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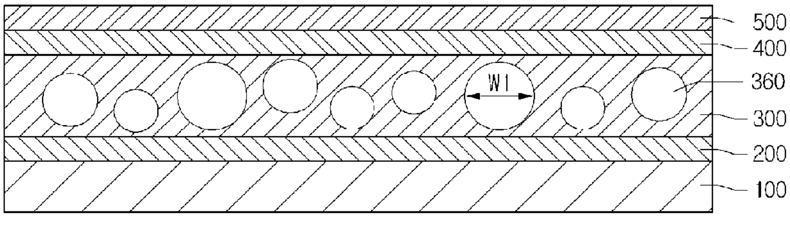
(54) Title: SOLAR CELL AND METHOD OF FABRICATING THE SAME

[Fig. 1]



(57) Abstract: Provided are a solar cell and a method of fabricating the same. The solar cell includes: a substrate; a back electrode layer on the substrate; a light absorbing layer on the back electrode layer; a buffer layer on the light absorbing layer; and a window layer on the buffer layer, wherein the light absorbing layer includes a plurality of voids.

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Description

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

Technical Field

[1] The present disclosure relates to a solar cell and a method of fabricating the same.

Background Art

[2] As the need for energy is increased recently, development on a solar cell that converts solar energy into electrical energy is in progress.

[3] Especially, a Copper Indium Gallium Selenide (CIGS) based solar cell, i.e., a pn-hetero junction device 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 window layer, is widely being used nowadays.

[4] Additionally, a variety of research is under way to improve electrical characteristics of the solar cell such as low resistance and high transmittance.

Disclosure of Invention

Technical Problem

[5] Embodiments provide a solar cell having improved efficiency and high productivity.

Solution to Problem

[6] In one embodiment, a solar cell includes: a substrate; a back electrode layer on the substrate; a light absorbing layer on the back electrode layer; a buffer layer on the light absorbing layer; and a window layer on the buffer layer, wherein the light absorbing layer includes a plurality of voids.

[7] In another embodiment, a method of fabricating a solar cell includes: forming a back electrode layer on a substrate; forming a light absorbing layer having a plurality of voids on the back electrode layer; a buffer layer on the light absorbing layer; and forming a window layer on the buffer layer.

Advantageous Effects of Invention

[8] According to an embodiment, provided is a solar cell in which an amount of absorbed light is augmented by increasing the scattering of incident light through a light absorbing layer including voids.

[9] Moreover, since the voids are formed while the light absorbing layer is formed, no additional manufacturing process is required. As a result, it is effective in terms of productivity.

Brief Description of Drawings

[10] Fig. 1 is a plan view of a solar cell according to an embodiment.

[11] Figs. 2 to 5 are sectional views illustrating a method of fabricating a solar cell according to an embodiment.

Mode for the Invention

[12] In the description of embodiments, it will be understood that when a layer (or film), region, pattern or structure is referred to as being on another layer (or film), region, pad or pattern, the terminology of on and under includes both the meanings of directly and indirectly . Further, the reference about on and under each layer will be made on the basis of drawings. In the drawings, the thickness or size of each layer is exaggerated, omitted, or schematically illustrated for convenience in description and clarity. Also, the size of each element does not entirely reflect an actual size.

[13] Fig. 1 is a plan view of a solar cell according to an embodiment. Referring to Fig. 1, a solar cell panel includes a supporting substrate 100, a back electrode layer 200, a void 360, a light absorbing layer, a buffer layer 400, and a window layer 500.

[14] The supporting substrate 100 has a plate shape, and supports the back electrode layer 200, the light absorbing layer 300, the buffer layer 400, and the window layer 500.

[15] The supporting substrate 100 may be an insulator. The supporting substrate 100 may be a glass substrate, a plastic substrate, or a metallic substrate. In more detail, the supporting substrate 100 may be a soda lime glass substrate.

[16] If the supporting substrate 100 is formed of soda lime glass, Na in the soda lime glass may spread into the light absorbing layer 300 formed of copper indium gallium selenide (CIGS) during a manufacturing process of the solar cell. Due to this, a charge concentration of the light absorbing layer 300 may be increased. This may be a factor that increases the photoelectric conversion efficiency of the solar cell.

