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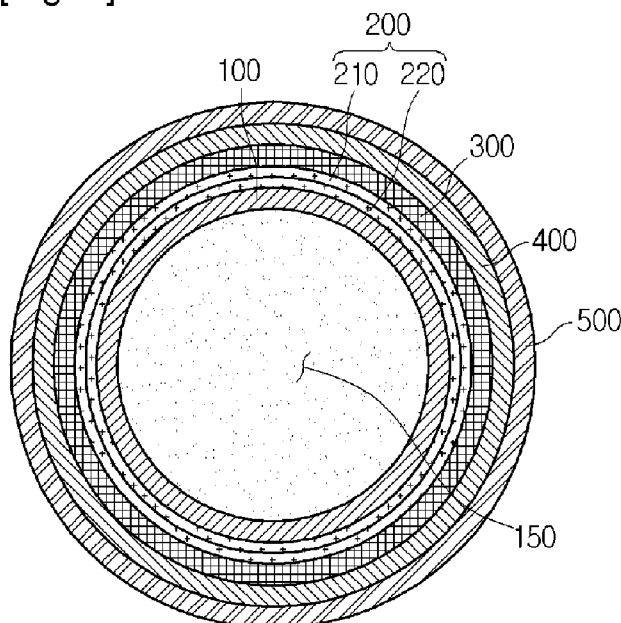
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(54) Title: SOLAR CELL APPARATUS AND METHOD OF FABRICATING THE SAME

[Fig. 2]



(57) Abstract: Disclosed is a solar cell apparatus including a plurality of cells. Each cell includes a metal layer formed therein with a hole; a light absorbing layer around the metal layer; and a transparent electrode layer around the light absorbing layer.

Description

Title of Invention: SOLAR CELL APPARATUS AND METHOD OF FABRICATING THE SAME

Technical Field

- [1] The embodiment relates to a solar cell apparatus and a method of fabricating the same.

Background Art

- [2] Recently, as energy consumption is increased, a solar cell apparatus has been developed to convert solar energy into electrical energy.
- [3] In particular, a CIGS-based cell, which is a PN hetero junction apparatus having a substrate structure including a glass substrate, a metallic back electrode layer, a P type CIGS-based light absorbing layer, a high-resistance buffer layer, and an N type front electrode layer, has been extensively used.
- [4] Further, a silicon-based solar cell apparatus employing a P type layer and an N type layer as a light absorbing layer has been extensively used.
- [5] In addition, studies have been performed to improve electrical and optical characteristics, such as low resistance and high transmittance, in a solar cell apparatus.

Disclosure of Invention

Technical Problem

- [6] The embodiment provides a solar cell apparatus capable of improving the reliability and photoelectric conversion efficiency and a method of fabricating the same.

Solution to Problem

- [7] A solar cell apparatus according to the embodiment includes a metal layer formed therein with a hole; a light absorbing layer around the metal layer; and a transparent electrode layer around the light absorbing layer.
- [8] A method of fabricating a solar cell apparatus according to the embodiment includes the steps of forming a light absorbing layer around a metal layer formed therein with a hole; and forming a transparent electrode layer around the light absorbing layer.

Advantageous Effects of Invention

- [9] The solar cell apparatus according to the embodiment includes the light absorbing layer and the transparent electrode layer, which surround the metal layer formed therein with the hole. That is, the solar cell apparatus according to the embodiment can be prepared in the form of a hollow cylinder. Thus, air heated in the solar cell apparatus may dissipate to the outside and air having the relatively low-temperature is introduced into the solar cell apparatus, so the degradation of productivity, which is

caused due to the increase of the temperature in the solar cell apparatus, can be prevented.

- [10] In addition, indoor air can be circulated through convection of air without an additional circulation device.

Brief Description of Drawings

- [11] FIG. 1 is a sectional view showing a solar cell apparatus according to the embodiment;
- [12] FIG. 2 is a sectional view of a solar cell apparatus according to the embodiment;
- [13] FIG. 3 is a view showing the application of a solar cell apparatus according to the embodiment; and
- [14] FIGS. 4 and 5 are views showing the procedure for fabricating a solar cell apparatus according to the embodiment.

