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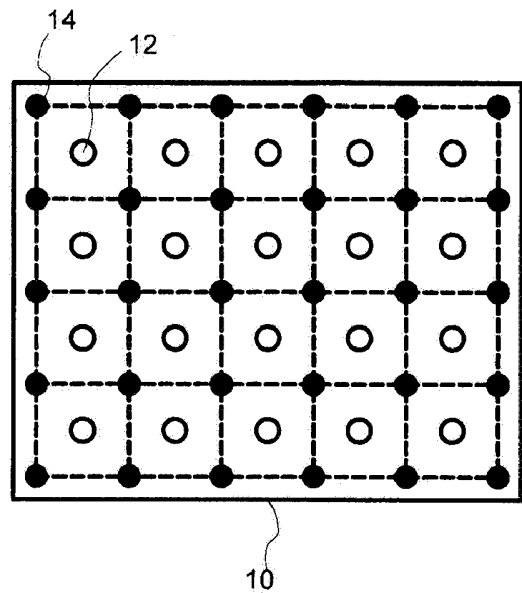
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54 **Photovoltaic cell.**

57 A photo-voltaic cell has a first and second two-dimensional array of contact points on the first surface, each coupled to a respective one of base and emitter areas in or on the semi-conductor body. Electrically separate first and second conductor structures on the first surface are coupled to contact points of the first and second two-dimensional array. The first conductor structure comprises sets of first conductor line branches, branching out from the contact points of the first two-dimensional array. The second conductor structure comprises second conductor line branches in areas between respective pairs of adjacent non-parallel ones of the first conductor line branches, each second conductor line branch coupled at least to a respective one of the contact points of the second two-dimensional array.



NL C 2006932

Dit octrooi is verleend ongeacht het bijgevoegde resultaat van het onderzoek naar de stand van de techniek en schriftelijke opinie. Het octrooischrift komt overeen met de oorspronkelijk ingediende stukken.

P94835NL00

Title: Photovoltaic cell

Field of the invention

The invention relates to a photovoltaic cell comprising first and second sets of conductors on a back surface of the cell, coupled to emitter and base areas on the back surface, for collecting currents from charge carriers of mutually opposite polarity respectively.

Background

The collection efficiency of photovoltaic cells depends on many factors, including the design of the conductor system that is used to conduct currents from charge carriers of mutually opposite polarity in the cell from the emitter and base. In the art, two classes of conductor systems are known: one class in which electrically separate grids are provided for the emitter and base on the front and back surface of the cell and one class in which electrically separate grids for the emitter and base are provided on the same surface (the back surface). Conventionally grids are used that have one or more relatively wide central conductor lines, called the bus bar and parallel straight linear fingers of relatively narrow elongated shape emanating from the central conductor line. Thus effectively, H shaped connection pattern are provided, the bus bar forming the horizontal line of the H.

US 6,573,445 shows photovoltaic cells with separate base and emitter grids on opposite surfaces wherein the density of the fingers is varied with distance from the central line. The document also shows photo-voltaic cells wherein the area covered by the front surface grid is reduced by using repeated sub-regions each with conductor lines that radiate from one or more concentric circular lines, with an increasing number of bifurcations in the radiating lines with distance from the centre.

In the class of photovoltaic cells wherein both electrically separate grids are provided on the back surface, interdigitated conductor grids are used. Such cells are called IBC cells (Interdigitated Back Contact cells). Each grid has a H- or E-shaped pattern with a series of straight parallel fingers of a long narrow shape emanating from a bus bar. The fingers of both grids run in parallel, the length of each finger of one grid extending between the lengths of a different pair of fingers of the other grid. In this way each fingers of both grids can be realized in close proximity of a finger of the other grid.

However, the bus bars give rise to efficiency loss due to enhanced recombination underneath the central lines, which is sometimes called electric shading.

Summary

Among others, it is an object to provide for a photo-voltaic cell wherein currents of both polarities can be collected from the back surface with less loss.

According to one aspect, a photo-voltaic cell is provided that comprises

- a semi-conductor body having a first and second surface opposite each other;

- a first and second two-dimensional array of contact points on the first surface, each coupled to a respective one of base and emitter areas in or on the semi-conductor body;

- electrically separate first and second conductor structures, both on the first surface, coupled to contact points of the first and second two-dimensional array respectively;

- the first conductor structure comprising sets of first conductor line branches, the first conductor line branches of each set branching out from a respective one of the contact points of the first two-dimensional array in at

least three successive different directions at less than a hundred and eighty degrees to each other;

- the second conductor structure comprising second conductor line branches in at least three different directions in areas between respective pairs of adjacent ones of the first conductor line branches, the first conductor line branches of different ones of the respective pairs being non parallel to the first conductor line branches of other ones of the respective pairs, the first conductor line branches including pairs each second conductor line branch coupled at least to a respective one of the contact points of the second two-dimensional array.

The first and second surface may be the back and front surface of the photo-voltaic cell, respectively, which will be turned away from and towards the sun for example. The contact points may replace the bus bars of known photo-voltaic cells. For example, the output terminal of one electrical pole of the photo-voltaic cell may be coupled to each of the contact points of the first two dimensional array. Instead of using interdigitated conductor fingers that are all parallel, interdigitation of conductor lines at more angles is used. The need for a broad bus bar is avoided because the first conductor line branches branch out from the contact point in a plurality of directions, wherein the first conductor line branches may have equal width and may be provided for example in directions radiating from the contact point. Preferably, the base area is kept as small as possible to prevent electrical shading, i.e. enhanced recombination in the base or at the surface. From the viewpoint of increasing the current, the emitter area fraction is preferable as large as possible. However, the emitter area is limited since resistive losses due to lateral current flow will reduce the efficiency. Lateral current flow will also cause a voltage gradient in the lateral direction which makes that the diodes formed by the emitter-base junction are not operated at the maximum power point. This is also referred to as distributed series resistance losses.

