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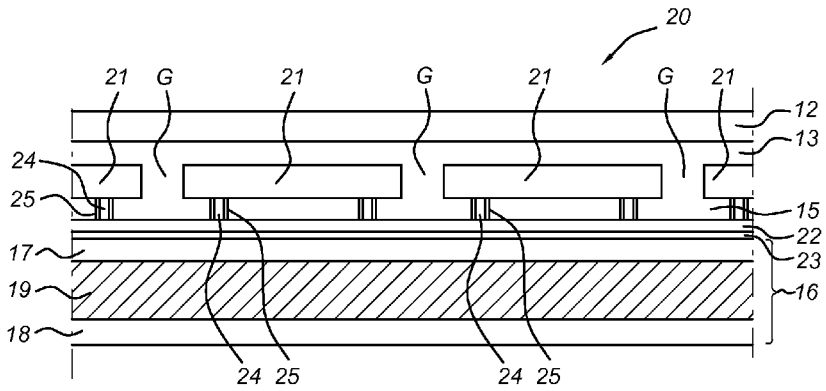
(54) Title: SOLAR PANEL AND METHOD FOR MANUFACTURING SUCH A SOLAR PANEL

Fig. 3



(57) Abstract: A solar panel includes a front cover layer, a plurality of solar cells and a back sheet. The plurality of solar cells is arranged between the front cover layer and the back sheet. The back-sheet is created from a plated honeycomb panel that includes a honeycomb plate. The honeycomb plate is arranged in between two plates of composite material. In an embodiment, the composite plate material is a reinforced plastic.

Solar panel and method for manufacturing such a solar panel

Technological field

The present invention relates to a solar panel. Additionally, the invention relates to a method for manufacturing such a solar panel.

Background

Commercially available solar panel modules typically comprise a carrying framework and a plurality of solar cells which are supported by the carrying framework.

Within the framework the solar cells are sandwiched between a front side carrier and a rear side carrier. The front side carrier is arranged as light receiving surface and is therefore made of a transparent material. The solar cells are connected to a junction box. The junction box can be connected through a regulation unit to an external energy carrier, e.g. an electric grid.

The front side carrier is typically a glass plate or a foil layer which covers the light receiving surfaces of the solar cells as a protective layer.

The rear side carrier is typically made of a plastic plate or layer.

In case of so-called H-cells (i.e. solar cells having front side and rear side electrical contacts) the solar cells are interconnected by tabs to form an electrical network. The electrical network is connected to the junction box.

In case of back-contacted solar cells, all electrical contacts of the solar cell are available at the rear side of the solar cell and external electrical connections for the solar cells are made to the rear side carrier that is typically arranged as a carrier with a contacting foil comprising a conductive network pattern that connects to contacts of the solar cells for transmitting electric energy from the solar cells to a junction box. The conductive network pattern is positioned on the rear side carrier.

In such a construction the framework and the glass layer provide the mechanical stiffness and strength since the materials of the rear side carrier have relatively low stiffness. Moreover, for glass based front side carriers the stiffness of the framework also should prevent that external forces act on the relatively brittle cell layer.

In particular the glass layer and to a lesser extent the frame contribute to a relatively high weight of the solar panel. The weight of the solar panel imposes restrictions on the application of these type of solar panels.

Firstly, a maximum weight which PV (photovoltaic panel) installers are allowed to handle on a roof without the use of a crane limits the size of solar panel modules. Secondly, the weight of PV modules limits the application of PV on many roofs which are not able to carry the total weight of a complete PV system of several solar panel modules.

From WO2012148279 it is known to use a thin layer glass window as front side carrier in a standard module. The relatively low thickness of the glass layer reduces the weight of the solar panel module but at the same time the mechanical strength. The strength of the solar panel module is improved by a support construction that is glued on the back sheet of the solar panel module.

Gluing on a back sheet is commonly difficult by the nature of the back sheet material. Also, the support construction at the rear side as described in patent WO2012148279 only supports the module locally. Therefore to obtain sufficient strength, the support construction still needs to be rather extensive which may largely undo the intended weight reduction of the solar panel module. Also, to apply the prior art support construction on the solar panel module requires adaptation of, and additional steps to, the manufacturing process.

