

TITLESOLAR PANELS AND PROCESS FOR MANUFACTURE THEREOF
FIELD OF THE INVENTION

This invention relates to solar panels,
5 particularly those comprising a plurality of
photovoltaic cells, and to a direct compression molding
process for the manufacture thereof, whereby the solar
panel can be made to conform to the shape required by
the end use.

BACKGROUND OF THE INVENTION

Solar panels useful for converting radiant energy
directly into electrical energy commonly consist of a
plurality of photovoltaic cells or wafers fixed to a
suitable support and covered by a transparent protective
15 material. Each cell on the support contains electrodes
for the transport of the current resulting from the
incident radiation and is conductively interconnected
with the other cells on the support so that the current
generated by the individual cells can be collected and
20 available to perform work.

Commercially available photovoltaic cells typically
fall into two categories, i.e., heterojunction and
Schottky barrier devices. Typical heterojunction
devices include epitaxially grown $\text{Ga}_{1-x}\text{Al}_x\text{As-GaAs}$, ZnSe-
25 GaAs , GaP-Si and ZnS-Si devices. Schottky barrier
devices are the simplest types to prepare in that they
only require an ohmic contact on the back of the device
and a transparent conductive material on the front.
Examples include transparent conductive In_2O_3 or SnO_2
30 glass on Si and GaAs substrates. Various types of
photovoltaic cells based on amorphous silicon alloys,
prepared in accordance with U.S. Patent No. 4,226,898,
are disclosed in U.S. Patent No. 4,443,652.

Solar panels or arrays of photovoltaic cells have
35 been prepared in a variety of ways. U.S. Patent No.

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3,780,424 discloses a silicon solar cell array in which a series of solar cells are provided with grid systems connected to bus bars for the collection and distribution of electric current. The solar panels disclosed therein are formed by supporting the cells on a polyimide substrate via a layer of adhesive material and covering the cells with protective transparent cover. U.S. Patent No. 3,368,596 discloses a solar cell modular assembly in which silicon photovoltaic cells are fused between two sheets of fluorinated ethylene/propylene copolymer. The solar cells in the modular assembly are provided with negative grids and collectors. U.S. Patent No. 3,849,880 discloses a method of fabricating a solar cell array in which individual solar cells are positioned on preprinted areas of a substrate by an adhesive. Electrical interconnectors must be carefully slid into place and welded.

Several methods have been developed to avoid the need to separately place the cells in an array and electrically interconnect the cells, which renders the manufacturing process labor intensive and expensive. One method described in U.S. Patent 4,084,985 involves photoetching a pattern of collector grid systems with appropriate interconnections and bus bar tabs into a plastic or glass sheet. The etched regions are then filled with a first thin conductive metal film followed by a layer of a mixed metal oxide, such as InAsO_x or InSnO_x . The resulting multiplicity of solar cells are then bonded between the protective plastic or glass sheet at the sites of the collector grid systems and a back electrode substrate by conductive metal filled epoxy to complete the fabrication of the solar panel. Another method described in U.S. Patent 4,443,652 involves utilizing an electrically conductive strip to



interconnect small area segments (electrically isolated semiconductor bodies) of each large area (collection of small area segments) to provide a first electrode of the large area photovoltaic cell and access to the substrate from the layered surface of each large area cell to provide the second electrode of that cell.

In spite of the many improvements which have been made in the art of solar panel construction, there is still a need for separate manufacturing steps to produce a solar panel large enough to produce sufficient useful power. In other words solar modules, i.e., collections of electrically interconnected cells, still need to be interconnected to form a solar panel large enough to produce sufficient power. The cell modules typically require placement in an aluminum or similar metal gasketed frame, or an injection molded plastic frame to protect the sub-module from damage, provide additional support, and provide a large enough collection of cells to provide sufficient power. Conventional adhesive lamination cannot provide adequate panels directly, and economically, are prone to moisture penetration or thermal cycling delamination, and have the additional disadvantage of generally employing very heavy rigid materials, such as glass. Conventional injection molding and compression molding have the disadvantages in processing of relatively high molding pressures as well as the product risk of delamination from thermal cycling.