In an embodiment the branches of at least part of the pairs between which the conductor line branches of the second conductor structure extend are non-parallel within the pair. Thus a closer spacing is made possible.

In an embodiment the first conductor line branches branch into a tree structure with increasing numbers of branch conductor lines with distance from the respective one of the contact points. In this way a first conductor structure with substantially uniform density can be realized, so that the maximum distance from surface points on the first surface to the first conductor structure does not need to become large for surface points further away from the contact point.

In an embodiment the second conductor line branches extend to areas between each pair of adjacent branches in the tree structure. In this way the maximum distance from surface points on the first surface to the second conductor structure does not need to become large for surface points closer to the contact point.

In an embodiment the first conductor line branches the second conductor line branches in the areas between the respective pairs of adjacent non-parallel ones of the first conductor line branches extend at least partly along a virtual line that bisects an angle between the first conductor line branches in the pair. In this way the maximum distances between the conductor line branches may be kept small with a minimum of conductor area.

In an embodiment the photo-voltaic has a periodic pattern of unit cells with first and second conductor line branches from the first and second conductor structures, wherein the first conductor structure in the unit cell comprises conductor line branches radiating from a first one of the contact points within the unit cell, and the second conductor structure comprises conductor lines along a border of the unit cell as well as branch conductor lines from the border into the unit cell. This makes it possible to realize the photo-voltaic cell with a limited variation in the conductor lines. The unit cells may be rectangular (e.g. square) or hexagonal for example.

In a further embodiment the contact points of the second two-dimensional array are located on the borders of the unit cells, in electrical contact with the conductor lines along the borders. The contact points of the second two-dimensional array may in fact be located where the borders from corners of the unit cell. In this way the use of broad bus bars can be avoided In an embodiment the contact points may be located at the same positions in each cell, but in another embodiments the contact points may be located differently in different unit cells, for example in unit cells at the edge of the periodic pattern. Some contact points may lie astride a plurality of unit cells for example, crossing the border of a unit cell, and some may be located inward, merely touching the border.

In a further embodiment the branch conductor lines of the second conductor structure in the unit cell branch into a tree structure with increasing numbers of branch conductor lines with decreasing distance to the first one of the contact points in the unit cell. In this way the maximum distances between the conductor line branches may be kept small with a minimum of conductor area.

In a further embodiment at least part of the branch conductor lines in the tree structure of the second conductor lines is bent, at least part of the branch conductor lines having a tip, the tips of the at least part of the branch conductor lines being directed at a respective branch point where the first conductor line branches branch into multiple first conductor line branches. In this way the maximum distances between the conductor line branches may be kept small with a minimum of conductor area.

25

Brief description of the drawing

These and other objects and advantageous aspects will become apparent from a description of exemplary embodiments using the following figures

30

Figure 1 shows a back surface of a photo-voltaic cell with an array structure

Figure 2 shows a conductor pattern in a unit cell of the array

Figure 3, 4 show conductor patterns of further unit cells

5 Figure 5 shows a cross-section of a solar cell

Figure 6 shows a cross-section of the cell with connection foils

Detailed description of exemplary embodiments

10 The photo-voltaic cell comprises a semi-conductor body with a relatively small thickness compared to its diameter (e.g. length and/or height). The semi-conductor body has a first and second surface, separated by the thickness of the semi-conductor body. The first and second surface will be called the back surface and the front surface, because during use the second

15 surface will face an energy providing light source (e.g. the sun) and the first surface will be turned away from the light source.

The semi-conductor body has a first conductivity type (p or n) due to doping. A patterned layer of a second conductivity type opposite to the first conductivity type (n or p) is provide in or on the back surface. Where present,

20 the patterned layer defines a semiconductor junction between the bulk of the semi-conductor body and the patterned layer. A first set of electrodes (emitter electrodes) on the back surface is coupled to first areas where the patterned layer is present and a second set of electrodes (base electrodes) on the back surface is coupled to second areas where the patterned layer is not present.

25 Instead a patterned layer with enhanced conductivity of the same conductivity type as the bulk of the semi-conductor body may be provided in the second areas, forming a back surface field.

Figure 1 schematically shows the back surface 10 of the photo-voltaic cell, with a two-dimensional array of first and second contacts 12, 14 to

30 the emitter electrodes (not shown) and the base electrodes (not shown). By way

of example an array with a two-dimensionally periodic arrangement of square unit cells is shown (indicated by dashed lines), with the first contacts 12 at the central points of the unit cells and the second contacts 12 at the corners of the unit cells.

5 Figure 2 schematically shows an example of a conductor pattern in a unit cell of the two-dimensional array. This conductor pattern in the unit cell may be periodically repeated in two dimensions on the back surface of the photo-voltaic cell. The conductor pattern comprises first conductor lines 20 emanating from the first contact 12 at the central position of the unit cell and
10 second conductor lines 22 coupled to the second contacts 14 at the corners of the unit cell.

 For the sake of illustration, first conductor lines 20 are shown by dashed lines, but it should be understood that they form continuous
conductors. First conductor lines 20 radiate at a plurality of angles from first
15 contact 12 in directions that are not all parallel to each other. By way of example a unit cell has been shown wherein the conductor lines 20 at ninety degrees from each other (at zero, ninety, a hundred and eighty and at two hundred and seventy degrees). But different angles may be used, for example
20 three angles at a hundred and twenty degrees, seventy two degrees, sixty degrees etc, or at irregularly different angles. The first conductor lines 20 radiating from first contact 12 will be called first order branches. The first order branches branch out into second order branches and so on, the distance from first contact 12 increasing along the branches of each order.