Further from CN202839683U a solar panel is known which has a glass based front side and comprises a rear side supporting plate consisting of an aluminum based plated honeycomb carrier.

However, the solar panel module of CN202839683U has some disadvantages that reduce its applicability.

Firstly, since aluminum is a conductor, the prior art solar panel module requires that an insulating layer is arranged on the surface of the rear side plate to avoid any short circuit or leakage from the conductive network pattern. Additionally, the thermal expansion coefficient of aluminum differs substantially from the thermal expansion coefficients of the other layers in the module. Thus during manufacturing thermal stresses are created in the layered solar panel structure which can cause warping, cracking of cells and/or delamination between layers.

Also the use of a metal based rear support may cause undesirable electrostatic charging of the module.

JP 2013 110301 A discloses a solar panel comprising a front cover layer, a plurality of solar cells and a back sheet, wherein the plurality of solar cells are arranged between the front cover layer and the back sheet, the back sheet being shaped from a plated honeycomb panel comprising a honeycomb plate that is arranged in between two plates of composite material.

It is an object of the invention to overcome or mitigate one or more of the disadvantages of the prior art.

Summary of the invention

The object is achieved by a solar panel as defined in claim 1.

By such a plated honeycomb panel consisting of a plastic honeycomb plated with composite plates, a rear side carrier is provided which has a relatively high stiffness. The composite plates are arranged for strengthening the honeycomb. The solar panel can be self supported without the need of a (metal) framework, which reduces the weight of the solar panel construction. Also, the mechanical properties of plated honeycomb panel diminish the need for a stiff front-side glass layer.

Moreover, due to the use of composite plate material as part of the rear side carrier, the difference in thermal expansion coefficient between the rear side carrier and the other components of the solar panel is reduced. As a result the thermal stresses in the solar panel and the associated risk of breakage of solar cells can be largely reduced.

According to an aspect of the invention there is provided a solar panel as described above, wherein the honeycomb plate is consisting of hollow cells arranged adjacent to each other, the longitudinal axis of said hollow cells being directed substantially perpendicular to a surface of the honeycomb panel.

According to an aspect of the invention there is provided a solar panel as described above wherein the plate of composite material comprises a reinforced plastic.

According to an aspect of the invention there is provided a solar panel as described above, wherein the solar cells are H-cell types, the solar cells being interconnected by tabs, and the tabs are embedded in the encapsulant layer, between the solar cells and the back sheet and between the solar cells and the front cover layer.

According to an aspect of the invention there is provided a solar panel as described above, wherein the solar cells are back-contact type cells, the solar panel comprising a back sheet layer provided with an electrically conductive pattern, the back sheet contacts of each solar cell being connected through a conductor with the electrically conductive pattern; the back sheet layer with electrically conductive pattern being arranged between the rear side of the encapsulant layer and the surface of the plated honeycomb panel and the conductor extending through an opening in the encapsulant layer.

According to an aspect of the invention there is provided a solar panel as described above, wherein the back contact type cells are selected from a group comprising the types "emitter wrap through (EWT)", "metal wrap through (MWT)", "interdigitated back-contact (IBC)".

According to an aspect of the invention there is provided a solar panel as described above, wherein the front cover layer is selected from a glass layer, a plastic layer or a plastic foil.

According to an aspect of the invention there is provided a solar panel as described above, wherein the glass layer has a thickness of at most 2 mm.

According to an aspect of the invention there is provided a solar panel as described above, wherein the encapsulant layer is one selected from a group comprising ethyl-vinyl-acetate, poly vinylbutryal and poly-olefine.

According to an aspect of the invention there is provided a solar panel as described above, wherein the solar panel is self-carrying.

According to an aspect of the invention there is provided a solar panel as described above, wherein the solar panel is frame-less.

The present invention also relates to a wall covering element comprising a solar panel as described above.

