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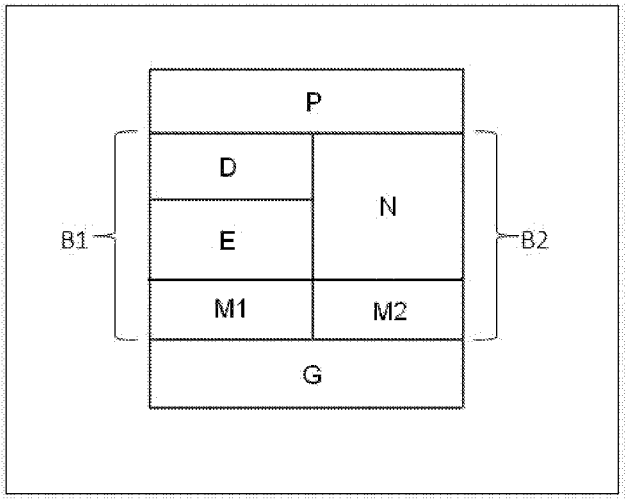


Fig. 2

(57) **Abstract**: A CdTe solar battery and a method of manufacturing the same are provided. The CdTe solar battery comprises: a glass substrate (G); a light absorption layer (P); and a first electrode area (B1) and a second electrode area (B2) each formed between the glass substrate (G) and the light absorption layer (P), in which the first electrode area (B1) includes a Te-rich layer (D), a back contact transition layer (E), and a positive layer (M1) laminated sequentially; the second electrode area (B2) includes an N-type layer (N) and a negative layer (M2) laminated sequentially; and the first electrode area (B1) and the second electrode area (B2) are insulated from each other.

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CdTe SOLAR BATTERY AND METHOD OF MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims priority to and benefits of Chinese Patent Application No.201110142088.7, filed with the State Intellectual Property Office of the People's Republic of China (SIPO) on May 30, 2011, the entire content of which is incorporated herein by reference.

FIELD

The present disclosure relates to the field of solar battery, more particularly to a CdTe solar battery and a method of manufacturing the same.

BACKGROUND

The statements in this section merely provide background information related to the present disclosure and may or may not constitute prior art.

CdTe is a compound semiconductor with a bandgap most suitable for photoelectric energy conversion. Solar batteries made from this semiconductor may directly convert solar energy into electric energy with a high theoretical conversion efficiency (for example, 27% at room temperature). Moreover, CdTe may be easily deposited at a high deposition rate to form a large area film. Furthermore, compared with a silicon solar battery, the manufacturing cost of the CdTe solar battery may be reduced, and therefore the CdTe solar battery may be a new solar battery with wide applicability.

As shown in Fig. 1, a conventional CdTe solar battery may have a lamination structure including a glass substrate G, a transparent conductive film T, a CdS layer N, a CdTe layer P, a transition layer DE, and a back electrode layer M laminated sequentially. The effective light reaching the CdTe layer is reduced because of the absorption by the glass substrate G and the transparent conductive film T. Therefore, the photoelectric conversion efficiency of the conventional CdTe solar battery is low.

SUMMARY

In viewing thereof, the present disclosure is directed to solve at least one of the problems existing in the prior art. Therefore, a CdTe solar battery with a new structure may need to be provided, which may have high photoelectric conversion efficiency and low cost and may be manufactured on a large scale with a simple process.

According to an embodiment of the present disclosure, a CdTe solar battery may be provided. The CdTe solar battery may comprise: a glass substrate; a light absorption layer; and a first electrode area and a second electrode area each formed between the glass substrate and the light absorption layer, in which the first electrode area includes a Te-rich layer, a back contact transition layer, and a positive layer laminated sequentially; the second electrode area includes an N-type layer and a negative layer laminated sequentially; and the first electrode area and the second electrode area are insulated from each other.

In the present disclosure, the glass substrate, the positive layer, the negative layer, the Te-rich layer, the back contact transition layer, the N-type layer and the light absorption layer each have an upper surface and a lower surface, in which the upper surface of the glass substrate is contacted with the lower surfaces of the positive layer and the negative layer, the upper surface of the positive layer is contacted with the lower surface of the back contact transition layer, the upper surface of the negative layer is contacted with the lower surfaces of the N-type layer, the upper surface of the Te-rich layer is contacted with the lower surface of the light absorption layer, and the upper surface of the N-type layer is contacted with the lower surface of the light absorption layer.