It is an object of the present invention to provide a solar panel that is formed as a homogeneous substrate that is not prone to delamination. It is a further object of the present invention to provide a solar panel having the solar cells flush with the surface. A feature of the present invention is its adaptability to coatings and the like. An advantage of the present



invention is that it does not require glass plating, metal support, or in some cases adhesives. Another advantage of the present invention is that the coefficient of thermal expansion may be controlled to avoid damage during thermocycling. These and other objects, features and advantages will become more readily apparent upon having reference to the following description of the invention.

SUMMARY OF THE INVENTION

10 The present invention is directed to a solar panel comprising:

- (a) a plurality of solar cells having a first surface in contact with a conductive grid and a second supported surface;
- 15 (b) a thermoplastic substrate secured to the solar cells upon the second supported surface;
- (c) a transparent cover secured to the solar cells upon the first surface; and
- (d) means for electrical interconnectivity of the
- 20 solar cells.

There is also disclosed a process for the preparation of a solar panel. The process comprises:

- (a) arranging a plurality of solar cells having a first surface in contact with a conductive grid and a
- 25 second supported surface and means for electrical interconnectivity, in an array of solar cells having regions therebetween, the array being suitable for movement into a roll press;
- (b) introducing the array of solar cells into at
- 30 least one pair of opposed rollers and together with a backing layer in contact with the second supported surface and a surface layer filling the regions between solar cells, the backing layer and the surface layer comprising a thermoplastic material;



(c) applying pressure, and optionally heat, to the array of solar cells and the backing layer and the surface layer, sufficient to form a composite; and

(d) applying a transparent cover to the first
5 surface and the conductive grid of the solar cells.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an exploded view of a conventional design for a solar panel.

Figure 2 is an exploded view of a solar panel
10 according to the invention including solar cells with conductive grids which are placed into slots in the backing layer and connected by electrodes.

Figure 3 is an exploded view of a solar panel according to the invention including solar cells with
15 conductive grids placed into a web impregnated with thermoplastic material and connected by electrodes.

Figure 4 is an exploded view of a solar panel according to the invention and illustrating that the transparent cover can be applied to the solar cells
20 without adhesive.

Figure 5 is an exploded view of a solar panel according to the invention and illustrating that a conductive material can be applied to the solar cells and conductive grids to establish electrical
25 interconnectivity.

Figure 6A is a side view of a roll press apparatus utilized to make the present solar panels according to a process of the invention.

Figure 6B is a side view of a roll press apparatus
30 utilized to make the present solar panels according to another process of the invention.

Figures 7A and 7B are top and exploded side views of a solar panel according to the invention, including layers of thermoplastic material; and

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Figures 8A and 8B are top and exploded side views of a solar panel according to the invention and having a unique design configuration.

DETAILED DESCRIPTION OF THE INVENTION

5 The invention relates to a process for preparing solar panels by direct compression molding thermoplastic preform sheets, preferably fiber reinforced. Compression molding with fiber reinforcing thermoplastic preform sheets has advantages over other plastic molding
10 techniques in that relatively large thin flat sheets, layered or homogeneous, can be cost effectively manufactured within close physical tolerances.

Photovoltaic cells, such as those described above, are available in a wide variety of forms, any of which
15 are useful in producing the solar panels in accordance with this invention. The cells can most conveniently be purchased with a conductive grid already applied to the top of the cell and, optionally with a conductive coating on the bottom of the cell. Solar sub-modules,
20 also available commercially, are electrically interconnected collections of cells on a support. A plurality of such sub-modules may be arranged and electrically interconnected to form arrays. For purposes of the present invention it is to be understood
25 that all of these configurations of solar cells are considered as within the scope thereof.

