

SOLAR PAVEMENTS

RELATED APPLICATION

[0001] This application claims the benefit of priority to the Singapore patent application no. 10202401489Y filed May 27, 2024, the contents of which are hereby incorporated by reference in their entirety for all purposes.

TECHNICAL FIELD

[0002] The present disclosure relates to solar energy devices and more particularly to solar pavements.

BACKGROUND

[0003] Many governments and municipalities have set ambitious renewable energy targets to combat climate change and reduce reliance on non-renewable energy sources. However, the actual physical environment can impose inherent constraints that prevent the harvesting of renewable energy. For example, wind farms and solar farms typically require vast expanses of unblocked land. In the city, tall buildings block out sunlight from much of the unbuilt spaces while conditions at the rooftops of skyscrapers are generally unsuitable for large installations.

SUMMARY

[0004] In one aspect, various embodiments of the solar tile of the present disclosure includes a photovoltaic device, a cover, and a frame. The frame and the cover define an enclosure in which the photovoltaic device may be wholly disposed in the enclosure. The photovoltaic device includes a light-sensitive area. The cover including a light-transmissive area. The frame includes a first frame component and a second frame component. The first frame component is coupled with the cover. The first frame component supports the cover spaced apart from the photovoltaic device. A lap joint is formed between the first frame component and the second frame component.

[0005] The first frame component and the second frame component are in a nested assembly with one another.

[0006] In another aspect, various embodiments disclose a solar pavement module, in which the solar pavement module includes a plurality of the solar tile and a case, in which the plurality of the solar tile are disposed in the case in a tight fit engagement between adjacent ones of the plurality of the solar tile.

[0007] In yet another aspect, various embodiments of the present disclosure relates to a solar pavement including two or more solar tiles, each one of the two or more solar tiles comprising: a photovoltaic device, the photovoltaic device including a light-sensitive area; a cover, the cover including a light-transmissive area; and a frame, the frame and the cover defining an enclosure, the photovoltaic device being wholly disposed in the enclosure, the frame including: a first frame component, the first frame component including a first wall element defining a first port, the first frame component being coupled with the cover, the first frame component supporting the cover spaced apart from the photovoltaic device; a second frame component, the second frame component including a second wall element, the second wall element defining a second port; and a lap joint, the lap joint being formed between the first frame component and the second frame component, the first wall element and the second wall element being disposed in abutment with one another with the first port and the second port in alignment to define a cable slot extending from the photovoltaic device to an external side of the frame, wherein the enclosure is in communication with an exterior of the solar tile solely via the cable slot, and wherein the frame defines a flange, the flange extending transversely to overhang a base of the frame, and wherein the respective flange of the two adjacent ones of the two or more solar tiles are in abutment to define a channel, and wherein the cable slot opens into the channel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] To aid understanding, various embodiments of the present disclosure will be described with reference to the following figures:

[0009] FIG. 1 is a schematic drawing of a perspective view of a solar tile according to one embodiment of the present disclosure;

[0010] FIG. 2 is a schematic top view of a section of a road formed by an assembly of multiple solar tiles;

[0011] FIG. 3 is an exploded view of the solar tile;

[0012] FIG. 4 is a side view of the solar tile of FIG. 1;

- [0013] FIG. 5 is a top view of the solar tile of FIG. 1;
- [0014] FIG. 6A is a cross-sectional view of the solar tile at line A-A;
- [0015] FIG. 6B is another cross-sectional view of the solar tile at line B-B;
- [0016] FIG. 6C is a partial magnified view of FIG. 6B;
- [0017] FIG. 7A shows an example of a solar pavement module formed by a plurality of the solar tiles;
- [0018] FIG. 7B shows an exploded view of the solar tile according to another embodiment of the present disclosure;
- [0019] FIG. 8 is a schematic drawing of a top view of a solar tile of FIG. 7B;
- [0020] FIG. 9 is a bottom view of the solar tile of FIG. 8;
- [0021] FIG. 10 is a side view of the solar tile of FIG. 8;
- [0022] FIG. 11 is a perspective view of the solar tile of FIG. 8; and
- [0023] FIG. 12 is a cross-sectional view of the solar tile of FIG. 8.