The present invention also relates to a method for manufacturing a solar panel as described above, according to claim 13 or alternatively according to claim 14.

According to an aspect of the invention there is provided a method as described above, further comprising: during arranging said plurality of solar cells on the encapsulant layer, arranging tabs for interconnecting said solar cells, said solar cells being H-cell type cells.

According to an aspect of the invention there is provided a solar panel as described above, wherein the solar cells are back-contact type cells, and the method further comprises:

- providing a plated honeycomb panel
- arranging an adhesive layer on a surface of the honeycomb panel;
- arranging a back sheet layer provided with an electrically conductive pattern on the adhesive layer
- arranging a conductive adhesive on the contact point of the electrically conductive pattern
- arranging an encapsulant layer with openings at the places corresponding with the contact points of the electrically conductive pattern
- arranging back contact cells with the contacts positioned on the conductive adhesive
- arranging a second encapsulant on top of the cells
- arranging a front cover layer, and

exposing said solar panel stack to elevated temperature.

The adhesive layer between the plated honeycomb panel and the back sheet layer can also be the same encapsulant material adjacent to the cells.

According to an aspect of the invention there is provided a solar panel as described above, wherein the solar cells are back-contact type cells, the method further comprising:

- providing a plated honeycomb panel provided with an electrically conductive pattern
- arranging a conductive adhesive on the contact point of the electrically conductive pattern
- arranging an encapsulant layer with openings at the places corresponding with the contact points of the electrically conductive pattern
- arranging back contact cells with the contacts positioned on the conductive adhesive
- arranging a second encapsulant on top of the cells
- arranging a front cover layer, and

exposing said solar panel stack to elevated temperature.

Advantageous embodiments are further defined by the dependent claims.

Brief description of drawings

The invention will be explained in more detail below with reference to drawings in which illustrative embodiments of the invention are shown.

Figure 1 shows a solar panel in accordance with an embodiment of the invention;
Figure 2 shows a detailed cross-section of plated honeycomb panel for use a rear side support for a solar panel;
Figure 3 shows a cross-section of a solar panel in accordance with an embodiment of the invention;
Figure 4 shows a cross-section of a solar panel in accordance with an embodiment of the invention.

In the drawings, entities with the same reference number refer to corresponding entities.

Description of embodiments

Figure 1 shows a cross-section of a solar panel in accordance with an embodiment of the invention.

The solar panel 10 is arranged with so – called H cells 14 that have front contact and back contacts. As known in the art, the H cells 14 are typically connected to each other in a series connection by tabs 11 that run between back contacts of one H-cell and front contacts of an adjacent H-cell.

The solar panel 10 comprises a front cover layer 12, a front and rear encapsulant layer 13, 15, H-cells 14 and a plated honeycomb panel 16 acting as rear side carrier.

On the plated honeycomb panel the layers are stacked in order. On the front side of the plated honeycomb panel the rear encapsulant layer 15 is arranged. On the rear encapsulant layer the solar cells of the H-cell type are arranged.

Further, the rear encapsulant layer envelopes the rear tabbing elements 11a of tabs 11 that are connected to the back contacts (not shown) of the H-type solar cells.

On top of the H-type solar cells the front encapsulant layer 13 is arranged. The front encapsulant layer covers both the solar cells and the front tabbing elements 11b of tabs 11.

Between the solar cells the rear and front encapsulant layers are in contact with each other so as to fill the gap G between adjacent H-type solar cells

On top of the front encapsulant layer a front cover layer 12 is arranged. The front cover layer 12 may be a glass layer or alternatively a transparent plastic layer or plastic foil.

It will be appreciated that due to a relatively high stiffness/mechanical strength of the plated honeycomb panel 16, the construction of the solar panel is strengthened and the requirements for the mechanical strength of the front cover layer 12 may therefore be lessened. As a result, in comparison to standard PV modules the thickness of the glass layer may be reduced for example to a glass layer thickness of 2 mm or less. Also, the glass layer may be replaced by a plastic layer or a foil. Both measures would beneficially add to a further reduction of the weight of the panel.