According to another embodiment of the present disclosure, a method of manufacturing a CdTe solar battery may be provided. The method may comprise the steps of:

(a) providing and washing a glass substrate;

(b) forming a first electrode area and a second electrode area on the glass substrate respectively, wherein the first electrode area includes a Te-rich layer, a back contact transition layer, and a positive layer laminated sequentially; the second electrode area includes an N-type layer and a negative layer laminated sequentially; and the first electrode area and the second electrode area are insulated from each other;

(c) forming a light absorption layer on the Te-rich layer and the N-type layer.

In the step (b), there are no special limits on the sequence of steps of forming the first electrode area and the second electrode area which are insulated from each other on the glass substrate respectively. In one embodiment, after forming the first electrode area on a

first region of the upper surface of the glass substrate, the second electrode area is formed on a second region of the upper surface of the glass substrate. In another embodiment, after forming the second electrode area on a second region of the upper surface of the glass substrate, the first electrode area is formed on a first region of the upper surface of the glass substrate. In still another embodiment, the first electrode area and the second electrode area which are insulated from each other may be formed on the glass substrate simultaneously. For example, a metal electrode layer is directly deposited on the upper surface of the glass substrate and cut by laser to form the positive layer and form the negative layer, the back contact transition layer and the Te-rich layer is deposited on the positive layer sequentially, and the N-type layer is formed on the negative layer, so as to form the first electrode area and the second electrode area.

In the method of manufacturing a CdTe solar battery according to an embodiment of the present disclosure, in one embodiment, a gap may be formed between the first electrode area and the second electrode area to achieve mutual insulation between the first electrode area and the second electrode area. In another embodiment, after the positive layer, the negative layer, the back contact transition layer, the Te-rich layer and the N-type layer are formed, the first electrode area and the second electrode area are separated and insulated by laser cutting. In still another embodiment, mutual insulation between the first electrode area and the second electrode area may be achieved by other methods which are well known to those skilled in the art.

In some embodiments, the step (b) includes the steps of:

b1) placing the glass substrate in a vacuum sputtering device for sputtering using a metal target material to form a metal electrode layer, and then laser cutting the metal electrode layer to form the positive layer and the negative layer, wherein the positive layer and the negative layer are insulated from each other;

b2) covering the positive layer and then coating a CdS film onto the negative layer in a CdS coating device to form the N-type layer;

b3) covering the second electrode area and using ZnTe:Cu and ZnTe target materials for sputtering in the vacuum sputtering device to form a ZnTe/(ZnTe:Cu) composite layer on the positive layer so as to form the back contact transition layer; and

b4) using a Te target material for vacuum sputtering to form the Te-rich layer on the back contact transition layer.

In some embodiments, the glass substrate has a thickness of about 1mm to about 5mm; the light absorption layer is a CdTe film with a thickness of about 2μm to about 5μm; the N-type layer is a CdS film with a thickness of about 50nm to about 300nm; the Te-rich layer is a Te film with a thickness of about 3nm to about 30nm; the back contact transition layer is a ZnTe/(ZnTe:Cu) composite layer with a thickness of about 10nm to about 100nm; and the positive layer and the negative layer are each a layer of a metal with a thickness of about 50nm to about 300nm.

With the CdTe solar battery according to an embodiment of the present disclosure, the conventional CdTe solar battery is improved, the light absorption layer is formed on the light receiving surface of the battery to be exposed to the light directly; and the positive layer for leading the positive current out and the negative layer for leading the negative current out are formed on the backlight surface respectively, that is, the positive current and the negative current are led out from the backlight surface of the battery respectively, and the glass substrate is also formed on the backlight surface. Therefore, the light absorption layer is directly exposed to sunlight, thus avoiding absorption of light by the glass substrate and the transparent conductive film, improving the utilization rate of light, omitting the transparent conductive film in the conventional CdTe solar battery, simplifying the process flow, reducing the production cost, increasing the photoelectric conversion efficiency of the CdTe solar battery largely, and facilitating large scale production.

Additional aspects and advantages of the embodiments of the present disclosure will be given in part in the following descriptions, become apparent in part from the following descriptions, or be learned from the practice of the embodiments of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects and advantages of the disclosure will become apparent and more readily appreciated from the following descriptions taken in conjunction with the drawings in which:

Fig. 1 is a schematic cross-sectional view of a conventional CdTe solar battery; and

Fig. 2 is a schematic cross-sectional view of a CdTe solar battery according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

It will be appreciated by those of ordinary skill in the art that the disclosure may be embodied in other specific forms without departing from the spirit or essential character thereof. The presently disclosed embodiments are therefore considered in all respects to be illustrative and not restrictive. The same or similar elements and the elements having same or similar functions are denoted by like reference numerals throughout the descriptions.