DETAILED DESCRIPTION

[0024] The following detailed description is made with reference to the accompanying drawings, showing details and embodiments of the present disclosure for the purposes of illustration. Features that are described in the context of an embodiment may correspondingly be applicable to the same or similar features in the other embodiments, even if not explicitly described in these other embodiments. Additions and/or combinations and/or alternatives as described for a feature in the context of an embodiment may correspondingly be applicable to the same or similar feature in the other embodiments.

[0025] The word “exemplary” is used herein to mean “serving as an example, instance, or illustration.” Any embodiment described herein as “exemplary” is not necessarily to be construed as preferred or advantageous over other embodiments. As used herein, the singular ‘a’ and ‘an’ may be construed as including the plural “one or more” unless apparent from the context to be otherwise. In the context of various embodiments, the articles “a”, “an” and “the” as used with regard to a feature or element include a reference to one or more of the features or elements.

[0026] As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

[0027] In the context of various embodiments, the term “about” or “approximately” as applied to a numeric value encompasses the exact value and a reasonable variance as generally understood in the relevant technical field, e.g., within 10% of the specified value.

[0028] Terms such as “first” and “second” are used in the description and claims only for the sake of brevity and clarity, and do not necessarily imply a priority or order, unless required by the context.

[0029] Some methods may be described in terms of steps merely to aid understanding and/or for convenient reference. The delineation between one step and another step may be merely for convenient reference in the present disclosure. It will be understood that in actual implementation there may not be a clear division or transition from one step to another subsequent step. There may be a certain amount of overlap among the steps and/or more than one step may occur or be performed concurrently in time, etc.

[0030] **FIG. 1** is a schematic drawing of a perspective view of a solar tile 100 according to one embodiment of the present disclosure. The solar tile 100 includes a cover 200 and a frame 700. The cover 200 and the frame 700 together define or form an enclosure. One or more photovoltaic devices (PV devices) 500 are disposed in the enclosure. For the sake of brevity, reference to a PV device 500 in a solar tile 100 may be understood to include one or more PV devices 500 in the solar tile 100.

[0031] As used herein, the terms “solar cell”, “photovoltaic cell”, and “PV cell” may be used interchangeably to refer to a device configured to produce a photovoltaic (PV) effect, e.g., convert solar energy or radiant energy to electricity. The term “photovoltaic device” or “PV device” may include one or more PV cells. A PV cell may include a monocrystalline, polycrystalline, or amorphous silicon cell, a thin film PV cell, a semiconductor multijunction PV cell, etc. The PV device 500 is installed with its light-sensitive area facing the cover 200.

[0032] The frame 700 defines an opening 702. The cover 200 is coupled to the frame 700 to completely cover the opening 702. The cover 200 may be made of glass or other transparent material. In some examples, the cover 200 may be made of toughened glass or tempered glass. The area of the cover 200 that allows light to transmit therethrough is referred to as the light-transmissive area. The cover 200 may define a planar major surface 202. In some examples, the cover 200 and the frame 700 in assembly together provide a planar surface.

[0033] As used herein, the term “planar” refers to a flat or level surface, without limitation in terms of the orientation of the surface. Taking into consideration manufacturing tolerances and material properties, reference to a planar surface is not limited to surfaces that are absolutely flat. For example, as used herein, the term “planar” may include a substantially flat surface or a generally flat surface.

[0034] The solar tile 100 may be configured as a three-dimensional geometrical article, for example, but not limited to a cuboid. For example, the solar tile 100 may be configured with width dimensions (W1, W2) greater than a height (H). In some examples, the solar tile 100 of the present disclosure may be configured with a geometric profile.

[0035] For example, the solar tile 100 is configured to be modular. For example, as illustrated in **FIG. 2**, multiple units of the solar tile 100 may be laid together to form a paved area or to form at least a part of a solar pavement 120. In some examples, the sides 203 of a solar tile 100 of the present disclosure are shaped to be complementary with an adjacent solar tile 100, e.g., to facilitate a tiling arrangement (as shown in **FIG. 2**) when a plurality of the solar tiles 100 are laid to form a solar pavement 120.