In an embodiment the invention provides that due to a relatively high stiffness of the plated honeycomb panel 16, a frame supporting and/or surrounding the solar panel's circumference so as to strengthen the solar panel is not required, but may be optional as a coupling element for coupling of adjacent solar panels.

Additionally, the composite material of the plated honeycomb panel provides an improvement of electrical isolation for high voltage conditions in comparison with the prior art solar panel of CN202839683U.

Moreover, the solar panel according to the present invention can be used as wall cover with improved thermal isolation due to the thermal properties of the composite material of the honeycomb plate 16.

As detailed in Figure 2, the plated honeycomb panel 16 comprises a front plate 17, a back plate 18 and an intermediate honeycomb plate 19. The intermediate honeycomb plate 19 is covered on one surface by the front plate 17 and on an opposite surface by the back plate 18. The honeycomb plate 19 consists of hollow cells arranged in a closed packed order. The walls of the cells typically extend in the normal direction of the plated honeycomb panel 16.

The cells of the intermediate honeycomb plate 19 are made from a plastic material. The honeycomb material typically consists of hollow cells arranged in a closed packed order. For example, the cells each may have a tubular or hexagonal shape.

The intermediate honeycomb plate 19 is laminated between the front and back plates 17, 18, that consist of a composite material, a fibre reinforced plastic, based on a plastic and a fibre material.

The fibre material may be a glass fibre material, or a carbon fibre material.

Such a plated honeycomb panel 16 has relatively low weight due to the use of low weight plastic and fibre materials. The use of reinforced plastic in the front and back plates provides that the plates 17, 18 are relatively stiff construction elements with relatively high mechanical strength and a thermal expansion coefficient comparable with the other elements in the solar module. As a result, the construction of the plated honeycomb panel 16 provides a strong and light weight support for the solar panel.

In an embodiment, the exterior surface 17A of the front plate 17 of the plated honeycomb panel is provided with a texture for improving adhesion of the rear encapsulant layer to the front plate 17 of the honeycomb panel 16.

In an embodiment, the plastic of at least the front plate 17 is selected from plastics compatible with the material of the rear encapsulant layer for improving adhesion. Alternatively, the exterior surface 17A of the front plate 17 may be treated with a surfactant or agent for improvement of adhesion between the front plate and the rear encapsulant layer.

Figure 3 shows a cross-section of a solar panel in accordance with an embodiment of the invention. In an embodiment, the solar cells arranged in the solar panel 20 are back contact type solar cells, selected from Emitter Wrap Through (EWT), Metal Wrap Through (MWT), Interdigitated Back Contact (IBC) or other back contact (BC) solar cell types.

These types of solar cells require a back-sheet provided with a conductive contacting pattern between the rear-side of the solar cells and the front-side plate 17 of the plated honeycomb panel 16.

In the cross-section of figure 3, the solar panel 20 comprises a front cover layer 12, a front and rear encapsulant layer 13, 15, back contact solar cells 21, a back-sheet 22 provided with a conductive pattern, an adhesive layer 23 and a plated honeycomb panel 16 acting as rear side carrier.

The adhesive layer 23 is arranged on the front side plate of the honeycomb panel 16. Next, on top of the adhesive layer 23 is the back-sheet layer 22 provided with the conductive pattern. On the conductive pattern connections 24 are present that provide

electrical contact to back contact areas of the back-contact type solar cells 21. The connections 24 extends through local openings 25 in the rear side encapsulant layer 15 that is arranged on top of the back-sheet layer 22 to prevent shorts between the rear side of the solar cells and the back-sheet layer 22.

The back-contact solar cells 21 are embedded between the front and rear encapsulant layers 13, 15. Gaps G between adjacent solar cells 21 are filled by the encapsulant layers. On top of the front encapsulant layer 13, a front cover layer 12 is arranged.

In the cross-section of figure 3 the connections 24 between the back-contact areas of the solar cells and the back-sheet provided with the conductive pattern are only shown very schematically. The skilled in the art will appreciate that the connections 24 comprise both negative and positive polarities that connect to different portions of the conductive pattern.