 Second conductor lines 22 include conductor lines that run between
25 the second contacts 14 along the borders of the unit cell and branch conductor lines that branch off from the conductor lines along the borders into the unit cell into regions between the branches of first conductor lines 20. In the illustrated example each pair of branches at each order of the first conductor lines 20 has one corresponding branch of the second conductor line 22
30 respectively. The corresponding branch of second conductor line 22 of a pair of

branches of the first conductor lines 20 extends from the border of the unit cell (the border including second contacts 14) to a position between the pair of branches, i.e. a virtual line between the end points of the branches intersects their corresponding second conductor line 22.

5 In order to reduce recombination loss, it is preferred that the maximum distance from any point on the back surface to any one of the first and second conductor lines 20, 22 is kept small. To do so it is preferred that at least the tips of the branches of the second conductor line 22 run along a virtual line that bisects the angle formed between adjacent branches of the
10 first conductor line 20. Where there is a branch point where a pair of branches of the first conductor line 20 branch out at an acute angle or a ninety degree angle, a branch of the second conductor line 22 is preferably located between these branches of the first conductor line 20 with at least a tip part of the branch of the second conductor line 22 directed towards the branch point. In
15 this way the maximum distance from any point on the back surface to any one of the first and second conductor lines 20, 22 is kept small.

 Many different layout patterns may be used for the first and second conductor lines 20, 22. More orders of branches may be used for example, or different angles between the branching lines. Figure 3 shows a further
20 example of the first and second conductor lines 20, 22 in a unit cell. Herein the second conductor lines are provided along the outline of a parallelogram that forms a periphery of the unit cell (a square is shown by way of example of a parallelogram, but any square or other parallelogram may be used). The first conductor lines extend diagonally from a contact point at the centre of the
25 parallelogram to each of the four corners, with branches from the diagonal lines. The branches include first branches running parallel to one set of parallel edges of the parallelogram and second branches running parallel to the other set of parallel edges of the parallelogram. The first and second branches branch in opposite directions from the diagonal. In the case of a
30 rectangular unit cell, the first and second branches extend perpendicularly to

each other. The second conductor lines along the outline have branches towards the inside of the parallelogram, branches from different parts of the outline being parallel to and interdigitated with the first and second branches of the first conductor lines respectively.

5 The unit cells need not be square. Figure 4 shows an example of a hexagonal unit cell. By way of example, second contacts 12 are shown at all corners of the unit cell, but alternatively second contacts 12 may be provided at every second corner only. For the sake of illustration, second conductor lines 22 are shown by dashed lines in this figure, but it should be understood that
10 they form continuous conductors. First conductor lines 20 radiate from the first contact at the centre of the unit cell at a number of angles, each at a sixty degree angle to its predecessor. First conductor lines 20 branch out, each time into a first radially directed conductor line that forms a first main branch and a pair of conductor lines that form first side branches 40 directed transverse to
15 the radial direction. Second conductor lines 22 include conductor lines that run between the second contacts 14 along the borders of the unit cell and further conductor lines that are directed radially towards the centre of the unit cell. The further conductor branches out, each time into a radially directed conductor line that forms a second main branch and a pair of conductor lines
20 that form second side branches 42 that are directed in parallel to the first side branches. The conductor lines that run between the second contacts 14 along the borders of the unit cell can also be seen as such second side branches. Each first side branch 40 extends between a respective pair of the second side
branches 42.

25 Although the embodiment of figure 4 has been illustrated by means of straight conductor line sections in the side branches, that each branch off at the same angle to the main branch, it should be appreciated that this is not necessary. In an embodiment the side branches may be bent (having a continuous bend or straight sections at an angle to each other). The side
30 branches may be bent for example so that a first part from the point where the

first or second side branch branches off runs parallel to the tips of the adjacent second or first side branch respectively, and the tip of the first or second side branch is directed towards the branch point where an adjacent second or first side branch branches off. When the main branch and the side branch at a
5 branch point are at an acute angle to each other, the tip of the adjacent side branch of the other conductor line may be directed towards this branch point. The side branch at the tip may extend the virtual line that bisects this acute angle. This reduces the distance from points on the back surface to the closest part of the first and second conductor lines 20, 22. In an embodiment, the side
10 branches themselves may branch out into branches directed at adjacent branch points.

Although the conductor lines have been shown as lines in the figures, it should be realized that the term conductor line refers to a body of conductor material with a height and width transverse to the line direction
15 that are greater than zero. The width (transverse to the lines shown in figures 1-4) need not be as wide everywhere: it may narrow towards the tips of the branches. The width of the conductor lines may fill part of the space between the lines shown the conductor lines in the figures, leaving an opening to prevent short circuit: the lines shown in the figures may be considered to
20 represent centre lines of the conductor lines rather than actual conductor lines. The part of the space between mutually closest points on conductor lines for base and emitters that is covered by the conductor lines need not be equally divided between the conductor lines for base and emitter areas. For example, the conductor lines for emitter areas may cover a greater part of the distance
25 between the mutually closest points than the conductor lines for emitter areas. This may increase efficiency.

Figure 5 shows a cross-section of a solar cell comprising a semiconductor body 50, emitter areas 52, emitter contact electrodes 54 on the emitter areas 52 and base contact electrodes 56. Details such as dielectric
30 layers, anti-reflection coating, texturing etc are not shown. The structure of

such a cross-section is known per se. The emitter contact electrodes 54 and base contact electrodes 56 form part of the first and second conductor structure respectively, or the second and first conductor structure respectively, and are provided with branches as shown in the surface views. Preferably, the emitter
5 fraction (the fraction of the surface that is covered by emitter areas 52) is maximized, or at least larger than the base fraction (the fraction of the surface that functions as base area). This may be realized by realizing the edges of the emitter areas under the conductor patterns such as shown in figures 1-4 closer to the base electrodes than to the emitter electrodes. Thus, the emitter areas
10 extend over more than half the distance between base electrodes.

