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(74) Gemachtigde:
**Ir. H.Th. Heuvel c.s. te 's-Hertogenbosch.**

(54) **Method of monolithic photo-voltaic module assembly.**

(57) Method for manufacturing a photovoltaic module comprising:
a) providing an electrically conductive substrate, the substrate being provided with a predetermined electrical pattern;
b) depositing a solder paste onto the electrically conductive substrate at pre-defined interconnection locations;
c) placing a first encapsulant layer provided with a pattern of openings onto the electrically conductive substrate, the pattern of openings corresponding with the locations of the solder paste;
d) placing back-contact solar cells on the first encapsulant layer so as to have a match of the electrical pattern of the back-contact solar cells with the electrical pattern of the electrically conductive substrate;
e) placing a second encapsulant layer on the back-contact solar cells, and placing a glass layer on the second encapsulant layer;
f) applying heat and pressure to the components to cause the encapsulant materials to flow and form a monolithic photovoltaic module, characterised by local application of heat at the interconnection locations utilizing a laser to couple its energy locally into the solar cell from the side of the glass layer, so as to cause the solder paste to reflow between each interconnection location and its respective matching connection location on the back-contact solar cell for establishing electrical interconnection between the back-contact solar cells and the electrically conductive substrate.

NL C 2001958

# Method of monolithic photo-voltaic module assembly

## Field of the invention

The present invention relates to a method for manufacturing a photo-voltaic module assembly.

## Background

A photo-voltaic (PV) module is a device comprising an array of solar cells that convert the solar energy directly into electricity.

One manner of achieving low-cost PV modules is the use of high-efficient thin back-contact solar cells. In back-contact solar cells conductive lines that are opaque to sunlight are located on the back side of the solar cell (back-contact pattern). Thus on the front side of the solar cell substantially no conductive lines are needed, resulting in a relatively larger area available to collect sunlight. Therefore, back-contact solar cells provide larger electrical current generation surface area, as compared to the conventional H-pattern solar cells, Also a reduction in the in-between cell spacing is achieved, leading to an overall increase in PV module electrical output.

To form such PV module a process flow is known from USA patent 5,972,732. In this process flow the following steps are carried out:

An electrically conductive substrate with a pre-defined electrical pattern is provided that matches the design of the back contact pattern of the back-contact solar cells to be installed.

Next, a solder paste is deposited onto the electrically conductive substrate at pre-defined interconnection locations on the predefined electrical pattern. The interconnection locations match with connection locations of the conductive lines on the back-contacted solar cell(s) for connecting the conductive lines to the electrical pattern.

Then, a pre-patterned first encapsulant layer is placed onto the electrically conductive substrate.

On the pre-patterned first encapsulant layer one or more back-contact solar cells are placed. The pattern of the pre-patterned first encapsulant layer is designed so as to allow connection between the back contact pattern of the solar cell and the electrical pattern on the electrically conductive substrate.

Next, a second encapsulant layer is placed on top of the solar cells.

Additionally, a top glass layer is placed on the second encapsulant layer.

Then, heat and pressure are applied to cause the first and second encapsulant materials to flow and form a monolithic laminate.

However, it is observed that like the encapsulant, the solder paste does reflow, but does not necessarily form electrical pathways. This has an adverse effect on the reliability of the process, since the state of the electrical connections is not well defined.

It is an object of the present invention to reduce the disadvantages of the process from the prior art.

**Summary of the invention**

The object of the invention is achieved by a method as defined by the preamble of claim 1, wherein localized heat is applied at the interconnection locations utilizing a laser to couple its energy locally into the solar cell, so as to cause the solder paste to reflow between each interconnection location and its respective matching connection location on the back-contacted solar cell for establishing electrical interconnection between the back-contact solar cells and the electrically conductive substrate.

Advantageously, the laser annealing allows a controlled manner to deposit a well-defined amount of energy at (a) well defined location(s), which allows to improve the quality of the electrical connections between electrically conductive substrate and the one or more back-contact solar cells.