In an embodiment, the front and rear plates 17, 18 of the plated honeycomb panel 16 consist of reinforced plastic or composite material, comprising a plastic matrix material with embedded fibre material.

Figure 4 shows a cross-section of a solar panel in accordance with an embodiment of the invention.

Similar as in figure 3, the solar cells arranged in the solar panel 30 are back contact type solar cells, selected from Emitter Wrap Through (EWT), Metal Wrap Through (MWT), Interdigitated Back Contact (IBC) or other back contact (BC) solar cell types.

In the cross-section of figure 4, the solar panel 30 comprises a front cover layer 12, a front and rear encapsulant layer 13, 15, back contact solar cells 21, a conductive pattern 26 and a plated honeycomb panel 16 acting as rear side carrier.

The conductive pattern 26 is arranged the front side plate of the honeycomb panel 16 facing towards the back contact solar cells.

That is, the electrically conductive pattern 26 is applied on the surface of the plate of composite material of the plated honeycomb panel that faces the solar cells.

On the conductive pattern 26 connections 24 are present that provide electrical contact to back contact areas of the back-contact type solar cells 21. The connections 24 extends through local openings 25 in the rear side encapsulant layer 15 that is arranged between the rear side of the solar cells and the conductive pattern 26.

The back-contact solar cells 21 are embedded between the front and rear encapsulant layers 13, 15. Gaps G between adjacent solar cells 21 are filled by the encapsulant layers. On top of the front encapsulant layer 13, a front cover layer 12 is arranged.

In an alternative for the embodiments shown in figure 3 or 4, the conductive contacting pattern is arranged on the front side of the solar panel, with the conductive contacting pattern arranged between the front cover layer 12 and the layer holding the solar cells. The layer holding the conductive contacting pattern is transparent.

In an embodiment, the solar panel is constructed by a method starting from the plated honeycomb panel. Such a method to form a solar panel stack comprises in a sequence:

- providing a plated honeycomb panel;
- arranging a first encapsulant layer on a surface of the honeycomb panel;
- arranging a plurality of solar cells on the encapsulant layer;
- arranging a second encapsulant layer on the plurality of solar cells;
- arranging a front cover layer on the second encapsulant layer, and

exposing said solar panel stack to elevated temperature.

Intermediate steps may be performed at some stage of the process depending on the types of solar cells being used and/or on the arrangement of the conductive connections between the solar cells and/or connections between the solar cells and external terminals (e.g. junction box).

Additionally, the skilled in the art will appreciate that alternatively the method to construct the solar panel may start from the front cover layer comprising in a sequence:

- providing a front cover layer;
- arranging an encapsulant layer on top of the front cover layer;
- arranging a plurality of solar cells on the encapsulant layer;
- arranging a second encapsulant layer on the plurality of solar cells;
- arranging a plated honeycomb panel on the second encapsulant layer, and

exposing said solar panel stack to elevated temperature.

The invention has been described with reference to the preferred embodiment. Obvious modifications and alterations will occur to the skilled in the art upon reading and understanding the preceding detailed description. It is intended that the invention

be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims.

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Claims

1. Solar panel comprising a front cover layer, a plurality of solar cells and a back construction, the plurality of solar cells being arranged between the front cover layer and the back construction, the back construction being shaped from a plated honeycomb panel comprising a honeycomb plate that is arranged in between two plates of composite material,
the plurality of solar cells being embedded in an encapsulant layer between the front cover layer and the back construction,
wherein the solar cells are back-contact type cells, the back construction comprises an electrically conductive layer provided with a pattern, the back contacts on the rear side of each solar cell being connected by a conductor to the pattern, and wherein the electrically conductive layer is arranged on the surface of the plate of composite material of the plated honeycomb panel that faces the solar cells and the conductor extending through an opening in the encapsulant layer between the rear side of the solar cell and the electrically conductive layer.

2. Solar panel according to claim 1, wherein the honeycomb plate is consisting of hollow cells arranged adjacent to each other, the longitudinal axis of said hollow cells being directed substantially perpendicular to a surface of the honeycomb panel.