Mode for the Invention

- [15] In the description of the embodiments, it will be understood that, when a support substrate, a layer, a film or an electrode is referred to as being on or under another support substrate, another layer, another film or another electrode, it can be directly or indirectly on the other support substrate, layer, film or electrode, or one or more intervening layers may also be present. Such a position of the layer has been described with reference to the drawings. The thickness and size of each layer shown in the drawings may be exaggerated, omitted or schematically drawn for the purpose of convenience or clarity. In addition, the size of elements does not utterly reflect an actual size.
- [16] FIG. 1 is a sectional view showing a solar cell apparatus according to the embodiment and FIG. 2 is a sectional view of the solar cell apparatus according to the embodiment.
- [17] Referring to FIGS. 1 and 2, the solar cell apparatus according to the embodiment includes a metal layer 100, a light absorbing layer 200, a buffer layer 300, a transparent electrode layer 400 and a protective layer 500.
- [18] The metal layer 100 extends in one direction. The metal layer 100 includes a conductor. Current may flow through the metal layer 100.
- [19] The metal layer 100 may include a hollow hole 150 and can be prepared in the form of a hollow cylinder.
- [20] The metal layer 100 may be provided therein with a support layer having a hole. The support layer may include glass or ceramic. The support layer may be flexible or rigid.
- [21] The metal layer 100 may have a circular sectional shape or an oval sectional shape. That is, the outer peripheral surface of the metal layer 100 may be curved.
- [22] In addition, the metal layer 100 may have a polygonal sectional shape. That is, the

- outer peripheral surface of the metal layer 100 may consist of a plurality of planes.
- [23] The metal layer 100 is a conductive layer. The metal layer 100 may be formed by using a general metal. In addition, one of Mo, Ni, Au, Al, Cr, W and Cu may be coated on the surface of the metal layer 100.
- [24] The metal layer 100 may include at least two layers. In this case, the layers may be formed by using the same metal or different metals.
- [25] The light absorbing layer 200 is disposed around the metal layer 100. In detail, the light absorbing layer 200 surrounds the metal layer 100. That is, the light absorbing layer 200 is disposed at an outer peripheral surface of the metal layer 100.
- [26] The light absorbing layer 200 absorbs light, which is incident through the protective layer 500 and the transparent electrode layer 400. The light absorbing layer 200 absorbs solar light to generate photoelectrons. That is, the light absorbing layer 200 can generate electric energy by receiving the solar light.
- [27] The P type layer 210 is disposed on the metal layer 100. In detail, the P type layer 210 is disposed at the outer peripheral surface of the metal layer 100 to surround the metal layer 100. The light absorbing layer 200 may include the P type layer 210 and the N type layer 220.
- [28] The P type layer 210 can be formed by doping P type impurities into amorphous silicon or silicon carbide.
- [29] The N type layer 220 is formed on the surface of the P type layer 210. Amorphous silicon or polysilicon doped with N type impurities may be used as a material for the N type layer 220.
- [30] The N type layer 220 may have the function the same as that of the buffer layer 300 and may include CdS, ZnS or CdZnS.
- [31] In contrast, the light absorbing layer 200 includes group I-III-VI compounds. In detail, the light absorbing layer 200 may include CIGS-based semiconductor compounds.
- [32] For instance, the light absorbing layer 200 may have a CIGS (Cu-In-Ga-Se)-based crystal structure, a Cu-In-Se-based crystal structure, or a Cu-Ga-Se based crystal structure. The light absorbing layer may be prepared in the form of a single layer.
- [33] The buffer layer 300 is provided between the light absorbing layer 200 and the transparent electrode layer 400. Since the light absorbing layer 200 and the transparent electrode layer 400 represent great difference in a lattice constant and band gap energy, a buffer layer having the intermediate band gap between the band gaps of the two materials is required in order to form a superior junction.
- [34] The buffer layer 300 may include CdS or ZnS, and the CdS is superior to the ZnS in terms of the efficiency of the solar cell. The CdS layer is an N type semiconductor and may have a low resistance value by doping In, Ga and Al into the CdS layer.

