Description

Method for producing a photovoltaic module, and photovoltaic module

Field of application and prior art

[0001] The invention relates to a method for producing or electrically connecting a photovoltaic module having a plurality of solar cells according to the preamble of claim 1, and to such a photovoltaic module.

[0002] During the production of a photovoltaic module composed of a plurality of solar cells, often so-called strings or chains of a plurality of solar cells are placed onto a front-side carrier glass alongside one another with the interposition of a laminating film, to be precise usually a plurality of such chains of solar cells alongside one another. These chains are longitudinally contact-connected to contacts on the front side and the rear side for the two poles of the electrical connections, to be precise advantageously a plurality of such connections both on the front side and on the rear side. Transverse contact wires run at a front side of the solar cells, said transverse contact wires being connected to the connections on the front side and the rear side of the solar cells. The transverse contact wires lead together to a connection device that is subsequently to be fitted, for example a so-called connection box. The latter serves for the electrical connection of the entire photovoltaic module. The solar cells in turn then have a further laminated film placed onto them and, finally, a rear-side film is placed thereon. This is followed by the lamination of the photovoltaic module and then the fitting of the connection device as electrical contact-connection to the transverse contact wires.

[0003] At the present time, transverse contact wires are bent through 90° from the front edge of the solar cells and placed onto the rear side of the solar cells for the purpose of subsequent electrical connection to the connection device. For this purpose, the transverse contact wires have to be manually led in complex fashion through cutouts in the rear-side film and the laminating film at the rear side of the solar cells. This is disadvantageous.

Object and how it is achieved

[0004] The invention is based on the object of providing a method mentioned in the introduction, and a corresponding photovoltaic module, with which problems in the prior art can be eliminated and, in particular, a possibility of an electrical connection to a photovoltaic module can be achieved which is simple to carry out and is readily automated.

[0005] This object is achieved by means of a method having the features of Claim 1 and a photovoltaic module having the features of Claim 11. Advantageous and preferred configurations of the invention are the subject matter of the further claims and are explained in greater detail below. Some of the features below are described only for the method or only for the photovoltaic module itself. Independently of this, however, they are intended to be able to apply both to the method and to the photovoltaic module. The wording of the claims is incorporated by express reference in the content of the description.

[0006] According to the invention, a plurality of connections of identical polarity of the solar cells are connected to one another via the transverse contact wires and the transverse contact wires are led alongside or in front of the solar cells above a front-side carrier glass. In this case, they can advantageously bear on the carrier

glass or on a laminating film directly on the carrier glass. Furthermore, the transverse contact wires are led below the rear-side film, which also runs above the solar cells. The transverse contact wires are bent together or folded up together in such a way that they have a larger thickness or the multiple of their own thickness in accordance with the folding and protrude or extend from the carrier glass or project above the latter. These protruding bent regions of the transverse contact wires are led through previously produced cutouts in the rear-side film, if appropriate also in a laminating film placeded between solar cells and rear-side film. As a result of the larger thickness, the transverse contact wires project above the rear-side film or above the surface thereof.

[0007] These folded or bent regions advantageously still lie within the cutout of the films, such that they do not have to be specially moved or led through. The abovementioned electrical connection, which will be described in detail below, can then easily be carried out at these folded or bent regions. What can be achieved as a result of the transverse contact wires being bent together or folded up is that they as it were automatically project above the surface of the rear-side film and can readily be reached for the electrical connection.

[0008] In an advantageous configuration of the invention, a transverse contact wire is folded up at least once, such that the thickness is therefore at least doubled. Particularly advantageously, it is bent or folded up twice or three times. A multiple folding-up can be effected at least in part with a coiling folding, whereby it is possible to begin the folding from the end of the transverse contact wire. However, this is crucially dependent on a production-technological optimization of the folding. In this case, in a further configuration of the invention it may be provided that the transverse contact wires remain along their general longitudinal orientation including during folding and in the folded state, that is to say that no

bendings towards the side are performed. The number of instances of folding-up is also dependent on the thickness of the laminating film and the rear-side film. As an advantageous thickness of a laminating film, approximately 0.4 mm can be taken as a basis, and somewhat less for the rear-side film. A transverse contact wire, which is advantageously a tin-plated wire, which can particularly advantageously be composed of copper, can have a thickness of 0.3 mm to 0.5 mm. Consequently, a sufficient height and a sufficient overhang of the folded or bent regions above the films can therefore be achieved with two or even better with three bends. The width of a transverse contact wire can be at least 3 mm, advantageously approximately 5 mm.

