

A SOLAR MODULE

Field of the disclosure

The present disclosure relates to a solar module and to a method of manufacturing a solar module.

5 Background

Solar modules for providing electrical energy from sunlight typically include an array of photovoltaic cells (i.e. solar cells), each comprising a semiconductor substrate.

To protect the solar cells from damage, a glass layer is provided that defines the front of the solar module (i.e. the side of the solar cell configured in use to substantially face the sun). A
10 back sheet is also provided to define a back of the solar module, which is opposite the front.

A general aim for solar module development is to increase the operational lifetime of the solar cells, balanced by a need for reduced production costs. Efforts to achieve this have focussed, in particular, on providing an encapsulant on each side of the solar cells to attach the glass layer and the back sheet to the solar cell and to fill any gaps therebetween. The solar cells are
15 typically embedded within the encapsulant during the fabrication of the module, such that the encapsulant helps to hold them in position within the module.

A known arrangement comprises an encapsulant foil formed of ethylene-vinyl acetate (EVA). While this can result in protection for the solar cell against environmental damage, there is an ongoing desire to further improve the protection for the solar cells, and therefore prolong their
20 useful life.

Summary

According to a first aspect there is provided a solar cell comprising:

- a first solar cell and a second solar cell;
- an outer casing arranged to overlie the first and second solar cells;
- 25 an encapsulant interposed between the outer casing and the first and second solar cells; and
- a barrier film interposed between the encapsulant and the first and second solar cells, wherein the film substantially overlies the first and second solar cells and extends from the first solar cell to the second solar cell.

It will be understood that the term 'barrier' refers to an element which is configured to form an obstruction, or impediment, to gas and/or liquid molecules which may enter the solar module (e.g. through gaps in the outer casing) and which may cause significant degradation of the solar cells if they make contact therewith. In this way, the barrier film may be configured to
5 form a substantially impermeable membrane.

The combination of the barrier film and the encapsulant reduces the permeation and penetration of gas and liquid particles compared with a single uniform encapsulant, which thereby increases the reliability of the solar cells over the life of the solar module. Positioning the barrier film such that it is interposed between the encapsulant and solar cells means that
10 the barrier film can prevent gases and liquids that have permeated through the encapsulant from reaching the solar cells. In this way, the barrier film may be considered as a co-encapsulant, which together with the encapsulant layer, provides a more effective obstruction to ingressive gas and/or liquid molecules (i.e. compared with a single encapsulant layer). Thus, the solar module according to the present invention is able to prevent environmental
15 humidity and ingressive gas and/or liquid molecules from reaching the solar cells, which thereby prolongs the operational life of the solar module.

Moreover, by providing the combination of the barrier film and the encapsulant, the encapsulant can be made thinner than in conventional solar modules due to the protection provided by the barrier film, thereby making the encapsulant more transparent.
20 Optional features will now be set out. These are applicable singly or in any combination with any aspect.

One or more of the solar cells may have a length and a width that is greater than a thickness of the solar cell. A plane extending through the centre of said solar cell substantially parallel to the length and width may be taken as a reference plane of the solar module. "Overlie" as
25 used herein may be understood to mean that a layer/film/element of the solar module is positioned further from the reference plane than another layer/film/element that it is said to overlie.

In an embodiment, the gas and/or liquid molecules may comprise water molecules (e.g. liquid water and/or water vapour (i.e. the gas may have a non-zero humidity)) and/or chemicals from
30 the encapsulant material.

The barrier film is advantageously configured to substantially overlay both the first solar cell and the second solar cell. In this way, the barrier film may be configured such that it substantially covers a first surface (e.g. the surface configured in use to substantially face the

sun) of the first solar cell and a corresponding first surface (e.g. the surface configured in use to substantially face the sun) of the second solar cell (e.g. the barrier film overlies a surface of the first solar cell and a surface of the second solar cells that face in the same direction as each other). The barrier film is further configured to extend between the first solar cell and the
5 second solar cell such that it defines a substantially continuous (e.g. uninterrupted) covering of the solar cells in the length and width directions of the solar module.

Accordingly, the barrier film may be configured to extend from the first surface of the first solar cell to the first surface of the second solar cell. In an embodiment, the first and second solar cells are spaced from one another such that the barrier film extends between the first and
10 second solar cells, across this spacing or gap. However, in some other embodiments, the first and second cells may be arranged such that there is no spacing or gap between them (e.g. a shingled arrangement) and, in this case, the barrier film extends directly from the first solar cell to the second cell.

The barrier film and the encapsulant may be configured to inhibit the transmission of different
15 types of invasive substances (e.g. different gas and/or liquid compositions), which provides hybrid protection for the solar cells.

The barrier film is advantageously interposed between the solar cell and the encapsulant so as to protect the solar cell from the ingress of gas and/or liquid molecules over time. In this way, the barrier film further increases the operational life of the solar module compared with
20 an equivalent solar module comprising an encapsulant alone. Also, by introducing the barrier film, it is possible to use an encapsulant material that provides benefits such as low cost, long lifespan, good reliability, good optical properties, etc. even where that material might otherwise be problematic (e.g. because its chemical composition may cause damage to the solar cell absent the barrier film). In addition, the barrier film may be configured to provide auxiliary
25 protection to the solar cells in the event that the encapsulant (and/or the outer casing) become damaged (e.g. by falling debris or by a person standing on the solar module).

The barrier film may be distinguished from the encapsulant by virtue of the fact that the barrier film may be configured to form a barrier between the solar cells and the encapsulant. The barrier film may also be differentiated from the encapsulant in that it may be configured to be
30 more impermeable to ingressive elements than the encapsulant. The barrier film may also be substantially thinner than the encapsulant, such that it may not provide structural support for the solar cells. By way of example, the encapsulant may be between 1 times and 100 times the thickness of the barrier film. By contrast the encapsulant may be configured to hold the components of the solar module (e.g. the solar cells and the barrier film) in position within the

module (i.e. the encapsulant provides structural support to components of the solar module). The encapsulant may be more than 5 times, more than 10 times, more than 20 times, more than 30 times, more than 40 times, more than 50 times, more than 60 times, more than 70 times, more than 80 times, or more than 90 times the thickness of the barrier film. The
5 encapsulant may less than 5 times, less than 10 times, less than 20 times, less than 30 times, less than 40 times, less than 50 times, less than 60 times, less than 70 times, less than 80 times, less than 90 times, or less than 100 times the thickness of the barrier film.

It will be understood that when an element such as a film, sheet, or substrate is referred to as being “on”, “adjacent” or “opposite” to an element, it can be “directly on”, “directly adjacent” or
10 “directly opposite” to that further element; alternatively, there may be one or more intervening elements present. In contrast, when an element is referred to as being “directly on”, “directly adjacent” or “directly opposite” another element, there are no intervening elements present.