[0036] For the sake of brevity, in the present disclosure, the term “solar pavement” refers to an area at least partially paved with one or more of the solar tile 100 in which the at least partially paved area is intended for pedestrian or vehicular traffic. Examples of where the solar pavement may be installed include, but is not limited to, roads, driveways, sidewalks, bike paths, walkways, paths, trails, plazas, etc.

[0037] The modularity of the solar tile 100 facilitates comparatively quick and cost-efficient installation and maintenance (for example, in comparison with closing off sections of a road and resurfacing the road with asphalt or tarmac).

[0038] **FIG. 3** shows the solar tile 100 exploded along a first axis 101. The first axis 101 may be defined by a normal to the planar major surface 201 of the cover 200. For the sake of brevity, reference to an axial direction refers to a direction parallel to the first axis 101.

[0039] The frame 700 includes a first frame component 710 and a second frame component 720. The first frame component 710 is coupled with the cover 200 and disposes the cover 200 spaced apart from the PV device 500. The cover 200 is axially spaced apart from the PV device 500. A gasket or a seal 300 may be provided between the cover 202 and the first frame member 710. The seal 300 is configured to prevent water seepage into the enclosure or the enclosed space in the solar tile 100.

[0040] The solar tile 100 includes fasteners 400. The fasteners 400 may include a clamp to secure the PV device 500 to the frame 700. In the example of **FIG. 3**, the clamp is formed by a set of T-section bars 410 that can be screwed to a baseboard 721 of the second frame component 720, with the PV device 500 clamped between the T-section bar 410 and the baseboard 721.

[0041] The fasteners 400 may include blocks 430. Each block 430 may define a plurality of through-holes. Referring also to the side view of the solar tile 100 in **FIG. 4**, in assembly, respective ones of a first slot 713 (defined at a side of the first frame component 710) and a second slot 723 (defined at a side of the second frame component) may be aligned with one another. Respective blocks 430 may be fitted through or keyed into the corresponding first slot 713 and the corresponding second slot 723. Fasteners 400 such as screws 440 (**FIG. 6C**) may secure each block 430 to the second frame component 720. The first frame component 710 and the second frame component 720 are secured to one another indirectly via the blocks 430. The proposed assembly provides a water-tight enclosure which is tolerant of or resilient under stresses placed on the solar tile 100 by pedestrian or vehicular traffic.

[0042] **FIG. 5** schematically illustrates a top view of the solar tile 100. In this example, the light-sensitive area of the PV device 500 is aligned with the light-transmissive area of the cover 200. The light-transmissive area of the cover 200 is configured to be greater than the light-sensitive area of the PV device.

[0043] **FIG. 6A** is a cross-sectional view of the solar tile 100 as viewed from a cutting plane (represented by line A-A in **FIG. 5**). The first frame component 710 and the second frame component 720 may be described as being in a nested assembly with one another. The first frame component 710 and the second frame component 720 may be at least partially stacked along the first axis 101 to form the nested assembly. For the sake of brevity, the term “nested assembly” may refer to an assembly in which a part of one component is at least partially received by another component. It can be seen from the example illustrated in **FIG. 6A** of the proposed nested assembly that the first frame component 710 and the second frame component 720 are axially nested and prevent a relative transverse displacement. The nested assembly enable the fasteners securing the first frame component 710 to the second frame component 720 to be located only at the sides. The major surface

109 of the solar tile 100 that will be exposed to the weather and the traffic may be free of holes and fasteners.

[0044] **FIG. 6B** is a cross-sectional view of the solar tile 100 as viewed from another cutting plane (represented by line B-B in **FIG. 5**), in which the cutting planes are orthogonal to one another. **FIG. 6C** is a partial magnified view 106 of **FIG. 6C**.

[0045] In assembly, a lap joint 752 is formed between the first frame component 710 and the second frame component 720. The first frame component 710 may include a first rim 715, and the second frame component may include a second rim 725. The lap joint 752 is formed by the first rim 715 and the second rim 725 being in abutment with one another.

[0046] The lap joint 752 is disposed in a transverse plane relative to the first axis 101 (e.g., the transverse plane is normal to the first axis 101). The lap joint 752 circumscribes the PV device 500. The lap joint 752 is transversely spaced apart from the PV device 600.

