

PHOTOVOLTAIC HEAT INSULATION DEVICE

The invention relates to a heat insulation device, and more particularly to a photovoltaic heat insulation device that can generate electric energy from solar energy.

In view of the present situation of global climate change, environmental pollution, resource shortage, etc., renewable energy has advantages of cleanliness, reduction of room-temperature gas discharge, energy self-generation, etc. Increasing numbers of countries therefore take renewable energy into consideration for their energy policies. One type of renewable energy is power generation by solar energy. At present, various sorts of photovoltaic units have been developed not only for installation on calculators, electric products, transportation vehicles, etc., but also for installation as part of the building structures, such as roofs, walls, skylights, windows, etc., where solar energy is converted into electric power.

For those photovoltaic units that are installed in the building structures, in order to have sufficient transparency so that users can view outdoor scenery from indoors, the photovoltaic units are made translucent. Therefore, the conventional photovoltaic units are unable to provide sufficient heat insulation. In addition to the sun light that shines in a room, heat radiation and ultra-violet light also enters the rooms.

Not only does this raise the temperature in the rooms,
but it also whitens the objects exposed to the heat
radiation and ultra-violet light. The conventional
photovoltaic unit therefore has poor
5 sunlight-shielding effect. Moreover, when the
photovoltaic units operate, high heat can be generated.
Although some vendors adhere a layer of insulating
membrane to the photovoltaic unit, since the insulating
membrane is made of plastic material, the endurance of
10 the conventional insulating membrane is poor and prone
to becoming fragile. Thus, the heat insulation effect
is adversely affected and the long-term appearance of
the building structure may become spoiled.

The main object of this invention is to provide a
15 photovoltaic heat insulation device with good esthetic
properties, good heat insulation effect, good solar
light reflection effect and a significant increase of
power generation.

Accordingly, a photovoltaic heat insulation device
20 of the present invention comprises at least one
photovoltaic unit that includes a solar panel having
inner and outer sides, and a heat insulator that has
a transparent substrate attached to the inner side of
the solar panel, and at least one film layer formed on
25 the transparent substrate.

Other features and advantages of the present
invention will become apparent in the following detailed

description of the preferred embodiments with reference to the accompanying drawings, of which:

Fig. 1 is a front perspective view of the first preferred embodiment of a photovoltaic heat insulation device according to the present invention;

Fig. 2 is a fragmentary sectional view of the first preferred embodiment;

Fig. 3 is a fragmentary sectional view of the second preferred embodiment of the present invention;

Fig. 4 is a fragmentary sectional view of the third preferred embodiment of the present invention;

Fig. 5 is a fragmentary sectional view of the fourth preferred embodiment of the present invention;

Fig. 6 is a fragmentary sectional view of the fifth preferred embodiment of the present invention;

Fig. 7 is a fragmentary sectional view of the sixth preferred embodiment of the present invention;

Fig. 8 is a fragmentary sectional view of the seventh preferred embodiment of the present invention;

Fig. 9 is a fragmentary sectional view of the eighth preferred embodiment of the present invention;

Fig. 10 is a fragmentary sectional view of the ninth preferred embodiment of the present invention;

Fig. 11 is a fragmentary sectional view of the tenth preferred embodiment of the present invention;

Fig. 12 is a fragmentary sectional view of the eleventh preferred embodiment of the present invention;

Fig. 13 is a fragmentary sectional view of the twelfth preferred embodiment of the present invention;

Fig. 14 is a fragmentary sectional view of the thirteenth preferred embodiment of the present invention;

Fig. 15 is a fragmentary sectional view of the fourteenth preferred embodiment of the present invention;

Fig. 16 is a fragmentary sectional view of the fifteenth preferred embodiment of the present invention;

Fig. 17 is a fragmentary sectional view of the sixteenth preferred embodiment of the present invention; and

Fig. 18 is a fragmentary sectional view of the seventeenth preferred embodiment of the present invention.

Before the present invention is described in greater detail with reference to the accompanying preferred embodiments, it should be noted herein that like elements are denoted by the same reference numerals throughout the disclosure.

As shown in Figures 1 and 2, the first preferred embodiment of a photovoltaic heat insulation device according to the present invention is shown to include a plurality of juxtaposed photovoltaic units 1 that are assembled together to form a structure, such as a roof,

wall, skylight, window, etc. In Figure 1, twelve photovoltaic units 1 are juxtaposed to constitute a photovoltaic heat insulation device. Each photovoltaic unit 1 includes a solar panel 21, a photocatalyst layer 22 attached to an outer side 211 of the solar panel 21, and a heat insulator 3.

