disclosed, but the claim refers to "*a crystalline semiconductor substrate*" in

general which includes e.g. perovskite or even materials that may be useful in solar cells only in the future.

5.1.3 (iii) The subject-matter is insufficiently disclosed over the whole scope of protection because in the absence of the doped layers on the side surfaces new interfaces were to be realised between the passivation layers and the conductive transparent layer. The application documents remained silent as to how to deal with these interfaces.

5.2 Concerning these three different objections (i) to (iii), the board came to the following conclusions:

5.2.1 Ad (i): A person skilled in wafer production will find a way using standard methods such as CVD (chemical vapour deposition) or PECVD (plasma-enhanced chemical vapour deposition) to realise these layers on the defined surfaces. Neither opponent 1 nor opponent 2 explained in detail any particular problems the skilled person might encounter when trying to coat the defined surfaces using standard methods like CVD or PECVD. Even if parameters had to be chosen which would lead to a lower efficiency or performance of the solar cell, the solar cell as such could still be realised and is consequently sufficiently disclosed.
Thus that the deposition of the layers is not described in detail in the application documents does not prevent the skilled person from carrying out the subject-matter defined in the claims. They would simply carry out the deposition using standard procedures or techniques generally known to the skilled person.

5.2.2 Ad (ii): The patent proprietor objected that this argument was not discussed during the opposition

proceedings and consequently does constitute an amendment to the appeal case under Article 12(2) and (4) RPBA. However, irrespective of its admission into the proceedings, the board notes that hetero junction silicon solar cells have been successfully produced for decades. Their functionality has thus been well-known to the skilled person well before the priority date of the opposed patent, and the board sees no reason to believe that the skilled person could not have transferred this knowledge to materials other than silicon. Thus, in the board's view, a solar cell with perovskite as semiconductor substrate would in principle be realisable in a similar manner. At worst, such a solar cell would be less efficient than a solar cell made with a silicon hetero junction.
The board further notes that opponent 1, who raised this objection, did not mention any particular problem the skilled person might encounter when trying to use perovskite or a newly found material for the semiconductor substrate. Therefore this objection cannot convince the board either.

5.2.3 Ad (iii): The general knowledge of the skilled person is sufficient to find a solution for manufacturing a solar cell without the doped layers overlapping onto the side surfaces using standard processes. Even if a solar cell with lower efficiency or performance were the result of applying standard measures, the skilled person would still be able to manufacture it. No convincing argument has been provided as to why the skilled person would not be able to implement the subject-matter if only the conductive transparent layer and the passivation layers overlapped on the side surfaces without the doped layers overlapping on these side surfaces.

5.3 The board therefore concludes that Article 83 EPC does not prejudice maintenance of the patent in accordance with auxiliary request 2.

6. Objections under Article 84 EPC and Rules 80 and 43(2) EPC

Opponents 1 and 2 raised objections under Article 84 EPC and Rules 80 and 43(2) EPC. However, since these objections concerned the presence of two independent claims, they do not apply to auxiliary request 2 and are consequently not to be dealt with in this decision.

7. Inventive step - auxiliary request 2 - claim 1

7.1 Closest prior art

Opponent 2 considered documents D1 and D2 as suitable starting points for assessing inventive step, as did the opposition division. None of the remaining parties objected to this, and the board also concurs.

7.2 Disclosure of document D1

7.2.1 In the board's view, document D1 discloses the following features using the wording of claim 1 (the references in parentheses in the following paragraph refer to document D1):

A solar cell (title) comprising:
a crystalline semiconductor substrate of a first conductive type (11; paragraph [0023]);
a front passivation layer (part of layer stack 12; paragraph [0024]) located between the front doped layer and the semiconductor substrate (paragraph [0024]),

a front doped layer (part of layer stack 12; paragraph [0024]) located on a front surface of the semiconductor substrate and forming a hetero junction with the semiconductor substrate (paragraph [0024]);

a back passivation layer (part of layer stack 13; paragraph [0026]) located between the back doped layer and the semiconductor substrate (paragraph [0026]),

a back doped layer (part of layer stack 13; paragraph [0026]) located on a back surface of the semiconductor substrate and forming a hetero junction with the semiconductor substrate;

a front transparent conductive layer (14; Figures 6 and 7; paragraph [0027]) located on the front doped layer (Figures 6 and 7);

