**Title of invention: Equipping a conveying unit during the production of solar modules**

The invention relates to a method for producing solar modules, wherein solar elements are combined to form lines, wherein each line comprises at least two solar elements and wherein the solar modules are constructed from electrically interconnected lines.

The solar elements which are combined to form lines may be solar cells, photovoltaic solar cells, photovoltaic cells or partially sectioned parts thereof, what is known as shingle, that is to say for example solar cell shingle or photovoltaic cell shingle.

In such a method, individual solar elements or basic elements of a solar cell may be passed in lines onto a transfer unit, the transfer unit may be displaced into an assembling region and in the assembling region the solar elements may be deposited in lines on a tray or another conveying unit, in particular a motorized conveying unit. The depositing of the solar element on the motorized conveying unit for provision of a solar module is also referred to as equipping the solar module. The assembling region is therefore also referred to as equipping, mounting or construction region.

For the equipping of the solar module, in particular of a one-piece solar module, the lines, that is to say the lines of solar elements or solar elements arranged in lines, may be arranged so as to overlap one another along a longitudinal axis of two lines arranged next to one another. In the region of overlap, an adhesive or another fastening means for connecting the lines arranged next to one another may be applied. The adhesive may be applied, for example, to the solar elements or to the lines located on the transfer unit. For the application of the adhesive, delivery units may be used. By way of example, dispensers which can carry out linear applications of adhesive may be used. As an alternative, the adhesive may be applied by a printing apparatus. By way of example, the adhesive may be applied by means of a printing method, such as web-fed printing or screen printing. The lines provided with the adhesive may be aligned with one another and connected to one another on the motorized conveying unit and thus be combined to form a solar module.

US 2016/163914 A1 and US 2018/175233 A1 describe systems and methods for producing solar modules.

In such methods, the time required between the provision of an individual solar element and the equipping of a solar module with the individual solar element, also referred to as the cycle time, plays a decisive role. A shortened cycle time leads to a considerable shortening of the processing time for producing the entire solar module. The object on which the disclosure is based is therefore to increase the efficiency of a method for producing solar modules, in particular to accelerate such a method.

In a first aspect, the present disclosure provides a method for producing solar modules (14), wherein solar elements (15) are combined to form lines , wherein each line comprises at least two solar elements and wherein the solar modules are conducted from electrically interconnected lines, characterized in that, for the equipping of the solar module, at least two lines are picked up in one operation and held ready at different heights above the solar module, and in that, for the equipping of the solar module, the lines are lowered together in each case only to the extent that only the respective line currently to be equipped contacts the solar module.

The disclosure is based on the realization that the cycle time can be shortened by simultaneously carrying out individual method steps for a plurality of solar cells. By way of example, in the method according to the disclosure, a plurality of lines, that is to say at least two lines, are picked up in one operation from the transfer unit by a pick-up apparatus, in order to deposit these on the motorized conveying unit in a subsequent step. The motorized conveying unit constitutes, for example, a tray or a conveyor belt. In this case, the method according to the disclosure furthermore allows at least two lines to be successively deposited, which overlap after the deposition. In this way, the number of pick-up processes and the travel of the pick-up apparatus within a production process of a solar module is reduced and the time required for the production method is shortened. The efficiency of the method mentioned in the introduction is thus increased.

In one refinement, provision is made for the remaining lines to remain vertically spaced apart from the solar module. By way of example, two or three lines are picked up simultaneously by the pick-up apparatus and provided above the solar module. In the method according to the disclosure, the pick-up apparatus is able to move toward the solar module in a vertical direction until a first line, or the line currently to be equipped, contacts the solar module, for example contacts it so as to overlap a previously deposited line, and a second and third line, or the remaining lines, continue to remain vertically spaced apart from the solar module by their vertical spacing when the solar module is contacted by the first line. In this way, the pick-up apparatus can equip the solar module with a line while simultaneously guiding a plurality of lines. In one or more further deposition steps, the solar module can be equipped with the further lines.