If the cells or sub-modules are not already equipped with electrodes, so that the cells or sub-modules can be electrically interconnected in the solar
30 panel, such electrodes must be applied to the cells in some way. The electrodes can be applied by conventional techniques to each individual cell or individual sub-module or array prior to placement onto the backing layer in accordance with this invention. The electrodes
35 can also be applied by placing them in the side of the



transparent layer adjacent to the solar cells, sub-modules or arrays, positioned relative to the solar cells, solar sub-modules or arrays to provide electrical interconnectivity. Then, when the transparent layer is
5 placed on top of the backing containing the cells, sub-modules or arrays, the electrical interconnectivity can be accomplished in one step coincident with the compression step, i.e., the application of heat and pressure. Since to complete the circuits between the
10 cells, it is necessary to have a conductive material in contact with the side of the solar cell adjacent to the backing layer, if the solar cell, sub-module or array does not already have such a backing, it is necessary to apply such a conductive material either to the
15 appropriate side of the solar cell, sub-module or array prior to placement on the backing layer in accordance with this invention or to apply a conductive material to the entire backing layer or sections of backing layer prior placement of the cells onto the backing layer.

20 Typical solar cells useful in the practice of this invention include silicon-based material, such as single crystalline, polycrystalline cast ingot amorphous silicon ribbon or sheet (including polycrystalline thin film), III-V semiconductor and other non-silicon based
25 materials. Solar sub-modules useful in the practice of this invention are typically direct deposit, laser-scribed, transparent surface electrode products.

The backing layer used in accordance with this invention must contain a thermoplastic or resin useful
30 in compression molding. Typical thermoplastic resins useful in the practice of this invention include polyethylene, polypropylene, polyesters, copolyesters, thermoset (ABS), polyamides including Nylon 6, 66, 11, 12, 612, and J2, "high temperature" Nylons (such as
35 Nylon 46), polyetheretherketone (PEEK),

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polyetherketoneketone (PEKK), polymethylphenylene, polyarylates, polyimides, polyvinylidene fluoride and other thermoplastic fluoropolymers, and thermoplastic liquid crystalline polymers. Additionally, these resins
5 may be used in blends or alloys thereof according to techniques readily appreciated by those skilled in the art.

Thermoset glass or fiber reinforced sheet molding compounds, commonly available to those skilled in the
10 art, may also be employed in the backing layer. Typical thermoset resins useful in the practice of this invention include those containing unsaturated polyesters, and the like. Additionally, these resins may be used in blends or alloys thereof according to
15 techniques readily appreciated by those skilled in the art.

In addition to the resin component the backing layer can also contain other materials, such as high modulus reinforcing fibers, depending on the strength,
20 coefficient of thermal expansion flexibility and durability desired. The incorporation of the reinforcing fibers by any of a variety of techniques known to those skilled in the art imparts a desired coefficient of thermal expansion to the substrate. By
25 varying parameters such as the fiber type or orientation on filler material, desirable coefficients can be achieved.

The backing layer preferably contains reinforcing material for rigidity and/or conduction. Conductive
30 materials are necessary when the solar cells or sub-modules to be placed on the backing layer do not contain wiring or other forms of interconnection and/or conduction. Non-conductive materials include glass or other non-conductive reinforcements of random in-plane
35 discrete variety, such as those described in U.S. Patent



5,134,016, or woven or aligned reinforced sheet intimately impregnated with thermoplastic or thermoset resin. Conductive materials may consist of carbon fiber or particle, graphite fiber or particle, metal fiber or particles, metallized particles or fibers, conductive plastics, or other conductive reinforcements or fillers of random in-plane discrete variety, or woven or aligned reinforced sheet intimately impregnated with thermoplastic resin.