The terms “front” and “forward” are used herein to refer to a direction towards a light source (e.g. the sun) in use and orthogonal to a front surface of the solar module, and the terms “rear”,
15 “back” and “rearwardly” are intended to refer to a direction that is opposite to the front/forward direction.

The barrier film, alternatively referred to as a barrier foil, may form a substantially impermeable barrier between, on the one hand, the encapsulant and/or the outer casing and, on the other hand, the first and second solar cells. Accordingly, the barrier film may be configured to
20 substantially inhibit the penetration of gas and/or liquid molecules therethrough. In embodiments, the barrier film may define a substantially gas and/or liquid impermeable barrier.

The barrier film may be configured to form a substantially continuous film (e.g. substantially continuous in length and width directions of the solar module but optionally comprising multiple layers in a height/thickness direction of the solar module). In some embodiments, the barrier
25 film is integrally formed, e.g. it may be fashioned from a single, continuous (e.g. planar) piece of material. In this way, the barrier film may be configured so as to be devoid of any holes, openings, spaces, internal interfaces, or apertures, which may otherwise provide a pathway through which ingressive molecules (e.g. gas and/or liquid molecules) could flow towards the solar cells.

30 The barrier film may be comprised of a plurality of barrier film sections, which may be bonded, or fused, together so as to form a continuous barrier between the encapsulant and the solar cells. In this way, the barrier film may be configured such that it does not comprise any joins,

seams or openings, which may otherwise provide a pathway through which ingressive molecules could flow (e.g. diffuse).

The barrier film may extend from the first solar cell to the second solar cell. In this way, the same barrier film which is configured to overlie the first solar cell may be configured to overlie
5 the second solar cell, without any interruption of the barrier film.

The first and second solar cells may be spaced apart from each other. In particular, the first solar cell may be arranged adjacent to and spaced apart from the second solar cell. In this case, the barrier film may be configured to extend across a gap between the first and second solar cells. Accordingly, the barrier film may be configured to form a barrier which prevents
10 the ingress of ingressive molecules into the gap which forms between the solar cells.

It will be understood that the gap between the first and second solar cells may define a space, void, or interval, which is formed between opposing ends, or surfaces, of the respective solar cells. The first solar cell may comprise a first (e.g. rightmost) lateral surface which, when the solar cells are arranged in the solar module, is arranged to face a second (e.g. leftmost) lateral
15 surface of the second solar cell. In this instance, the gap between the first and second solar cells may be defined by the separation between their respective first and second lateral surfaces.

The barrier film may be arranged such that it is substantially flat across each of the first and second solar cells and also across the gap which is formed therebetween. Alternatively, the
20 barrier film may be arranged to sag into the gap which forms between the spaced apart first and second solar cells. In some embodiments, the barrier film may be configured to deform in order to accommodate conductive wire portions arranged on surfaces of the solar cells that the barrier film overlies (e.g. arranged on front or rear surfaces of the first and/or second solar cells).

25 The barrier film may comprise a first barrier film region which substantially overlies the first solar cell, a second barrier film region which substantially overlies the second solar cell. Where the solar module is such that there is a gap between the first solar cell and second solar cell, the barrier film may further comprise a third barrier film region which extends between the first and second solar cells (e.g. that overlies the gap between the first and second solar cells).

30 The third region may be arranged such that it is substantially aligned in parallel with at least one of the first and second regions (e.g. is coplanar with the first region and/or second region). Alternatively, the third barrier film region may be configured to sag between the first and

second solar cells. The third barrier film region may be configured to define a sag span curve (e.g. a parabolic curve) between the first and second barrier film regions.

It will be appreciated that the term 'film' refers to an element which defines a substantially thin strip, or foil (i.e. a substantially planar element, with a width and length of the element significantly greater than a thickness of the element). The barrier film may have a thickness which is significantly smaller than its length and width. The barrier film thickness may be substantially uniform across its width and/or length. In embodiments, the thickness of the barrier film may be substantially less than a thickness of the encapsulant. The barrier film may have a thickness which is greater than or equal to 30 microns and/or less than or equal to 100 microns. The barrier film may be substantially planar. The barrier film thickness may be greater than or equal to 30 microns, greater than or equal to 40 microns, greater than or equal to 50 microns, greater than or equal to 60 microns, greater than or equal to 70 microns, greater than or equal to 80 microns, or greater than or equal to 90 microns. The barrier film thickness may be less than or equal to 40 microns, less than or equal to 50 microns, less than or equal to 60 microns, less than or equal to 70 microns, less than or equal to 80 microns, less than or equal to 90 microns, or less than or equal to 100 microns.

The barrier film may be electrically insulating. In this way, the barrier film may be configured to prevent short circuiting between the first and second solar cells. The barrier film may be optically transparent. Accordingly, the barrier film may be configured such that it does not inhibit the transmission of light to the solar cells upon which it is overlaid.

The barrier film may be formed of (e.g. comprise, or consist, of) a non-crosslinked polymer (or polymeric material), for example, the barrier film may be formed of a non-crosslinked polymer. In this way, the polymer may be configured such that there are substantially no bonds (e.g. a cross-link bond) which links one polymer chain to another. Accordingly, the barrier film may be formed of a thermoplastic material. The barrier film may be configured with elastomeric properties (e.g. having viscoelasticity) caused by weak intermolecular forces between the polymer chains.

The barrier film may be formed of a thermoplastic polyolefin (TPO). It will be understood that a polyolefin defines a type of polymer produced from a simple olefin monomer (e.g. C_nH_{2n}). The TPO may refer to a polymer/filler blend being at least partially formed of a thermoplastic and an elastomer.

The barrier film may comprise a single layer, or may comprise multiple layers. By way of example, the barrier film may comprise a single layer, the single layer being formed of (e.g.

comprise or consist, of) a non-crosslinked polymer, as described in the preceding paragraphs. By way of further example, the barrier film may comprise a first layer arranged to provide an external surface of the barrier film that faces the solar cells (e.g. abuts the solar cells), and a second layer arranged to provide an external surface of the barrier film that faces the encapsulant (e.g. abuts the encapsulant). In this way, the first layer may provide an external surface of the barrier film that is arranged to face an opposing surface of the solar cell. The second layer may provide an external surface of the barrier film that is arranged to face an opposing surface of the encapsulant. In this way, the first and second layers of the barrier film may be arranged such that they are in physical contact with (i.e. abut) the solar cells and the encapsulant, respectively. The barrier film may comprise one or more further layers interposed between said first layer and said second layer. Said one or more further layers may have the same, or different, compositions to the first and/or second layers. Layers of the barrier film may be differentiated from each other by changes in composition and/or structure, or by surface interfaces present between the layers (e.g. where the barrier film is formed by lamination of multiple individual layers).