[17] Besides that, the supporting substrate 100 may be formed of ceramic such as alumina, stainless steel, and flexible polymer. The supporting substrate 100 may be transparent and rigid or flexible.

[18] The back electrode layer 200 is disposed on the supporting substrate 100. The back electrode layer 200 is a conductive layer. The back electrode layer 200 may allow current to flow into an external of the solar cell by transferring charges generated in the light absorbing layer 300 of the solar cell. In order to perform the above action, the back electrode layer 200 should have high electrical conductivity and low resistivity.

[19] Additionally, since the back electrode layer 200 contacts a CIGS compound used to form the light absorbing layer 300, the light absorbing layer 300 and the back electrode layer 200 should have an ohmic contact of low contact resistance value.

[20] Moreover, the back electrode layer 200 needs to maintain high temperature stability during thermal treatment under S or Se atmosphere, which occurs when the CIGS compound is formed. Moreover, the back electrode layer 200 should have excellent ad-

hesiveness to the supporting substrate 100 in order to prevent a de-lamination phenomenon between the back electrode layer 200 and the supporting substrate 100, which results from a difference in thermal expansion coefficients.

[21] This back electrode layer 200 may be formed of one of Mo, Au, Al, Cr, W, and Cu. Of those, especially, compared to other elements, Mo has a less difference in thermal expansion coefficients with respect to the supporting substrate 100, so that it may prevent de-lamination phenomenon due to excellent adhesiveness and satisfy overall characteristics required for the back electrode layer 200.

[22] The back electrode layer 200 may include at least two layers. At this point, each of the layers may be formed of the same or different metal.

[23] The light absorbing layer 300 may be formed on the back electrode layer 200. The light absorbing layer 300 includes a p-type semiconductor compound. In more detail, the light absorbing layer 300 includes a Group I-III-VI based compound. For example, the light absorbing layer 300 may have a $Cu(In,Ga)Se_2$ (CIGS) based crystal structure, a copper-indium-selenide based crystal structure, or a copper-gallium-selenide crystal structure.

[24] An energy band gap of the light absorbing layer 300 may be about 1.1 eV to about 1.2 eV.

[25] The void 360 may be formed in the light absorbing layer 300. The voide 360 may be formed using a polymer of polystyrene (PS) or Polymethylmethacrylate (PMMA).

[26] The void 360 has a diameter W1 of about 30 nm to about 1200 nm, and may be formed to scatter a wavelength of light. A plurality of voids 360 may be formed with the same diameter, or may be formed to have different volumes in the diameter range.

[27] In this embodiment, the void 360 may be formed in a spherical shape or a polygonal shape, but is not limited thereto.

[28] A light incident to the light absorbing layer 300 may be scattered by the void 360. The light is more likely to be reflected in a parallel direction due to the scattering, so that photoelectric conversion efficiency may be increased.

[29] That is, since the light stays longer in the light absorbing layer 300 due to the scattering, an amount of absorbed light may be increased.

[30] The light absorbing layer 300 may be formed with a thickness of about 1.5 μm to about 5 μm.

[31] If the volume of the void 360 is small, light scattering effect is too little, and if it is increased greatly, a light absorbing area is reduced. Thus, the volume of the void 360 may be about 5 % to about 35 % of the total volume of the light absorbing layer 300, and more preferably may be about 20 % to about 25 %.

[32] The buffer layer 400 is disposed on the light absorbing layer 300. The solar cell including the light absorbing layer 300 of a CIGS based compound forms a pn junction

between a CIGS compound layer of a p-type semiconductor and the transparent electrode layer 500 of an n-type semiconductor. However, since two materials have a great difference in a lattice constant and band gap energy, a buffer layer having a band gap at the middle of the two materials is required to form a good junction.

[33] A material for forming the buffer layer 400 includes CdS and ZnS, and CdS is relatively excellent in terms of the power generation efficiency of the solar cell.

[34] The window layer 500 is disposed on the buffer layer 400. The window layer 500 is a transparent conductive layer. Additionally, the window layer 500 has a higher resistance than the back electrode layer 200.

[35] The window layer 500 includes an oxide. For example, the window layer 500 may include a zinc oxide, an indium tin oxide (ITO), or an indium zinc oxide (IZO).