A photo voltaic cell is provided that has a semi-conductor body having a first and second surface opposite each other and a first and second two-dimensional array of contact points on the first surface, each coupled to a respective one of base and emitter areas in or on the semi-conductor body. External electrical
15 contact to first and second two-dimensional array of contact points may be realized by means of layers of electrically conductive foil applied to the back surface, with an isolating layer in between. The layer closest to the semi-conductor substrate has openings for contacts to the layer further to the semi-conductor.

20 This is illustrated in figure 6, showing the semiconductor substrate 60 (details omitted) with contact points 62a,b from the first and second array, a first and second electrically conductive (e.g. metallic) foil 64a, b, separated by an electrically insulating foil 66. First and second electrically conductive foil 64a, b are electrically coupled to the contact points of the first and second
25 array respectively, for example by conductive adhesive. The innermost foil 64a and the insulating layer 66 have openings over the contact points of the second array. The contact to the other foil is provided through these openings. Of course, other ways of connecting to the contact points are possible, such as wiring, mounting on a PCB with contact pads opposite the contact points etc.
30 The use of foil makes it possible to provide for mass manufacture at lower cost.

Conclusies

1. Fotovoltaïsche cel omvattende:

- een halfgeleiderlichaam met een eerste en tweede oppervlak, welke tegenover elkaar liggen;

5 - een eerste en tweede tweedimensionaal array van contactpunten op het eerste oppervlak, elk gekoppeld aan respectievelijk een basis- of een emittergebied in of op het halfgeleiderlichaam; en

- elektrisch separate eerste en tweede geleiderstructuren, beide op het eerste oppervlak, welke gekoppeld zijn aan contactpunten van respectievelijk het eerste en tweede tweedimensionaal array,

10 waarbij de eerste geleiderstructuur sets eerste geleiderlijn-takken omvat, waarbij de eerste geleiderlijn-takken van elke set zich vertakken vanuit één van de contactpunten van het eerste tweedimensionaal array in ten minste drie opeenvolgende verschillende richtingen op minder dan honderdtachtig graden ten opzichte van elkaar,

15 en waarbij de tweede geleiderstructuur tweede geleiderlijn-takken omvat in ten minste drie verschillende richtingen in gebieden tussen respectievelijk paren van aangrenzende eerste geleiderlijn-takken, waarbij de eerste geleiderlijn-takken van verschillende van de respectievelijke paren niet parallel zijn aan de eerste geleiderlijn-takken van andere van de
20 respectievelijke paren, waarbij de eerste geleiderlijn-takken paren omvatten, waarbij elke tweede geleiderlijn-tak is gekoppeld aan ten minste één van de contactpunten van het tweede tweedimensionaal array.

2. Fotovoltaïsche cel volgens conclusie 1, waarbij de eerste geleiderlijn-takken van ten minste een deel van de paren waartussen de geleiderlijn-takken van de tweede geleiderstructuur zich uitstrekken niet parallel zijn
25 binnen het paar.

3. Fotovoltaïsche cel volgens conclusie 1 of 2, waarbij de eerste geleiderlijntakken zich vertakken in een boomstructuur met toenemende aantallen takgeleiderlijnen bij toenemende afstand vanaf het respectievelijke contactpunt.
4. Fotovoltaïsche cel volgens conclusie 3, waarbij de tweede geleiderlijntakken zich uitstrekken naar gebieden tussen elk paar aangrenzende takken in de boomstructuur.
5. Fotovoltaïsche cel volgens één van de voorgaande conclusies, waarbij de tweede geleiderlijntakken in de gebieden tussen de respectievelijke paren aangrenzende niet-parallelle eerste geleiderlijntakken zich ten minste gedeeltelijk uitstrekken langs een virtuele lijn die een hoek tussen de eerste geleiderlijntakken in het paar in tweeën splitst.
6. Fotovoltaïsche cel volgens één van de voorgaande conclusies, waarbij de eerste geleiderlijntakken die zich vertakken vanuit het eerste contactpunt of vanuit een onvertakte, het contactpunt bevattende regio een onderling gelijke breedte hebben.
7. Fotovoltaïsche cel volgens één van de voorgaande conclusies, omvattende een periodiek patroon van eenheidscellen met eerste en tweede geleiderlijntakken van de eerste en tweede geleiderstructuren, waarbij de eerste geleiderstructuur in de eenheidscel geleiderlijntakken omvat welke stervormig uitlopen van een eerste van de contactpunten binnen de eenheidscel, en waarbij de tweede geleiderstructuur zowel geleiderlijnen omvat langs een grens van de eenheidscel, als ook takgeleiderlijnen van de grens de eenheidscel in.
8. Fotovoltaïsche cel volgens conclusie 7, waarbij de contactpunten van het tweede tweedimensionaal array zijn geplaatst op de grenzen van de eenheidscellen, in elektrisch contact met de geleiderlijnen langs de grenzen.
9. Fotovoltaïsche cel volgens conclusie 7 of 8, waarbij de takgeleiderlijnen van de tweede geleiderstructuur in de eenheidscel zich vertakken in een boomstructuur met toenemende aantallen takgeleiderlijnen bij afnemende afstand tot de eerste van de contactpunten in de eenheidscel.

10. Fotovoltaïsche cel volgens één van de conclusies 7 tot 9, waarbij ten minste een deel van de tak-geleiderlijnen in de boomstructuur van de tweede geleiderlijnen gebogen is, waarbij ten minste een deel van de tak-geleiderlijnen een tip heeft, en waarbij de tippen van het ten minste deel van de tak-geleiderlijnen is gericht naar een respectievelijk vertakkingspunt waar de eerste geleiderlijn-takken zich vertakken in meervoudige eerste geleiderlijn-takken.
- 5
11. Fotovoltaïsche cel volgens één van de conclusies 7 tot 10, waarbij de eenheidscellen rechthoekig zijn.
- 10 12. Fotovoltaïsche cel volgens één van de conclusies 7 tot 10, waarbij de eenheidscellen zeshoekig zijn.