[0047] An inner perimeter of the frame 700 may define a shelf 760. A peripheral area of the cover 200 is disposed on the shelf 760 to support the cover 200. The frame 700 may in this manner maintain the cover 200 in a position that is axially spaced apart from the PV device 600. In the example illustrated in **FIG. 6C**, more specifically, in assembly the peripheral area of the cover 200 is surrounded or wrapped around by the seal 300, and the seal 300 is in physical contact with the shelf 760. Alternatively described, the seal 300 defines a trough into which a periphery of the cover 200 may be fitted.

[0048] The frame 700 provides a base that can uniformly (or substantially uniformly) contact the floor (ground) and spread the vertical load (e.g., from pedestrian and/or vehicular traffic) to avoid bending of the solar tile 100. The frame 700 may be made of a stiff material, including but not limited to mild steel, aluminum, etc.

[0049] The frame 700 advantageously ensures a locking of the components of the solar tile 100 to avoid water leakage into the enclosure. The locking or interlocking configuration further promotes joint integrity. In other words, the nesting arrangement provides an additional guard against water seepage (into the enclosure) and enables the PV device in the solar tile, as well as any electronic or electrical parts therein, to remain operable. At the same time, the watertight configuration is achieved without sacrificing the solar tile's ability to absorb stresses and handle dynamic loading conditions (e.g., as traffic moves over the solar tile 100).

[0050] In some embodiments, the light-transmissive area of the cover 200 is partially blocked by the shelf 760 as a result of a (peripheral) part of the cover 200 resting on the shelf 760. The solar tile 100 may be configured such that an unblocked part of the light-transmissive area defines an unblocked area greater than the light-sensitive area of the PV device 600.

[0051] **FIG. 7A** shows an example of a solar pavement module 110 formed by a plurality of the solar tiles 100 disposed in a case 112. The time required to make a solar pavement can be reduced by using the solar tile 100 of the present disclosure. Advantageously, the modular nature of the solar tiles 100 enable the pre-fabrication of solar pavement modules 110. The time required to make a solar pavement can be further reduced by laying down solar pavement modules 110. The plurality of the solar tiles 100 may be disposed in the case 112 such that adjacent solar tiles 100 are in a tight fit engagement with one another.

[0052] **FIG. 7B** shows an exploded view of the solar tile 100 forming the solar according to another embodiment of the present disclosure. The solar tile 100 includes a cover 200 and a frame 700 which can be assembled together to define an enclosure. One or more PV devices 500 may be disposed in the enclosure and secured in place (relative to the frame 700) by using fasteners 400 such as solar clamps 480. The frame 700 includes a first frame component 710 and a second frame component 720.

[0053] **FIG. 8** is a schematic drawing of a top view of the solar tile of **FIG. 7B**. **FIG. 9** is a bottom view of the solar tile of **FIG. 8**. **FIG. 10** is a side view of the solar tile of **FIG. 8**. **FIG. 11** is a perspective view of the solar tile of **FIG. 8**.

[0054] As can be seen from **FIG. 8** and **FIG. 11**, the major surface of the solar tile 100 that in use (e.g., in use to form a part of a solar pavement and will thus be exposed to the weather and to the pedestrian and/or vehicular traffic) can be free of fasteners. The only possible passage for water (e.g., from the rain, melting snow, etc.) to seep into the enclosure (where the PV device 500 is disposed) will be the interface between the cover 200 and the frame 700. This possible passage can be adequately blocked or sealed by a seal, e.g., a continuous solid seal 300.

[0055] In the example illustrated in **FIG. 8** to **FIG. 11**, the first frame component 710 and the second frame component 720 are in a nested assembly such that any openings for fasteners can be solely disposed at one or more sides of the frame, similar to the embodiment described above with reference to **FIG. 3**.

[0056] **FIG. 12** shows a schematic cross-sectional view of the solar tile of **FIG. 8** to show another embodiment of the nested assembly with aligned slots or holes at one or more sides of the solar tile 100.

[0057] The first frame component 710 may include a first wall element 717 defining a first port 718. The second frame component 720 may include a second wall element 727 defining a second port 728. The first wall element 717 and the second wall element 727 may be disposed in abutment with one another. The first port 718 and the second port 728 may be aligned to define a cable slot 780 extending from the PV device 500 to an external side of the frame 700. In some embodiments, the enclosure is in communication with an exterior of the solar tile solely via the cable slot 780.