As shown in Fig. 2, a CdTe solar battery according to an embodiment of the present disclosure comprises: a glass substrate G; a light absorption layer P; and a first electrode area B1 and a second electrode area B2 each formed between the glass substrate G and the light absorption layer P. The first electrode area B1 includes a Te-rich layer D, a back contact transition layer E, and a positive layer M1 laminated sequentially. The second electrode area B2 includes an N-type layer N and a negative layer M2 laminated sequentially. The first electrode area B1 and the second electrode area B2 are insulated from each other. The light absorption layer P is formed on the Te-rich layer D and the N-type layer N. The Te-rich layer D is contacted with the light absorption layer P, the positive layer M1 is contacted with the glass substrate G, the N-type layer N is contacted with the light absorption layer P, and the negative layer M2 is contacted with the glass substrate G. In one embodiment, the first electrode area B1 and the second electrode area B2 have the same thickness. In one embodiment, a gap is formed between the first electrode area B1 and the second electrode area B2.

The glass substrate G may be used as a support for the absorption layer of the solar battery. In some embodiments, the glass substrate G may be a substrate of common glass, ultra clear glass, or other high temperature resistant and transparent materials, which has a thickness of about 1mm to about 5mm. The glass substrate G may be commercially available.

In some embodiments, the positive layer M1 and the negative layer M2 are each a layer of a metal having high conductivity with a thickness of about 50nm to about 300nm; and the metal is at least one selected from the group comprising Mo, Ni, Cu, and Ag. In one embodiment, the positive layer M1 and the negative layer M2 may be formed by vacuum sputtering respectively. In another embodiment, a metal electrode layer is formed by vacuum sputtering, and then cut by laser to form the positive layer M1 and form the negative layer M2. The positive layer M1 and the negative layer M2 are insulated from each other.

In some embodiments, the N-type layer N is a light yellow N-type CdS film with a thickness of about 50nm to about 300nm. The N-type layer N may be formed by techniques of chemical bath deposition (CBD), vacuum deposition, etc.

In some embodiments, the light absorption layer P is a P-type brownish black CdTe film with a thickness of about 2μm to about 5μm. The light absorption layer P may be formed by techniques of close-spaced sublimation (CSS), vapor transportation deposition (VTD), screen printing, etc.

The back contact transition layer E may be mainly used for enhancing ohmic contact. In some embodiments, the back contact transition layer E is a composite layer of ZnTe and Cu-doped ZnTe, i.e., a ZnTe/(ZnTe:Cu) composite layer, which has a thickness of about 10nm to about 100nm. The back contact transition layer E may be formed by vacuum evaporation or vacuum sputtering.

In some embodiments, the Te-rich layer D is a Te film with a thickness of about 3nm to about 30nm. The Te-rich layer D may be formed by vacuum evaporation or vacuum sputtering.

In the CdTe solar battery according to an embodiment of the present disclosure, it should be noted that the methods for forming the glass substrate G, the positive layer M1, the negative layer M2, the back contact transition layer E, the Te-rich layer D, the N-type layer N and the light absorption layer P are not limited to the methods listed above, however, the methods for forming the glass substrate G, the positive layer M1, the negative layer M2, the back contact transition layer E, the Te-rich layer D, the N-type layer N and the light absorption layer P which are well known to those skilled in the art shall all fall into the scope of the present disclosure.

In the conventional CdTe solar battery, as shown in Fig.1, the currents are led out from the transparent conductive film T which is a front electrode (i.e., a negative electrode) and the back electrode layer M which is a back electrode (i.e., a positive electrode) respectively. In the CdTe solar battery according to an embodiment of the present disclosure, the positive layer M1 and the negative layer M2 are used as a positive electrode to lead the positive current out and a negative electrode to lead the negative current out respectively; and the negative layer M2 below the N-type layer N is used as the negative electrode of the solar battery instead of the transparent conductive film T in the conventional CdTe solar battery.