[36] Additionally, the oxide may include a conductive impurity such as Al, Al_2O_3, Mg, or Ga. In more detail, the window layer 500 may include an Al doped zinc oxide (AZO) or a Ga doped zinc oxide (GZO).

[37] According to the solar cell, an absorption ratio of light incident to a light absorbing layer may be improved by forming the light absorbing layer with voids.

[38] Additionally, the voids are formed while the light absorbing layer is formed, thereby improving productivity.

[39] Figs. 2 to 5 are sectional views illustrating a method of fabricating a solar cell according to an embodiment. Description of the fabricating method refers to that of the above-mentioned solar cell. The description on the above solar cell may be substantially combined with that of the fabricating method.

[40] Referring to Fig. 2, the back electrode layer 200 may be formed on the supporting substrate 100. The back electrode layer 200 may be deposited using Mo. The back electrode layer 200 may be formed through Physical Vapor Deposition (PVD) or plating.

[41] Additionally, an additional layer such as a diffusion prevention layer may be interposed between the supporting substrate 100 and the back electrode layer 200.

[42] Referring to Figs. 3 and 4, the light absorbing layer 300 is formed on the back electrode layer 200.

[43] For example, methods of forming the CIGS based light absorbing layer 300 by evaporating copper, indium, gallium, and selenium simultaneously or separately, or performing a selenization process after forming a metallic precursor layer are widely used currently.

[44] Unlike this, the CIS based or CIG based light absorbing layer 300 may be formed through a sputtering process using only copper and indium targets or only copper and gallium targets and a selenization process.

[45] According to this embodiment, the light absorbing layer 300 is formed while

evaporating copper, indium, gallium, and selenium simultaneously or separately.

[46] The bead 350 may be formed including a polymer such PS or PMMA. The beads 350 may be formed to have a diameter of about 30 nm to about 600 nm, and may have different diameters within the diameter range.

[47] Then, the beads 350 are thermally treated for about 5 min to about 60 min at a temperature of about 150 ℃ to about 650 ℃, more preferably, about 300 ℃ to about 500 ℃. Due to the thermal treatment, oxygen may be separated from the forming materials 310 of the light absorbing layer 300, i.e., CuO, In2O3, Ga2O3 and selenium, and polymer, i.e., the forming material of the bead 350, may be removed. As the polymer is removed, the bead 350 changes into the processed void 360. As the polymer is removed, some carbon content in the bead 350 may remain.

[48] Referring to Fig. 5, the buffer layer 400 and the high resistance buffer layer 500 are formed on the light absorbing layer 300. A material for forming the buffer layer 400 includes CdS and ZnS, but CdS is relatively excellent in terms of the power generation efficiency of the solar cell. The CdS layer is formed of an n-type semiconductor and may have a low resistance value through doping of In, Ga, and Al.

[49] The buffer layer 400 may be deposited and formed through a sputtering process or Chemical Bath Deposition (CBD).

[50] Then, the window layer 500 is disposed on the buffer layer 400. The window layer 500 is a transparent conductive layer. Additionally, the window layer 500 has a higher resistance than the back electrode layer 200. For example, the window layer 500 may have a resistance, which is about 10 to about 200 times greater than that of the back electrode layer 200.

[51] The window layer 500 includes an oxide. For example, the window layer 500 may include a zinc oxide, an indium tin oxide (ITO), or an indium zinc oxide (IZO).

[52] Additionally, the oxide may include a conductive impurity such as Al, Al_2O_3, Mg, or Ga. In more detail, the window layer 500 may include an Al doped zinc oxide (AZO) or a Ga doped zinc oxide (GZO).

[53] As mentioned above, light scattering is increased due to a light absorbing layer including void so that an amount of light absorbed in a solar cell may be increased.

[54] Moreover, since the voids are formed while the light absorbing layer is formed, no additional manufacturing process is required. As a result, it is effective in terms of productivity.

[55] Additionally, the features, structures, and effects described in the above embodiments are included in at least one embodiment, but the present invention is not limited thereto. Furthermore, the features, structures, and effects in each embodiment may be combined or modified for other embodiments by those skilled in the art Accordingly, contents regarding the combination and modification should be construed as being in

the scope of the present invention.

[56] 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 comprising:
a substrate;
a back electrode layer on the substrate;
a light absorbing layer on the back electrode layer;
a buffer layer on the light absorbing layer; and
a window layer on the buffer layer,
wherein the light absorbing layer comprises a plurality of voids.

