(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
2 May 2013 (02.05.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/062284 A1

(51) International Patent Classification:
H01L 31/042 (2006.01) *H01L 31/18* (2006.01)

(21) International Application Number:
PCT/KR2012/008710

(22) International Filing Date:
23 October 2012 (23.10.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10-2011-0109732 26 October 2011 (26.10.2011) KR

(71) Applicant: **LG INNOTEK CO., LTD.** [KR/KR]; Seoul Square, 541, Namdaemunno 5-ga, Jung-gu, Seoul 100-714 (KR).

(72) Inventor: **SUNG, Myoung Seok**; Seoul Square, 541,Namdaemunno 5-ga, Jung-gu, Seoul 100-714 (KR).

(74) Agent: **SEO, Kyo Jun**; 9th Fl. Hyun Juk Bldg., 832-41, Yeoksam-dong, Gangnam-gu, Seoul 135-080 (KR).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

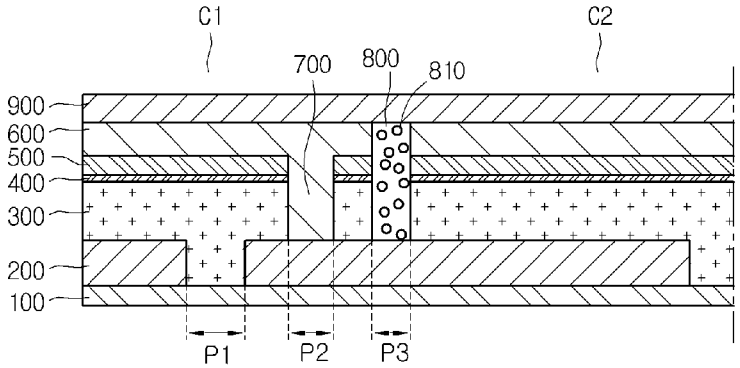
Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

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

[Fig. 8]



(57) Abstract: Disclosed are a solar cell module and a method of preparing the same. The solar cell module include a plurality of solar cells including a back electrode layer, a light absorbing layer, and a front electrode layer that are sequentially formed on a support substrate, a light path conversion part provided between solar cells and including ceramic particles, and a polymer layer on the solar cells.

WO 2013/062284 A1

Description

Title of Invention: SOLAR CELL MODULE AND METHOD OF PREPARING THE SAME

Technical Field

[1] The embodiment relates to a solar cell module and a method of preparing the same.

Background Art

[2] Recently, the requirement for new renewable energy and the interest of the new renewable energy have been more increased due to the serious environmental pollution and the lack of fossil fuel. In this regard, a solar cell is spotlighted as a pollution-free energy source for solving the future energy problem because it rarely causes environmental pollution and has the semi-permanent life span and there exists infinite resources for the solar cell.

[3] Solar cells may be defined as devices for converting light energy into electric energy by using a photovoltaic effect of generating electrons when light is incident onto a P-N junction diode. The solar cell may be classified into a silicon solar cell, a compound semiconductor solar cell mainly including a group I-III-VI compound or a group III-V compound, a dye-sensitized solar cell, and an organic solar cell according to materials constituting the junction diode.

[4] A solar cell made from CIGS (CuInGaSe), which is one of group I-III-VI Chalcopyrite-based compound semiconductors, represents superior light absorption, higher photoelectric conversion efficiency with a thin thickness, and superior electro-optic stability, so the CIGS solar cell is spotlighted as a substitute for a conventional silicon solar cell.

[5] The quantity of electricity produced from the solar cell module is proportion to the quantity of light. Accordingly, in order to improve the efficiency of the solar cell module, the solar cell module must have the structure in which the quantity of the solar light incident into the light absorbing layer of the solar cell can be increased as much as possible. To this regard, various studies, in which protrusions are formed on the surface of the cover glass or an anti-reflective layer is coated on the surface of the cover glass, have been performed.

Disclosure of Invention

Technical Problem

[6] The embodiment provides a solar cell module representing improved photo-electric conversion efficiency.

Solution to Problem

[7] According to the embodiment, there is provided a solar cell module including a

plurality of solar cells including a back electrode layer, a light absorbing layer, and a front electrode layer that are sequentially formed on a support substrate, a light path conversion part provided between solar cells and including ceramic particles, and a polymer layer on the solar cells.