[0009] In an advantageous configuration of the invention, the transverse contact wires are led near the front edges of the front solar cells, and in particular parallel to one another, including those of connections of different polarity. Particularly advantageously, the transverse contact wires run at the narrow sides of the photovoltaic module, such that they can be kept shorter. Transverse contact wires of different polarity should have a distance of a few millimetres with respect to one another.

[0010] In yet another advantageous configuration of the invention, a single connection device with a plurality of regions of folded-up transverse contact wires can be provided per photovoltaic module. If a photovoltaic module has for example six abovementioned stringers of solar cells, then it is regarded as advantageous to provide two of such connection devices. Either specific solar cells or stringers can be provided per connection device or both connection devices lie as it were parallel to one another and are respectively connected to all the solar cells.

[0011] Per connection device, which in each case has both poles of the solar cells or the electrical connections thereof, two folded regions of transverse contact wires can advantageously be provided per pole. These can be led from the left and from the right to the connection device. In this case, it is also possible to offset the folded regions relative to one another in such a way that they are spatially separated and cannot be confused. Thus, by way of example, the transverse contact wires connected to front-side contacts of the solar cells can in each case run very close to the solar cells, and the others at a somewhat greater distance therefrom. The transverse contact wires which are led more closely to the solar cells can, if they come to the connection device from the left and right, be led closer to one another than the other transverse contact wires.

[0012] In yet another development of the invention, the cutouts are produced, for example by being stamped out, in the rear-side film, in particular also in the laminating film placed onto the solar cells on the rear side, prior to placement. The cutouts advantageously have a rectangular form or square form. They should be significantly larger than the folded-up regions of the transverse contact wires themselves in order to compensate for tolerances and, primarily in the case of the laminating film, in order to compensate for areal spreading during lamination. By way of example, they can have approximately a length double that of said regions and a width that is a multiple of the width of said regions. The cutouts in the rear-side film and the laminating film should lie one above another.

[0013] An overhang of the bent-up or folded-up transverse contact wires above the top side of the rear-side film is intended to be at least 0.1 to 0.2 mm. A reliable electrical connection is thus possible, under certain circumstances even by means of a pressed-on contact connection in the connection device. This is effected after

the lamination of the photovoltaic module. The connection device can then be fixed to the edge of the carrier glass or of an edge profile connected thereto. Fixing is likewise possible by adhesive bonding to the rear-side film. For this purpose, the connection box can have a closable cover, for example, which is put on after the fixing of the connection box and the production of the electrical connections to the transverse contact wires. An electrical connection of the connection device to the transverse contact wires can either be effected by abovementioned pressure contacts or the like that are present. For reliable contact-connection, however, soldering or welding is recommended in order to avoid later contact-connection problems.

[0014] These and further features emerge not only from the claims but also from the description and the drawings, wherein the individual features can be realized in each case by themselves or as a plurality in the form of subcombinations in an embodiment of the invention and in other fields and can constitute advantageous and inherently protectable embodiments for which protection is claimed here. The subdivision of the application into individual sections and sub-headings do not restrict the general validity of the statements made thereunder.

Brief description of the drawings

[0015] An exemplary embodiment of the invention is illustrated schematically in the drawings and is explained in greater detail below. In the drawings:

Figure 1 shows an oblique view from below of solar cells with transverse contact wires that are bent up multiply at their end regions,

Figure 2 shows a plan view of the arrangement from Figure 1 from the rear side, and

Figure 3 shows a side view precisely of the folded-up end regions of the transverse contact wires.