With the CdTe solar battery according to an embodiment of the present disclosure, the conventional CdTe solar battery is improved, the light absorption layer P is formed on the light receiving surface of the battery to be exposed to the light directly; and the positive layer M1 for leading the positive current out and the negative layer M2 for leading the

negative current out are both formed on the backlight surface respectively, that is, the positive current and the negative current are led out from the backlight surface of the battery respectively, and the glass substrate G is also formed on the backlight surface. Therefore, the light absorption layer P is directly exposed to sunlight, thus avoiding absorption of light by the glass substrate G and the transparent conductive film T, improving the utilization rate of light, omitting the transparent conductive film T in the conventional CdTe solar battery, simplifying the process flow, reducing the production cost, increasing the photoelectric conversion efficiency of the CdTe solar battery largely, and facilitating large scale production.

Because the structure of the CdTe solar battery according to an embodiment of the present disclosure is different from the structure of the conventional CdTe solar battery, the method of manufacturing the CdTe solar battery according to an embodiment of the present disclosure is also different from the method of manufacturing the conventional CdTe solar battery. In the method of manufacturing the CdTe solar battery according to an embodiment of the present disclosure, after the glass substrate G is formed, a metal electrode layer is deposited on the glass substrate G, and finally the light absorption layer P is formed.

According to an embodiment of the present disclosure, a method of manufacturing the CdTe solar battery comprises the steps of:

(a) providing and washing the glass substrate G;

(b) forming the first electrode area B1 and the second electrode area B2 on the glass substrate G respectively, in which the first electrode area B1 includes a Te-rich layer D, a back contact transition layer E, and a positive layer M1 laminated sequentially; the second electrode area B2 includes an N-type layer N and a negative layer M2 laminated sequentially; and the first electrode area B1 and the second electrode area B2 are insulated from each other;

(c) forming the light absorption layer P on the Te-rich layer D and the N-type layer N.

In some embodiments, in the step (a), washing the glass substrate G may include the steps of:

a1) ultrasonic washing the glass substrate G with acetone, a glass cleaning reagent, and deionized water sequentially;

a2) drying the glass substrate G; and

a3) plasma cleaning the glass substrate G.

In some embodiments, the step (b) includes the steps of:

b1) placing the glass substrate G in a vacuum sputtering device for sputtering using a metal target material to form a metal electrode layer, and then laser cutting the metal electrode layer to form the positive layer M1 and the negative layer M2, in which the positive layer M1 and the negative layer M2 are insulated from each other;

b2) covering the positive layer M1 and then coating a CdS film onto the negative layer M2 in a CdS coating device to form the N-type layer N;

b3) covering the second electrode area B2 and using ZnTe:Cu and ZnTe target materials for sputtering in the vacuum sputtering device to form a ZnTe/(ZnTe:Cu) composite layer on the positive layer M1 so as to form the back contact transition layer E; and

b4) using a Te target material for vacuum sputtering to form the Te-rich layer D on the back contact transition layer E.

In one embodiment, a method of preparing the CdTe solar battery comprises the steps of:

1) providing and washing a glass substrate G:

using common glass or ultra clear glass with a thickness of about 1mm to about 5 mm as the glass substrate G;

ultrasonic washing the glass substrate G with acetone for about 10min to about 60 min to remove oil and fat on the surface of the glass substrate G;

ultrasonic washing the glass substrate G with a glass cleaning reagent for about 10min to about 60 min to remove inorganic contaminants on the surface of the glass substrate G;

ultrasonic washing the glass substrate G with deionized water for about 10min to about 60 min to remove impurities on the surface of the glass substrate G;

drying the glass substrate G; and

placing the glass substrate G into a pretreatment room for plasma cleaning;

2) forming the positive layer M1 and the negative layer M2:

placing the glass substrate G obtained in the step 1) into a vacuum sputtering device;

using at least one of Mo, Ni, Cu, and Ag as a target material for sputtering to form a metal electrode layer with a thickness of about 50nm to about 300nm on the glass substrate G; and

laser cutting the metal electrode layer to form the positive layer M1 and the negative layer M2, in which the positive layer M1 and the negative layer M2 are insulated from each other;

3) forming the N-type layer N:

placing the semi finished product obtained in the step 2) into a CdS coating device;

covering the positive layer M1;

using a high pure CdS powder as a sublimation source, vacuumizing the CdS coating device to about 10Pa to about 200Pa, introducing an inert gas (for example, Ar/O_2 gases) into the CdS coating device at a flow rate of about 1ml/min to about 20ml/min, adjusting the temperature of the sublimation source to about 450ºC to about 700ºC, and adjusting the temperature of the glass substrate G to room temperature to about 500ºC; and

coating for about 1min to about 30min to form the N-type layer N with a thickness of about 50nm to about 300nm on the negative layer M2;