a back transparent conductive layer (15; Figures 6 and 7; paragraph [0031]) located under the back doped layer (Figures 6 and 7),

a front collector electrode (21; paragraph [0034]) located on the front transparent conductive layer (Figure 7); and

a back collector electrode (22; paragraph [0034]; Figure 7) located under the back transparent conductive layer,

wherein the front collector electrode (21) is not physically and directly in contact with the front doped layer (being part of layer stack 12; Figure 7),

wherein the back collector electrode (22) is not physically and directly in contact with the back doped layer (being part of layer stack 13; Figure 7),

wherein one of the front doped layer and the back doped layer has a second conductive type opposite the first conductive type to form a p-n junction with

the semiconductor substrate (paragraph [0002] in combination with title), and the other of the front doped layer and the back doped layer has the first conductive type (paragraph [0002] in combination with title), and

wherein a planar area of the front transparent conductive layer is larger than a planar area of the back transparent conductive layer (Figure 7; paragraphs [0009] and [0010]),

wherein the front passivation layer and the back passivation layer overlap each other on the side surface of the semiconductor substrate (Figure 7; since layer stacks 12 and 13 overlap, the layers themselves also overlap) and the front transparent conductive layer is further located on the front passivation layer and the back passivation layer which overlap each other on the side surface of the semiconductor substrate (Figure 7; each of layers 12 and 13 presents a layer stack of a passivation layer and a doped layer; paragraphs [0024] and [0026]),

wherein the front collector electrode (21) includes a plurality of first finger electrodes (21, "*grid metallization*"; paragraph [0034]) extending in a first direction, and at least one first bus bar electrode (21, "*grid metallization*"; paragraph [0034]) extending in a second direction and physically connected to the plurality of first finger electrodes,

wherein the back collector electrode includes a sheet electrode (22; paragraph [0034]; Figure 7) which covers entirely the back surface of a back transparent conductive layer (15),

wherein each of the front surface and the back surface of the semiconductor substrate includes an edge region (A1) that is continuously formed from an

edge of the semiconductor substrate to an inside of the semiconductor substrate along the edge and a center region (A2) that is a remaining region except for the edge region (Figures 6 and 7; paragraph [0017], lines 28 to 33),

and wherein the back transparent conductive layer (15) is formed only in the center region except for the edge region of the back surface (Figure 7; paragraph [0009], lines 10 to 14).

7.2.2 The patent proprietor contested the disclosure of the following features in document D1:

- (a1) "*the front passivation layer (120) and the back passivation layer (160) overlap each other on the side surface of the semiconductor substrate (110) and the front transparent conductive layer (140) is further located on the front passivation layer and the back passivation layer which overlap each other on the side surface of the semiconductor substrate*"
- (b1) "*wherein a planar area of the front transparent conductive layer is larger than a planar area of the back transparent conductive layer*"

7.2.3 The board considers that features (a1) and (b1) are at least implicitly present in the solar cell disclosed in document D1.

With respect to feature (a1), in document D1 the front layer 12 and the back layer 13 can each be realised by a layer stack comprising an intrinsic silicon layer (D1: paragraphs [0024], [0026] and [0027]). This intrinsic silicon layer corresponds to the passivation layers as defined in claim 1. Since both layer

stacks 12 and 13 overlap on the side surface, and additionally the transparent conductive front layer overlaps these layer stacks on the side surface (D1: Figure 7), feature (a1) is disclosed in document D1.

As far as feature (b1) is concerned, the cross-sections shown in Figures 1 to 8 of document D1 disclose that the front transparent conductive layer is larger in the direction shown in the cross-section than the back transparent conductive layer. There is no explicit disclosure in document D1 as to how to realise the layer stacks in the direction perpendicular to the cross-sections shown in Figures 1 to 8. However, the only technically reasonable understanding of these figures is that the layer stacks are realised in the same manner in both perpendicular directions. This is also coherent with the disclosure of document D1, paragraph [0028] that the "*edge*" refers to the "*whole surrounding side surface(s)*".
In Figures 6 to 8, the extension of the front transparent conductive layer 14 extends more in the direction shown in cross-section than the back transparent conductive layer 15. Hence feature (b1) is implicitly disclosed in Figures 6 to 8.

Thus features (a1) and (b1) are disclosed in document D1.