- [35] The transparent electrode layer 400 may be formed on the surface of the buffer layer 300. The transparent electrode layer 400 is transparent and serves as a conductive layer. The transparent electrode layer 400 may include oxide. For instance, the transparent electrode layer 400 may include zinc oxide, indium tin oxide (ITO), or indium zinc oxide (IZO).
- [36] In addition, the oxide may include conductive impurities such as aluminum (Al), alumina (Al_2O_3), magnesium (Mg), or gallium (Ga). In more detail, the transparent electrode layer 400 may include Al doped zinc oxide (AZO) or Ga doped zinc oxide (GZO).
- [37] The protective layer 500 is disposed around the transparent electrode layer 400. The protective layer 500 surrounds the outer peripheral surface of the transparent electrode layer 400.
- [38] The protective layer 500 is transparent and serves as an insulating layer. The protective layer 500, for example, can be formed by using transparent resin. For instance, the protective layer 500 may include polyethylene terephthalate (PET) resin, acryl resin, epoxy resin, polyvinylchloride (PVC) resin or polystyrene (PS) resin.
- [39] The protective layer 500 protects the transparent electrode layer 400 and the light absorbing layer 200 from the external physical impact and chemical corrosion.
- [40] FIG. 3 is a view showing the application of the solar cell apparatus according to the embodiment.
- [41] In the case of the solar cell apparatus according to the related art, the productivity of power may be reduced due to the heat generated in the solar cell apparatus. In order to solve the above problem, an additional device, which lowers the temperature of the solar cell apparatus by using other energy, is required. That is, the additional device is necessary to lower the temperature and additional energy is needed.
- [42] Referring to FIG. 3, the solar cell apparatus according to the embodiment includes the hole 150. Thus, when the internal temperature of the solar cell apparatus rises, an air volume in the hole may be increased, so air density is decreased. Therefore, heated air 50 may dissipate to the outside through the hole 150.
- [43] In addition, an air circulation path 30 is formed in the underground at the depth of 1m to 2m from the ground. Thus, air 40 having the relative low temperature can be introduced into an interior 20 of a house through the air circulation path 30. The air introduced through the air circulation path 30 can be introduced into the hole 150 through convection.
- [44] Referring to FIG. 3, the solar cell apparatus according to the embodiment may include a plurality of solar cells C1, C2, ... and Cn.
- [45] The solar cells C1, C2, ... and Cn may be separated from each other by a pattern 550, which is parallel to the ground or inclined to the ground at the gradient of 20° or less.

If the pattern is perpendicular to the ground, some cells may be completely blocked from the solar light, causing the degradation of efficiency. For this reason, the pattern is preferably parallel to the ground.

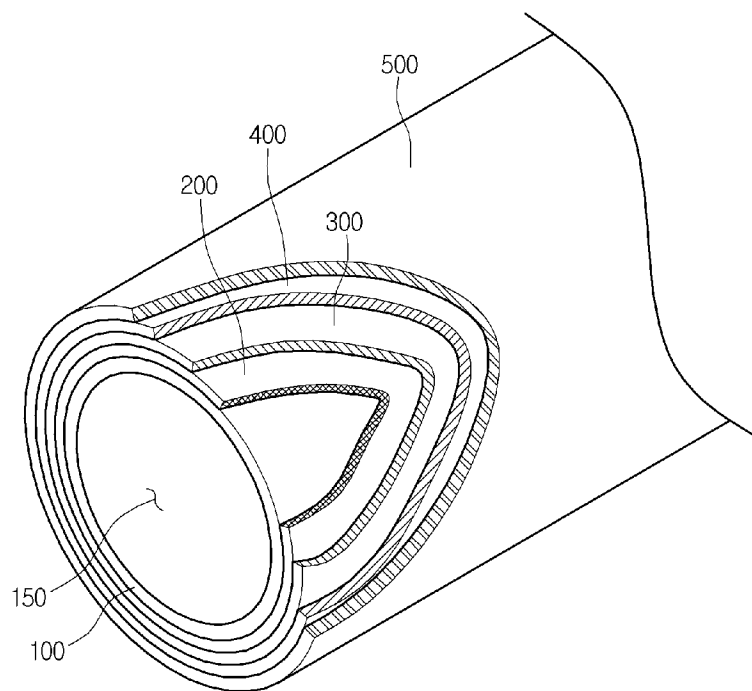
- [46] The solar cells C1, C2, ... and Cn may be connected to each other in series and/or in parallel.
- [47] According to the solar cell apparatus of the embodiment, the low-temperature air 40 is introduced into the hole 150 of the solar cell apparatus, so the temperature of the solar cell apparatus can be lowered without using the additional device. Thus, the degradation of the productivity, which is caused due to the increase of the temperature in the solar cell apparatus, can be prevented.
- [48] In addition, an air circulation device, such as a fan driven by the power generated from the solar cell apparatus having the cylindrical shape, can be installed at an upper portion of the solar cell apparatus. In this case, indoor air can be smoothly circulated through the convection.
- [49] FIGS. 4 and 5 are views showing the procedure for fabricating the solar cell apparatus according to the embodiment.
- [50] The following description will be made based on the above-described solar cell apparatus. The description about the solar cell apparatus will be incorporated herein by reference.
- [51] Referring to FIG. 4, the light absorbing layer 200 is formed on the outer peripheral surface of the metal layer 100 formed therein with the hole 150. The light absorbing layer 200 can be formed through the deposition process, such as the chemical vapor deposition process or the physical vapor deposition process.
- [52] The light absorbing layer 200 can be formed by depositing group I-III-VI compounds on the outer peripheral surface of the metal layer 100.
- [53] For instance, the light absorbing layer 200 may be formed through various schemes such as a scheme of forming a Cu(In,Ga)Se₂ (CIGS) based-light absorbing layer by simultaneously or separately evaporating Cu, In, Ga, and Se and a scheme of performing a selenization process after a metallic precursor layer has been formed.
- [54] Regarding the details of the selenization process after the formation of the metallic precursor layer, the metallic precursor layer is formed on the outer peripheral surface of the metal layer 100 through a sputtering process employing a Cu target, an In target, or a Ga target.
- [55] Thereafter, the metallic precursor layer is subject to the selenization process so that the Cu(In,Ga)Se₂ (CIGS) based-light absorbing layer is formed.
- [56] Different from the above, the sputtering process employing the Cu target, the In target, and the Ga target and the selenization process may be simultaneously performed.