4) forming the back contact transition layer E:

placing the semi finished product obtained in the step 3) into the vacuum sputtering device;

covering the N-type layer N (i.e., the CdS film);

vacuum sputtering for about 1min to about 30min with a radio frequency power source using ZnTe:Cu as a target material at a power of about 300W; and

vacuum sputtering for about 1min to about 30min using ZnTe as a target material at a power of about 600W, to form a ZnTe/(ZnTe:Cu) composite layer, i.e., the back contact transition layer E, with a thickness of about 10nm to about 100nm on the positive layer M1;

5) forming the Te-rich layer D:

placing the semi finished product obtained in the step 4) into the vacuum sputtering device;

covering the N-type layer N (i.e., the CdS film); and

vacuum sputtering for about 1min to about 30min using Te as a target material at a power of about 200W, to form the Te-rich layer D with a thickness of about 3nm to about 30nm on the back contact transition layer E; and

6) forming the light absorption layer P:

placing the semi finished product obtained in the step 5) onto a work rest of a vacuum coating device;

using a high pure CdTe powder as the sublimation source, vacuumizing the coating device to about 10Pa to about 200Pa, introducing an inert gas (for example, an Ar gas) at a flow rate of about 1ml/min to about 20ml/min, adjusting the temperature of the sublimation source to about 550°C to about 800°C, and adjusting the temperature of the glass substrate G to about 300°C to about 550°C; and

coating for about 5min to about 30min to form the light absorption layer P with a thickness of about 2μm to about 5μm on the Te-rich layer D and the N-type layer N.

Therefore, the CdTe solar battery is manufactured. In the CdTe solar battery, the first electrode area B1 includes a Te-rich layer D, a back contact transition layer E, and a positive layer M1 laminated sequentially; and the second electrode area B2 includes an N-type layer N and a negative layer M2 laminated sequentially.

The present disclosure will be further described with reference to particular embodiments thereof.

Embodiment 1

A CdTe solar battery was manufactured by:

1) providing and washing a glass substrate G: using common glass with a thickness of about 2.2 mm as the glass substrate G; ultrasonic washing the glass substrate G with acetone for about 10 min to remove oil and fat on the surface of the glass substrate G; ultrasonic washing the glass substrate G with a glass cleaning reagent for about 10 min to remove inorganic contaminants on the surface of the glass substrate G; ultrasonic washing the glass substrate G with deionized water for about 10 min to remove impurities on the surface of the glass substrate G; drying the glass substrate G; and then placing the glass substrate G into a pretreatment room for plasma cleaning;

2) forming the positive layer M1 and the negative layer M2: placing the glass substrate G obtained in the step 1) into a vacuum sputtering device; using Mo as a target material for sputtering with a direct current power source at a power of about 300W for about 10 min to form a Mo metal electrode layer with a thickness of about 150nm on the glass substrate G; and then laser cutting the Mo metal electrode layer to form the positive

layer M1 and the negative layer M2, in which the positive layer M1 and the negative layer M2 were insulated from each other;

3) forming the N-type layer N: placing the semi finished product obtained in the step 2) into a CdS coating device; covering the positive layer M1; using a high pure CdS powder as a sublimation source, vacuumizing the CdS coating device to about 100Pa, introducing an inert gas (i.e., Ar/O_2 gases with a volume ratio of 1:1) into the CdS coating device at a flow rate of about 10ml/min, adjusting the temperature of the sublimation source to about 550ºC, and adjusting the temperature of the glass substrate G to about 500ºC; then coating for about 1min to form the N-type layer N with a thickness of about 120nm on the negative layer M2;

4) forming the back contact transition layer E: placing the semi finished product obtained in the step 3) into the vacuum sputtering device; covering the N-type layer N (i.e., the CdS film); vacuum sputtering for about 3min with a radio frequency power source using ZnTe:Cu as a target material at a power of about 300W; and then vacuum sputtering for about 5min using ZnTe as a target material at a power of about 600W, to form a ZnTe/(ZnTe:Cu) composite layer, i.e., the back contact transition layer E, with a thickness of about 50nm on the positive layer M1;

