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"APPARATUS AND METHOD TO METALIZE SUPPORTS FOR PHOTOVOLTAIC CELLS"

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FIELD OF THE INVENTION

5 The present invention concerns an apparatus and a method to metalize supports used to make photovoltaic cells, that is, to print metal conductor tracks on said supports.

BACKGROUND OF THE INVENTION

10 Photovoltaic cells are known, consisting of a thin support, generally made of silicon, which is first treated in a known manner in order to increase the light-sensitivity thereof, and is then metalized, that is, it is subjected to a printing process by means of which an ink or paste of metallic composition is deposited on the support
15 in order to make the conductor tracks which define the layout of the photovoltaic cells.

20 To be more exact, it is known to perform said metalization by means of a serigraphy process, in which the support, disposed on a supporting base, is taken below and in contact with a mesh, made with interwoven metal wires, very close together, called a screen, which defines thin through fissures which reproduce the conductor tracks to be printed.

25 The screen is sprinkled with the metalization ink and subsequently subjected to pressure so as to make the ink pass through the fissures and deposit on the support below.

30 Supports for the production of photovoltaic cells are generally obtained from a block of silicon by means of a transverse cut, so as to form thin foils with a thickness of some tenths of a millimeter and of a substantially rectangular shape equivalent to the front surface intended for exposure to the sun. Although it allows to obtain supports with very regular surfaces, this production

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technique is costly because of the need to perform high-precision cutting operations.

In order to reduce these costs, supports have been obtained directly by extrusion; however, such supports,
5 commonly known as "string ribbons", have irregular surfaces, with transverse undulations which on the one hand are convenient, because they increase the useful exposure surface of the support, but on the other hand entail disadvantages during the metalization operation.

10 The presence of undulating surfaces implies both the risk of imprecise printing of the conductor tracks, and also discontinuous resting of the support on the base below, so that the pressure, even minimal, imparted by the screen to the support, often causes the latter to break.

15 A purpose of the present invention is to achieve an apparatus and a method that allow to carry out, in a precise and efficient manner, and at limited cost, the metalization of supports to make photovoltaic cells, preventing the supports from breaking during the
20 metalization process as a consequence of the pressure exerted thereon, even when the silicon supports are obtained by extrusion.

The Applicant has devised and embodied the present invention to overcome the shortcomings of the state of the
25 art, to achieve the above purpose and to obtain other advantages set forth hereafter.

SUMMARY OF THE INVENTION

The present invention is set forth and characterized essentially in the main claims, while the dependent claims
30 describe other innovative characteristics of the invention.

In accordance with the above purpose, an apparatus according to the present invention to metalize a support, advantageously made of silicon, for photovoltaic cells,

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comprises metalization means able to transfer onto a first front surface of the support a metal compound in order to achieve the conductor tracks of the photovoltaic cells, and a supporting base on which the support is able to be rested
5 with a second surface, opposite the first surface.

According to a characteristic of the present invention, the supporting base is made of an elastically yielding material, that is, with a high coefficient of elasticity, and is able to adapt to the second supporting structure,
10 inserting itself into its possible irregularities, following the action of the metalization means.

In a preferential form of embodiment, the supporting base is made of a polymeric compound, such as silicon, rubber, polyvinyl chloride (PVC) or suchlike. Advantageously, the
15 supporting base is made of silicon.

According to a variant, the supporting base is made of very soft natural rubber.

In a preferential form of embodiment, the metalization means comprises at least a screen, able to be put in
20 contact with said first surface of the support and having through fissures which reproduce the conductor tracks to be made, and at least a spreading member, able to slide and act with a determinate pressure on the screen in order to distribute the metal compound and make it pass through its
25 through fissures, so that it is deposited on the first surface of the support. In this embodiment, the supporting base is able to deform due to the effect of the pressure exerted by the spreading member on the screen and transmitted to the support to be metalized.

30 Advantageously, the spreading member is oscillating with respect to an axis of rotation substantially parallel to its direction of sliding and to a longitudinal axis of the support to be metalized.

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The spreading member is also selectively mobile towards the screen, perpendicularly to it and to the first surface of the support to be metalized.

5 The spreading member is also associated with abutment means, able to cooperate with mating end-of-travel means, in order to limit the travel thereof, and the pressure exerted on the screen.

10 In a preferential form of embodiment, the spreading member comprises at least a spatula or blade, provided at the lower part with an edge made of elastically yielding material, able to act directly on the screen.

BRIEF DESCRIPTION OF THE DRAWINGS

15 These and other characteristics of the present invention will become apparent from the following description of a preferential form of embodiment, given as a non-restrictive example with reference to the attached drawings wherein:

- figs. 1 and 2 show a lateral view, partly in section, of an apparatus to metalize supports for photovoltaic cells according to the present invention in two different functioning steps;
- 20 - fig. 3 is a detail of a view from above of the apparatus in fig. 1;
- fig. 4 is a detail of a front view of the apparatus in fig. 2;
- 25 - fig. 5 is a detail of a cross section of the apparatus according to the present invention.