**Brief description of drawings**

The invention will be explained in more detail below on the basis of a number of drawings, illustrating exemplary embodiments of the invention. The drawings are only intended to illustrate the objectives of the invention and should not be taken as any restriction on the inventive concept as defined by the accompanying claims.

Figure 1 shows a schematic overview of the different layers in the back-contact solar cell module.

Figure 2 shows a partially exploded view of a PV module to illustrate describing how the interconnection between the solar cells and the conductive substrate is established

Figure 3 shows the process of applying heat and pressure on the module assembly to achieve a monolithic laminate.

Figure 4 shows an embodiment of the invention of a laser soldering process to establish the electrical pathways between solar cells and electrical conductive substrate.

Figure 5 shows cross-sectional microscopic views of an laser-soldered joint in PV module.

**Detailed description**

Figure 1 shows the overview of the different layers in the construction of the back-contact solar cell module laminate 1. From bottom-to-top, the laminate 1 comprises or is built up from a conductive substrate 2, a rear-side perforated first encapsulant layer 3, back-contact solar cells 4, a top second encapsulant layer 5 and a glass plate 6 on top. These layers are placed subsequently through the assembly process.

The conductive substrate 2 can be of any type such as tedlar-PET-copper, tedlar-PET-aluminium, but also on alternative structures that are glass based, epoxy based, or coated PET, etc.

Back-contact solar cells 4 can be of any type such as metal-wrap through (MWT), emitter wrap through (EWT), back-junction (BJ), heterojunction (HJ), etc.

Figure 2 is a more detailed schematic describing how the interconnection between the solar cells and the conductive substrate is established. This picture does not show the encapsulant layers for the sake of simplicity. The substrate pattern on the conductive substrate 2 is defined to match the electrical pattern of the back-contact solar cells 4. Solder paste 7 is applied to each of the interconnection locations (indicated by white dots on substrate 2), either onto the solar cell, or onto the conductive substrate. The solar cells 4 are then automatically positioned onto the conductive substrate 2 such that the positions are matched.

Interconnection material can be of any type of solder paste 7 with metal combinations such as tin-lead, tin-bismuth, tin-lead-silver, tin-copper, tin-silver, etc.

Figure 3 illustrates the process of applying heat and pressure on the module assembly to achieve a monolithic laminate. Portion A shows the situation in the assembly process after the following steps:

Providing the electrically conductive substrate 2 with a pre-defined electrical pattern;

Depositing solder paste 7 onto the electrically conductive substrate at pre-defined interconnection locations on the predefined electrical pattern;

Placing a pre-patterned first encapsulant layer 3 onto the electrically conductive substrate 2 with solder paste 7 at selected locations in between;

Placing on the pre-patterned first encapsulant layer 3 one or more back-contact solar cells 4 while matching the electrical pattern of the back solar cells with the electrical pattern on the conductive substrate 2;

Next, placing a second encapsulant layer 5 on top of the solar cells 4, and

placing a top glass layer 6 on the second encapsulant layer 5.

The encapsulant layers may consist of a rubber-adhesive material, for example ethylene vinyl acetate (EVA).

Portion B of Figure 3 shows the situation after applying heat and pressure on the assembled layers 2,3,4,5,6.

As shown in portion B, like the encapsulants 3, 5, the solder paste 7 does reflow, but does not necessarily form electrical pathways.

Figure 4 illustrates an embodiment of the invention for a laser soldering process to establish the electrical pathways between solar cells 4 and electrical conductive substrate 2.

The method of the present invention comprises a process step wherein localized heat is applied at the interconnection locations utilizing a laser to couple its energy locally into the solar cell, so as to cause the solder paste to reflow between each interconnection location and its respective matching connection location on the back-contacted solar cell for establishing electrical interconnection between the back-contact solar cells and the electrically conductive substrate.

Portion A shows the situation while applying laser generated heat at the predefined interconnection locations associated by the locations of the solder 7 in the module 1.

Laser-applied heat (indicated by arrows 8) is coupled onto the front-side of the solar cells at the interconnection locations to locally melt the solder paste 7 on the cell's rear side.