5) forming the Te-rich layer D: placing the semi finished product obtained in the step 4) into the vacuum sputtering device; covering the N-type layer N (i.e., the CdS film); and then vacuum sputtering for about 1min using Te as a target material at a power of about 200W, to form the Te-rich layer D with a thickness of about 15nm on the back contact transition layer E; and

6) forming the light absorption layer P: placing the semi finished product obtained in the step 5) onto a work rest of a vacuum coating device; using a high pure CdTe powder as the sublimation source, vacuumizing the coating device to about 100Pa, introducing an inert gas (i.e., an Ar gas) at a flow rate of about 10ml/min, adjusting the temperature of the sublimation source to about 600ºC, and adjusting the temperature of the glass substrate G to about 500ºC; then coating for about 20min to form the light absorption layer P with a thickness of about 3μm on the Te-rich layer D and the N-type layer N. Therefore, the CdTe solar battery is manufactured.

Embodiment 2

This embodiment is substantially the same as Embodiment 1, except that: the thickness of the glass substrate G is about 3.2mm.

Embodiment 3

This embodiment is substantially the same as Embodiment 1, except that: the thickness of the light absorption layer P is about 2μm.

Embodiment 4

This embodiment is substantially the same as Embodiment 1, except that: the thickness of the N-type layer N is about 50nm.

Embodiment 5

This embodiment is substantially the same as Embodiment 1, except that: the thickness of each of the positive layer M1 and the negative layer M2 is about 300nm.

Embodiment 6

This embodiment is substantially the same as Embodiment 1, except that: the thickness of the Te-rich layer D is about 3nm.

Embodiment 7

This embodiment is substantially the same as Embodiment 1, except that: the thickness of the back contact transition layer E is about 100nm.

Comparative Embodiment 1

This embodiment is substantially the same as Embodiment 1, except that: the CdTe solar battery comprises a lamination structure including a glass substrate G, a transparent conductive film T, a CdS layer N, a CdTe layer P, a transition layer DE, and a back electrode layer M laminated sequentially; the glass substrate G was a substrate of ultra clear glass with a thickness of about 2.2mm and was pretreated; the transparent conductive film T was FTO conductive glass with a thickness of about 0.5μm formed by sputtering; the glass substrate G was placed in a CdS coating device to coat the CdS layer N with a thickness of about 120nm on the transparent conductive film T; the glass substrate G was placed in a CdTe coating device to coat the CdTe layer P with a thickness of about 3μm on the CdS layer N; a Te layer (i.e., a Te-rich layer) was coated onto the CdTe layer P, and a ZnTe layer with a thickness of 30nm and a ZnTe:Cu layer with a thickness of about 20nm were deposited on the Te layer sequentially to form the transition layer DE; and the glass substrate G was placed in a vacuum sputtering device to form a

Mo layer, i.e., the back electrode layer M, with a thickness of about 150nm on the transition layer DE.

Performance Test

The CdTe solar batteries obtained according to Embodiments 1 to 7 and Comparative Embodiment 1 were tested as follows.

1) Open Circuit Voltage

The test was performed using the standard IEC 61646:2008.

2) Short Circuit Current

The test was performed using the standard IEC 61646:2008.

3) Photoelectric Conversion Efficiency

The test was performed using the standard IEC 61646:2008.

The results are shown in Table 1:

Table 1

CdTe Solar Battery	Open Circuit Voltage	Short Circuit Current	Photoelectric Conversion Efficiency
Embodiment 1	948 mV	23.9 mA	16.10%
Embodiment 2	945mV	24.1mA	16.00%
Embodiment 3	950 mV	25.5mA	16.30%
Embodiment 4	873 mV	22.9mA	15.35%
Embodiment 5	921mV	23.8mA	15.90%
Embodiment 6	906mV	23.4mA	15.60%
Embodiment 7	875mV	21.8mA	14.96%
Comparative Embodiment 1	768mV	21.2mA	11.90%

As shown in the Table 1, compared with the CdTe solar battery obtained according to Comparative Embodiment 1, the CdTe solar batteries obtained according to Embodiments 1 to 7 may have higher open circuit voltage, higher short circuit current, and higher photoelectric conversion efficiency. This indicates that with the CdTe solar battery according to an embodiment of the present disclosure, the glass substrate G is placed on the backlight surface as a substrate, the positive layer M1 for leading the positive current out and the negative layer M2 for leading the negative current out are both formed on the backlight surface respectively, and the light absorption layer P is formed on the light receiving surface to be exposed to sunlight directly, thus improving the light absorption

efficiency of the battery and increasing the photoelectric conversion efficiency of the CdTe solar battery.