The first layer may be formed of (e.g. comprise, or consist, of) a non-crosslinked polymer, as described in the preceding paragraphs. The second layer and/or any further layers of the barrier film may be formed of the same material as the first layer (e.g. a non-crosslinked polymer) or another material (e.g. a different crosslinked polymer(s), or a different material(s) that is not a non-crosslinked polymer).

The barrier film may be configured to be substantially flexible (e.g. non-rigid). In this way, the barrier film may be more easily manipulated, or worked, into position during the assembly of the solar module. The barrier film may also be configured to conform to the shape of the solar cells upon which it is overlaid.

The encapsulant may be configured to provide encapsulation of the solar cells. In general, this may be defined as a means of physically protecting the solar cells from external environmental conditions, which may include humidity, moisture, rain, and ultraviolet radiation (UV). The encapsulant may also be configured to hold the components of the solar module (e.g. the solar cells) in position within the module. The encapsulant may be configured to protect the solar cells from mechanical stresses such as twisting or bending, and low-energy impacts caused by, for example, hail or errant projectiles.

The encapsulant layer may be formed of ethylene vinyl acetate (EVA). It will be appreciated that during its operational lifetime, EVA may undergo chemical degradation when exposed to environmental conditions such as: moisture, heat and UV irradiation. This can cause leaching

of organic acids (e.g. acetic acid) from the EVA. Accordingly, the barrier film is advantageously interposed between the solar cells and the encapsulant so as to form a further protective barrier between the EVA encapsulant layer and the solar cells. Thus, the barrier film increases the operational life of the solar module. The costs associated with manufacturing the encapsulant from EVA are significantly lower than for other encapsulant materials. The barrier film enables EVA to be incorporated within the solar module, which thereby reduces the material costs associated with the encapsulant, whilst at the same time increasing the protection for the solar cells against humidity, for example.

The encapsulant (e.g. a front encapsulant, or a back encapsulant) may have a thickness which is significantly smaller than its length and width. The encapsulant thickness may be substantially uniform across its width and/or length. In embodiments, the thickness of the encapsulant may be greater than or equal to 100 microns and/or less than or equal to 1000 microns. The thickness of the encapsulant may be greater than or equal to 100 microns, greater than or equal to 200 microns, greater than or equal to 300 microns, greater than or equal to 400 microns, greater than or equal to 500 microns, greater than or equal to 600 microns, greater than or equal to 700 microns, greater than or equal to 800 microns, or greater than or equal to 900 microns. The thickness of the encapsulant may be less than or equal to 200 microns, less than or equal to 300 microns, less than or equal to 400 microns, less than or equal to 500 microns, less than or equal to 600 microns, less than or equal to 700 microns, less than or equal to 800 microns, less than or equal to 900 microns, or less than or equal to 1000 microns.

The outer casing may comprise a front sheet, or front plate, arranged on a front side of the solar module. The outer casing may comprise a back sheet, or back plate, arranged on a back side of the solar module. At least one or each of the front sheet and back sheet may be formed of glass. At least one, or each, of the front sheet and back sheet may be transparent. The back sheet may be reflective. The back sheet may be configured with a reflective surface such that it reflects unabsorbed light back towards the solar cells. That is, the outer casing may be suitable for bifacial and monofacial solar cells. The solar cells may be bifacial or monofacial.

The solar module may be arranged within a solar module assembly (e.g. a solar panel). The solar module assembly may include a frame, or one or more frame elements. The frame may be configured to hold the components of the solar module in place and to provide sealing around the perimeter of the outer casing (e.g. the front and back sheets). In embodiments where the solar module comprises a front sheet and a back sheet, the frame may apply a compressive force between the front and back sheet in order to retain the components of the solar module in position, as would be readily understood by the skilled person.

The first and second solar cells may each comprise a first and a second surface. The first surface may be configured to face a radiative source (e.g. the sun) when the solar module is in use. The second surface may be arranged opposite the first surface, wherein the barrier film is arranged to overlie the first surface of each of the first and second solar cells.

- 5 The barrier film may be arranged to extend lengthwise across the respective surfaces of the first and second solar cells in a longitudinal direction. The film may be arranged to extend widthways across the respective surfaces of the first and second solar cells in a transverse direction.

- 10 The first surface of each of the first and second solar cells may define a front (e.g. frontmost) surface. The second surface of each of the first and second solar cells may define a back (e.g. backmost) surface, such that the front surface is opposite the back surface.

- Each of the first and second solar cells may be configured with a length, a width and a height. The height (i.e. the thickness) of each solar cell may be less than its respective length and width. The length of each solar cell may be less than the respective width. The barrier film
15 may be configured such that it extends across the entire length and the width of each solar cell. In this way the barrier film may extend in a longitudinal (i.e. lengthwise) direction from one longitudinal end of the solar cell to an opposite longitudinal end of the solar cell. The barrier film may extend in a transverse (e.g. widthways) direction from one lateral end of the solar cell to an opposite lateral end of the solar cell.

- 20 The solar module may comprise plural barrier films. The solar module may comprise plural encapsulants. A first barrier film may be interposed between a first encapsulant and the first surface of each of the first and second solar cells (e.g. interposed between a front encapsulant and a front surface of each of the first and second solar cells. A second barrier film may be interposed between a second encapsulant and the second surface of each of the first and
25 second solar cells (e.g. interposed between a back encapsulant and a back surface of each of the first and second solar cells. Accordingly, where both the first and second barrier films are present in a solar module, the solar cells may be sandwiched between the first barrier film and second barrier films, and the barrier films may both be sandwiched between the first encapsulant and second encapsulant, with the solar cells interposed between said barrier
30 films.

In the proceeding paragraphs, any reference to 'the solar cell' will be understood as referring to at least one, or both, of the first and second solar cells. The solar cell may comprise a semiconductor substrate and an emitter arranged on a first surface of the substrate. The solar

cell may further comprise an accumulator, or back field layer, arranged on a second surface of the substrate, opposite the first surface. The first and second surfaces may define the front and back surfaces of the substrate, respectively. The solar cell may comprise a passivation layer arranged between the substrate and the emitter and/or accumulator.

- 5 The substrate may be configured with a first conductivity type (for example, n-type) and the emitter may be configured with a second conductivity type (for example, a p-type) opposite the first conductivity type, and thus forms a p-n junction along with the substrate.