Fig.1

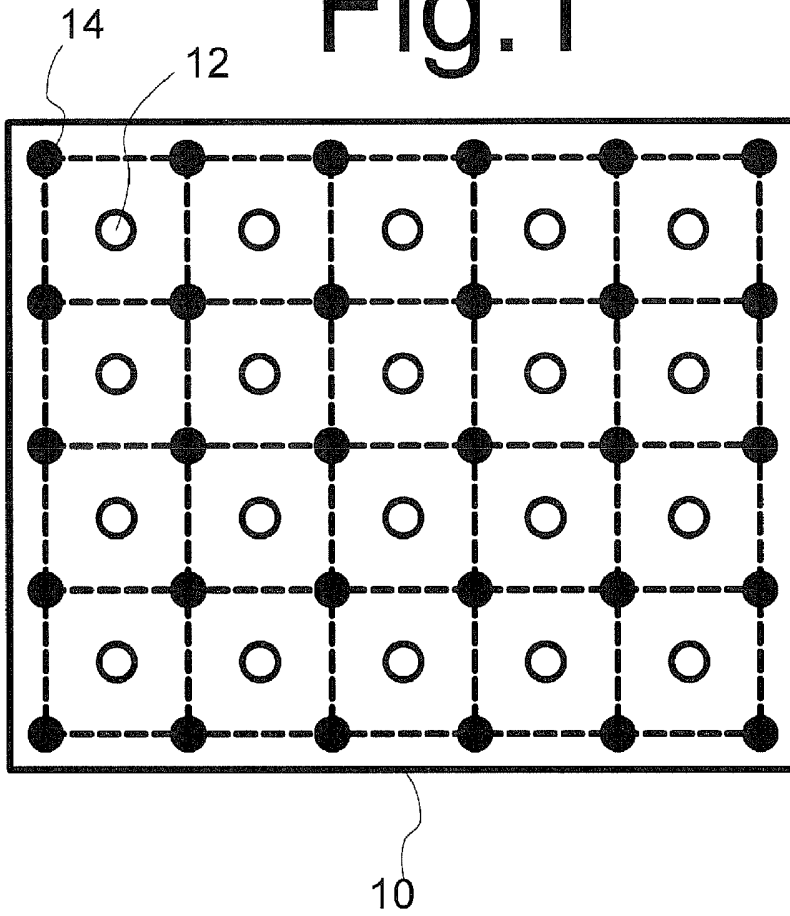
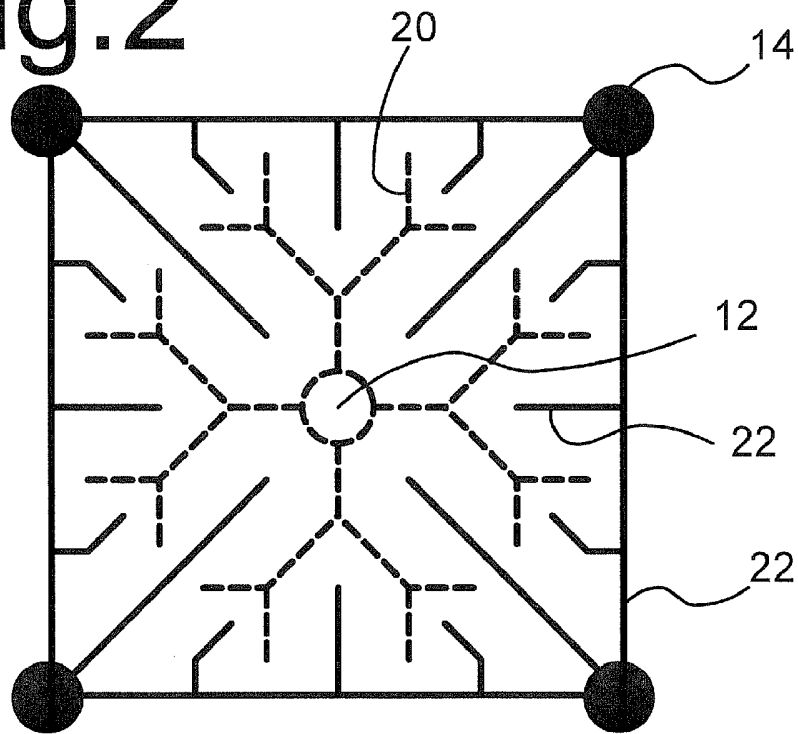