Detailed description of the exemplary embodiments

[0016] Figure 1 illustrates, in a view obliquely from below, how a plurality of solar cells 11, represented by way of example by two of such solar cells, are provided. They have front contacts 12 at front sides 13, as is generally known. Running above said front contacts 12 are collective contacts 15 formed by flat wires, which project somewhat beyond the side edges of the solar cells 11. In Figure 1, in the direction of the collective contacts 15, the solar cells 11 are provided in the form of so-called stringers, that is to say that, by way of example, six to ten solar cells 11 are connected as a chain. A plurality of said stringers in turn are arranged alongside one another, for example four or six.

[0017] Transverse contact wires 17 run in front of the solar cells 11, wherein transverse contact wires 17a run very close to the solar cells 11, for example at a distance of a few millimetres. Transverse contact wires 17b run parallel thereto and are formed identically, in particular, and they have a distance of a few millimetres with respect to the transverse contact wires 17a.

[0018] Folded regions 19a and 19b are provided at the illustrated ends of the transverse contact wires 17, which regions will be explained in greater detail with respect to Figure 3. They form as it

were the end of the transverse contact wires. It can also be discerned that the ends or folded regions 19a of the transverse contact wires 17a are very much closer to one another than the folded regions 19b of the transverse contact wires 17b.

[0019] It can be seen from Figure 1 and also Figure 2 that the collective contacts 15 are connected and contact-connected to the transverse contact wires 17a, preferably by soldering or welding thereto. Thus, as it were one of two electrical connections to the solar cells 11 can therefore be provided via the transverse contact wires 17a which are connected towards the left and right to further collective contacts 15 of front contacts 12 of solar cells 11. The illustration does not show rear-side contacts at the solar cells 11, which pass to the transverse contact wires 17b running somewhat further away and are electrically connected or welded thereto. However, this can readily be imagined and realized by the person skilled in the art.

[0020] It can also be seen from the plan view from Figure 2 how a front edge of a laminating film 24 projects somewhat beyond the transverse contact wires 17b and thus covers them well. The front edge of said laminating film 24 corresponds to the front edge of a carrier glass 22 illustrated in Figure 3, onto which carrier glass the solar cells 11 are placed by their front sides 13 with the interposition of a further laminating film (not illustrated). It is as it were a side edge of the entire finished photovoltaic module 30, the assembly of which is illustrated schematically in Figure 3.

[0021] Figure 2 primarily also illustrates how a rear-side film 26 is provided with cutouts 27 before it is placed over the rear sides of the solar cells 11 and the transverse contact wires 17. In this case, cutouts 27a are somewhat further away from a side edge and closer to one another than cutouts 27b. As can be discerned from Figure 3,

laminating film 24 and rear-side film 26 are placed onto the rear side of the solar cells 11, the laminating film 24 also having cutouts corresponding to those of the rear-side film 26. During placement in accordance with Figure 3, the folded regions 19a project through the cutouts 27a in the rear-side film 26 and the corresponding cutouts in the laminating film 24. The folded regions 19b likewise project through the cutouts 27b in the laminating film 24 and the rear-side film 26. It may be provided, as can be discerned from Figure 2, that the cutouts 27 are somewhat larger than folded regions 19, but not much larger.

[0022] It can be seen from Figure 3 that the transverse contact wires 17 are folded three times at the folded regions 19, that is to say have four times the thickness of the transverse contact wire. The folding is effected in such a way that an end region of the transverse contact wire having a length of one centimetre to two centimetres, for example, is reciprocally placed twice onto one another and then folded up inwards away from the end. Other foldings or bendings are also possible, as explained initially. Advantageously, all the folded regions 19 have the same height. This means that a uniform folding operation can be carried out and electrical connection devices, which, although not illustrated here, can easily be realized by the person skilled in the art, can therefore be embodied identically in each case.