During operation of the solar cell, a plurality of electron-hole pairs produced by light incident on the substrate is separated into electrons and holes by a built-in potential difference resulting from the p-n junction. Then, the separated holes move to the n-type semiconductor, and the separated electrons move to the p-type semiconductor. Thus, when the substrate is of the n-type and the emitter is of the p-type, the separated holes and electrons move to the substrate and the emitter, respectively. Accordingly, the holes become major carriers in the substrate, and the electrons become major carriers in the emitter.

- 15 According to an exemplary arrangement, the substrate may be formed from an n-type monocrystalline silicon wafer, which exhibits longer lifetime characteristics compared to a p-type monocrystalline silicon wafer. The emitter may comprise an amorphous material (e.g. amorphous silicon) which is at least partially doped so as to be p-type. Such an arrangement may contribute towards the formation of a heterojunction technology (HJT) type solar cell, which is so defined because it combines two different materials to create a charge separating field at the p-n junction.

When the semiconductor material is n-type, it may be configured to contain impurities of a group V element such as phosphor (P), arsenic (As), and antimony (Sb). When the semiconductor material is p-type, it may contain impurities of a group III element such as boron (B), gallium (Ga), and indium (In).

According to an alternative arrangement, the emitter may be n-type and the substrate may be p-type so as to form a p-n junction therebetween. In this instance, the separated electrons and holes move to the substrate and the emitter, respectively.

- Alternatively, the accumulator may be configured with the first conductivity type (e.g. n-type), which is the same as that of the substrate. As such, the accumulator may be configured to selectively screen, or extract, charge carriers from the substrate. In embodiments, the accumulator may comprise an amorphous material (e.g. amorphous silicon) which is at least partially doped so as to be n-type.

The solar cell may further comprise an anti-reflection layer, or coating, arranged opposite at least one of the front and back surfaces of the substrate. The anti-reflection layer may be arranged such that the emitter or accumulator is interposed between the substrate and the anti-reflection layer.

- 5 The anti-reflection layer may have a single-layered structure or a multi-layered structure. The anti-reflection layer may be formed of a transparent conductive oxide (TCO), such as indium tin oxide (ITO), which has been textured to provide an anti-reflective surface. The anti-reflection layer advantageously reduces the reflectance of light incident on the solar cell and increases selectivity of a predetermined wavelength band, thereby increasing the efficiency of
10 the solar cell.

- The anti-reflection layer may be arranged such that at least the emitter or accumulator is interposed between the transparent conductive oxide coating and the substrate. The transparent conductive oxide coating may be electrically connected to the emitter or accumulator. The transparent conductive oxide coating may be configured to increase lateral
15 carrier transport to an electrode arranged on the respective surface of the solar cell.

The solar cell may comprise an electrode configured to extract photo-generated charge carriers from the solar cell. The electrode may be arranged such that the emitter or accumulator is interposed between the electrode and the substrate.

- 20 When the emitter or accumulator is arranged on a front (e.g. frontmost) surface of the substrate, the electrode may be arranged on a front surface of the emitter or accumulator, to define a front electrode of the solar cell. When the emitter or accumulator is arranged on a back (e.g. backmost) surface of the substrate, the electrode may be arranged on a back surface of the emitter or accumulator, to define a back electrode of the solar cell.

- Accordingly, the solar cell may comprise a front electrode arranged on its front surface and /or
25 a back electrode arranged on its back surface, opposite the front surface.

- In embodiments, the solar cell comprises a front emitter and a back accumulator arranged on a front and back surface of the substrate, respectively, the solar cell may comprise a front electrode arranged on the front surface of the front emitter and a back electrode arranged on the back surface of the back accumulator. Each electrode may be configured to form an ohmic
30 contact with the respective surfaces of the solar cell.

The front and back electrodes may each comprise a plurality of finger electrodes which are arranged on the respective front and back surfaces of the solar cell. Each finger electrode may

be configured with an axial length which is substantially greater than its width. Both the width and axial length of the finger electrode may be measured in perpendicular directions in the plane of the respective surface of the solar cell. The finger electrodes may extend in a transverse direction which is parallel with the width direction of the solar cell.

- 5 The finger electrodes within each of the pluralities of front and/or back finger electrodes may be spaced apart across the respective front and back surfaces of the solar cell to define transversely-extending spaces between the finger electrodes. The finger electrodes may be spaced apart in a longitudinal direction which is substantially parallel with the length direction of the solar cell. The finger electrodes in each plurality may be substantially parallel to one another. Accordingly, the plurality of back finger electrodes may form an array of parallel, 10 longitudinally spaced (e.g. equally spaced) finger electrodes.

The front and/or back electrodes may comprise one or more conductive elements (e.g. elongate busbars), arranged on top of the finger electrodes. In this way, the plurality of finger electrodes may be interposed between the one or more elongate busbars and the substrate.

- 15 The one or more elongate busbars may be configured to form an electrical connection between the finger electrodes and an electrical circuit of the solar module. The first solar cell may define the solar cell and the electrical circuit may include a second solar cell.

- Each of the plurality of elongate busbars may be configured with a width, an axial length and a depth. Each such elongate busbar may be configured such that its axial length is 20 substantially greater than its width. The width and axial length of the elongate busbar may be measured in perpendicular directions aligned with the plane of the surface of the solar cell, and the depth may be measured in a direction which is perpendicular to the plane of the back surface of the solar cell.

- Each of the elongate busbars may be arranged such that they are aligned perpendicular to 25 the plurality of finger electrodes upon which they are overlaid. Each of the elongate busbars may be arranged to extend lengthwise across the surface of the solar cell in a longitudinal direction. These elongate busbars may be spaced apart in a transverse direction across the respective surface of the solar cell to define longitudinal-extending spaces between the busbars. These elongate busbars may be parallel or substantially parallel to one another.
- 30 These elongate busbars may be equally or substantially equally spaced in the transverse direction. Accordingly, the second plurality of busbars may form an array of parallel, transversely spaced (e.g. equally spaced) conductive busbars.

The plurality of elongate busbars and finger electrodes may each be formed of an electrically conductive material such that they enable the flow of electrical charge carriers from the surface of the solar cell to the external circuit. In this way, each one of the busbars and finger electrodes may define a current collector of the electrode.

- 5 Alternatively, instead of elongate busbars, the finger electrodes may be connected to an external circuit by way of a plurality of conductive wire portions. A first plurality of conductive wire portions may be arranged on the first surface of the first solar cell. The first plurality of conductive wire portions may be electrically coupled to a second plurality of conductive wire portions arranged on the second surface of the second solar cell. In an embodiment, the first
10 plurality of conductive wire portions may be integral with the second plurality of conductive wire portions.