In one refinement, provision is made for the lines to be picked up by means of suckers which are preferably vertically adjustable counter to a restoring force. By way

of example, the solar elements arranged in lines are each picked up by means of at least one sucker. In this case, the suckers may be arranged in such a way that the suckers for the first line protrude in the vertical direction beyond the suckers for the second line in the direction of the lines to be picked up. The suckers for the second line may in turn protrude vertically beyond suckers for a further, third line in the direction of the lines, etc. This enables selective pick-up or selective deposition

of an individual line, for example the deposition of the first line without depositing the second line. The suckers which are vertically adjustable for example counter to a restoring force allow a further, second line to be picked up and deposited after the first line has been picked up or deposited, in particular prior to one or more further, third lines being picked up or deposited. In other words: this thus allows a plurality of lines to be jointly picked up, in particular with a subsequent selective deposition of the jointly picked-up lines.

In the case of the method of the type mentioned in the introduction, the object mentioned in the introduction is alternatively achieved according to the disclosure in particular in that two successive lines cover different distances during the equipping process. By way of example, the pick-up apparatus is moved perpendicularly with respect to the lines, i.e. perpendicularly with respect to a longitudinal direction of the lines, during the equipping process. By way of example, a first line and at least a second line are picked up by the pick-up apparatus. In this case, the pick-up apparatus is moved, e.g. displaced in a motorized or mechanical manner, perpendicularly with respect to and relative to the first line for example after the first line has been deposited on the motorized conveying unit and prior to deposition of the second line on the motorized conveying unit. In this way, during the equipping, a movement of the motorized conveying unit is supplemented and/or replaced by a movement of the pick-up apparatus, which moves the lines from the transfer unit onto the conveying unit. This makes it possible for the individual lines to be arranged on the conveying unit in an effective manner in terms of time and space.

Provision is made according to the disclosure for two successive lines to be picked up in one operation during an equipping process for equipping the solar module. Provision is also made according to the disclosure for the two successive lines to cover distances of differing length during the equipping process.

In one refinement, provision is made for the solar module to remain positionally fixed during the equipping process with the two successive lines. In other words: in this refinement, the conveying unit is not moved during the equipping. In this refinement, after the first line has been deposited, the pick-up apparatus may move perpendicularly with respect to the deposited first line, in order for the second line for equipping the solar module to be deposited on the conveying unit so as to adjoin and overlap the first line. In this way, the relative arrangement of the lines is determinable or settable at least also by the movement of the pick-up apparatus. As an alternative, the conveying unit is moved during the equipping.

In one refinement, provision is made for the solar module to be moved in a clocked manner between two equipping processes. A clocked movement of the solar module or of the

conveying unit may be advantageous during the equipping of the conveying unit with the lines. During the equipping, the lines are aligned with one another and connected to one another on the conveying unit. A clocked forward movement makes it possible to provide space at the equipping location for new rows to be arranged on the conveying unit. It is thus conceivable for the pick-up apparatus to move, in order to successively deposit all the picked-up lines, while the conveying unit moves when the pick-up apparatus is intended to pick up a new load.

In one refinement, provision is made for the solar module to be moved in a clocked manner between two equipping processes, namely between a deposition of the lines which are picked up in the one operation and a deposition of further lines which are picked up in a further operation.

In this way, the relative arrangement of the lines during the equipping is determinable solely by the movement of the pick-up apparatus, while the movement of the conveying unit enables a smaller and thus shorter travel of the pick-up apparatus during the equipping. In this way, the equipping of the conveying unit can be carried out in a simplified, in particular more rapid, manner and with increased precision.

In one refinement, provision is made for the solar module to be moved continuously during the equipping process. In particular, the solar module is moved perpendicularly with respect to the lines during the equipping process. In other words: the conveying unit is moved continuously during the equipping process. In this way, the production process of the solar modules can be further accelerated. This is in particular because a line is moved further during and after the equipping of the module with this line and thus a subsequent method step is reached more rapidly.