The solar panel 21 may be, but is not limited to, a non-crystalline silicon solar panel, a monocrystalline silicon solar panel, a polycrystalline silicon solar panel, a semiconductor solar panel, a thin-film solar panel that is made from nanocrystalline silicon (nc-Si), microcrystalline silicon, (mc-Si), copper indium diselenide (CIS), copper indium gallium diselenide (CIGS), or GaAs multijunction, a dye-sensitized solar cell, or an organic/polymer solar cell.

The solar panel 21 in this embodiment is made by forming a solar panel layer on a glass substrate through a sputtering process. The photocatalyst layer 22 is used for protection and isolation purposes. Because the photocatalyst layer 22 facilitates removal of dust from the solar panel 31 by water, the solar panel 21 may have a clean outer surface. The photovoltaic unit 1 may further include a hub (not shown) to connect the solar panel 21 to a converter (not shown) to output electric power.

The heat insulator 3 has a transparent substrate 31

connected to an inner side 212 of the solar panel 21,
and a film layer 32 formed on the transparent substrate
31. The transparent substrate 31 has opposite first and
second surfaces 311, 312. The film layer 32 is a
5 patterned plastic coating layer which may be formed
directly on the first surface 311 by spray coating. In
this embodiment, the solar panel 21 is bonded to the
outer side of the film layer 32 through a transparent
adhesive 4 that may be made from EVA, PVB, etc.

10 The transparent substrate 31 may be selected from
the group consisting of transparent glass, colorless
glass, colored glass, semi-reflection glass,
total-reflection glass, slight-reflection glass and
low-radiation high-transparent glass. The aforesaid
15 glasses are capable of secondary reflection of light.

The film layer 32 may also be a digital image layer
that is formed on the transparent substrate 31 using
a computer and a digital spray coating technique. The
film layer 32 is made from a plastic coating material
20 that includes an anti-ultraviolet material. A coloring
agent may be added to the plastic coating material so
that the transparent substrate 31 may be formed with
a monochrome block, a pattern, characters, or a displayed
image or information. By controlling the concentration
25 of the coloring agent and the amount of the plastic
coating material applied to the transparent substrate
31, the light transmittance of the transparent substrate

31 may be adjusted. The resin used in the plastic coating material may be a fluorocarbon resin. The anti-ultraviolet material may be TiO_2 and ZnO .

5 For installation, the photovoltaic units 1 are disposed side by side and assembled together to form a building structure. The film layers 32 cooperate to display a pattern, such as a figure of a lady, a scenery, a product sample, a trademark, etc. A viewer can directly see the pattern from the outside of the
10 photovoltaic heat insulation device. Because the photovoltaic unit 1 has sufficient transparency, outdoor scenery can be viewed from indoor. In addition, because the film layer 32 is formed on the transparent substrate 31, it is durable.

15 When sunlight shines on the photovoltaic units 1, the solar panels 21 convert the sunlight into electric energy. Parts of the visible light and ultraviolet light that penetrate the solar panels 21 and go toward the heat insulators 3 are reflected by the film layers
20 32 to emit outward through the solar panels 21. As such, undesired extra light is prevented from entering the building structure and from de-coloring and yellowing things inside the building structure. Furthermore, the heat radiated from light can be insulated. In addition,
25 the reflected light can re-enter the solar panels 21 to provide more solar energy for the production of more electric energy.

Referring to Figure 3, the second preferred embodiment of the photovoltaic heat insulation device according to this invention is generally similar to the first preferred embodiment except that the film layer 32 is formed directly on the second surface 312, and the inner side of the solar panel 21 is bonded adhesively to the first surface 311 through the transparent adhesive 4.

Referring to Figure 4, the third preferred embodiment of this invention is generally similar to the first preferred embodiment except that the film layer 32 in this embodiment is a metallic reflection layer made from a metal, such as by sputtering or vaporizing the metal on the first surface 311 of the transparent substrate 31. The degree of transparency of the photovoltaic unit 1 may be adjusted by controlling the concentration or density of the metal so that a user can view outdoor scenery from indoor. Any suitable metal may be used to form the metallic reflection layer. Aluminum may be used to reflect ultraviolet light. An aluminum-silver alloy may be used to reflect visible light. An alloy of gold, copper and silver may be used to reflect infrared light components. Moreover, a material named distributed Bragg reflector (abbreviated as DBR) membrane made by multi-layers of alternating materials, in particular, dielectric layers with high/low reflection rates may also be used in forming

the film layer 32.

Referring to Figure 5, the fourth preferred embodiment of this invention is generally similar to the third preferred embodiment except that the film layer 32 is formed on the second surface 312 of the transparent substrate 31 by sputtering.