Although explanatory embodiments have been shown and described, it would be appreciated by those skilled in the art that changes, alternatives, and modifications can be made in the embodiments without departing from spirit and principles of the disclosure. Such changes, alternatives, and modifications all fall into the scope of the claims and their equivalents.

1. A CdTe solar battery, comprising:

a glass substrate (G);

a light absorption layer (P); and

a first electrode area (B1) and a second electrode area (B2) each formed between the glass substrate (G) and the light absorption layer (P),

wherein

the first electrode area (B1) includes a Te-rich layer (D), a back contact transition layer (E), and a positive layer (M1) laminated sequentially;

the second electrode area (B2) includes an N-type layer (N) and a negative layer (M2) laminated sequentially; and

the first electrode area (B1) and the second electrode area (B2) are insulated from each other.

2. The CdTe solar battery of claim 1, wherein the Te-rich layer (D) is contacted with the light absorption layer (P), the positive layer (M1) is contacted with the glass substrate (G), the N-type layer (N) is contacted with the light absorption layer (P), and the negative layer (M2) is contacted with the glass substrate (G).

3. The CdTe solar battery of claim 1, wherein the glass substrate (G) has a thickness of about 1mm to about 5mm.

4. The CdTe solar battery of claim 1, wherein the light absorption layer (P) is a CdTe film with a thickness of about 2μm to about 5μm.

5. The CdTe solar battery of claim 1, wherein the N-type layer (N) is a CdS film with a thickness of about 50nm to about 300nm.

6. The CdTe solar battery of claim 1, wherein the Te-rich layer (D) is a Te film with a thickness of about 3nm to about 30nm.

7. The CdTe solar battery of claim 1, wherein the back contact transition layer (E) is a ZnTe/(ZnTe:Cu) composite layer with a thickness of about 10nm to about 100nm.

8. The CdTe solar battery of claim 1, wherein the positive layer (M1) and the negative layer (M2) are each a layer of a metal with a thickness of about 50nm to about 300nm; and the metal is at least one selected from the group comprising Mo, Ni, Cu, and Ag.

9. The CdTe solar battery of claim 1, wherein the first electrode area (B1) and the second electrode area (B2) have the same thickness.

10. The CdTe solar battery of claim 1, wherein a gap is formed between the first electrode area (B1) and the second electrode area (B2).

11. A method of manufacturing the CdTe solar battery, comprising steps of:

(a) providing and washing a glass substrate (G);

(b) forming a first electrode area (B1) and a second electrode area (B2) on the glass substrate (G) respectively, wherein the first electrode area (B1) includes a Te-rich layer (D), a back contact transition layer (E), and a positive layer (M1) laminated sequentially; the second electrode area (B2) includes an N-type layer (N) and a negative layer (M2) laminated sequentially; and the first electrode area (B1) and the second electrode area (B2) are insulated from each other;

(c) forming a light absorption layer (P) on the Te-rich layer (D) and the N-type layer (N).

12. The method of claim 11, wherein the step (b) includes the steps of:

b1) placing the glass substrate (G) in a vacuum sputtering device for sputtering using a metal target material to form a metal electrode layer, and then laser cutting the metal electrode layer to form the positive layer (M1) and the negative layer (M2), wherein the positive layer (M1) and the negative layer (M2) are insulated from each other;

b2) covering the positive layer (M1) and then coating a CdS film onto the negative layer (M2) in a CdS coating device to form the N-type layer (N);

b3) covering the second electrode area (B2) and using ZnTe:Cu and ZnTe target materials for sputtering in the vacuum sputtering device to form a ZnTe/(ZnTe:Cu) composite layer on the positive layer (M1) so as to form the back contact transition layer (E); and

b4) using a Te target material for vacuum sputtering to form the Te-rich layer (D) on the back contact transition layer (E).

13. The method of claim 11 or 12, wherein the step (a) includes the steps of:

ultrasonic washing the glass substrate (G) with acetone, a glass cleaning reagent, and deionized water sequentially; drying the glass substrate (G); and plasma cleaning the glass substrate (G).

14. The method of claim 11 or 12, wherein the step (c) includes the steps of:

coating a CdTe film on the Te-rich layer (D) and the N-type layer (N) to form the light absorption layer (P).