7.2.4 With regard to document D2, the board shares the opponents' opinion that all the features apart from those relating to the "*non-formed portion (A3)*" are disclosed in document D2. The only dispute concerned the layer arrangement. The patent proprietor was of the opinion that document D2 did not disclose a back passivation layer. The board, however, agrees with opponent 2 in that the use of the same reference

sign 13 indicates that the stack of layers overlying at the side surfaces and coming from the front and the back side is identical. Thus a passivation layer is present in both layer stacks, the front side layer stack and the back side layer stack. Hence the disclosure of document D2 is equivalent to that of document D1.

7.3 Differentiating features

It is undisputed that neither document D1 nor document D2 discloses the following features, which are therefore differentiating features:

"*wherein the front transparent conductive layer (140) is formed in the center region and a remaining edge region except for a non-formed portion (A3) formed discontinuously in a part of the edge region of the front surface*," and

"*wherein the non-formed portion (A3) is located at both ends of the at least one first bus bar electrode, and a width (W1) in the first direction of the both ends of the first bus bar electrode is larger than a width (W2) in the first direction of a remaining portion of the first bus bar electrode located between the both ends along the second direction*"

7.4 Technical effect - objective technical problem

7.4.1 Opponent 1's objection that the "*non-formed portion (A3)*" is not essential and should be ignored (reply of 13 December 2022, page 8, first eight paragraphs) cannot be accepted. The "*non-formed portion (A3)*" is a structural feature defined in claim 1 derived from a

manufacturing step using a tray with pins for holding the substrate. It can therefore not simply be ignored.

7.4.2 Opponent 1 and opponent 2 argued that the presence of the "*non-formed portion (A3)*" only lowered the solar cell's efficiency. Thus no technical effect was achieved and consequently no technical problem was solved by the solar cell of claim 1. Instead, the solar cell of claim 1 merely represented a solar cell of inferior quality compared with the solar cells known from documents D1 or D2. Hence an inventive step could not be acknowledged.

7.4.3 The patent proprietor argued that even if no clear advantage was realised by the differentiating features, it was sufficient to simply formulate the technical problem as being to provide an alternative solar cell compared with the solar cells known from documents D1 or D2. Inventive step should then be assessed based on this technical problem. Since none of the solar cells known from the prior art hinted at the differentiating features, the subject-matter defined in claim 1 involved an inventive step.

7.4.4 The board is not convinced by the statement of the two opponents that the claimed solar cell is merely disadvantageous compared with the solar cell disclosed in document D1, so no technical effect is achieved and consequently no inventive step can be acknowledged.

The board notes that in the regions of the solar cell corresponding to the "*non-formed portion (A3)*" no front transparent conductive layer is present. The collection of charge carriers produced in these regions is therefore problematic. Thus these regions are not as effective as comparable regions in which the front

transparent conductive layer is present. The presence of the "*non-formed portion (A3)*" thus has a negative impact on the performance of the solar cell by reducing the effective surface of the solar cell.

However, there are further factors besides its effective surface which contribute to a solar cell's total efficiency, like for example the particular type of the solar cell due to the selected materials, the purity and quality of the semiconductor materials, the cell's response to ambient temperature, or coatings and/or further layer materials. Thus the presence of the "*non-formed portion (A3)*" in the solar cell defined in claim 1 as compared with the solar cells known from D1 or D2 is *per se* not sufficient to conclude that the claimed solar cell is less efficient than the solar cells known from documents D1 or D2.

7.4.5 Instead, the technical effect provided by the first differentiating feature is that (the front transparent conductive layer of) the solar cell can be manufactured using a tray with pins for holding the substrate.

Each solar cell is normally connected to neighbouring solar cells by wires extending between the bus bar electrodes of the respective front collector electrodes, as submitted by the patent proprietor. The alignment of the (discontinuous parts of the) "*non-formed portion (A3)*" with the at least one bus bar electrode(s) in accordance with the second differentiating feature thus has the effect that the region of the solar cell where no light is incident during operation due to the shading effect of these connecting wires coincides with the non-effective "*non-formed portion (A3)*". By means of this coincidence, the connecting wires only shade (during operation) a region

which would essentially not, or at least not much, contribute to the performance of the solar cell anyway, namely the "*non-formed portion (A3)*" (see illustrations of the patent proprietor in its last letter of 2 February 2025, page 14, option 5, and section 3. above).
Hence the second differentiating feature has the technical effect that the reduction of the effective surface which is the result of the first differentiating feature (see section 7.4.4 above) is mitigated.
This corresponds in substance to what the opposition division set out with reference to paragraphs [0103] to [0105] of the patent (see point 4.2.1 of the impugned decision).