In a subsequent method step, the solar modules may be moved, for example, for thermal treatment, i.e. for curing of the adhesive means in a region of thermal action, for example in a furnace. In this case, the solar modules may still be located on the conveying unit. Here, the continuous movement of the conveying unit is advantageous. This is because a clocked movement produces regions of overlap of the thermal action, produced by a different dwell time of the rows of solar cells under thermal action, which results in thermal action which is too strong or too weak and thus a striped pattern. By contrast, in the case of a continuous movement of the solar module or of the conveying unit, the solar module is moved uniformly through a region of thermal action, the adhesive applied to and between the lines curing in said region.

The movement of the conveying system may be compensated by a corresponding movement of the pick-up apparatus during the deposition of a line. In this way, a movement of

the conveying unit relative to the pick-up apparatus during the deposition of the line can be prevented. As an alternative, the duration of the deposition process may be selected such that, in particular may be selected to be so short that, the described relative movement during the depositing of the line is negligible.

In a second aspect, the present disclosure provides an apparatus for producing solar modules, wherein solar elements are combined to form lines, wherein each line comprises at least two solar elements and wherein the solar modules are constructed from electrically interconnected lines, characterized in that the apparatus comprises a pick-up apparatus which is designed, for the equipping of the solar module, to pick up at least two lines in one operation and to hold them ready at different heights above the solar module and, for the equipping of the solar module, to lower the lines together in each case only to the extent that only the respective line currently to be equipped contacts the solar module.

In one refinement, provision is made for the pick-up apparatus to be designed to hold the remaining lines vertically spaced apart from the solar module.

In one refinement, provision is made for the pick-up apparatus to comprise suckers which are preferably vertically adjustable counter to a restoring force and which are designed to pick up the lines, in particular to jointly pick up the lines in one working step.

The object mentioned in the introduction is achieved according to the disclosure in particular by providing an apparatus for producing solar modules, wherein solar elements are combined to form lines, wherein each line comprises at least two solar elements and wherein the solar modules are constructed from electrically interconnected lines, wherein the apparatus comprises a pick-up apparatus which is designed to cover different distances for at least two successive lines during the equipping process. To this end, the pick-up apparatus may be displaced in a running direction of the conveying apparatus and/or in the vertical direction, for example in a direction along the lines.

Provision is made according to the disclosure for the pick-up apparatus to be configured to pick up at least two successive lines in one operation during an equipping process for equipping the solar module.

Provision is also made according to the disclosure for the pick-up apparatus to be configured to cover distances of differing length for the at least two successive lines during the equipping process.

In one refinement, provision is made for the pick-up apparatus to preferably be

movable relative to the solar module during the equipping process, in particular to be movable in a direction transverse to the lines. As an alternative or in addition, the pick-up apparatus may

preferably be movable in a direction longitudinally with respect to the lines during the equipping process.

In one refinement, provision is made for the apparatus to comprise a conveying unit for accommodating the solar module and for the apparatus to be designed to hold the conveying unit positionally fixed during the equipping process with the two successive lines.

In one refinement, provision is made for the apparatus to be designed to move the conveying unit in a clocked manner between two equipping processes. In one refinement, provision is made for the apparatus to be designed to move the conveying unit in a clocked manner between two equipping processes, namely between a deposition of the lines which are picked up in the one operation and a deposition of further lines which are picked up in a further operation.

In one refinement, provision is made for the apparatus to be designed to move the conveying unit continuously, in particular during the equipping process.

The disclosure will be described in more detail below on the basis of a plurality of preferred exemplary embodiments.

In the figures:

figure 1A shows a three-dimensional view of a first apparatus for producing solar modules,

figure 1B shows a top view of the first apparatus,

figure 2A shows a three-dimensional view of a second apparatus for producing solar modules,

figure 2B shows a top view of the second apparatus,

figure 2C shows a side view of the second apparatus,

figure 3A shows a three-dimensional view of a third apparatus for producing solar modules,

figure 3B shows a top view of the third apparatus,

figure 3C shows a side view of the second apparatus,

figures 4A-H show a first pick-up apparatus, a transfer unit and a conveying unit of the first, second or third apparatus in side views and in different arrangements according to different method steps,

figure 5A shows a side view of a second pick-up apparatus of the first, second or third apparatus, and

figure 5B shows a three-dimensional view of the second pick-up apparatus above a conveying unit of the first, second or third apparatus, and also an exploded illustration of an