DETAILED DESCRIPTION OF A PREFERENTIAL FORM OF EMBODIMENT

30 With reference to the attached drawings, the number 10 denotes generally an apparatus according to the present invention able to be used to metalize supports 11 for the production of photovoltaic cells.

To be more exact, the apparatus 10 is able to print with ink or paste, of metal composition, the conductor tracks 13

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defining the lay-out of the photovoltaic cell 12 to be produced, on a first surface 11a of a support 11, advantageously made of silicon.

5 The apparatus 10 comprises a bench 17 on which a supporting structure 18 is disposed, able to move slightly both horizontally and vertically, in order to adapt its position to that of the support 11 to be printed, as will be clear hereafter.

10 On the supporting structure 18 a frame 14 is mounted in cantilevered manner, defining a through aperture 15 inside which a screen 16 is disposed and suitably clamped, that is, a mesh with a close weave, made of thin steel wires, defining a plurality of through fissures reproducing the conductor tracks 13 to be printed on the support 11.

15 Above the frame 14, also associated with the supporting structure 18, there is a spreader unit 19 provided with a head 21 mobile longitudinally, in the direction indicated by "A" in fig. 1, substantially from one end to the other of the screen 16.

20 A blade or spatula 20 is mounted on the head 21, provided below with an edge 26 made of yielding material, for example rubber or silicon, with the function of distributing and spreading the metallic ink on the screen 16, as will be explained hereafter.

25 The blade 20 is associated with a bracket 22 by means of a ball bearing 23, so as to be able to oscillate slightly with respect to said bracket 22 around an axis "X" substantially parallel to the direction "A" of movement of the head 21, that is, the longitudinal axis of the support
30 11.

The bracket 22 is associated with relative actuators able to allow the vertical movement thereof, in the direction "B" indicated in fig. 1, with respect to the head 21 and

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hence to allow a selective approach of the blade 20 with respect to the screen 16 below, until it manages to contact it, exerting thereon a desired pressure.

5 An abutment element 24 is also associated with the bracket 22, able to be disposed in contact with an end-of-travel 25, solid with the head 21, in order to limit the pressure able to be exerted by the blade 20 on the screen 16.

10 A mobile platform 27 is mounted sliding on the bench 17, able to be selectively moved from a first position, in which it is disposed laterally to, in this case in front of, the frame 14, to a second position, in which it is disposed below the screen 16.

15 Above the mobile platform 27 there is a supporting base 28 on which the support 11 is able to be rested, with a second surface 11b, opposite the first surface 11a.

The supporting base 28 is made of an elastically yielding material, that is, having a high coefficient of elasticity, such as for example natural or synthetic rubber, silicon or
20 PVC, such as to be temporarily deformable when subjected even to a minimum pressure.

The apparatus 10 is advantageously completed by a delivery member, able to deliver the metallic ink used for printing the conductor tracks 13 onto the screen 16, and by
25 display means cooperating with a command and control unit, in order to determine the correct positioning of the frame 14 and hence of the screen 16 according to the position of the support 11 on the supporting base 28.

30 The apparatus 10 as described heretofore functions as follows.

With the mobile platform 27 in its first position, the support 11 is first of all disposed on the supporting base

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28, so as to rest on the latter with its second surface 11b.

In the case of supports 11 made directly by extrusion, and therefore having undulations 29, or other surface irregularities, the support 11 is advantageously disposed
5 with the undulations 29 directed parallel to the edge 26 of the blade 20, that is, orthogonal to the axis "X" (fig. 5).

The display means detect the exact position of the support 11 and the command and control unit determines a
10 correlated movement on the horizontal plane of the frame 14, in order to center it with respect to the support 11 in the condition where the mobile platform 27 is in its second position.

Subsequently, the mobile platform 27 is disposed in its
15 second position and the supporting structure 18 is lowered, so as to take the screen 16 to rest on the first surface 11a of the support 11.

Then, after the delivery member has delivered the metallic ink onto the screen 16, the spreader unit 19 is
20 activated.

To be more exact, the bracket 22 is lowered, until it determines contact between the abutment element 24 and the end-of-travel 25, for a travel "c" correlated to the gap "l" initially present between the edge 26 of the blade 20
25 and the screen 16, so that the blade 20 moves into contact with the screen 16, exerting a determinate pressure on the latter.

In this condition, the head 21 is made to advance progressively, so that the blade 20, with its edge 26,
30 distributes the metallic ink on the screen 16, making it pass through its through fissures, in order to deposit it on the first surface 11a of the support 11, thus achieving the conductor tracks 13.

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In the presence of the undulations 29 of the support 11, the pressure exerted by the blade 20 on the screen 16, and hence on the support 11 and on the supporting base 28 below, determines a slight flexion of the screen 16 which, under the thrust of the blade 20, deforms elastically according to the profile of the undulations 29, thus allowing to carry out a print of the conductor tracks 13 which is more precise and efficient.