7.4.6 In view of these technical effects, the objective technical problem can be formulated as how to provide an alternative design for a solar cell that can be easily manufactured and has a similar effective surface to known solar cells. Such a formulation is essentially in line with the patent proprietor's submissions.

7.5 Obviousness

7.5.1 Document D1 suggests manufacturing the layer stack of solar cells using PECVD (paragraph [0024]). The board notes that the same method is also used in the impugned patent. Hence, starting from document D1 and trying to solve the objective technical problem set out above, the skilled person would consider all kinds of documents that concern the production of solar cells using plasma deposition.

7.5.2 The skilled person would thus consider document D5, which relates to improving plasma flow (page 2, fourth

paragraph) *inter alia* during the production of solar cells (page 1, first two paragraphs). In particular, the skilled person would consider the use of the tray shown in Figures 1 and 2 of document D5 for manufacturing the solar cell of document D1.

7.5.3 When using this tray, the pins on which the substrate has to be placed during the coating step would prevent coating of parts of the substrate. This would automatically lead to a "*non-formed portion (A3)*" with discontinuous parts on the edges of the solar cell as defined in the first differentiating feature.

7.5.4 However, the pins in document D5 are provided on all four edges (for the board's interpretation of the second differentiating feature, see section 3.2.2 above). Therefore, combining documents D1 and D5, the discontinuous parts of the "*non-formed portion (A3)*" would be formed on all four edges of the solar cell, instead of being formed on only two parallel opposite edges as defined by the second differentiating feature.

7.5.5 Opponent 2 submitted that the skilled person would simply omit the pins on two opposite sides of the tray shown in document D5 as a design feature or as a matter of course in order to reduce the non-effective area of the "*non-formed portion (A3)*". It would thereby arrive at the structural set-up as defined in claim 1 without exercising an inventive step.

7.5.6 However, for reliable coating of the semiconductor substrate or layer stack, the substrate needs to be well positioned in the tray in a stable manner. Thus, if the skilled person wanted to reduce the non-effective area of the "*non-formed portion (A3)*", they would, rather, reduce the number of discontinuous parts

on each of the four sides instead of omitting the pins on two parallel, opposite edges.

Hence the provision of the discontinuous parts of the "*non-formed portion (A3)*" on only two parallel, opposite edges of the solar cell as defined in claim 1 has to be considered as a purposeful decision in order to obtain the technical effect achieved by the second differentiating feature as set out above (see section 7.4.5). The second distinguishing feature is therefore not a simple design feature or a matter of course, as submitted by opponent 2, and its alleged obviousness is the result of an *ex post facto* analysis.

7.5.7 Although document D1 discloses a metallised grid electrode on the upper surface of the solar cell, it does not teach the exact form of this metallised grid electrode. If the "*non-formed portion (A3)*" were provided on all four edges, as would be the case after combining the teaching of document D1 with document D5 (see section 7.5.4 above), the skilled person would probably apply a grid electrode similar to that shown in Figure 7.8 of document D3 (page 276), which would not extend to the edges of the solar cell at all.

7.5.8 The specific positional arrangement of the bus bar electrodes with respect to the "*non-formed portion (A3)*" is not disclosed in or suggested by document D9, either. Document D9 discloses "*an ornamental design for a metallisation pattern of a solar cell*" which, at first glance, appears to be very similar to the electrode arrangement defined in claim 1. In particular, the figures of document D9 show recesses in the electrode structure at the end of the thicker electrodes (i.e. the bus bar electrode(s)) which are

similar to the non-formed portion of the opposed patent.
However, document D9 does not disclose any technical details as to why these recesses are present and what they are supposed to represent. More particularly, document D9 is totally silent regarding the position of the metallisation pattern with respect to other features of the solar cell.