The solar module may comprise a wire-supporting film interposed between the barrier film and the plurality of conductive wire portions arranged on the first surface of the first solar cell. As such, the wire-supporting film may be arranged on the first surface of the first solar cell.

- 15 The wire-supporting film may be configured so as not to overlie the second solar cell. For example, the wire-supporting film be arranged to only overlie (e.g. substantially cover) the first surface of the first solar cell. As such, the wire-supporting film is not configured to form a barrier which extends from the first solar cell to the second solar cell. It is noted that the wire-supporting film may in some embodiments overlap an edge of the first solar cell but, in this
20 case, the wire-supporting film does not bridge a gap between the first and second solar cells.

- The solar module may comprise a second wire-supporting film which may be arranged on the first surface of the second solar cell, such that it is interposed between the barrier film and the plurality of conductive wire portions arranged thereon. The second wire-supporting film may be configured so as not to overlie the first solar cell. For example, the second wire-supporting
25 film be arranged to only overlie (e.g. substantially cover) the first surface of the second solar cell. As such, the second wire-supporting film is not configured to form a barrier which extends from the second solar cell to the first solar cell. It is noted that the second wire-supporting film may in some embodiments overlap an edge of the second solar cell but, in this case, the second wire-supporting film does not bridge a gap between the second and first solar cells.

- 30 It will be understood that the terms 'conductive' and 'insulating' as used herein, are expressly intended to mean electrically conductive and electrically insulating, respectively. The meaning of these terms will be particularly apparent in view of the technical context of the disclosure, being that of photovoltaic solar cell devices. It will also be understood that the term 'ohmic

contact' is intended to mean a non-rectifying electrical junction (i.e. a junction between two conductors which exhibits a substantially linear current–voltage (I-V) characteristic).

In embodiments, the front and/or back surface(s) of at least one, or each, of the constituent layers of the solar cell (e.g. the substrate, emitter, accumulator, passivation layer and/or transparent-conductive layer) may be textured such that it corresponds to having an uneven surface, or having uneven characteristics. For example, the front surface of the substrate may be textured. In this case, the amount of light incident on the substrate increases because of the textured surface of the substrate, and thus the efficiency of the solar cell may be improved.

At least one of the emitter and the accumulator may comprise a plurality of layers having different dopant levels, as would be appreciated by the skilled person. At least one of the passivation layers may be configured with no conductivity type such that it forms an intrinsic layer between the substrate and the emitter/accumulator.

The solar module may comprise a plurality of solar cells arranged in an array. As such, the solar cells may be arranged in an ordered series which extends across a horizontal plane of the solar module. The array of solar cells may extend in a first direction and a second direction perpendicular to the first direction. The barrier film may be arranged to extend in both the first and second directions so as to overlie the plurality of solar cells in the array. In embodiments, the barrier film may be arranged to overlap the array of solar cells and extend beyond the array in a lengthwise and a widthways direction across the solar module. In an embodiment, the barrier film may extend as far as the edges of the outer casing; however, in some other embodiments, the barrier film may fall short of the edges of the outer casing so as to maintain a peripheral gap between the edges of the outer casing and corresponding edges of the barrier film.

The first and second solar cells may be arranged in substantially the same plane. Accordingly, the solar cells may be arranged in a substantially planar array. The solar cells may each be arranged so that they are aligned within the same reference plane. For example, the first solar cell may be arranged, e.g. orientated, such that a horizontal plane of the first solar cell is aligned with a horizontal plane of the second solar cell. The reference plane of the first and second solar cells may be substantially aligned (e.g. parallel) with a horizontal plane of the solar module.

The solar module may comprise a width, a length and a height. The solar module may have a thickness, which is measured in the height direction, which is substantially less than its length and its width. The array of solar cells may be arranged in an array which extends in a

longitudinal (e.g. lengthwise) and/or a transverse (e.g. widthways) direction of the solar module. In embodiments, the solar cells may be arranged in a grid formation, such as a rectangular or square grid pattern.

5 In embodiments, the solar module may comprise a back sheet, a back encapsulant, a back barrier film, a first solar cell, a second solar cell, a front barrier film, a front encapsulant and a front sheet.

10 The first and second solar cells may be sandwiched between the front and back barrier films. The front and back barrier films may be sandwiched between the front encapsulant and the back encapsulant. The front and back encapsulants may be sandwiched between the front sheet and the back sheet.

The front and back encapsulants may be formed of the same material (e.g. EVA). The front and back barrier films may be formed of the same material (e.g. TPO).

15 The solar cells may be arranged in a shingling arrangement. As such, the first solar cell may be arranged to at least partially overlap the second solar cell. The horizontal plane of the first solar cell may be substantially parallel with the horizontal plane of the second solar cell.

According to a second aspect there is provided a method for manufacturing a solar module, the method comprising:

20 arranging a first solar cell and a second solar cell;
 arranging a barrier film on the first and second solar cells;
 arranging an encapsulant on the barrier film; and
 arranging an outer casing to overlie the encapsulant;
 wherein arranging the barrier film comprises configuring the barrier film such that it substantially overlies the first and second solar cells and extends from the first solar cell to the second solar cell.

25 The method of arranging the first and second solar cells may comprise positioning the first solar cell adjacent to and spaced apart from the second solar cell to define a gap therebetween. In this situation, the method of arranging the barrier film may comprise configuring the barrier film to extend across the gap between the first and second solar cells.

30 The method of arranging the first and second solar cells may comprise arranging the solar cells such that they are substantially aligned (e.g. in parallel) with the same reference plane.

In the above embodiment, the first and second solar cells are spaced from one another such that the barrier film extends between the first and second solar cells, across this spacing or

gap. However, in some other embodiments, the first and second cells may be arranged (e.g. shingled) such that there is no spacing or gap between them and, in this case, the barrier film is arranged to extend directly from the first solar cell to the second cell.

5 The method may comprise laminating at least one of the barrier film and the encapsulant onto the solar cells. The barrier film and the encapsulant may be arranged, sequentially onto the solar cells. The method may comprise applying heat and/or pressure to at least one of the barrier film and the encapsulant in order to adhere the at least one barrier film and encapsulant onto the surface upon which it has been arranged.

10 The method may comprise arranging the barrier film onto the solar cells and then applying heat and/or pressure to cause the barrier film to adhere to the first and second solar cells. The method may further comprise arranging the encapsulant onto the barrier film and then performing a further application of heat and/or pressure in order to adhere the encapsulant to the barrier film.