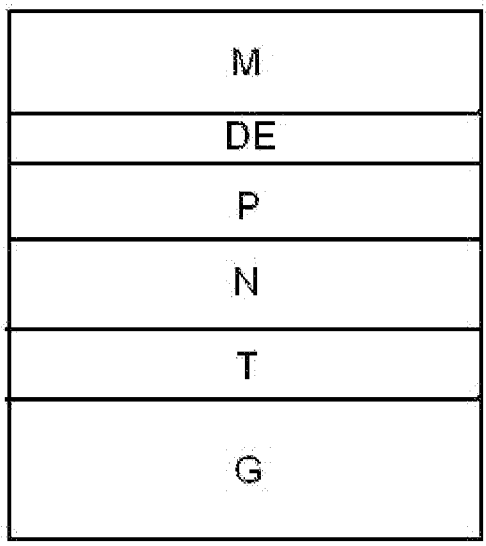


Fig. 1

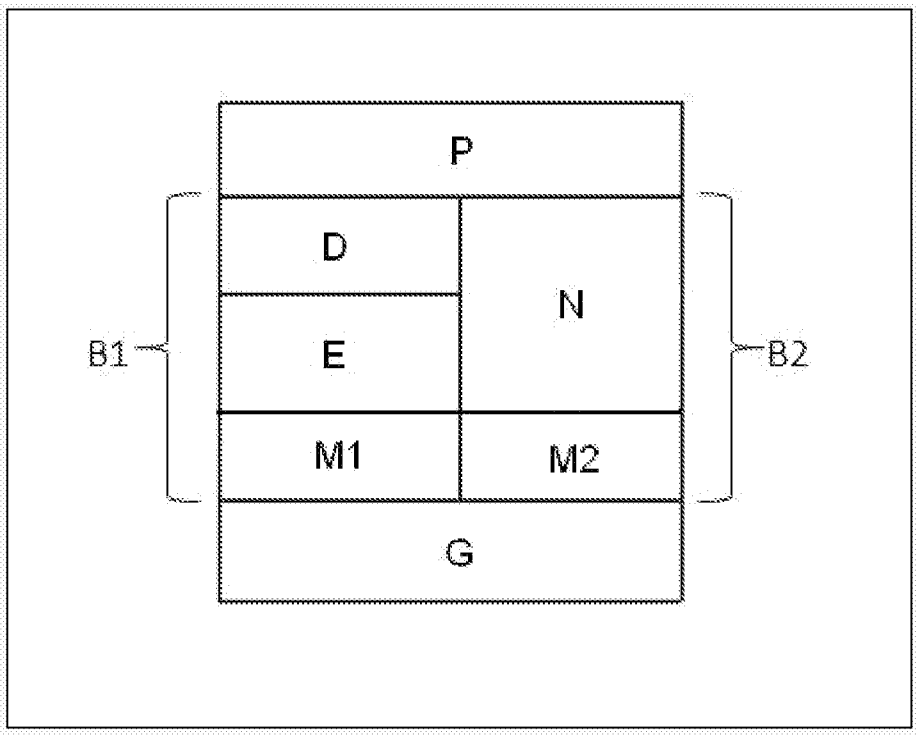


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/075898

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01L 31

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CPRS, CNTXT, WPI, EPODOC: battery, cell, photo+volt+, CdTe, electrode, contact, conduct+, substrate, ZnTe

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2011/0041899 A1 (NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY) 24 Feb. 2011 (24.02.2011) paragraphs 0051-0071; figure 2	1-14
Y	CN 101615638 A (SICHUAN UNIVERSITY) 30 Dec. 2009 (30.12.2009) pages 2-4; figure 3	1-14
Y	CN 201780976 U (BYD CO LTD) 30 Mar. 2011 (30.03.2011) paragraphs 0036-0037	3-5

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 Aug. 2012 (02.08.2012)	**23 Aug. 2012 (23.08.2012)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer SHEN, Jun Telephone No. (86-10)62412114

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/075898

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
US 2011/0041899 A1	24.02.2011	None	
CN 101615638 A	30.12.2009	None	
CN 201780976 U	30.03.2011	WO 2012/013155 A1	02.02.2012

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/075898

CLASSIFICATION OF SUBJECT MATTER:

H01L 31/0352 (2006.01) i

H01L 31/073 (2012.01) i