Portion B shows the situation of a PV module 1 where reflow of the solder paste 7 has occurred

Figure 5 shows the proof of the invention by a first microscopic cross-sectional view 5A and a second microscopic cross-sectional view 5B. The first microscopic

cross-sectional view 5A shows a cross-sectional view of the laser-soldered joint 7 between conductive substrate 2 and back-contacted solar cell 4. The molten solder paste 7 shows a good interface to both of the contact surfaces, i.e., the electrical conductive substrate 2 and the solar cells 4.

The second microscopic cross-sectional view 5B shows the laser-soldered joint 7 in more detail.

It is noted that a state-of-the-art automated one-step module assembly line using the method of the present invention may provide a high throughput process, eliminating many manual handling steps that contributes to module assembly yield loss. The one step module assembly process in addition allows for the interconnection of the solar cells to be established in an automated high throughput fashion. The laser system can be controlled to generate localized heat on the module at the predefined interconnection locations.

Moreover, it is noted that the above described in-laminate laser soldering has the advantage of providing mechanical support to the fragile solar cells during the soldering process. As a result, solar cells do not break, resulting in reduced yield losses. This technology enables the use of extremely thin (<160um) crystalline silicon solar cells.

Other alternatives and equivalent embodiments of the present invention are conceivable within the concept of the invention, as will be clear to a person skilled in the field. The concept of the invention is limited only by the accompanying claims.

**Conclusies**

1. werkwijze voor het vervaardigen van een photovoltaische module (1), omvattend:

a) het verschaffen van een elektrisch geleidend substraat, waarbij het substraat voorzien is van een vooraf bepaald elektrisch patroon;

b) het plaatsen van soldeerpasta (7) op het elektrisch geleidend substraat op vooraf bepaalde verbindingslocaties;

c) het plaatsen van een van een openingen-patroon voorziene eerste inkapsellaag (3) op het elektrisch geleidend substraat, waarbij het openingenpatroon correspondeert met de locaties van de soldeerpasta (7);

d) het plaatsen van achterzijde gecontacteerde zonnecellen (4) op de eerste inkapsellaag, zodanig dat het elektrisch patroon van de achterzijde gecontacteerde zonnecellen past op het elektrisch patroon van het elektrisch geleidend substraat;

e) het plaatsen van een tweede inkapsellaag (5) op de achterzijde gecontacteerde zonnecellen (4), en het plaatsen van een glaslaag (6) op de tweede inkapsellaag (5);

f) het verwarmen onder druk van de componenten (2, 3, 4, 5, 6, 7) zodat het materiaal van de inkapsellagen vloeit en een monolithische photovoltaische module wordt gevormd, gekenmerkt door:

het gelokaliseerd toevoeren van warmte op de verbindingslocaties onder gebruikmaking van een laser om lokaal energie vanaf de glaslaag zijde in de zonnecellen in te brengen, om de soldeerpasta opnieuw te laten vloeien tussen iedere verbindingslocatie op het elektrisch geleidend substraat en de respectieve overeenkomende locatie op de achterzijde gecontacteerde zonnecellen voor het verkrijgen van elektrische verbinding tussen de achterzijde gecontacteerde zonnecellen en het elektrisch geleidend substraat.

2. werkwijze volgens conclusie 1, waarbij het elektrisch geleidend substraat gekozen wordt uit een groep omvattend tedlar-PET-koper, tedlar-PET-aluminium, of een structuur die gebaseerd is op glas, epoxy of gecoate PET.

3. werkwijze volgens één van conclusies 1 – 2, waarbij het type van de achterzijde gecontacteerde zonnecellen gekozen wordt uit een groep omvattend: metal-

wrap through (MWT), emitter wrap through (EWT), back-junction (BJ), en heterojunction (HJ).

4. Werkwijze volgens één van conclusies 1 -3 , waarbij de soldeerpasta kan bestaan uit een legering gekozen uit een groep omvattend tin-lood, tin-bismut, tin-lood-zilver, tin-koper, en tin-silver.