15 In embodiments, the solar module may comprise a back sheet, a back encapsulant, a back barrier film, a first solar cell, a second solar cell, a front barrier film, a front encapsulant and a front sheet. In this case, the method of manufacturing the solar module may comprise: arranging a first solar cell and a second solar cell; arranging a front barrier film on the first and second solar cells; arranging a back barrier film on the first and second solar cells; arranging a front encapsulant on the front barrier film; arranging a back encapsulant on the back barrier film; arranging a front sheet to overlie the front encapsulant; and arranging a back sheet to overlie the back encapsulant; wherein arranging the front and back barrier film comprises configuring each barrier film such that it substantially overlies the first and second solar cells and extends from the first solar cell to the second solar cell.

25 The step of arranging the front barrier film may comprise arranging the front barrier film on a front surface of the first and second solar cells. The step of arranging the back barrier film may comprise arranging the back barrier film on a back surface of the first and second solar cells. The step of arranging the front encapsulant on the front barrier film may comprise arranging the front encapsulant directly on a front surface of the front barrier film. The step of arranging the back encapsulant on the back barrier film may comprise arranging the back encapsulant directly on a back surface of the back carrier film. The step of arranging the front sheet may comprise arranging the front sheet to directly overlie a front surface of the encapsulant. The step of arranging the back sheet may comprise arranging the back sheet to directly overlie a back surface of the encapsulant.

The skilled person will appreciate that except where mutually exclusive, a feature or parameter described in relation to any one of the above aspects may be applied to any other aspect. Furthermore, except where mutually exclusive, any feature or parameter described herein may be applied to any aspect and/or combined with any other feature or parameter described
5 herein.

Brief description of the drawings

Embodiments will now be described by way of example only, with reference to the Figures, in which:

Figs. 1A and 1B show plan and sectional side views of a solar module comprising a
10 plurality of solar cells, respectively;

Figs. 2A and 2B show plan and sectional views, respectively, of one of the plurality of solar cells of the solar module shown in Figs. 1A and 1B; and

Fig. 3 is a flowchart illustrating a method of manufacturing the solar module of Fig. 1.

Detailed description

15 Aspects and embodiments of the present disclosure will now be discussed with reference to the accompanying figures. Further aspects and embodiments will be apparent to those skilled in the art.

In the drawings, the thickness of sheets, layers, films, etc., are exaggerated for clarity. Furthermore, it will be understood that when an element such as a layer, film, region, or
20 substrate is referred to as being "on" another element, it can be directly on the other element or intervening elements may also be present. In contrast, when an element is referred to as being "directly on" another element, there are no intervening elements present.

Fig. 1A and Fig 1B illustrate a solar module assembly 100 comprising a solar module 10 according to the present invention. The solar module 10 includes an array of solar cells 12
25 arranged in a grid-like pattern. The solar cells 12 are sandwiched between a transparent glass sheet 24a at a front side 26 of the solar module 10 and a reflective back sheet 24b arranged at a rear side 28 of the solar module 10. As such, the reflective back sheet 24b and the transparent glass sheet 24a define front and back outer casings of the solar module 10, respectively.

The solar module 10 is mounted within a rectangular frame 102 of the assembly 100, which extends about a periphery of the solar module 10. The frame 102 protects the edges of the solar module 10 and provides a means for mounting the solar module 10 to a structure (e.g. a building roof). The frame 102 comprises four elongate frame members 104 that are each
5 mounted to, and extend along, a respective edge of the solar module 10.

Fig. 1A illustrates the top (front) view of the solar module 10, whereas Fig. 1B depicts a transverse section of the solar module 10 taken along the dashed lines A-A, as shown in Fig. 1A. The solar module 10 has a length which is the horizontal dimension of Fig. 1A, and a width which is the vertical dimension of Fig. 1A.

10 Fig 1B depicts a plurality of solar cells 12a-f arranged in a substantially horizontal reference plane RP of the solar module 10 extending substantially parallel to the length and width of the solar cells and through the centre of said solar cells. The reference plane RP is substantially parallel to the front and back outer casings of the solar module 10 and extends substantially centrally therebetween.

15 The dashed arrows at the top of Fig. 1B show the direction of the solar radiation which is incident upon the solar module 10. Each of the solar cells 12a-f has a front surface 16 (upon which light is incident in normal use) and a rear surface 18 opposite the front surface 16. The front surface is configured in use to substantially face the sun.

The solar cells 12a-f are sandwiched between a pair of barrier layers 14a, 14b, which extend
20 across the solar module 10 (in a horizontal direction as shown in Fig. 1A), from one side of the solar module 10 to the other.

The solar cells 12a-f are arranged in a planar array which extends in both a lengthways and a widthways direction of the solar module 10, as shown in Fig. 1A. The barrier films 14a, 14b extend in both the lengthwise and widthways directions so as to overlie the plurality of solar
25 cells 12a-f in the array (i.e. both the barrier films are positioned further from the reference plane RP than the solar cells 12a-f).

The space defined between the barrier films 14a, 14b and the respective outer casings is filled with an encapsulant 20a, 20b, which helps to secure the various components of the solar module 10 in position. The barrier films 14a, 14b work in combination with the encapsulant
30 20a, 20b to protect the solar cells 12a-f from humidity, which would otherwise degrade the solar cells 12a-f.

The barrier films 14a, 14b are each configured to substantially inhibit the penetration of liquid and gas molecules to the solar cells 12a-f. Accordingly, they each form a substantially impermeable barrier on the front and back surfaces, respectively, of the solar cells 12a-f. Each of the barrier films 14a, 14b is formed from a continuous piece of material. In this way, the barrier films 14a, 14b are devoid of any holes, openings, spaces or apertures, which may otherwise provide a pathway through which ingressive elements could diffuse towards the solar cells 12a-f.

The barrier films 14a, 14b are conveniently interposed between the solar cells 12a-f and the encapsulant 20a, 20b so as to protect the solar cells 12a-f from the ingress of gas and/or liquid molecules over time.

A front barrier film 14a is arranged on the front surface 16 of the solar cells 12a-f such that a back surface of the front barrier film 14a is adjacent to the front surface 16 of the solar cells 12a-f. A back barrier film 14b is arranged on the back surface 18 of the solar cells 12a-f such that a front surface of the back barrier film 14b is adjacent to the back surface 18 of the solar cells 12a-f.

A front encapsulant 20a is arranged on the front surface 30 of the front barrier film 14a such that a back surface of the front encapsulant 20a is adjacent to the front surface 30 of the front barrier film 14a. A back encapsulant 20b is arranged on the back surface 32 of the back barrier film 14b such that a front surface of the back encapsulant 20b is adjacent to the back surface 32 of the back barrier film 14b.