3. Solar panel according to claim 1 or 2, wherein the plate of composite material comprises a reinforced plastic.

4. Solar panel according to claim 1, wherein the solar cells are H-cell types, the solar cells being interconnected by tabs, and the tabs are embedded in the encapsulant layer, between the solar cells and the back construction and between the solar cells and the front cover layer.

5. Solar panel according to claim 1, wherein the solar cells are back-contact type cells, the solar panel comprising a back sheet contact layer provided with an electrically conductive pattern, the back sheet contacts of each solar cell being

connected through a conductor with the electrically conductive pattern;
the back layer with electrically conductive pattern being arranged between the rear side of the encapsulant layer and the surface of the plated honeycomb panel and the conductor extending through an opening in the encapsulant layer.

6. Solar panel according to claim 1, wherein the back contact type cells are selected from a group comprising the types "emitter wrap through (EWT)", "metal wrap through (MWT)", "interdigitated back-contact (IBC)".

7. Solar panel according to any one of the preceding claims, wherein the front cover layer is selected from a glass layer, a plastic layer or a plastic foil.

8. Solar panel according to claim 7, wherein the glass layer has a thickness of 2 mm or less.

9. Solar panel according to any one of the preceding claims 1 – 8, wherein the encapsulant layer is one selected from a group comprising ethyl-vinyl-acetate, poly vinylbutryal and poly-olefine.

10. Solar panel according to any one of the preceding claims, wherein the solar panel is self-carrying.

11. Solar panel according to claim 9 or 10, wherein the solar panel is frame-less.

12. Wall covering element comprising a solar panel according to any one of the preceding claims 1 – 11.

13. Method for manufacturing a solar panel according to one of the claims 1 – 12, comprising:
forming a solar panel stack which in sequence comprises:
- providing a front cover layer;
- arranging an encapsulant layer on top of the front cover layer;
- arranging a plurality of solar cells on the encapsulant layer;

- arranging a second encapsulant layer on the plurality of solar cells;
- arranging a plated honeycomb panel that comprises a honeycomb plate arranged in between two plates of composite material on the second encapsulant layer, and exposing said solar panel stack to elevated temperature,
wherein the solar cells are back-contact type cells, the method further comprising after arranging said second encapsulant layer on the plurality of solar cells and and preceding arranging said plated honeycomb panel on the second encapsulant layer:
creating openings in said second encapsulant layer corresponding with positions of back contacts on said solar cells;
wherein the surface of the plate of composite material of the plated honeycomb panel facing the second encapsulant layer is provided with a patterned electrically conductive layer with a pattern corresponding to said openings and conductor elements on the positions of back contacts on said solar cells.

14. Method for manufacturing a solar panel according to one of the claims 1 – 12, comprising:
forming a solar panel stack which in sequence comprises:
- providing a plated honeycomb panel that comprises a honeycomb plate arranged in between two plates of composite material, wherein the surface of the plate of composite material of the plated honeycomb panel that will be facing the solar cells is provided with a patterned electrically conductive layer with a pattern corresponding to positions of back contacts on said solar cells;
- arranging a first encapsulant layer on a surface of the honeycomb panel;
- arranging a plurality of solar cells on the first encapsulant layer;
- arranging a second encapsulant layer on the plurality of solar cells;
- arranging a front cover layer on the second encapsulant layer, and
exposing said solar panel stack to elevated temperature,
wherein the solar cells are back-contact type cells, and the method further comprises
after arranging said first encapsulant layer on said plated honeycomb panel:
creating openings in said first encapsulant layer corresponding with the positions

of the back contacts on said solar cells.

15. Method according to claim 13, further comprising:
during arranging said plurality of solar cells on the encapsulant layer: arranging tabs for interconnecting said solar cells, said solar cells being H-cell type cells.