[0058] According to another aspect of the present disclosure, the solar pavement 120 may be formed by two or more solar tiles 100. Each one of the two or more solar tiles 100 includes one or more PV device 500. The PV device 500 includes a light-sensitive area. The solar tile 100 includes the cover 200. The cover may be made of 12 millimeter-thick toughened glass. The cover 200 is coupled with the frame 700 all along the perimeter or a peripheral area of the cover. An opening of the frame 700 may thus define a light-transmissive area that is smaller than the area of the glass sheet used as the cover 200.

[0059] In some embodiments, as illustrated in **FIG. 12**, the frame 700 defines a flange 790. The flange 790 may extend transversely to overhang a base 792 of the frame 700. In some examples, the base 792 has a base area greater than the light-transmissive area. The flanges 790 of an adjacent solar tile 100 may be disposed in abutment. As illustrated, the abutting flanges 790 may define a channel 900. The cable slot 780 is preferably positioned to open into the channel 900. The channel 900 may provide a sheltered or protected path for cables or wiring to/from the respective solar tiles.

[0060] Advantages

[0061] The present disclosure describes a modular solar tile or a solar pavement module that involves integrating PV devices within a durable, load-bearing surface capable of withstanding pedestrian and vehicular traffic. The solar tiles are configured to be modular for ease of installation, maintenance, and replacement. According to various embodiments of the present disclosure, the solar tile includes several features, components, and layers to provide functionality, durability, and safety. Examples include:

[0062] Photovoltaic Layer

[0063] A photovoltaic layer may be formed by a plurality of PV cells disposed to provide a light-sensitive area. The PV layer may be referred to as a core of the solar tile in which sunlight is converted into electricity. The PV cells may be made of silicon (monocrystalline or polycrystalline) and are configured to generate electrical power.

[0064] Electrical Wiring

[0065] Electrical wiring may be embedded within the solar tile, e.g., with the electrical wiring connecting the PV cells to one another (e.g., forming the PV device) and to an external circuit for power distribution.

[0066] Protective Surface Layer

[0067] A protective surface layer may be made of a transparent and durable material. A top layer may be made from tempered glass or a strong, transparent composite material that allows sunlight to pass through while providing protection to the PV cells. This layer is preferably slip-resistant to improve safety. This layer is preferably textured to improve light absorption, e.g., anti-glare.

[0068] Load-Bearing Capacity

[0069] The material of the frame and the cover are selected to withstand the weight and pressure from pedestrian and vehicular traffic without cracking or degrading.

[0070] Encapsulation Layer

[0071] Weatherproof Sealing

[0072] Encapsulation materials such as but not limited to EVA (ethylene-vinyl acetate) or polyolefin films may be used to seal the solar tile, protecting the enclosure and PV device from moisture, dirt, and/or environmental wear.

[0073] Thermal Management

[0074] This layer also helps with the dissipation of heat, which can affect the efficiency of the PV cells.

[0075] Structural Support Layer

[0076] A durable base material is preferably selected to form a robust base that supports the weight above and ensures the solar tile remains intact under pressure. Examples of materials that can be used include but are not limited to reinforced concrete, metal, and/or durable plastics.

[0077] Modularity Features

[0078] The solar tile and the solar pavement module are configured to enable efficient interlocking or seamless integration with adjacent solar tiles or solar pavement modules, facilitating straightforward installation and replacement.

[0079] Electrical and Safety Features

[0080] Power Management

[0081] Integrated microinverters or DC-DC (direct current) converters to optimize power output and ensure compatibility with the electrical grid may be connected to the respective PV devices.

[0082] Safety Measures

[0083] Ground Fault Circuit Interrupters (GFCIs) and other safety mechanisms to protect against electrical hazards may be integrated with the PV devices in the solar tiles.

[0084] Smart Features

[0085] Light-Emitting Diodes (LED) lights may be provided and powered by the solar tile. The solar tile may further include a switch to switch on or switch off the LED lights, e.g., to illuminate the pavement and/or provide dynamic road markings.

[0086] Sensors may be incorporated with the solar pavement to monitor environmental conditions, traffic data, or tile performance.