Referring to Figure 6, the sixth preferred embodiment of this invention is generally similar to the first to fourth preferred embodiments. However, the transparent substrate 31 is a colored glass containing a coloring agent, and can present monochrome or polychrome variation. The colored glass can insulate the heat radiated from the sunlight, and block high temperature heat generated by the solar panel 21. The second surface 312 of the transparent substrate 31 is an uneven surface, which enhances reflection of the sunlight and thereby increases electric energy. Alternatively, the first surface 311 may be an uneven surface, or both of the first and second surfaces 311, 312 may be uneven surfaces.

Referring to Figure 7, the sixth preferred embodiment according to this invention is generally similar to the first preferred embodiment. However, the sixth preferred embodiment further includes a transparent cover layer 34 facing the second surface 312, a looped frame layer 33 disposed between the transparent cover layer 34 and the second surface 312, an isolating space

36 defined by the looped frame layer 33, the transparent cover layer 34 and the substrate 31, and a sealant 35 surrounding the looped frame layer 33 between the transparent cover layer 34 and the second surface 312.

5 The isolating space 36 is used to block the radiated heat generated by the sunlight, and may be filled with air or inert gas to enhance heat insulation. The transparent cover layer 34 may be glass, fireproof glass, wire glass, safety glass and colored glass. The looped
10 frame layer 33 in this embodiment is a hollow frame structure that defines a looped chamber 333 filled with a drying agent 332, and an inner peripheral wall adjacent to the isolating space 36 and formed with a plurality of through holes 331 for absorbing water or moisture
15 that permeates into the isolating space 36 through clearances of the sealant 35. As such, the isolating space 36 can be prevented from becoming foggy and affecting the transparency of the photovoltaic unit 1.

Referring to Figure 8, the seventh preferred
20 embodiment of this invention is generally similar to the sixth preferred embodiment except that the film layer 32 is formed on the second surface 312 of the transparent substrate 31 by sputtering.

Referring to Figure 9, the seventh preferred
25 embodiment according to this invention is generally similar to the sixth preferred embodiment. However, the film layer 32 is attached to the transparent cover

layer 34. In particular, the transparent cover layer 34 has a third surface 341 facing the isolating space 36 and a fourth surface 342 opposite to the third surface 341 and distal from the isolating space 36. The film layer 32 is attached to the third surface 341, and the solar panel 21 is directly bonded to the first surface 311 of the transparent substrate 31.

Referring to Figure 10, the ninth preferred embodiment according to this invention is generally similar to the eighth preferred embodiment except that the film layer 32 of the heat insulator 3 is attached to the fourth surface 342 of the transparent cover layer 34.

Referring to Figure 11, the tenth preferred embodiment of this invention is generally similar to the sixth to eighth preferred embodiments. However, the photovoltaic unit 1 further includes a light-emitting unit 5 that has a plurality of light-emitting elements 51 disposed in the isolating space 36 and mounted to the annular frame layer 33 (only one is shown in the Figure). Each light-emitting element 51 may be a single light-emitting diode, an array of light-emitting diodes, a light bulb, a string of lamps, or a CCFL.

During the daytime, or when the sunlight is sufficient, the solar panel 21 operates for energy conversion, and the generated power is stored in a storage battery (not

shown in the Figure) or an energy-storing unit. When the sunlight is insufficient or during the nighttime, the energy-storing unit provides power to the light-emitting unit 5 so that the pattern of the film layer 32 is illuminated.

Referring to Figure 12, the eleventh preferred embodiment of this invention is generally similar to the sixth preferred embodiment except that the film layer 32 is a metallic reflection layer made from a metallic material. The metallic reflection layer may be formed directly over the first surface 311 of the transparent substrate 31 by sputtering.

Referring to Figure 13, the twelfth preferred embodiment of this invention is generally similar to the eleventh preferred embodiment except that the film layer 32 is formed on the second surface 312 of the transparent substrate 31 by sputtering.

Referring to Figure 14, the thirteenth preferred embodiment of this invention is generally similar to the eleventh preferred embodiment except that the film layer 32 is formed on the third surface 341 of the transparent cover layer 34 by sputtering.

Referring to Figure 15, the fourteenth preferred embodiment of this invention is generally similar to the thirteenth preferred embodiment except that the film layer 32 is formed on the fourth surface 342 of the transparent cover layer 34 by sputtering.

Referring to Figure 16, the fifteenth preferred embodiment of this invention is generally similar to the sixth to ninth preferred embodiments, and the eleventh to the fourteenth preferred embodiments.

5 However, the heat insulator 3 in this embodiment has two film layers 32, 32'. The film layer 32 is a metallic reflection layer formed by sputtering on the substrate 31. The film layer 32' is a patterned plastic coating layer formed on the outer surface of the film layer 32.