10 The solar cells or sub-modules can be placed onto the backing layer in a wide variety of ways. If the thermoplastic resin chosen has sufficient adhesion to hold the cells or sub-modules in place on the backing layer, no further processing is necessary prior to
15 applying a transparent covering layer. If adhesion is not sufficient, a plurality of slots can be molded in the backing layer in a predetermined pattern, the size of the slots sufficient to accommodate an individual solar cell or solar sub-module. The individual solar
20 cells or solar sub-modules can then be placed into the slots in the backing layer. The cells or sub-modules can be manually or robotically placed in the slots. If the cells or sub-modules themselves do not have a conductive material on the side adjacent to the backing
25 layer, a conductive layer must be applied to each cell or sub-module or to the backing layer per se prior to insertion of the cells in the slots.

 If a solar panel delivering very high current at low voltage is desired, the conductive material can be
30 deposited on the entire surface of the backing layer prior to placement of the cells or sub-modules thereon/therein. However, it is more common for one to want high voltage, so the conductive material should be applied so that it is positioned under each solar
35 cell or sub-module.

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The transparent covering material, which may or may not contain electrodes or other conductive material or agent embedded therein, can be any durable rigid or flexible material. The transparent covering material
5 can conveniently be applied by simple coating, e.g., spin casting, spraying, etc., of solutions of organic or inorganic materials or blends thereof. The transparent covering material can also be in the form of a film, which may or may not require an adhesive. The film can
10 simply be placed on the surface of the backing layer containing the solar cells or sub-modules and fused to the backing layer under the conditions of temperature and pressure employed in the compression molding process. If the application of the transparent material
15 occurs following compression molding of the solar cells or sub-modules to the backing layer, then the temperature and pressure are chosen in accordance with adhesive requirements. Pressures and temperatures useful in the practice of this invention are described
20 in U.S. Patent 5,134,016, which is herein incorporated by reference.

The practice of this invention can be further understood relevant to a conventional method with reference to the drawings. A traditional manufacturing
25 process is represented generally at 10 in Figure 1. Commercially available solar cells 12 are equipped with a conductive surface grid and soldered together in a series of wiring 14. After which, sheets of adhesive film 16 such as ethyl vinyl acetate are applied to the
30 top of the cells. A transparent glass or plastic film 18 such as Tefzel® fluoropolymer modified copolymer of ethylene and tetrafluoroethylene (a trademark of E. I. du Pont de Nemours and Company).. Sheets of adhesive 20 are applied to the back of the cells 12 followed by a
35 backing film 22 such as Tedlar® polyvinyl fluoride film

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(a trademark of the E. I. du Pont de Nemours and Company). The resulting sandwich is compressed and cured to form a bond between the cells, the cover and the backing material. The resulting solar sub-module is then placed in a rigid frame 24 after which electrical connections are added.

One of the embodiments of the practice of this invention is shown in Figure 2. Commercially available solar cells 12 are equipped with a conductive grid, 26. An electrode (as wiring 14), is applied to each of the solar cells 12. The resulting solar cells 12 are then placed into a backing layer 28 containing molded slots 32 optionally having a conductive material 34 in each slot 32 which is fabricated by conventional molding techniques from a thermoplastic resin and deposition. An adhesive 36 is applied to bond the solar cell 12 to the backing layer 28. A transparent covering material 36, typically in the form of a plastic sheet is bonded to the top of the sandwich by a clear adhesive film 40, such as ethylene vinyl acetate film and adhered thereto by application of temperature and pressure. Note that while the covering material 38 and adhesive 40 are depicted in cross-hatch for purposes of illustration, in actuality these components are transparent.

A second embodiment of the practice of this invention is shown in Figure 3 generally at 50. Commercially available solar cells 12 are equipped with a conductive grid 26. An electrode (as wiring 14) is applied to each of the solar cells 12. The resulting solar cells 12 are then placed onto a backing layer 28 comprising a web impregnated with thermoplastic material. The backing layer 28 and solar cells 12 are then compression molded to form a composite. A transparent covering material 38, typically in the form of a plastic sheet is bonded to the top of the sandwich



by a clear adhesive film 40, such as ethylene vinyl acetate film and adhered thereto by application of temperature and pressure.