16. Method according to claim 13, wherein the solar cells are back-contact type cells, the method further comprising
after arranging said second encapsulant layer on the plurality of solar cells and preceding arranging said plated honeycomb panel on the second encapsulant layer:
creating openings in said second encapsulant layer corresponding with positions of back contacts on said solar cells;
arranging a back contact layer sheet provided with an electric conductive pattern corresponding to said positions of back-contacts over said second encapsulant layer, with conductor elements on the contact layer at the positions of back contacts on said solar cells and
arranging an insulating layer over said back sheet contact layer.

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Fig. 1

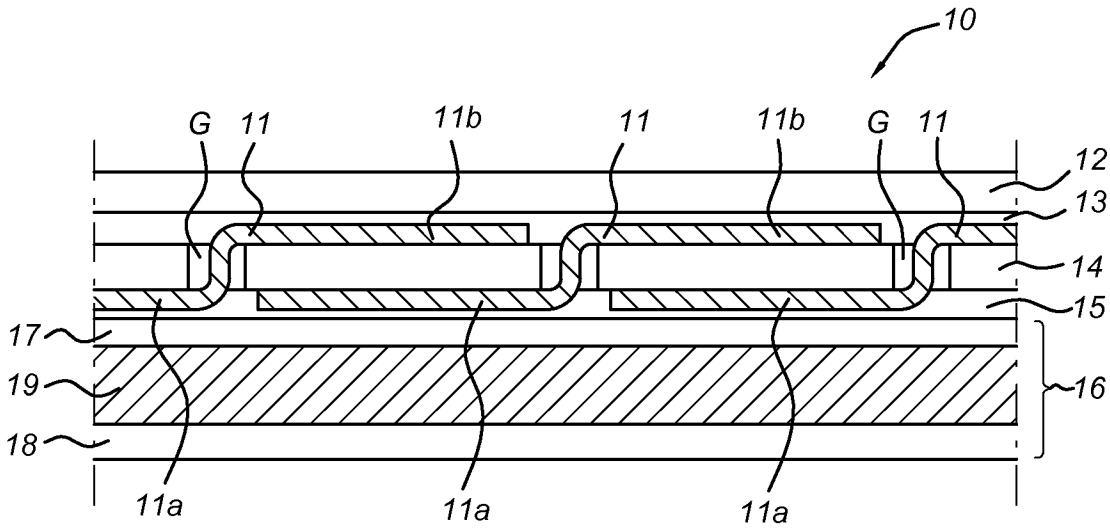
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Fig. 2

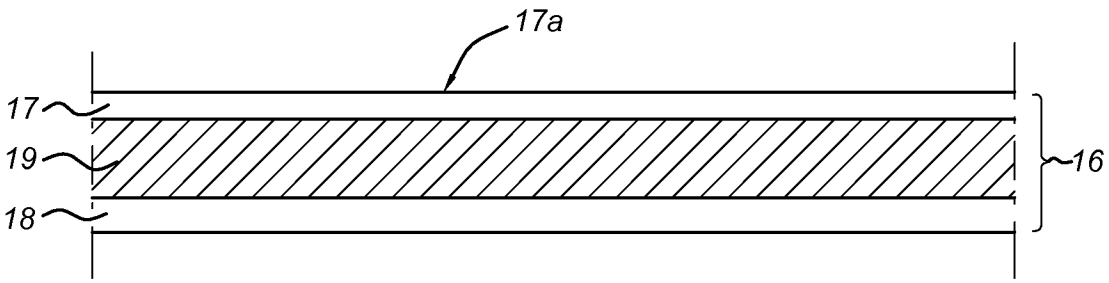
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Fig. 3