Fig 1

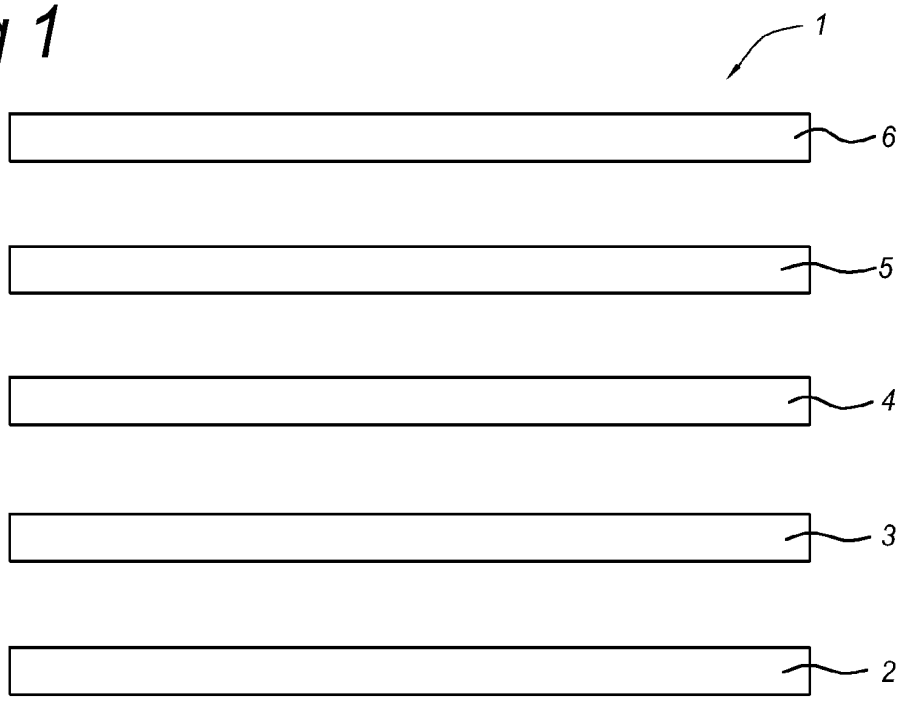



Fig 2

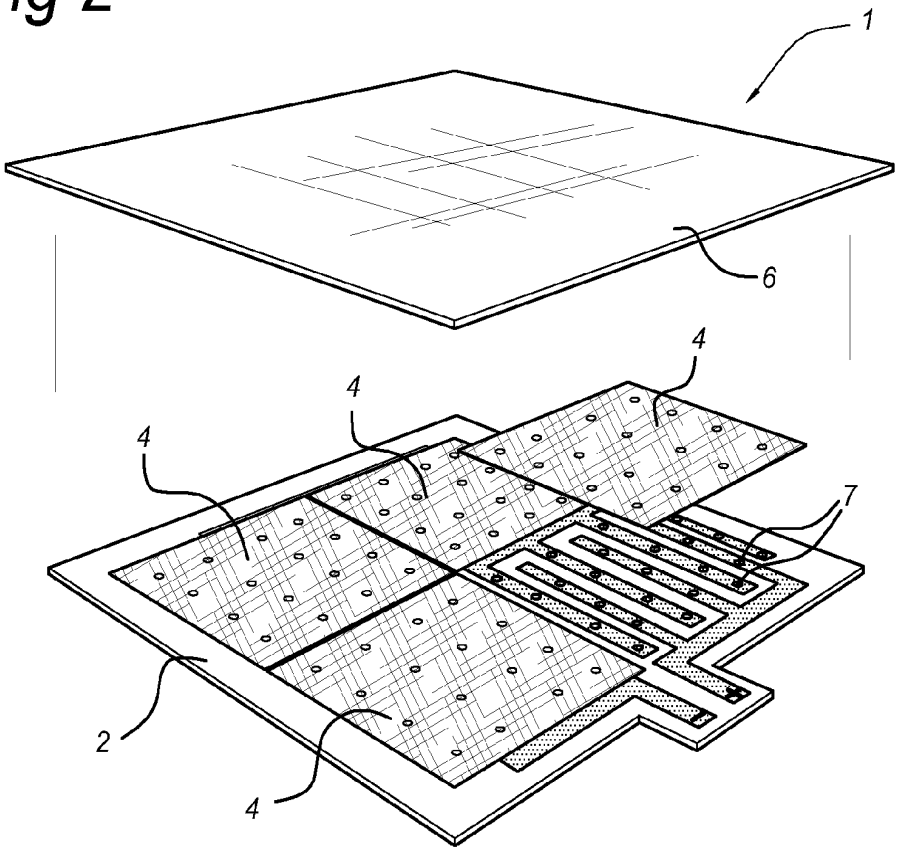


Fig 3a

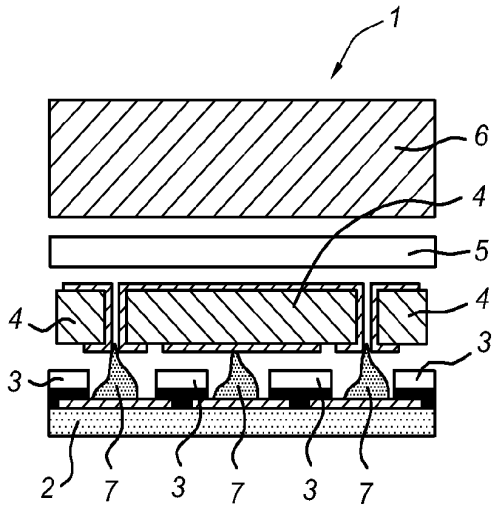



Fig 3b

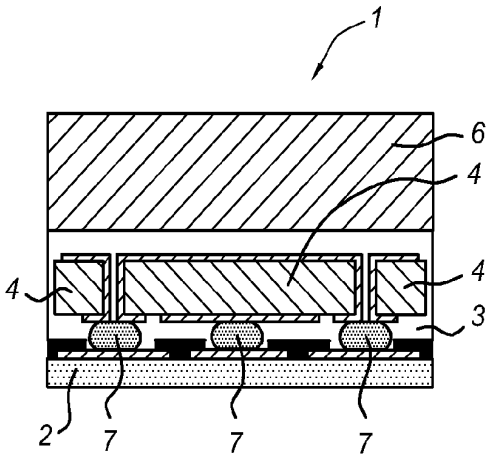



Fig 4a

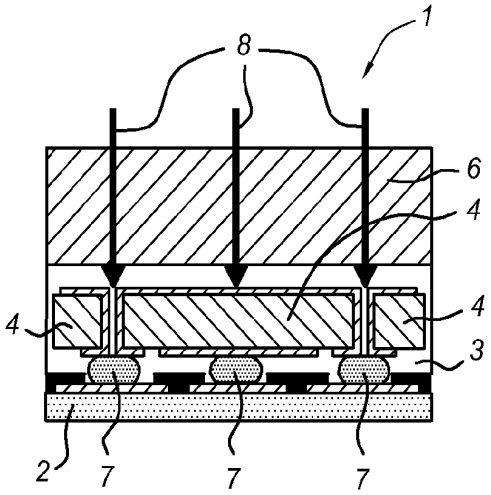



Fig 4b

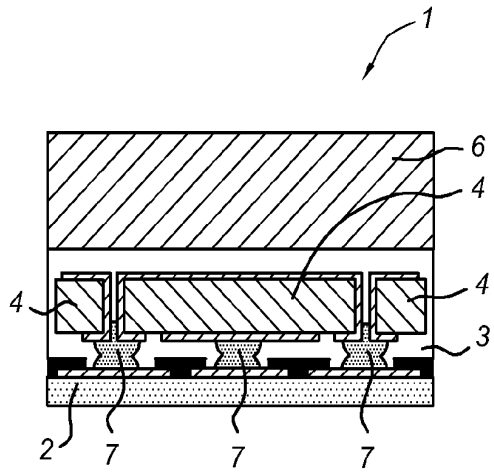


Fig 5a

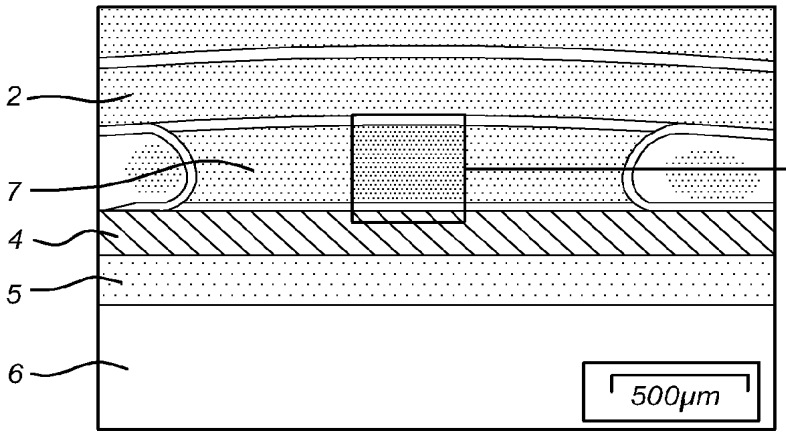
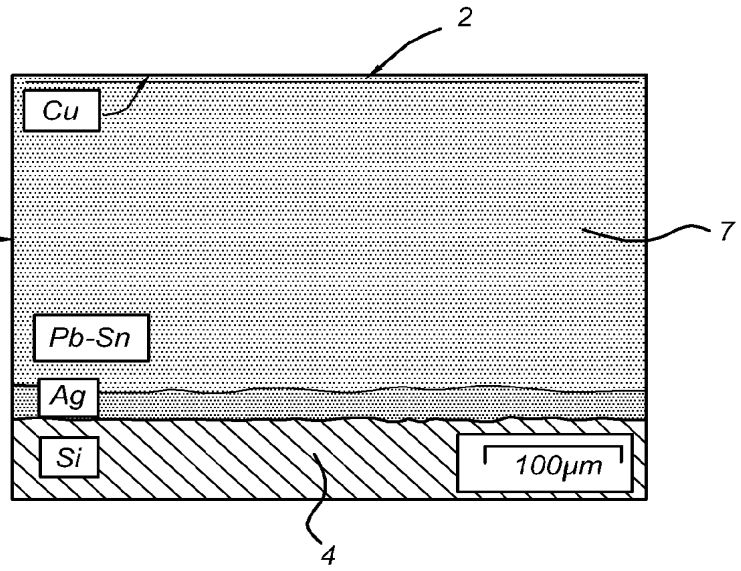



Fig 5b



# SAMENWERKINGSVERDRAG (PCT)

## RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

| IDENTIFICATIE VAN DE NATIONALE AANVRAGE | KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE |
|---|---|
| | P6023335NL |
| Nederlands aanvraag nr.<br>2001958 | Indieningsdatum<br>05-09-2008 |
| | Ingeroepen voorrangsdatum |
| Aanvrager (Naam)<br>Stichting Energieonderzoek Centrum Nederland | |
| Datum van het verzoek voor een onderzoek van internationaal type<br>03-02-2009 | Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr.<br>SN 51624 |

**I. CLASSIFICATIE VAN HET ONDERWERP** (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

H01L31/05 H01L31/18 H01L31/048

**II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK**

Onderzochte minimumdocumentatie

| Classificatiesysteem | Classificatiesymbolen |
|---|---|
| IPC8 | H01L |

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

| | | | |
|---|---|---|---|
| III. | ☐ | GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES | (opmerkingen op aanvullingsblad) |
| IV. | ☐ | GEBREK AAN EENHEID VAN UITVINDING | (opmerkingen op aanvullingsblad) |

# ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2001958

A. CLASSIFICATIE VAN HET ONDERWERP
INV. H01L31/05 H01L31/18 H01L31/048

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte mirninum documentatie (classificatie gevolgd door classificatiesymbolen)
H01L