Thus the specific positional and structural arrangement of the bus bar electrode(s) with respect to the "*non-formed portion (A3)*" is neither disclosed in nor suggested by document D9 either. Hence, even by combining document D1 with document D5 and document D9, the skilled person would not arrive at the subject-matter of claim 1 of auxiliary request 2 without hindsight.

7.5.9 Opponent 2 submitted that the wording of claim 1 could also be understood such that the ends of the bus bar electrode(s) are slightly offset in their perpendicular direction from the discontinuous parts of the "*non-formed portion (A3)*" (see point 3.1 above). In that case, the non-formed portion would still be at the ends of the bus bar electrodes. However, they would not be exactly aligned with them along the longitudinal axis of the bus bar electrode(s). Claim 1 thus comprised arrangements in which the technical effect alleged by the patent proprietor was not achieved.

As set out above in section 3., the board does not agree that such a non-aligned arrangement of the non-formed portion and the ends of the bus bar electrode(s) falls, in view of the patent as whole, under the wording of claim 1.

Nevertheless, and only for the sake of argument, even if that were the case, such a non-aligned arrangement would still allow the wiring to the neighbouring solar cells to be made such that the regions shaded by the wires in operation coincide to a certain extent with the "*non-formed portion (A3)*".
Thus less precise superposition of the connecting wires with the "*non-formed portion (A3)*" would nevertheless reduce the negative impact of the shading effect of the wires. This applies in particular to any arrangement of bus bar electrode(s) in which the discontinuous parts of the "*non-formed portion (A3)*" and the ends of the bus bar electrode(s) at least slightly coincide (see also point 4.2.5 of the impugned decision). In other words, even if claim 1 were interpreted as submitted by opponent 2, some compensation for the shading effect could still be achieved.

7.5.10 The board notes that even the mere selection of the number of discontinuous parts of the "*non-formed portion (A3)*" being exactly twice as high as the number of bus bar electrodes (see point 3.2.2 above) is not straightforward. There is no disclosure or suggestion in any of the prior-art documents to select the number of bus bar electrodes depending on the number of discontinuous parts of the "*non-formed portion (A3)*".

7.5.11 To summarise, the negative impact of the "*non-formed portion (A3)*" which would exist due to the use of a tray with pins during the manufacturing process of the solar cell is mitigated according to claim 1 of the second auxiliary request by an advantageous geometrical arrangement of the bus bar electrodes. This arrangement is specifically adapted to the "*non-formed portion (A3)*" such that, in operation, the wiring from the bus bar electrode(s) of the solar cell to the bus bar

electrode(s) of the neighbouring solar cells shades only parts of the solar cell where the "*non-formed portion (A3)*" is located. In that manner, the negative impact of the presence of the "*non-formed portion (A3)*" and the negative impact of the shading of a part of the solar cell by the wiring concern the same regions of the solar cell. Therefore the overall negative impact of these two effects on the performance of the solar cell is reduced.

Starting from D1, the skilled person would consider using the manufacturing process disclosed in D5. They would thereby arrive at a solar cell with discontinuous parts of a "*non-formed portion (A3)*" in a part of the edge region of the front surface. However, these discontinuous parts would be present on all four and not only on two opposite edges of the solar cell. In addition, there is no disclosure or incentive in the available prior art to adapt the geometrical arrangement of the bus bar electrodes to the geometrical arrangement of the "*non-formed portion (A3)*" as defined in claim 1 of the second auxiliary request such that the overall negative impact of these two arrangements is reduced.

7.6 For the reasons set out above, the solar cell defined in claim 1 of auxiliary request 2 is not rendered obvious when starting from document D1 (or D2, which does not even refer to plasma deposition) and combining it with document D5 (and/or document D9). In view of the available prior art, the subject-matter defined in claim 1 of auxiliary request 2 thus involves an inventive step within the meaning of Article 56 EPC. Since claim 1 is the only independent claim of auxiliary request 2, the same conclusion applies to all the dependent claims.

8. Conclusion

In view of the above, the board finds that the subject-matter defined in auxiliary request 2 and the invention to which it relates meet the requirements of the EPC, so opponent 2's appeal fails.

Since a final decision is taken on the basis of auxiliary request 2, opponent 1's and opponent 2's requests concerning the lower-ranked requests, in particular the requests for non-admission of auxiliary requests 3 and 6 to 9, can be left aside.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

B. Atienza Vivancos M. Stenger

Decision electronically authenticated