[0087] Wireless communications between the solar tile and a processor (e.g., may be local or cloud-based) may be enabled, e.g., by provided a wireless module in the solar tile or solar pavement module. For example, the solar tile, the solar pavement module, or the solar pavement may be configured to send data to a central system for monitoring and management.

[0088] Installation System

[0089] Foundation Requirements & Connection Systems

[0090] The conventional construction of a solar pavement requires requiring expertise in materials science, electrical engineering, civil engineering, and sustainability. Depending on the application (e.g., sidewalk, road, plaza, etc.), the conventional construction would require a specific foundation or underlayment to ensure stability and longevity. Advantageously, the proposed solar tile and/or solar pavement module overcomes the multidisciplinary engineering challenge in the conventional construction of solar pavements as the solar tile may be installed in a modular manner.

[0091] Electrical and physical connectors (referred to herein generally as “fasteners”) further allow for the easy integration of the solar tiles into existing infrastructure.

[0092] The modularity of the solar tile further provides efficiency, durability, and cost, making solar pavements a more viable option for the future of urban infrastructure and renewable energy generation.

[0093] Applications

[0094] In accordance with various embodiments of the present disclosure, the solar tile includes PV cells (a PV device) configured to generate electricity from sunlight. The solar tile includes a transparent, durable top layer that is slip-resistant and allows light to reach the PV cells. A transparent hydrophobic coating may be provided on the transparent top material (e.g., the cover) to render the surface with a minimal surface energy and thereby minimizes adhesion of the dirt to the surface.

[0095] An encapsulation layer that seals the PV cells, protecting the PV cells from environmental elements (e.g., heavy downpour rain, etc.) is included in the solar tile.

[0096] Also provided is a structural support layer that is transparent and configured to enable the solar tile to withstand pedestrian and light vehicular traffic such as cycles, wheelchair and e-bikes.

[0097] Electrical connectivity features enable the solar tile to be interconnected with adjacent solar tiles to form a continuous power-generating surface.

[0098] The solar tile may be implemented as a part of a system configured to generate electricity and to perform health monitoring, for example, a plurality of solar tiles as described above may be arranged to cover a predetermined area. An electrical distribution system may be connected to the solar tiles for collecting and distributing the generated electricity. A control unit configured to manage the operation of the solar tile, including but not limited to enabling power optimization and safety functionalities.

[0099] The solar tile may be implemented as a part of an asset health monitoring system that is configured to observe a strain through an integrated strain sensor system (disposed in the solar tile) to monitor parameters such as strain, temperature, and fatigue loads, etc., to ascertain a residual strength and a remaining useful life of the solar tile, as part of a condition monitoring system.

[00100] Additionally, parameters related to the generation of electrical energy is monitored to ascertain a degradation over time and to provide an alert when the photovoltaic

performance falls short of a target. For example, the PV performance may be affected by the degree of cleanliness of the transparent layer (cover).

[00101] Additionally, the solar tile may be installed and connected to a lighting system. For example, the solar tile may include a LED lighting system that is powered from a battery in the night or dark environment to guide the pedestrians, while being responsive to irradiation of sunlight to power the LED lighting system in the daytime.

[00102] Method for Installing a Solar Pavement System

[00103] A method of installation may include:

[00104] (1) Preparing a base layer on a surface intended to receive the solar pavement.

[00105] (2) Placing a plurality of modular solar pavement tiles on the base layer according to a predetermined layout.

[00106] (3) Interconnecting the modular solar pavement tiles electrically and mechanically to form a unified structure.

[00107] (4) Connecting the solar pavement to an electrical distribution network.

[00108] According to embodiments of the present disclosure, a system may include the solar pavement and integrated sensors in at least one of the solar tiles, configured to monitor environmental conditions or acquire traffic data. LED lighting elements may be controlled by the solar tile or the system for providing illumination or displaying information. The system may include wireless communication capabilities for transmitting data collected by the integrated sensors or for receiving operational instructions.

[00109] According to other embodiments, the solar pavement may be configured as a system that is optimizable or tunable to vary energy generation and energy distribution, e.g., to achieve a preferred level of efficiency. A system of the present disclosure may be in the form of a management system configured to utilize algorithms for maximizing the electrical output from the solar pavement based on real-time environmental and usage data.