Fig.2



2/4

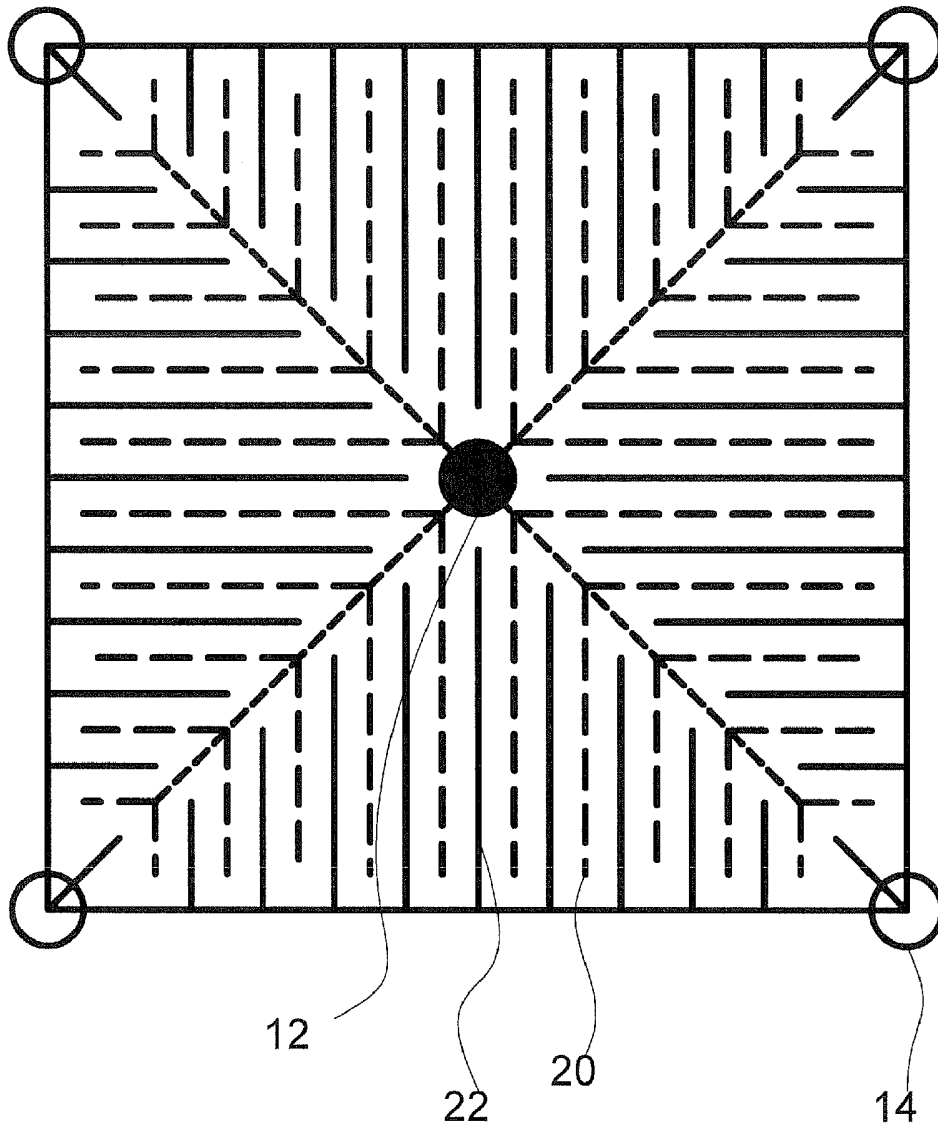


Fig.3

3/4

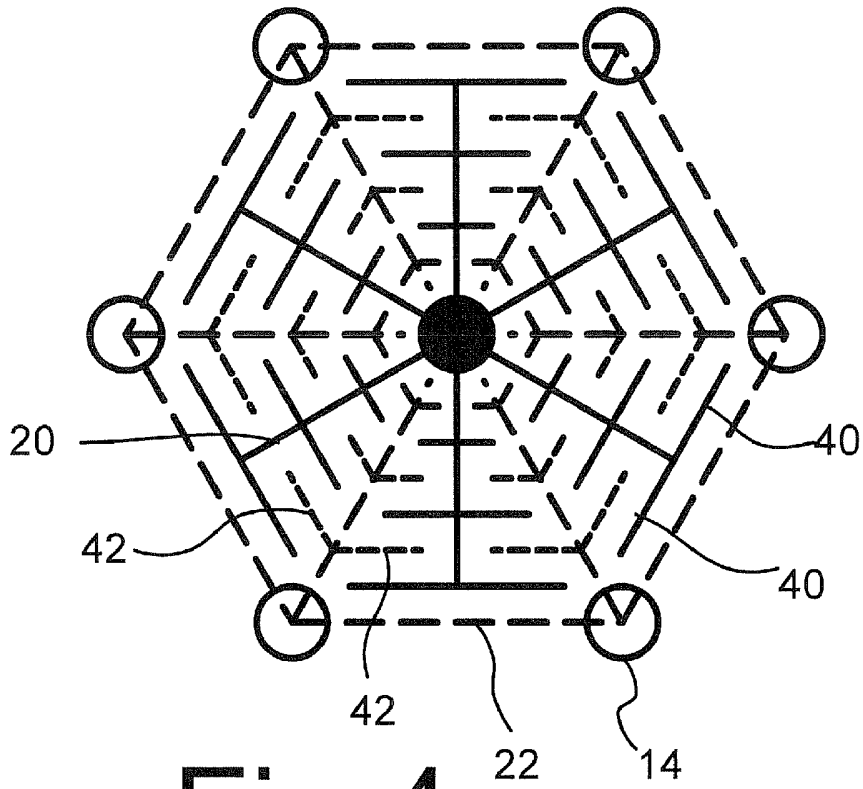


Fig.4

4/4

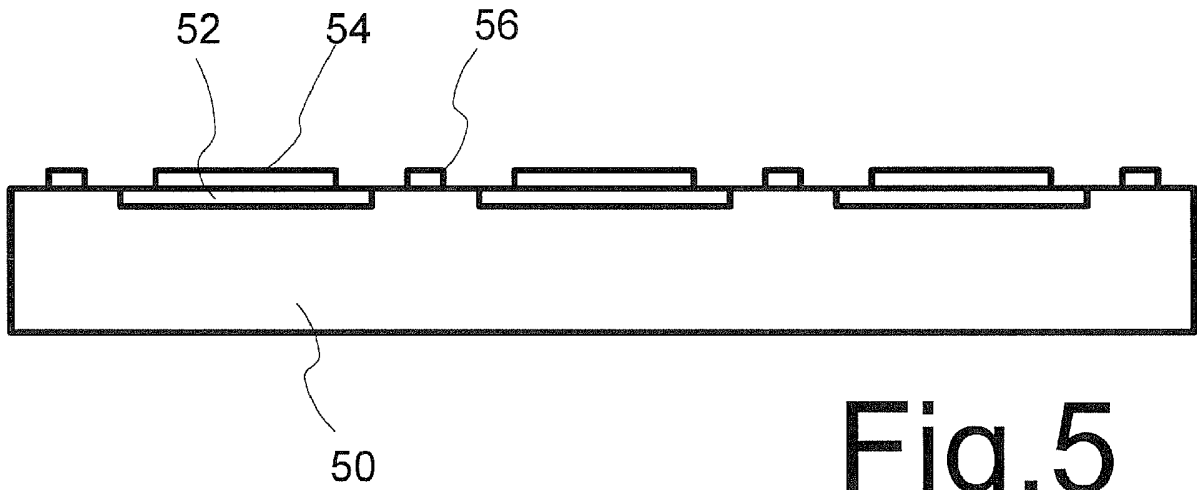


Fig.5

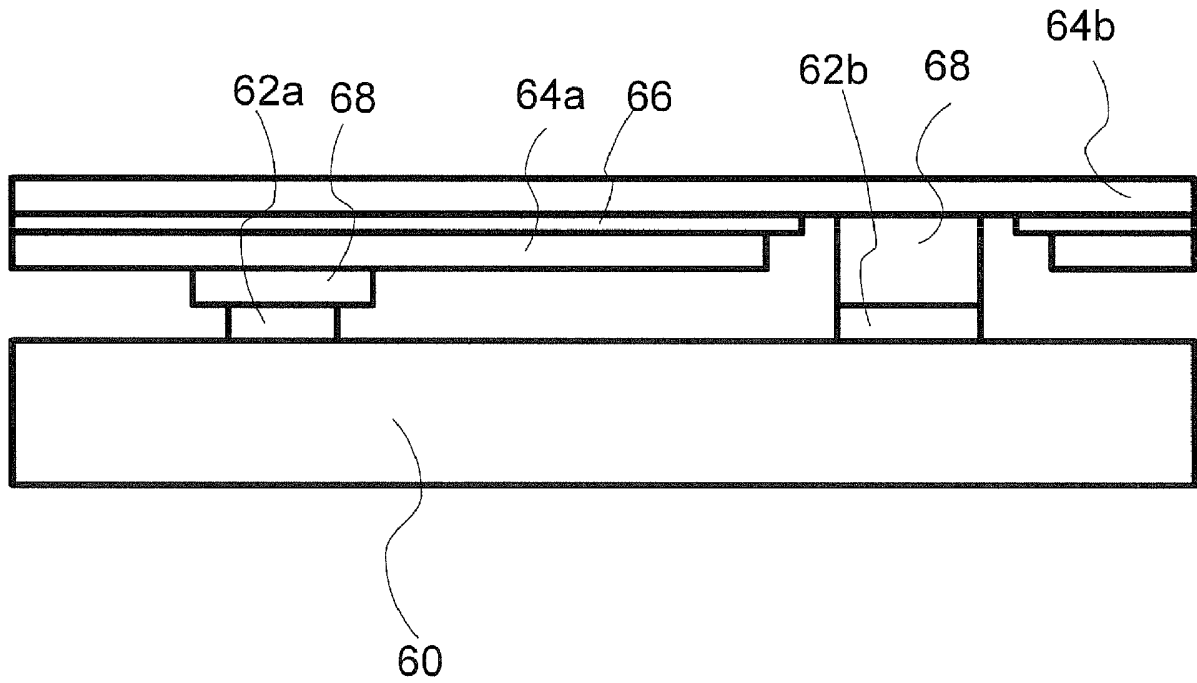


Fig.6

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE P94835NL00
Nederlands aanvraag nr. 2006932	Indieningsdatum 14-06-2011
	Ingeroepen voorrangdatum
Aanvrager (Naam) Stichting Energieonderzoek Centrum Nederland	
Datum van het verzoek voor een onderzoek van internationaal type 29-10-2011	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. SN 57121
I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)	
Volgens de internationale classificatie (IPC) H01L31/0224 H01L31/18	
II. ONDERZOCHE 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. <input type="checkbox"/>	GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES (opmerkingen op aanvullingsblad)
IV. <input type="checkbox"/>	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 2006932

A. CLASSIFICATIE VAN HET ONDERWERP
INV. H01L31/0224 H01L31/18
ADD.

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

B. ONDERZOCHE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimum documentatie (classificatie gevolgd door classificatiesymbolen)
H01L

Onderzochte andere documentatie dan de minimum 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.
X	WO 2011/067338 A2 (STIEBEL ELTRON GMBH & CO KG [DE]; MEYER RUEDIGER [DE]; EHLERS LOTTE [D] 9 juni 2011 (2011-06-09) * samenvatting; figuren 2,3 * * bladzijde 12, regel 34 - bladzijde 13, regel 21 * * bladzijde 16, regel 36 - bladzijde 17, regel 17 * * bladzijde 39, regel 34 - bladzijde 40, regel 24 *	1-3,5-12
A	----- US 6 573 445 B1 (BURGERS ANTONIUS R [NL]) 3 juni 2003 (2003-06-03) * samenvatting; figuren 6-10 * ----- -/--	1,3,4,9

Verdere documenten worden vermeld in het vervolg van vak C.