Onderzochte andere documentatie dan de mirnimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

| Categorie ° | Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages | Van belang voor conclusie nr. |
|---|---|---|
| Y | US 5 972 732 A (GEE JAMES M [US] ET AL)<br>26 oktober 1999 (1999-10-26)<br>in de aanvraag genoemd<br>kolom 4, regel 40 - kolom 7, regel 27;<br>conclusies 1,2,7-9; figuren 1,3,4 | 1-4 |
| Y | WO 2008/080160 A (ADVENT SOLAR INC [US];<br>HACKE PETER [US]; MEAKIN DAVID H [US]; GEE<br>J.) 3 juli 2008 (2008-07-03)<br>bladzijde 17, regel 26 - bladzijde 18,<br>regel 25; conclusies 1-3,14-16,18<br>bladzijde 8, regel 9 - bladzijde 9, regel<br>4<br>bladzijde 12, regel 29 - bladzijde 14,<br>regel 4<br>bladzijde 15, regels 2-24 | 1,3,4 |

-/--

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

| Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid | Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type |
|---|---|
| 30 Maart 2009 | |

| Naam en adres van de instantie | De bevoegde ambtenaar |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | Visentin, Alberto |



Formulier PCT/ISA/201 (tweede blad) (Januari 2004)

**ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2001958

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

| Categorie ° | Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages | Van belang voor conclusie nr. |
|---|---|---|
| A | BULTMAN J.H. ET AL.: "Fast and easy single step module assembly for back-contacted c-Si solar cells with conductive adhesives" 3RD WORLD CONFERENCE ON PHOTOVOLTAIC ENERGY CONVERSION, 11 mei 2003 (2003-05-11), - 18 mei 2003 (2003-05-18) bladzijden 979-982, XP002521573 OSAKA, JP | 1,3 |
| Y | het gehele document | 2 |
| A | BULTMAN J H ET AL: "Interconnection through vias for improved efficiency and easy module manufacturing of crystalline silicon solar cells" SOLAR ENERGY MATERIALS AND SOLAR CELLS, ELSEVIER SCIENCE PUBLISHERS, AMSTERDAM, NL, deel 65, nr. 1-4, 1 januari 2001 (2001-01-01), bladzijden 339-345, XP004217136 ISSN: 0927-0248 het gehele document | 1,3 |
| A | JP 2004 134654 A (SHARP KK) 30 april 2004 (2004-04-30) samenvatting; figuren 1-3,6-9 | 1 |
| A | SPÄTH M. ET AL.: "A novel module assembly line using back contact solar cells" 33RD IEEE PHOTOVOLTAIC SPECIALISTS CONFERENCE, 11 mei 2008 (2008-05-11), - 15 mei 2008 (2008-05-15) bladzijden 1-6, XP002521574 San Diego, CA, USA het gehele document | 1,3 |
| A | US 6 388 187 B1 (TAKEYAMA YOSHIFUMI [JP] ET AL) 14 mei 2002 (2002-05-14) | |

**ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2001958

| In het rapport genoemd octrooigeschrift | Datum van publicatie | Overeenkomend(e) geschrift(en) | Datum van publicatie |
|---|---|---|---|
| US 5972732 | A 26-10-1999 | GEEN | |
| WO 2008080160 | A 03-07-2008 | US 2008216887 A1 | 11-09-2008 |
| JP 2004134654 | A 30-04-2004 | GEEN | |
| US 6388187 | B1 14-05-2002 | JP 11243224 A | 07-09-1999 |

**OCTROOICENTRUM NEDERLAND**

# WRITTEN OPINION

| File No. | Filing date *(day/month/year)* | Priority date *(day/month/year)* | Application No. |
|---|---|---|---|
| SN51624 | 05.09.2008 | | NL2001958 |