[Claim 2] The solar cell according to claim 1, wherein each of the plurality of voids has a diameter of about 30 nm to about 600 nm.

[Claim 3] The solar cell according to claim 1, wherein the void has a spherical shape.

[Claim 4] The solar cell according to claim 1, wherein the light absorbing layer has a thickness of about 1.5 μm to about 5 μm.

[Claim 5] The solar cell according to claim 1, wherein the light absorbing layer comprises a polymer.

[Claim 6] The solar cell according to claim 5, wherein the polymer comprises polystyrene (PS) or Polymethylmethacrylate (PMMA).

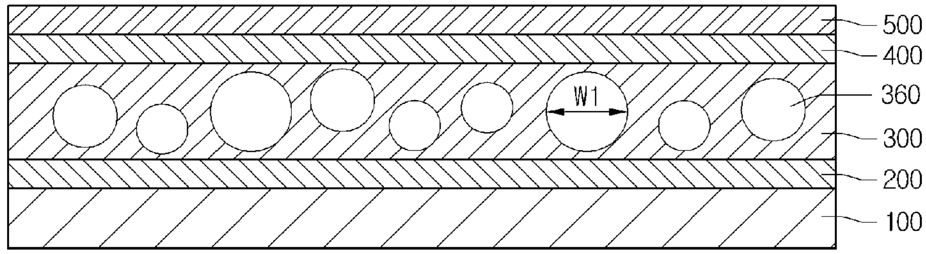
[Claim 7] The solar cell according to claim 1, wherein the light absorbing layer comprises carbon.

[Claim 8] A method of fabricating a solar cell, comprising:
forming a back electrode layer on a substrate;
forming a light absorbing layer having a plurality of voids on the back electrode layer;
a buffer layer on the light absorbing layer; and
forming a window layer on the buffer layer.

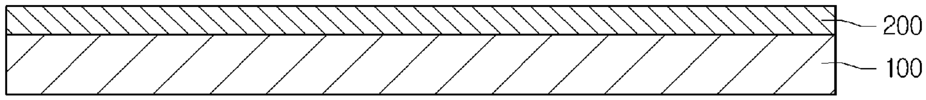
[Claim 9] The method according to claim 8, wherein the light absorbing layer is formed by thermally treating copper, indium, gallium, selenium, and polymer at a temperature of about 150 ℃ to about 500 ℃.

[Claim 10] The method according to claim 9, wherein the polymer comprises polystyrene (PS) or Polymethylmethacrylate (PMMA).

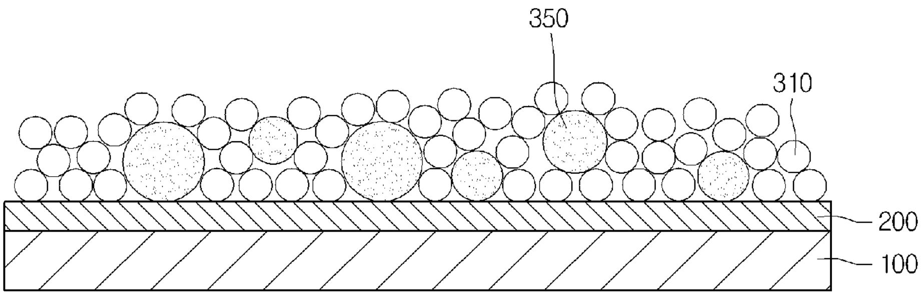
[Fig. 1]



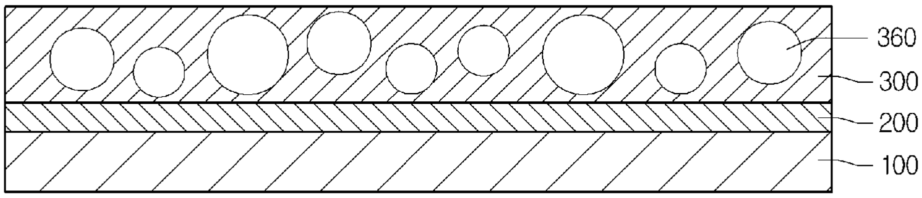
[Fig. 2]



[Fig. 3]



[Fig. 4]



[Fig. 5]