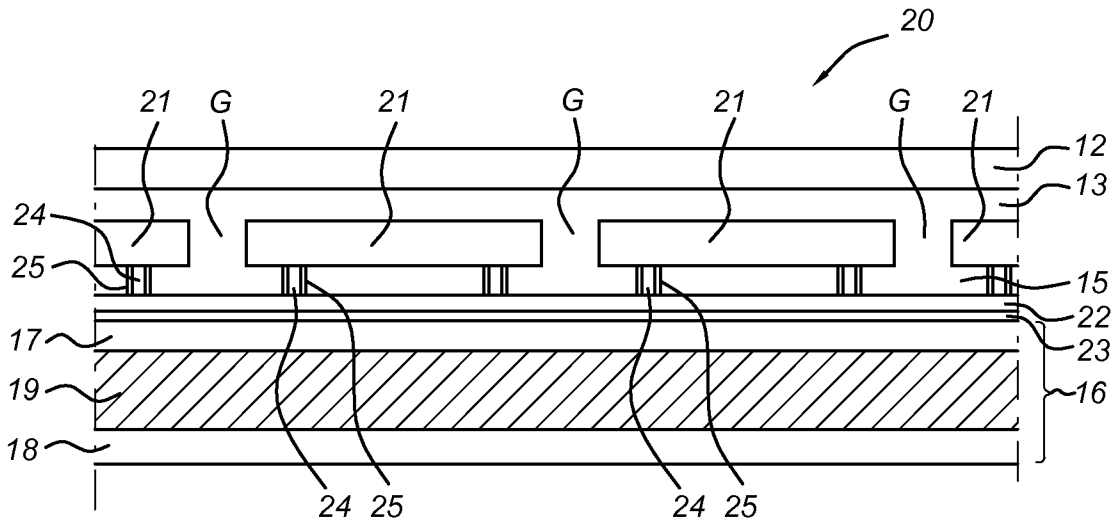
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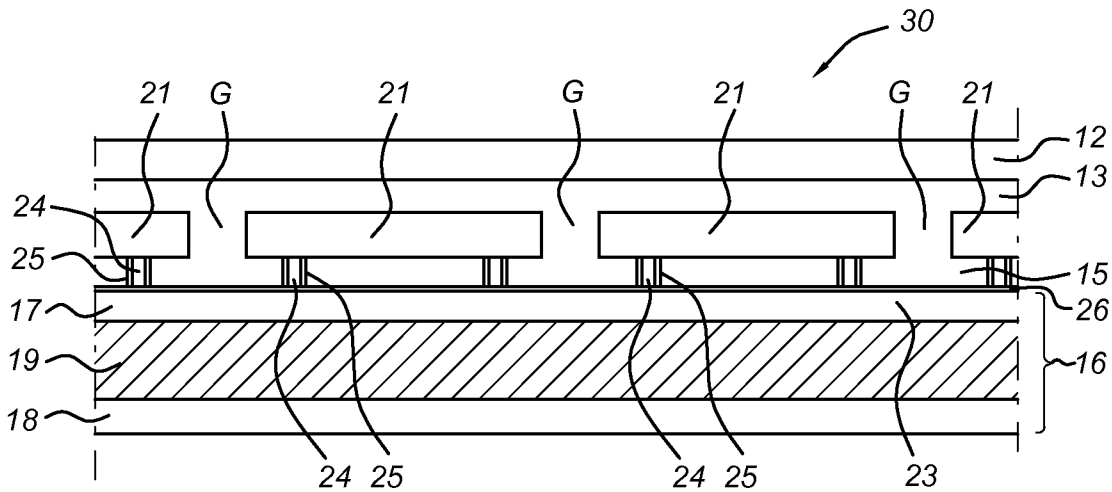
Fig. 4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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/097011

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01L31/049 H01L31/024 H01L31/05 H01L31/18
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 10 2011 104376 A1 (DAIMLER AG [DE]) 5 January 2012 (2012-01-05) paragraphs [0006], [0007], [0021] - [0029]; figures 1-8	1-16
Y	WO 2013/063738 A1 (DU PONT [US]; LIU ZELIN [CN]; WU QIUJU [CN]) 10 May 2013 (2013-05-10) page 9, line 11 - page 20, line 15; figures 4a-4f	1-16
X	US 2012/156824 A1 (STREETT ANDREW [US]) 21 June 2012 (2012-06-21) paragraphs [0024] - [0025], [0038] - [0044]; figures 3-6	1-13,15

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
29 May 2015	09/06/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Rodríguez-Gironés, M

INTERNATIONAL SEARCH REPORT

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