- [57] In addition, a CIS or a CIG light absorbing layer 200 may be formed through a sputtering process employing only Cu and In targets or only Cu and Ga targets and the selenization process.
- [58] The metal layer 100 may rotate about the longitudinal axis thereof. In this case, the light absorbing layer 200 can be uniformly formed on the outer peripheral surface of the metal layer 100.
- [59] In particular, if the light absorbing layer 200 is formed through the physical vapor deposition process, the material used to form the light absorbing layer 200 is deposited in one direction. At this time, if the metal layer 100 is rotated, the light absorbing layer 200 can be deposited on the outer peripheral surface of the metal layer 100 with a uniform thickness.
- [60] Referring to FIG. 5, the buffer layer 300 and the transparent electrode layer 400 are formed on the outer peripheral surface of the light absorbing layer 200. The buffer layer 300 and the transparent electrode layer 400 can be formed through the sputtering process.
- [61] Thereafter, the protective layer 500 is formed on the outer peripheral surface of the transparent electrode layer 400. In order to form the protective layer 500, resin composition is coated on the outer peripheral surface of the transparent electrode layer 400 and the coated resin composition is cured by heat or light.
- [62] Different from the above, the protective layer 500 can be formed by using thermoplastic resin. That is, the protective layer 500 can be formed by performing the injection-molding process using the thermoplastic resin.
- [63] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

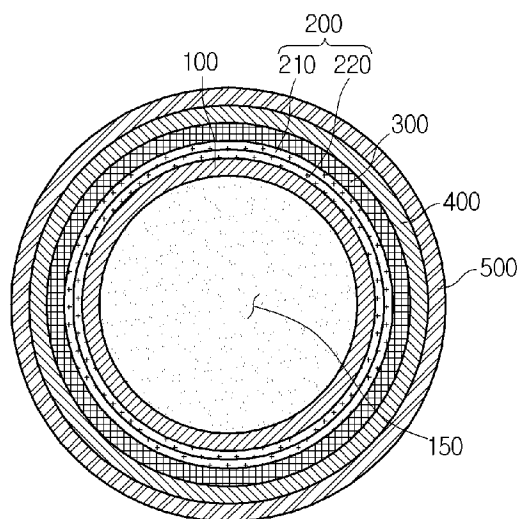
Claims

- [Claim 1] A solar cell apparatus comprising:
a plurality of cells,
wherein each cell comprises:
a metal layer formed therein with a hole;
a light absorbing layer around the metal layer; and
a transparent electrode layer around the light absorbing layer.
- [Claim 2] The solar cell apparatus of claim 1, further comprising a support layer having a hole and formed in the metal layer.
- [Claim 3] The solar cell apparatus of claim 1, wherein the support layer includes glass or ceramic.
- [Claim 4] The solar cell apparatus of claim 1, wherein one of Mo, Ni, Au, Al, Cr, W and Cu is coated on a surface of the metal layer.
- [Claim 5] The solar cell apparatus of claim 1, wherein the light absorbing layer includes a P type layer and an N type layer.
- [Claim 6] The solar cell apparatus of claim 5, wherein the N type layer includes CdS, ZnS or CdZnS.
- [Claim 7] The solar cell apparatus of claim 1, further comprising a buffer layer between the light absorbing layer and the transparent electrode layer.
- [Claim 8] The solar cell apparatus of claim 1, further comprising a protective layer surrounding the transparent electrode layer.
- [Claim 9] The solar cell apparatus of claim 1, wherein the metal layer has a cylindrical shape.
- [Claim 10] The solar cell apparatus of claim 1, further comprising an air circulation device in the hole.
- [Claim 11] The solar cell apparatus of claim 1, wherein the cells are separated from each other by a pattern, which is inclined to a ground at a gradient of 20° or less.
- [Claim 12] A method of fabricating a solar cell apparatus, the method comprising:
forming a light absorbing layer around a metal layer formed therein with a hole; and
forming a transparent electrode layer around the light absorbing layer.
- [Claim 13] The method of claim 12, wherein, in the forming of the light absorbing layer, the metal layer is rotated about a longitudinal axis thereof when semiconductor materials are deposited on a surface of the metal layer.