[0023] It can be discerned from the figures precisely how, after the transverse contact wires 17 have been folded to form the folded regions 19, the latter protrude in accordance with Figure 3 and, during the placement of the laminating film 24 and the rear-side film 26, they project through the cutouts 27 therein and, on account of their height, project above the top side of the rear-side film 26. After the photovoltaic module 30 has been laminated, too, the folded

regions 19 of the transverse contact wires 17 still project and can readily be electrically connected, as explained in principle initially.

[0024] For this purpose it is also unimportant whether, in the finished photovoltaic module, a single such connection array with folded regions 19 is provided, or two or three for example. This depends on the design and the electrical power of the photovoltaic module.

Patent Claims

1. Method for producing or electrically connecting a photovoltaic module having a plurality of solar cells, at least two of which in each case are interconnected in a series circuit, wherein said series circuit has two connections, and wherein the connections of a plurality of series circuits are brought together to a connection device, characterized in that in each case a plurality of connections of identical polarity are connected to one another via transverse contact wires, which are led alongside the solar cells above a front-side carrier glass below a rear-side film, wherein the rear-side film runs above the solar cells and the transverse contact wires, wherein the transverse contact wires are bent together or folded up to a larger thickness extending away from the front-side carrier glass, wherein the transverse contact wires are led through cutouts in the rear-side film and project above said rear-side film for subsequent electrical connection.

2. Method according to Claim 1, characterized in that a transverse contact wire is folded up at least once, preferably twice, wherein in particular a multiple folding-up with coiling folding is effected.

3. Method according to Claim 1 or 2, characterized in that the transverse contact wires are led along near the front edges of the front solar cells and in particular parallel to each other, preferably with a distance of only some mm to each other.

4. Method according to one of the preceding Claims, characterized in that cutouts are produced in the rear-side film

before its placement over the solar cells, preferably by stamping out.

5. Method according to Claim 4, characterized in that the cutouts have a rectangular form.

6. Method according to one of the preceding Claims, characterized in that the folded-up transverse contact wires are also led through cutouts in an adhesive or laminating film placed between the solar cells and rear-side film, wherein preferably the cutouts in the adhesive or laminating film correspond to the cutouts in the rear-side film when placed one on top of another.

7. Method according to one of the preceding Claims, characterized in that the rear-side film together with the adhesive or laminating film according to Claim 6 remains below the bent-up or folded-up transverse contact wires in such a way that the transverse contact wires project somewhat above the top side of the rear-side film, preferably with an overhang of at least 0,1 mm to 0,2 mm.

8. Method according to one of the preceding Claims, characterized in that, after the placement of the rear-side film, a laminating step is effected and the electrical connection is subsequently carried out with connection units being connected, in particular soldering, to the transverse contact wires, in particular connections of different polarity in a common connection box.

9. Method according to Claim 8, characterized in that firstly a connection to the connection units is effected and then a

connection box is fixed to the photovoltaic module, in particular adhesively bonded.

10. Method according to one of the preceding Claims, characterized in that a plurality of electrical connections are provided in proximity to one another, in particular two connections per same connection pole with one transverse contact wire, wherein preferably connections of different polarity are arranged offset with respect to one another.

11. Photovoltaic module, in particular produced by a method according to one of the preceding Claims, having a plurality of solar cells, at least two of which in each case are interconnected in a series circuit, wherein said series circuit has two connections, and wherein the connections of a plurality of series circuits are brought together to a connection device, characterized in that in each case a plurality of connections of identical polarity are connected to one another via transverse contact wires which are led alongside the solar cells above a front-side carrier glass below a rear-side film, wherein the rear-side film runs above the solar cells and the transverse contact wires, wherein the transverse contact wires are bent together or folded up to form a larger thickness extending away from the front-side carrier glass and are led through cutouts in the rear-side film and project above said rear-side film for electrical connection.

12. Photovoltaic module according to Claim 11, characterized in that a transverse contact wire is a tin-plated wire, preferably made of copper.

13. Photovoltaic module according to Claim 11 or 12, characterized in that a transverse contact wire is a flat wire having a

width of at least 3 mm, in particular about 5 mm, wherein it preferably has a thickness of 0.3 mm to 0.4 mm.