A third embodiment of the practice of this invention is shown in Figure 4, generally at 60. Commercially available solar cells 12 are equipped with a conductive grid 26. An electrode (as wiring 14) is applied to each of the solar cells 12. The resulting solar cells 12 are then placed onto a backing layer 28 comprising a web impregnated with thermoplastic material 44. The backing layer 28 and solar cells 12 are then compression molded to form a composite. A transparent covering material 38 is applied to the surface of the compression molded solar cells 12 and backing layer 28 by spraying or other coating or casting means.

A fourth embodiment of the practice of this invention is shown in Figure 5 generally at 70. Commercially available solar cells 12 are equipped with a conductive grid 26. These are placed onto a backing layer 28 comprising a web impregnated with thermoplastic material 42, which may consist of several layers containing conductive and non-conductive materials. The backing layer 28 and solar cells 12 are then compression molded to form a composite. A transparent covering material 38 is then applied to the surface of the compression molded solar cells and backing layer by spraying or other coating or casting means. The compression molding may be accomplished through a roller-press represented generally at 80 and 90 in Figures 6A and 6B, respectively. In Figure 6A, the solar cells 12 which may or may not be partially electrically interconnected (as with back electrodes 52), are fed into a roll press 44 with the backing layer 28 and a surface layer 56 comprising a web impregnated with thermoplastic material. Sufficient pressure is

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supplied by the roll press 44 to form the composite. Heat is optionally supplied to enhance consolidation of the material, by any of a wide variety of means known to those skilled in the art. For example, the roll press
5 44 may be designed to provide necessary heat. A conductive material 42 is then applied to the surface of the solar cells 12 by a first applicator 46 to complete the electrical interconnection. A transparent covering material 38 is then applied to the surface of the
10 compression molded solar cells 12 and backing layer 28 by spraying or other coating or casting means via a second applicator 48.

In Figure 6B, the solar cells 12 may be supplied with top and bottom electrodes 54. A pincher 58 which
15 acts to bond the top and bottom electrodes 54 may supply heat and pressure. The cells are fed into a roll press 44 together with the backing layer 28 comprising a web impregnated with thermoplastic material and a surface layer 56 also comprising a web impregnated with
20 thermoplastic material. Sufficient heat and pressure are supplied by the roll press to form the composite. A conductive material 42 as in Figure 6A may then be applied to the surface of the solar cells 12 to complete the electrical interconnection if necessary. A
25 transparent covering material 38 is then applied to the surface of the compression molded solar cells and backing layer by spraying or other coating or casting means via applicator 48.

EXAMPLE 1

30 A solar cell mounted in one face of a high modulus fiber reinforced thermoplastic polyethylene terephthalate composite plaque (as depicted in Figures 7A and 7B) was formed by first placing the solar cell in a steel tool lying face down against one surface of the
35 tool, then placing a layered assembly of high modulus



fiber reinforced thermoplastic impregnated preform sheet materials in a tool to cover the solar cell, and finally molding the preform layers with heat and pressure to form a consolidated plaque with a solar cell imbedded in one surface. It was observed that the solar cell withstood the temperature and pressure required to melt consolidate the reinforced thermoplastic sheets without loss of photovoltaic efficiency and without cracking. It was further observed that electrically conductive metallic or filled thermoplastic sheets material layers can be employed to conduct current from the back of the solar cell to complete the electrical circuit to potentially interconnect with additional cells.

Molding was accomplished using a steel picture frame molding tool, consisting of two 17.8 cm by 17.8 cm blocks of 5.1 cm thick which fit in close tolerance inside a steel frame also 5.1 cm thick and 25.4 cm square. A layered preform was captured inside the tool between the two steel blocks and the tool was placed in a heated platten press, whereby heat and pressure were applied to mold the preform.