[00110] In another aspect, the solar pavement may include energy storage units, e.g., configured to store excess electricity generated by the solar tiles for later use.

[00111] In yet another aspect, the solar tile may be operably connected to an adaptive lighting system powered by the electricity generated by the solar tile. The lighting intensity or the lighting patterns may be configured to be adjustable. For example, in response to ambient light levels or specific needs.

[00112] In one aspect, various embodiments of the solar tile of the present disclosure includes a photovoltaic device, a cover, and a frame. The frame and the cover define an enclosure in which the photovoltaic device may be wholly disposed in the enclosure. The photovoltaic device includes a light-sensitive area. The cover including a light-transmissive area. The frame includes a first frame component and a second frame component. The first frame component is coupled with the cover. The first frame component supports the cover spaced apart from the photovoltaic device. A lap joint is formed between the first frame component and the second frame component.

[00113] The first frame component and the second frame component are in a nested assembly with one another.

[00114] The first frame component may include a first rim, and the second frame component may include a second rim. The lap joint is formed by the first rim and the second rim being in abutment with one another.

[00115] The lap joint is disposed in a transverse plane. The lap joint may circumscribe the photovoltaic device. The lap joint may be transversely spaced apart from the photovoltaic device.

[00116] The first frame component may include a first wall element defining a first port. The second frame component may include a second wall element defining a second port. The first wall element and the second wall element are disposed in abutment with one another.

[00117] The first port and the second port may be aligned to define a cable slot extending from the photovoltaic device to an external side of the frame.

[00118] The enclosure may be in communication with an exterior of the solar tile solely via the cable slot.

[00119] The solar tile may further include a clamp in which the clamp is configured to couple the photovoltaic device to the frame.

[00120] An inner perimeter of the frame may define a shelf. A peripheral area of the cover may be disposed on the shelf.

[00121] The light-transmissive area may be partially blocked by the shelf, and an unblocked part of the light-transmissive area may define an unblocked area that is greater than the light-sensitive area.

[00122] The frame may define a base and a flange. The flange may circumscribe the base. The flange may extend transversely to overhang the base.

[00123] The base may have a base area greater than the light-transmissive area.

[00124] In another aspect, various embodiments of the solar pavement module include a case and a plurality of the solar tile according to any embodiment described above. The plurality of the solar tile may be disposed in the case in a tight fit engagement between adjacent ones of the plurality of the solar tile.

[00125] In yet another aspect, various embodiments of the solar pavement include two or more solar tiles in which each one of the two or more solar tiles includes: a photovoltaic device, a cover, and a frame. The photovoltaic device includes a light-sensitive area. The cover includes a light-transmissive area. The frame and the cover define an enclosure. The photovoltaic device is wholly disposed in the enclosure. The frame includes a first frame component, a second frame component, and a lap joint. The first frame component includes a first wall element defining a first port. The first frame component is coupled with the cover. The first frame component supports the cover spaced apart from the photovoltaic device. The second frame component includes a second wall element, and the second wall element defines a second port. The lap joint is formed between the first frame component and the second frame component. The first wall element and the second wall element are disposed in abutment with one another with the first port and the second port in alignment to define a cable slot extending from the photovoltaic device to an external side of the frame. The enclosure is in communication with an exterior of the solar tile solely via the cable slot. The frame defines a flange. The flange extends transversely to overhang a base of the frame. The respective flange of the two adjacent ones of the two or more solar tiles are in abutment to define a channel, in which the cable slot opens into the channel.

[00126] Various embodiments of the solar pavement as described above, in which the solar pavement includes the first frame component and the second frame component in a nested assembly with one another.

[00127] Various embodiments of the solar pavement as described above, in which the first frame component includes a first rim and in which the second frame component includes a second rim, and in which the lap joint is formed by the first rim and the second rim being in abutment with one another.

[00128] Various embodiments of the solar pavement as described above, in which the lap joint is disposed in a transverse plane, and in which the lap joint circumscribes the photovoltaic device, the lap joint being transversely spaced apart from the photovoltaic device.

[00129] All examples described herein, whether of apparatus, methods, materials, or products, are presented for the purpose of illustration and to aid understanding and are not intended to be limiting or exhaustive. Modifications may be made by one of ordinary skill in the art without departing from the scope of the claimed invention.