The transparent glass sheet 24a is configured to allow light to pass through into a central chamber in which the solar cells 12a-f are mounted. The front encapsulant 20a and the front barrier film 14a are also transparent to allow incident light to reach the solar cells 12a-f. The reflective back sheet 24b is configured to reflect any light which is incident upon its upper surface, back towards the solar cells 12a-f. Accordingly, the back encapsulant 20b and the back barrier film 14b are transparent to allow unabsorbed light to reach, and reflect back off, the reflective back sheet 24b.

The solar cells 12a-f are spaced apart from each other across the reference plane RP, as shown in Fig. 1. In particular, each of the solar cells 12a-f is arranged adjacently to and spaced apart from each other so as to form a series of gaps 34a-e between neighbouring solar cells. For example, a first solar cell 12a is spaced apart from a second solar cell 12b such that they define a first gap 34a therebetween.

The barrier films 14a, 14b extend across the plurality of gaps 34a-e which are formed between the solar cells 12a-f. Accordingly, the barrier films 14a, 14b are each configured to form barriers which prevent the ingress of invasive molecules into the plurality of gaps 34a-e.

5 The front and back encapsulants 20a, 20b are both formed of ethylene vinyl acetate (EVA), whereas the front and back barrier films 14a, 14b may be formed of a thermoplastic polyolefin (TPO). Each of the barrier films 14a, 14b has a thickness which is greater than or equal to 30 microns and/or less than or equal to 100 microns. The front encapsulant 20a has a thickness between 100 microns and 1000 microns and the back encapsulant 20b has a thickness between 100 microns and 1000 microns. By providing the combination of the barrier film 14 and the encapsulant 20, the encapsulant 20 may be made thinner than in conventional solar modules due to the protection provided by the barrier film 14, thereby making the encapsulant 20 more transparent.

15 With reference to Figs. 2A and 2B, a solar cell 12 will now be described in isolation from the solar module 10. Each one of the plurality of solar cells 12a-f is a heterojunction technology (HJT) solar cell, as would be readily understood by a person having ordinary skill in the art.

Fig. 2A illustrates the top (front) view of the solar cell 12, whereas Fig. 2B depicts a transverse section of the solar cell 12 taken along the dashed lines B-B, as shown in Fig. 2A. The solar cell 12 has a length which is the vertical dimension of Fig. 2A, and a width which is the horizontal dimension of Fig. 2A.

20 Each solar cell comprises a crystalline silicon substrate 60, an emitter layer 62 arranged on a front surface of the substrate, and a back field layer 64 arranged on a back surface of the substrate 60. Each of the plurality of solar cells 12a-f are electrically coupled together in one or more strings. The barrier films 14a, 14b are electrically insulating such that they help prevent short circuiting between the solar cells.

25 The substrate 60 is formed from an n-type monocrystalline silicon wafer and the emitter 62 is formed of p-type amorphous silicon which combine to create a charge separating field at the p-n junction to extract positive charge carriers. The back field layer 64 is formed of n-type amorphous silicon which is configured to selectively screen, or extract, negative charge carriers from the substrate 60.

30 A passivation layer 70a, 70b is arranged between the substrate 60 and each of the emitter 62 and back field layer 64. The passivation layers 70a, 70b are formed of intrinsic amorphous silicon (a-Si).

Each solar cell further comprises anti-reflection layers 66a, 66b arranged opposite the front and the back surfaces of the substrate 60. In particular, the emitter 62 and back field layer 64 are interposed, respectively, between front and back anti-reflection layers 66a, 66b and the substrate 60. The anti-reflection layers 66a, 66b are formed of a transparent conductive oxide (TCO), such as indium tin oxide (ITO), which is textured to provide an anti-reflective surface.

Each solar cell further includes a front and back electrode 68a, 68b configured to extract photo-generated charge carriers from the solar cell 12. Each of the front and back electrodes 68a, 68b comprises a plurality of conductive wire portions 78a, 78b arranged in a corresponding wire supporting film 76a, 76b, as shown in Fig. 2B.

Each plurality of wire portions 78a, 78b is configured to overlie a corresponding plurality of finger electrodes 72a, 72b, which are arranged on a front and a back surface 16, 18 of the solar cell 12. The wire portions are configured to form an ohmic contact with the finger electrodes 72a, 72b, and the finger electrodes 72a, 72b are configured to provide an electrical pathway between the wire portions and the respective front and back surfaces 16, 18 of the solar cell 12.

For each of the front and back electrodes 68a, 68b, it will be understood that the pluralities of front and back finger electrodes 72a, 72b are arranged perpendicular to their respective plurality of conductive wire portions 78a, 78b.

The finger electrodes within each of the pluralities of front and back finger electrodes 72a, 72b are parallel and extend widthways relative to the respective front and back surfaces 16, 18 of the solar cell 12 in a transverse direction (the horizontal direction in Fig. 2A). The finger electrodes are spaced apart widthways across the respective front and back surfaces 16, 18 of the solar cell 12 (the vertical direction in Fig. 2A) to define transversely-extending spaces between the finger electrodes. The plurality of finger electrodes 72a, 72b are each formed using a printed conductive material or similar, such as a silver paste.

The wire portions within each of the pluralities of conductive wire portions 78a, 78b are parallel and extend lengthwise relative to the respective front and back surfaces 16, 18 of the solar cell 12 in a longitudinal direction (the vertical direction in Fig. 2A). The wire portions are also equally spaced apart widthways in a transverse direction relative to the front and back surfaces 16, 18 of the solar cell 12 (the horizontal direction in Fig. 2A) to define longitudinal-extending spaces between the wire portions. Accordingly, each of pluralities of conductive wire portions 78a, 78b defines an array of parallel, transversely spaced wire portions.

Each of the plurality of conductive wire portions 78a, 78b is attached to a surface of its respective film 76a, 76b that faces the solar cell 12. This “solar cell-facing” surface of each film 76a, 76b is coated with an adhesive which adheres the wire portions 78a, 78b to their respective films 76a, 76b. The wire-supporting films 76a, 76b are configured such that they
5 are electrically insulating and optically transparent.

When the solar cell 12 is arranged in the solar module 10, the front barrier film 14a is arranged on a front surface 80a of the front wire-supporting film 78a, and the back barrier film 14a is arranged on a back surface 80b of the back wire-supporting film 78b. The wire-supporting films 78a, 78b are arranged to contact the respective front and back surface 16, 18 of the solar
10 cell 12 in the areas in-between the wire portions 78a, 78b and the finger electrodes 72a, 72b.

The wire-supporting films 78a, 78b are shown in Fig. 2 as not extending to the peripheral edges of the front and back surfaces 16, 18 of the solar cells 12. In an alternative exemplary arrangement, the wire-supporting films 78a, 78b may be arranged such that they extend over the entire front and back surfaces 16, 18 of the solar cell 12. According to a further exemplary
15 arrangement, the wire-supporting films 78a, 78b may overlap the peripheral edges of the front and back surface 16, 18 of the solar cell 12 and extend along its sides (i.e. in a substantially vertical direction as shown in Fig. 2). However, it will be understood that the wire-supporting films 78a, 78b are configured such that they do not extend from one solar cell 12 to another (e.g. they do not extend from a first solar cell to a second solar cell).