International Patent Classification (IPC)
INV. H01L31/05 H01L31/18 H01L31/048

Applicant
Stichting Energieonderzoek Centrum Nederland te Pe

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

| | Examiner |
|---|---|
| | Visentin, Alberto |

Application number

# WRITTEN OPINION

NL2001958

## Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

## Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

| | | | |
|---|---|---|---|
| Novelty | Yes: | Claims | 1-4 |
| | No: | Claims | |
| Inventive step | Yes: | Claims | |
| | No: | Claims | 1-4 |
| Industrial applicability | Yes: | Claims | 1-4 |
| | No: | Claims | |

2. Citations and explanations

**see separate sheet**

# WRITTEN OPINION

## Box No. VII Certain defects in the application

see separate sheet

**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1.) Reference is made to the following documents:

D1: US-A-5 972 732 (GEE JAMES M [US] ET AL) 26 October 1999

D2: WO 2008/080160 A (ADVENT SOLAR INC [US]; HACKE PETER [US]; MEAKIN DAVID H [US]; GEE JAMEs) 3 July 2008

D3: BULTMAN J.H. ET AL.: "Fast and easy single step module assembly for back-contacted c-Si solar cells with conductive adhesives" 3RD WORLD CONFERENCE ON PHOTOVOLTAIC ENERGY CONVERSION, 11 May 2003 - 18 May 2003, pages 979-982, OSAKA, JP

D4: BULTMAN J H ET AL: "Interconnection through vias for improved efficiency and easy module manufacturing of crystalline silicon solar cells" SOLAR ENERGY MATERIALS AND SOLAR CELLS, ELSEVIER SCIENCE PUBLISHERS, AMSTERDAM, NL, vol. 65, nr. 1-4, 1 January 2001, pages 339-345

2.) The present application does not meet the criteria of patentability, because the subject-matter of claim 1 does not involve an inventive step.

The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and discloses a method for the production of a photovoltaic module comprising back-contacted solar cells on a substrate which is provided with electrical contact lines for the connection of the cells, the method including the steps a) to f) as listed in the preamble of claim 1 (see D1, column 4, line 40-column 7, line 27; claims 1,2,7-9; figures 1,3,4).
The subject-matter of claim 1 therefore differs from this known method in that a further step is introduced, consisting of localised heating of the connection points using a laser beam in order to heat locally the solder paste and let it again flow between each connection point on the substrate and the respective contact on the back-contacted solar cells to ameliorate the electrical contact between the substrate and the cells.

The problem to be solved by the present invention may therefore be regarded as to achieve a better electrical contact between the substrate and the cells, so as to improve the quality of the electrical connections between the electrically conductive substrate and the back-contacted solar cells.

The solution proposed in claim 1 of the present application cannot be considered as involving an inventive step for the following reasons.

Document D2 describes a similar type of method for the production of a photovoltaic module comprising back-contacted solar cells on a substrate which is provided with electrical contact lines for the connection of the cells (see D2, page 8, line 9-page 9, line 4; page 12, line 29-page 14, line 4; page 15, lines 2-24; claims 1-3, 14-16, 18) and discloses the possibility of a localized heating source (laser) to be used after the lamination step to have a solder reflow to form the electrical interconnect between substrate and back-contacted cells. This is especially indicated by processes which require higher temperatures than the actual lamination step (e.g. high temperature solders) (see D2, page 17, line 26-page 18, line 18).
It would be obvious to the person skilled in the art, namely when the same result is to be achieved, to apply this additional localized heating feature with corresponding effect to the method known from D1 according to document D2, thereby arriving at the method according to claim 1. In this respect it is also worth to be cited that document D4 indicates precisely the need for this step of localised soldering in case of back-contacted solar cells having a number of localized contact points with the conductive substrate and discloses the corresponding advantages obtained (see D4, page 343, figure 3).

Consequently it is considered that claim 1 does not involve an inventive step.

3.) Dependent claims 2, 3 and 4 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of inventive step, see documents D1, D2 and D3 and the corresponding passages cited in the search report.

4.) All claims 1-4 meet the requirements of industrial applicability.

**Re Item VII**
**Certain defects in the application**

The relevant background art disclosed in the documents D2, D3 and D4 is not mentioned in the description, nor are these documents identified therein.