Moreover, the yielding of the material of which the supporting base 28 is made causes the upper surface of the latter to adapt to the profile of the undulations 29, filling the concavities of the second surface 11a, so as to guarantee a continuous and complete support for the support 11, limiting or substantially canceling the risk of breakage of the support 11 during the metalization process.

It is clear, however, that modifications and/or additions of parts or steps may be made to the apparatus 10 and the method to metalize supports for photovoltaic cells as described heretofore, without departing from the field and scope of the present invention.

For example, the spreader unit 19 and/or the frame 14 with the screen 16 can be replaced by other means suitable to obtain the print of the conductor tracks 13 on the support 11.

It is also clear that, although the present invention has been described with reference to specific examples, a person of skill in the art shall certainly be able to achieve many other equivalent forms of apparatus, or perfect analogous methods to metalize supports for photovoltaic cells, having the characteristics as set forth in the claims and hence all coming within the field of protection defined thereby.

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CLAIMS

1. Apparatus to metalize a support (11) for photovoltaic cells having a first front surface (11a), on which conductor tracks (13) are able to be made, and a second surface (11b), opposite said first surface (11a), wherein
5 said apparatus comprises metalization means (16, 19, 20) able to transfer onto said first surface (11a) a metal compound in order to achieve said conductor tracks (13) and a supporting base on which said support (11) is able to
10 rest with said second surface (11b), characterized in that said supporting base (28) is made of a material with a high coefficient of elasticity and is able to adapt to said second surface (11b) of said support (11), inserting itself into its possible irregularities (29), following the action
15 of said metalization means (16, 19, 20).
2. Apparatus as in claim 1, characterized in that said supporting base (28) is made of a polymeric compound.
3. Apparatus as in claim 1 or 2, characterized in that said supporting base (28) is made of silicon.
- 20 4. Apparatus as in claim 1 or 2, characterized in that said supporting base (28) is made of rubber.
5. Apparatus as in claim 1 or 2, characterized in that said supporting base (28) is made of polyvinyl chloride (PVC).
6. Apparatus as in any claim hereinbefore, wherein said
25 metalization means comprises at least a screen (16), able to be put in contact with said first surface (11a) and including through fissures reproducing said conductor tracks (13), and at least a spreading member (20), able to slide and to exert pressure on said screen (16) in order to
30 distribute said metal compound and make it pass through said through fissures in order to deposit it on said first surface (11a), characterized in that said supporting base (28) is able to deform due to the effect of the pressure

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exerted by said spreading member (20) on said screen (16) and transmitted to said support (11).

7. Apparatus as in claim 6, characterized in that said supporting base (28) is associated with a mobile body (27) able to be selectively moved at least from a first position, in which it disposes said supporting base (28) laterally to said screen (16), to a second position in which it disposes said supporting base (28) below said screen (16).
8. Apparatus as in claim 6 or 7, characterized in that said spreading member (20) is oscillating with respect to an axis of rotation (X) substantially parallel to its direction of sliding or to a longitudinal axis of said support (11).
9. Apparatus as in any claim from 6 to 8, characterized in that said spreading member (20) is selectively mobile towards said screen (16) and is associated with abutment means (24) able to cooperate with end-of-travel means (25) in order to limit the travel thereof and the pressure exerted on said screen (16).
10. Apparatus as in any claim from 6 to 9, characterized in that said spreading member comprises at least a spatula or blade (20), provided at the lower part with an edge (26) made of elastically yielding material able to act on said screen (16).
11. Method to metalize a support (11) for photovoltaic cells having a first front surface (11a), on which conductor tracks (13) are able to be made by means of a metal compound, and a second surface (11b), opposite said first surface (11a), wherein said method comprises at least a first step wherein first metalization means (16) reproducing said conductor tracks (13) are sprinkled with said metal compound, and a second step wherein said first

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metalization means (16) are taken into contact with said first surface (11a) in order to transfer under pressure said metal compound onto said first surface (11a) and thus achieve said conductor tracks (13), characterized in that, 5 in said second step, said support (11) is rested with said second surface (11b) on a supporting base (28) made of a material with a high coefficient of elasticity and is able to adapt to said second surface (11b) of said support (11), in order to insert itself into its possible irregularities 10 (29), following the pressure exerted by said first metalization means (16).

12. Method as in claim 11, wherein said first metalization means comprises at least a screen (16), including through fissures reproducing said conductor tracks (13), on which a 15 spreading member (20) is able to act under pressure, characterized in that in said first step said metal compound is sprinkled on said screen (16) and in said second step said spreading member (20) is made to advance on said screen (16) so as to exert thereon a defined 20 pressure and make said metal compound pass through said through fissures, making it deposit on said first surface (11a).

13. Method as in claim 12, characterized in that in said second step said screen (16) is elastically deformed so as 25 to adapt at least partly to the profile of said first surface (11a).