Having reference to Figures 7A and 7B, the preform for the plaque was built up from 17.8 cm by 17.8 cm square layers of composite sheet materials in the following manner: first a layer of 5 mil Du Pont Kapton® polyimide film (a trademark of E. I. du Pont de Nemours and Company) (not shown) was placed on the bottom of the mold to act as a release layer after molding. Next, a 10 cm square solar cell was centered, collector side down, on the Kapton® polyimide film. Then a layer of a 25% 1.27 cm glass fiber reinforced polyethylene terephthalate moldable composite sheet 62 having a basis weight of 500 grams per square meter was placed on the back of the solar cell. This layer had an 8 cm centered square hole 64 cut in it to

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reveal the conductive coated side of the solar cell through the hole. Next a layer of lightweight aluminum expanded metal screen 66 (as shown, copper screen) having a basis weight of 10 grams per square meter and a 5 50 mesh pattern was layered on the preform. Next, a composite sheet 62 was placed on the metal screen 66. Next were added multiple layers (as shown, four) of Essee® 500 (a trademark of E. I. du Pont de Nemours and Company) moldable composite sheet 68 having a basis 10 weight of 500 grams per square meter, where each sheet is composed of 10% 2.54 cm fiber glass dispersed randomly in plane, 40% conductive carbon particles and 50% polyethylene terephthalate. Four additional layers of a commercially available glass/polyethylene 15 terephthalate moldable composite sheet 72 were then added. A final layer of Kapton® polyimide film (not shown) was added to the top of the preform as a release film.

The resulting preform was placed in the square 20 plaque tool, which in turn was placed in an MTP-14 programmable press. The tool temperature was raised to 280°C under a pressure of 3.45×10^5 Pascals. When the temperature of the tool reached 280°C, the pressure was increased to 3.45×10^6 Pascals and held at those 25 conditions for ten minutes. After allowing the tool to cool to room temperature, the plaque was removed from the mold. The solar cell 26 was observed to be imbedded in the plaque with the upper surface flush with the plaque surface without flash covering the solar cell 26. 30 The conductive composite sheet 68 was observed to be captured between the upper and lower glass/polyethylene terephthalate layers to form an electrically conductive layer.

Using a high intensity lamp and a volt/ohm meter 35 the solar cell was observed to provide a current between

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the collector grid on the cell surface and the layer of conductive plastic visible at the edge of the plaque between the two non-conductive layers.

EXAMPLE 2

5 The procedure of Example 1 was followed except that the third layer (the metal screen 66) was in the form of a cross of 2 mil thick aluminum foil as shown in Figures 8A and 8B and the four layers of electrically conductive Essee® 500 moldable composite sheet 68 were replaced
10 with four layers of a commercially available glass/polyethylene terephthalate moldable composite sheet 71.

Using a high intensity lamp and a volt/ohm meter the solar cell 26 was observed to produce a current
15 between the collector grid on the cell surface and the aluminum foil layer contacted near the edge of the plaque through a hole in the upper conductive composite sheet layer.

It is to be appreciated that those skilled in the
20 art that a variety of modifications to the invention as described and claimed herein can be made without departing from the spirit of the scope hereof. Such modifications are contemplated as forming a portion of the exclusive property and privileges hereof.