CLAIMS

1. A solar tile comprising:

a photovoltaic device, the photovoltaic device including a light-sensitive area;

a cover, the cover including a light-transmissive area; and

a frame, the frame and the cover defining an enclosure, the photovoltaic device being wholly disposed in the enclosure, the frame including:

a first frame component, the first frame component being coupled with the cover, the first frame component supporting the cover spaced apart from the photovoltaic device;

a second frame component; and

a lap joint, the lap joint being formed between the first frame component and the second frame component.

2. The solar tile as recited in claim 1, wherein the first frame component and the second frame component are in a nested assembly with one another.

3. The solar tile as recited in claim 1 or claim 2, wherein the first frame component comprises a first rim, and wherein the second frame component comprises a second rim, and wherein the lap joint is formed by the first rim and the second rim being in abutment with one another.

4. The solar tile as recited in claim 3, wherein the lap joint is disposed in a transverse plane, and wherein the lap joint circumscribes the photovoltaic device, the lap joint being transversely spaced apart from the photovoltaic device.

5. The solar tile as recited in claim 3 or claim 4, wherein the first frame component comprises a first wall element defining a first port, and wherein the second frame component comprises a second wall element defining a second port, the first wall element and the second wall element being disposed in abutment with one another.

6. The solar tile as recited in claim 5, wherein the first port and the second port are aligned to define a cable slot extending from the photovoltaic device to an external side of the frame.
7. The solar tile as recited in claim 6, wherein the enclosure is in communication with an exterior of the solar tile solely via the cable slot.
8. The solar tile as recited in claim 7, further comprising a clamp, the clamp being configured to couple the photovoltaic device to the frame.
9. The solar tile as recited in any one of claims 5 to 8, wherein an inner perimeter of the frame defines a shelf, and wherein a peripheral area of the cover is disposed on the shelf.
10. The solar tile as recited in claim 9, wherein the light-transmissive area is partially blocked by the shelf, and wherein an unblocked part of the light-transmissive area defines an unblocked area greater than the light-sensitive area.
11. The solar tile as recited in claim 9, wherein the frame defines a base and a flange, the flange circumscribing the base, and wherein the flange extends transversely to overhang the base.
12. The solar tile as recited in claim 11, wherein the base has a base area greater than the light-transmissive area.
13. A solar pavement module comprising:
 - a plurality of the solar tile according to any one of claims 1 to 12; and
 - a case, the plurality of the solar tile being disposed in the case in a tight fit engagement between adjacent ones of the plurality of the solar tile.
14. A solar pavement comprising two or more solar tiles, each one of the two or more solar tiles comprising:
 - a photovoltaic device, the photovoltaic device including a light-sensitive area;
 - a cover, the cover including a light-transmissive area; and

a frame, the frame and the cover defining an enclosure, the photovoltaic device being wholly disposed in the enclosure, the frame including:

- a first frame component, the first frame component including a first wall element defining a first port, the first frame component being coupled with the cover, the first frame component supporting the cover spaced apart from the photovoltaic device;

- a second frame component, the second frame component including a second wall element, the second wall element defining a second port; and

- a lap joint, the lap joint being formed between the first frame component and the second frame component,

the first wall element and the second wall element being disposed in abutment with one another with the first port and the second port in alignment to define a cable slot extending from the photovoltaic device to an external side of the frame,

wherein the enclosure is in communication with an exterior of the solar tile solely via the cable slot,

and wherein the frame defines a flange, the flange extending transversely to overhang a base of the frame,

and wherein the respective flange of two adjacent ones of the two or more solar tiles are in abutment to define a channel, and wherein the cable slot opens into the channel.

15. The solar pavement as recited in claim 14, wherein the first frame component and the second frame component are in a nested assembly with one another.

16. The solar pavement as recited in claim 14 or claim 15, wherein the first frame component comprises a first rim, and wherein the second frame component comprises a second rim, and wherein the lap joint is formed by the first rim and the second rim being in abutment with one another.

17. The solar pavement as recited in claim 16, wherein the lap joint is disposed in a transverse plane, and wherein the lap joint circumscribes the photovoltaic device, the lap joint being transversely spaced apart from the photovoltaic device.