10 Referring to Figure 17, the sixteenth preferred embodiment of this invention is generally similar to the fifteenth preferred embodiment. However, the film layer 32 is a metallic reflection layer formed on the first surface 311 of the transparent substrate 31. The
15 film layer 32' is a plastic coating layer formed on the third surface 341 of the transparent cover layer 34.

Referring to Figure 18, the seventeenth preferred embodiment of this invention is generally similar to the sixth to sixteenth preferred embodiments. However,
20 the heat insulator 3 in this embodiment further includes a thin translucent ceramic layer 37 formed on the fourth surface 342 of the transparent cover layer 34.

CLAIMS:

1. A photovoltaic heat insulation device comprising:
at least one photovoltaic unit (1) that includes a
solar panel (21) having inner and outer sides, and
5 a heat insulator (3) that has a transparent substrate
(31) attached to said inner side of said solar panel
(21), and at least one film layer (32) formed on said
transparent substrate.
2. The photovoltaic heat insulation device of Claim 1,
10 wherein said transparent substrate (31) has opposite
first and second surfaces (311, 312), said film layer
(32) being formed directly on said first surface (311),
said inner side of said solar panel (21) being bonded
adhesively to said film layer (32).
- 15 3. The photovoltaic heat insulation device of Claim 1,
wherein said transparent substrate (31) has opposite
first and second surfaces (311, 312), said film layer
(32) being formed directly on said second surface
(312), said inner side of said solar panel (21) being
20 bonded adhesively to said first surface (311).
4. The photovoltaic heat insulation device of Claim 1,
wherein said film layer (32) is a digital image layer
made of a resin material that contains an
anti-ultraviolet material and formed by spray
25 coating.
5. The photovoltaic heat insulation device of Claim 1,
wherein said film layer (32) is a metallic film made

by vaporizing metal.

6. The photovoltaic heat insulation device of Claim 1, wherein said transparent substrate (31) is made of colored glass.
- 5 7. The photovoltaic heat insulation device of Claim 1, which comprises a plurality of said photovoltaic units (1) that are juxtaposed each other, said film layers (32) of said photovoltaic units (1) cooperating to define a pattern.
- 10 8. The photovoltaic heat insulation device of Claim 1, wherein said transparent substrate (31) has opposite first and second surfaces (311, 312), said first surface (311) being bonded to said solar panel (21), said heat insulator (3) further having a transparent
15 cover layer (34) facing said second surface (312), a looped frame layer (33) disposed between said transparent cover layer (34) and said second surface (312), an isolating space (36) defined by said looped frame layer (33) and said transparent cover layer (34) and said transparent substrate (31), and a
20 sealant (35) surrounding said looped frame layer (33).
- 25 9. The photovoltaic heat insulation device of Claim 8, wherein said transparent substrate (31) has opposite first and second surfaces (311, 312), said film layer (32) being formed directly on one of said first and second surfaces (311, 312).

10. The photovoltaic heat insulation device of Claim 8,
wherein said transparent cover layer (34) has
opposite third and fourth surfaces (341, 342), said
film layer (32, or 32') is formed on one of said third
5 and fourth surfaces (341, 342).

11. The photovoltaic heat insulation device of Claim 8,
wherein said looped frame layer (33) is a hollow frame
structure defining a looped chamber (333) that
surrounds said isolating space (36) and that is filled
10 with a drying agent (332), and a plurality of through
holes (331) in fluid communication with said looped
chamber (333) and said isolating space (36).

12. The photovoltaic heat insulation device of Claim 8,
wherein said photovoltaic unit (1) further has a light
15 emitting element 51 disposed within said isolating
space (36) and mounted to said looped frame layer
(33).

13. The photovoltaic heat insulation device of Claim 1,
wherein said heat insulator (3) has two said film
20 layers (32, 32'), one of said film layers (32) being
a metallic reflection layer, the other one of said
film layers (32') being a patterned plastic coating
layer made of a resin material that contain an
anti-ultraviolet material, said metallic reflection
25 layer being bonded directly to one of said transparent
substrate and said transparent cover layer, said
patterned plastic coating layer being bonded to said

metallic reflection layer.

14. The photovoltaic heat insulation device of Claim 1,
wherein said heat insulator (3) has two said film
layers (32, 32'), one of said film layers (32) being
5 a metallic reflection layer, the other one of said
film layers (32') being a patterned plastic coating
layer made of a resin material that contain an
anti-ultraviolet material, said metallic reflection
layer being disposed on an outside of said patterned
10 plastic coating layer, said film layers (32, 32')
being disposed respectively on said transparent
substrate (31) and said transparent cover layer (34).
15. The photovoltaic heat insulation device of Claim 1,
wherein said transparent substrate (31) is glass,
15 and said film layer (32) is a patterned coating layer
formed on the glass.