Leden van dezelfde octroofamilie 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 octrooiaanvraag vermeld

E eerdere octrooi(aanvraag), 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 octrooiaanvraag, 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 octroofamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid

2 maart 2012

Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type

Naam en adres van de instantie

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De bevoegde ambtenaar

Favre, Pierre

**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 2006932

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN		
Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
A	WO 2011/031156 A1 (STICHTING ENERGIE [NL]; VAN ROOSMALEN JOHANNES ADRIANUS MARIA [NL]) 17 maart 2011 (2011-03-17) * samenvatting; figuur 2a *	1,3,4,9
A	ROMJN I G ET AL: "An overview of MWT cells and evolution to the ASPIRE concept: a new integrated mc-Si cell and module design for high-efficiencies", THE COMPILED STATE-OF-THE-ART OF PV SOLAR TECHNOLOGY AND DEPLOYMENT : 23RD EUROPEAN PHOTOVOLTAIC SOLAR ENERGY CONFERENCE, EU PVSEC ; PROCEEDINGS OF THE INTERNATIONAL CONFERENCE, HELD IN VALENCIA, SPAIN, 1 - 5 SEPTEMBER 2008, WIP-RENEWABLE ENERGIES, M, 1 september 2008 (2008-09-01), bladzijden 1000-1005, XP002597501, ISBN: 978-3-936338-24-9 * het gehele document *	1,3,4,9
A	BULTMAN J H ET AL: "Fast and easy single step module assembly for back-contacted c-Si solar cells with conductive adhesives", WORLD CONFERENCE AND EXHIBITION ON PHOTOVOLTAIC SOLAR ENERGYCONVERSION, XX, XX, deel 3, nr. 40-D13-03, 11 mei 2003 (2003-05-11), bladzijden 979-982, XP002521573, * het gehele document *	1,3,4,9
A	DE 195 25 720 A1 (SIEMENS SOLAR GMBH [DE]) 16 januari 1997 (1997-01-16) * samenvatting; figuur 8 *	1
A	US 2004/043528 A1 (KRUEHLER WOLFGANG [DE] KRUEHLER WOLFGANG [DE]) 4 maart 2004 (2004-03-04) * samenvatting; figuren 3A,3B *	1

**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 2006932

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
WO 2011067338	A2	09-06-2011	GEEN

US 6573445	B1	03-06-2003	AU 772791 B2 06-05-2004
			AU 1298000 A 13-06-2000
			EP 1157427 A1 28-11-2001
			EP 2261994 A2 15-12-2010
			JP 2002530894 A 17-09-2002
			NL 1010635 C2 24-05-2000
			US 6573445 B1 03-06-2003
			WO 0031803 A1 02-06-2000

WO 2011031156	A1	17-03-2011	NL 2003482 C 15-03-2011
			WO 2011031156 A1 17-03-2011

DE 19525720	A1	16-01-1997	GEEN

US 2004043528	A1	04-03-2004	CN 1455959 A 12-11-2003
			DE 10045249 A1 04-04-2002
			EP 1317778 A1 11-06-2003
			JP 2004510323 A 02-04-2004
			US 2004043528 A1 04-03-2004
			US 2006102976 A1 18-05-2006
			WO 0223639 A1 21-03-2002



Agentschap NL
Ministerie van Economische Zaken,
Landbouw en Innovatie

WRITTEN OPINION

File No. SN57121	Filing date (<i>day/month/year</i>) 14.06.2011	Priority date (<i>day/month/year</i>)	Application No. NL2006932
International Patent Classification (IPC) INV. H01L31/0224 H01L31/18			
Applicant Stichting Energieonderzoek Centrum Nederland			

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 Favre, Pierre
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WRITTEN OPINION

Application number
NL2006932

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	3, 4, 9, 10, 12
	No: Claims	1, 2, 5-8, 11
Inventive step	Yes: Claims	4
	No: Claims	1-3, 5-12
Industrial applicability	Yes: Claims	1-12
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item V

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

CITED DOCUMENT

Reference is made to the following document:

D1 WO 2011/067338 A2 (STIEBEL ELTRON GMBH & CO KG [DE]; MEYER RUEDIGER [DE]; EHLERS LOTTE [D] 9 juni 2011

INDEPENDENT CLAIM 1 - NOVELTY OBJECTION

- 1 The present application does not meet the requirements of patentability, because the subject-matter of claim 1 is not novel.

Document D1 discloses a photovoltaic cell (abstract) comprising:

- a semiconductor body having a first and a second surface opposite each other (page 12, line 34 to page 13, line 21);
- a first (ref. 16 in Fig. 2) and a second (ref. 17) two-dimensional array of contact points on the first surface, each coupled to a respective one of base and emitter areas in or on the semiconductor body (page 39, line 34 to page 40, line 24; page 16, line 36 to page 17, line 17);
- electrically separate first (ref. 13) and second (ref. 11) conductor structures, both on the first surface (page 40, lines 19-24), couple to contact points of the first and second two-dimensional array respectively (Fig. 2);
- the first conductor structure (ref. 13) comprising sets of first conductor line branches, the first conductor line branches of each set branching out from a respective one of the contact points of the first two-dimensional array (ref. 16) in at least three successive different directions at less than a hundred and eighty degrees to each other (Fig. 2);
- the second conductor structure comprising second conductor line branches in at least three different directions in areas between respective pairs of adjacent ones of the first conductor line branches, the first conductive line branches of different ones of the respective pairs being non parallel to the first conductor line branches of other ones of the respective pairs, the first

conductor line branches including pairs each second conductor line branch coupled at least to a respective one of the contact points of the second two-dimensional array (Fig. 2).

Therefore claim 1 is not novel over document D1.

DEPENDENT CLAIMS

- 2 The additional features introduced by dependent claims 2, 5-8 and 11 are also disclosed in document D1, see Fig. 2 and page 39, line 34 to page 40, line 24.
- 3 Dependent claims 3, 9, 10 and 12 do not appear to contain any additional features which, in combination with the features of any claims to which they refer, meet the requirements of inventive step. The additional features are merely one of several straightforward design options from which the skilled person would select without the exercise of inventive skill.

SUGGESTION

- 4 It seems that a set of amended claims including one independent device claim that would combine the subject-matters of claims 1, 3 and 4 together could be considered novel and inventive with respect to the known prior art.