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WHAT IS CLAIMED IS:

1. A solar panel comprising:
 - (a) a plurality of solar cells having a first surface in contact with a conductive grid and a second supported surface;
 - (b) a thermoplastic substrate secured to said solar cells upon said second supported surface;
 - (c) a transparent cover secured to said solar cells upon said first surface; and
 - (d) means for electrical interconnectivity of said solar cells.
2. The solar panel of Claim 1 wherein said solar cells comprise a silicon-based material.
3. The solar panel of Claim 2 wherein said silicon-based material is selected from the group consisting of single crystalline silicon, polycrystalline silicon, and III-V semiconductor materials.
4. The solar panel of Claim 1 wherein said solar cells comprise a non-silicon based material.
5. The solar panel of Claim 1 wherein said thermoplastic substrate is a resin selected from the group consisting of polyethylene, polypropylene, polyesters, acrylonitrile butadiene styrene, polyamides, polyetheretherketone, polyetherketoneketone, polymethylphenylene, polyarylates, polyimides, and polyvinylidene fluoride.
6. The solar panel of Claim 1 wherein said thermoplastic substrate comprises a web impregnated with thermoplastic material.
7. The solar panel of Claim 6 wherein said thermoplastic substrate further comprises reinforcing fibers.
8. The solar panel of Claim 1 wherein said thermoplastic substrate comprises a plurality of layers of thermoplastic resins.

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9. The solar panel of Claim 1 wherein said thermoplastic substrate is secured to said second supported surface of said solar cells by an adhesive positioned therebetween.

5 10. The solar panel of Claim 1 wherein said thermoplastic substrate comprises a plurality of slots which receive and secure said solar cells along at least said second supported surface thereof.

10 11. The solar panel of Claim 1 wherein said transparent cover is self adherent to said first surface of said solar cells.

12. The solar panel of Claim 1 wherein said transparent cover is secured to said first surface of said solar cells by an adhesive positioned therebetween.

15 13. The solar panel of Claim 1 wherein said transparent cover is selected from the group consisting of as film and a coating.

14. The solar panel of Claim 1 wherein said means for electrical interconnectivity comprises electrodes
20 secured to said solar cells.

15. The solar panel of Claim 1 wherein said means for electrical interconnectivity comprises conductive material contained within said thermoplastic substrate.

25 16. The solar panel of Claim 15 wherein said conductive material is selected from the group consisting of carbon fibers, graphite fibers, metal fibers, and metallized fibers.

30 17. The solar panel of Claim 15 wherein said conductive material is selected from the group consisting of carbon particles, graphite particles, metal particles, and metallized particles.

18. The solar panel of Claim 1 wherein said transparent cover is a film and said means for electrical interconnectivity comprises conductive strips

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positioned relative to and in contact with said solar cells.

19. A process for the preparation of a solar panel comprising:

5 (a) arranging a plurality of solar cells having a first surface in contact with a conductive grid and a second supported surface and means for electrical interconnectivity, in an array of solar cells having regions therebetween, said array being suitable for
10 movement into a roll press;

(b) introducing said array of solar cells into at least one pair of opposed rollers and together with a backing layer in contact with said second supported surface and a surface layer filling said
15 regions between solar cells, said backing layer and said surface layer comprising a thermoplastic material;

(c) applying pressure, and optionally heat, to said array of solar cells and said backing layer and said surface layer, sufficient to form a composite; and

20 (d) applying a transparent cover to said first surface and said conductive grid of said solar cells.

20. The process of Claim 19 wherein said transparent cover (d) is applied via a spray nozzle.

25 21. A process for the preparation of a solar panel comprising:

(a) arranging a plurality of solar cells having a first surface in contact with a conductive grid and a second supported surface, in an array of solar
30 cells having regions therebetween, said array being suitable for movement into a roll press;

(b) introducing said array of solar cells into at least one pair of opposed rollers and together with a backing layer in contact with said second
35 supported surface and a surface layer filling said



regions between solar cells, said backing layer and said surface layer comprising a thermoplastic material;

(c) applying pressure, and optionally heat, to said array of solar cells and said backing layer and
5 said surface layer, sufficient to form a composite;

(d) applying a conductive material to said first surface of said solar cells sufficient to establish electrical interconnectivity of said array; and

10 (e) applying a transparent cover to said conductive material.

20. The process of Claim 21 wherein said conductive material (d) and said transparent cover (e) are applied via spray nozzles.



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