20 The various components of the solar module 10 are held together by the frame 102 in order to form the solar module assembly, as shown in Fig. 1A. The frame 102 is configured to hold the components of the solar module 10 together and to provide sealing around the perimeter of the outer casing.

An exemplary method of manufacturing the solar module 10 will now be described with
25 reference to Fig. 3, which illustrates a flow chart of the corresponding method steps.

The method 200 commences with a first step 202 in which a plurality of solar cells 12a-f are provided. According to an exemplary arrangement, the plurality of solar cells 12a-f are arranged in a planar array or grid, as described above with reference to Figs. 1A and 1B.

The method then proceeds to step 204 in which front and back barrier films 14a, 14b are
30 arranged onto the respective front and back surfaces 16, 18 of the solar cells 12a-f. The step of arranging the barrier films 14a, 14b comprises configuring each barrier film such that it substantially overlies each of the solar cells 12a-f, and also extends across each of the gaps 34a-e which lie therebetween. The method step 204 concludes by applying heat and pressure

to the front and back barrier films 14a, 14b so as to adhere them to the respective surfaces of the solar cells 12a-f. According to an exemplary method, the barrier films 14a, 14b are configured such that the heat at least partially melts the barrier films 14a, 14b, and the pressure then fixes them to the cells 12a-f as the films cool. In alternative arrangements, the
5 films 14a, 14b are configured with an adhesive layer, or region, on the solar cell-facing side of the films and/or an adhesive layer is provided on the front and back faces of the solar cells, or some combination thereof. The adhesive layer is activated by the application of heat and pressure to cause adhesion of the film to the solar cell surfaces.

In a subsequent method step 206, a front encapsulant 20a is overlaid onto the front surface
10 30 of the front barrier film 14a and a back encapsulant 20b is overlaid onto the back surface 32 of the back barrier film 14b. Similar to the previous method step, the front and back encapsulants 20a, 20b are subjected to heat and pressure so as to fix (e.g. adhere) them to the respective underlying barrier films 14a, 14b.

The method proceeds with step 208 in which a transparent glass sheet 24a is overlaid onto
15 the front surface of the front encapsulant 20a, and a reflective back sheet is overlaid onto the back surface of the back encapsulant 20b, thereby assembling the exemplary solar module 10 as shown in Fig. 1. The method step 208 includes a further application of heat and pressure so as to fix (e.g. adhere) the front and back encapsulants 20a, 20b to the transparent glass sheet 24a and the reflective back sheet 24b, respectively.

20 It will be understood that the invention is not limited to the embodiments above-described and various modifications and improvements can be made without departing from the concepts described herein. Except where mutually exclusive, any of the features may be employed separately or in combination with any other features and the disclosure extends to and includes all combinations and sub-combinations of one or more features described herein.

CLAIMS

1. A solar module comprising:
a first solar cell and a second solar cell;
an outer casing arranged to overlie the first and second solar cells;
5 an encapsulant interposed between the outer casing and the first and second solar cells; and
a barrier film interposed between the encapsulant and the first and second solar cells, wherein the film substantially overlies the first and second solar cells and extends from the first solar cell to the second solar cell.
10
2. The solar module according to claim 1, wherein the barrier film forms a substantially continuous film.
3. The solar module according to claim 1 or claim 2, wherein the first solar cell is arranged
15 adjacent to and spaced apart from the second solar cell, and the barrier film is configured to extend across a gap between the first and second solar cells.
4. The solar module according to any preceding claim, wherein the barrier film is formed of a non-crosslinked polymer.
20
5. The solar module according to any preceding claim, wherein the barrier film is formed of a thermoplastic polyolefin (TPO).
6. The solar module according to any preceding claim, wherein:
25 the barrier film comprises multiple layers including a first layer arranged to provide an external surface of the barrier film that faces the solar cells, and a second layer arranged to provide an external surface of the barrier film that faces the encapsulant; and
the first layer is formed of a non-crosslinked polymer.
- 30 7. The solar module according to any preceding claim, wherein the encapsulant layer is formed of ethylene vinyl acetate.
8. The solar module according to any preceding claim, wherein the barrier film has a thickness of at least 30 microns and/or at most 100 microns.

9. The solar module according to any preceding claim, wherein the barrier film is electrically insulating and/or optically transparent.
10. The solar module according to any preceding claim, wherein the outer casing is a front sheet arranged on a front side of the solar module or a back sheet arranged on a backside of the solar module.
11. The solar module according to any preceding claim, wherein:
the first and second solar cells each comprise first and second surfaces, the first surface configured in use to face a radiative source and the second surface being arranged opposite the first surface; and
the barrier film is arranged to overlie the first surface of each of the first and second solar cells.
12. The solar module according to claim 11, wherein:
the solar module comprises a first plurality of conductive wire portions arranged on the first surface of the first solar cell;
the solar module comprises a second plurality of conductive wire portions arranged on the second surface of the second solar cell; and
the first plurality of conductive wire portions are electrically coupled to the second plurality of conductive wire portions.
13. The solar module according to claim 12, wherein:
the solar module comprises a wire supporting film interposed between the barrier film and the plurality of conductive wire portions arranged on the first surface of the first solar cell; and
the wire supporting film is configured not to overlie the second solar cell.
14. The solar module according to any of claims 11 to 13, wherein the solar module further comprises a second barrier film, the second barrier film arranged to overlie the second surface of each of the first and second solar cells.
15. The solar module according to any preceding claim, wherein:
the solar module comprises a plurality of solar cells arranged in an array which extends in a first direction and a second direction perpendicular to the first direction; and
the barrier film extends in both the first and second directions so as to overlie the plurality of solar cells in the array.

16. A method for manufacturing a solar module, the method comprising:
arranging a first solar cell and a second solar cell;
arranging a barrier film on the first and second solar cells;
5 arranging an encapsulant on the barrier film; and
arranging an outer casing to overlie the encapsulant;
wherein arranging the barrier film comprises configuring the barrier film such that it
substantially overlies the first and second solar cells and extends from the first solar cell to the
second solar cell.
- 10
17. The method according to claim 16, wherein:
arranging the first and second solar cells comprises positioning the first solar cell
adjacent to and spaced apart from the second solar cell to define a gap therebetween; and
arranging the barrier film comprises configuring the barrier film to extend across the
15 gap between the first and second solar cells.