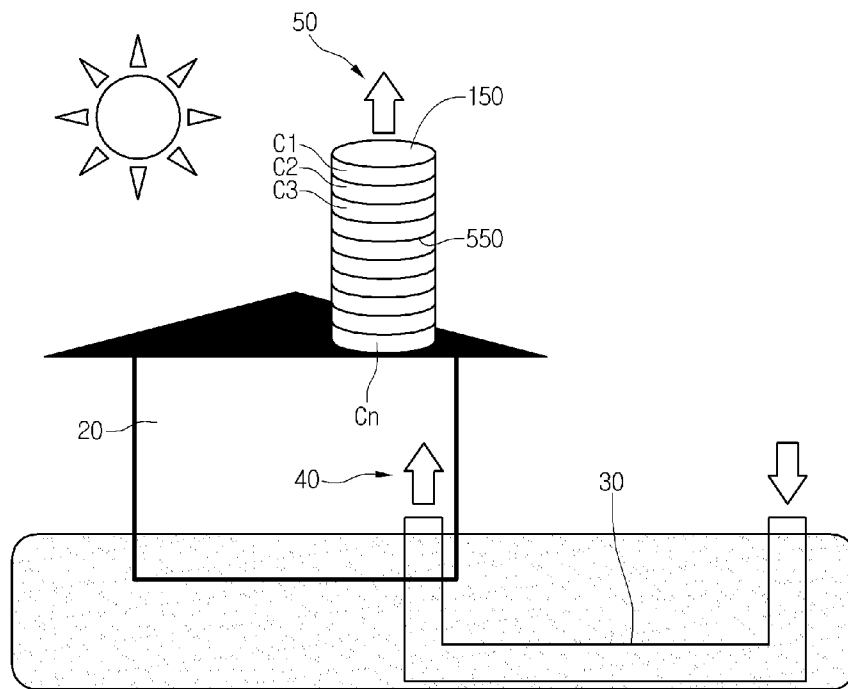
[Fig. 1]



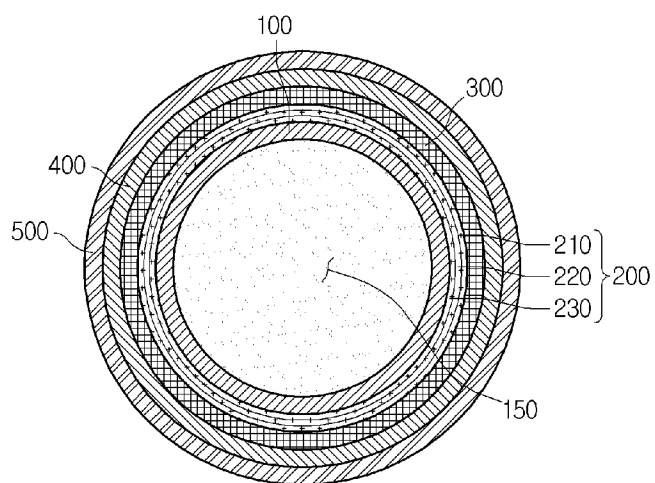
[Fig. 2]



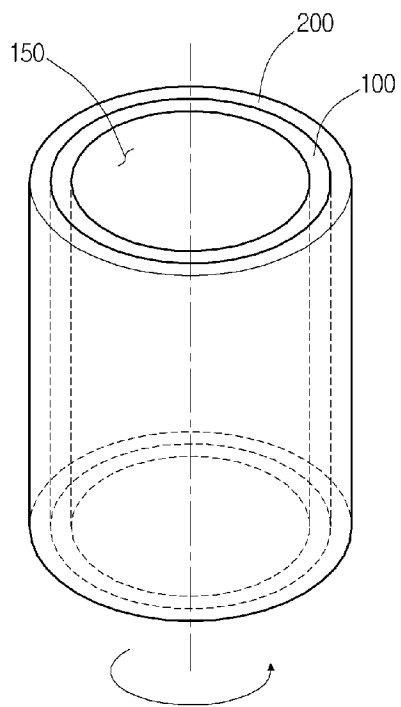
[Fig. 3]



[Fig. 4]



[Fig. 5]



[Fig. 6]