[8] According to the embodiment, there is provided a method of preparing a solar cell module. The method includes sequentially forming a back electrode layer, a light absorbing layer, and a front electrode layer that are sequentially formed on a support substrate, forming a plurality of solar cells by pattering the light absorbing layer and the front electrode layer, forming a light path conversion part including ceramic particles between the solar cells, and a polymer layer on the solar cells.

Advantageous Effects of Invention

[9] As described above, according to the solar cell module of the embodiment, the light path conversion part is formed between the solar cells, so that the solar light incident into the light path conversion part can be output to a surrounding light absorbing layer. Accordingly, the quantity of light incident into the light absorbing layer can be increased, so that the solar cell module according to the embodiment can be represent improved photo-electric conversion efficiency.

Brief Description of Drawings

[10] FIGS. 1 to 8 are sectional views showing a method of preparing the solar cell module according to the embodiment.

Mode for the Invention

[11] In the description of the embodiments, it will be understood that when a substrate, a layer, a film or an electrode is referred to as being "on" or "under" another substrate, another layer, another film or another electrode, it can be "directly" or "indirectly" on the other substrate, the other layer, the other film, or the other 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 size of the elements shown in the drawings may be exaggerated for the purpose of explanation and may not utterly reflect the actual size.

[12] FIGS. 1 to 8 are sectional views showing a method of preparing the solar cell module according to the embodiment.

[13] Referring to FIG. 1, a back electrode layer 200 is formed on a support substrate 100. The back electrode layer 200 may be formed through a physical vapor deposition (PVD) scheme or a plating scheme.

[14] The support substrate 100 has a plate shape, and supports a back electrode layer 200, a light absorbing layer 300, a buffer layer 400, a high resistance buffer layer 500, a front electrode layer 600, a connection wiring 700, a light path conversion part 800, and a polymer layer 900. The support substrate 100 may be transparent, and may be

rigid or flexible.

[15] The support substrate 100 may include an insulator. For example, the support substrate 100 may include a glass substrate, a plastic substrate, or a metallic substrate. In more detail, the support substrate 100 may include a soda lime glass substrate. Alternatively, the support substrate 100 may include a ceramic substrate including alumina, stainless steel, or polymer representing flexibility.

[16] The back electrode layer 200 is provided on the support substrate 100. The back electrode layer 200 is a conductive layer. The back electrode layer 200 may include one selected from the group consisting of molybdenum (Mo), gold (Au), aluminum (Al), chrome (Cr), tungsten (W), and copper (Cu). Among them, Mo represents a less thermal expansion coefficient difference from the support substrate 100 as compared with that of another element, so that Mo has a superior adhesive strength to prevent delamination from the support substrate 100.

[17] The back electrode layer 200 includes a first perforation hole P1. The back electrode layer 200 may be divided into a plurality of back electrodes 210, 220, ..., and N by the first perforation hole P1.

[18] Referring to FIG. 2, the light absorbing layer 300, the buffer layer 400, and the high resistance buffer layer 500 are formed on the back electrode layer 200.

[19] For example, the light absorbing layer 300 may be formed through various schemes such as a scheme of forming a $Cu(In,Ga)Se_2$ (CIGS) based-light absorbing layer 300 by simultaneously or separately evaporating Cu, In, Ga, and Se and a scheme of performing a selenization process after a metallic precursor film has been formed.

[20] Regarding the details of the selenization process after the formation of the metallic precursor layer, the metallic precursor layer is formed on the back contact electrode 200 through a sputtering process employing a Cu target, an In target, or a Ga target. Thereafter, the metallic precursor layer is subject to the selenization process so that the $Cu(In,Ga)Se_2$ (CIGS) based-light absorbing layer 300 is formed.

[21] In addition, the sputtering process employing the Cu target, the In target, and the Ga target and the selenization process may be simultaneously performed.

[22] In addition, a CIS or a CIG light absorbing layer 300 may be formed through a sputtering process employing only Cu and In targets or only Cu and Ga targets and the selenization process.

[23] Thereafter, the buffer layer 400 may be formed by depositing cadmium sulfide (CdS) on the light absorbing layer 300 through a chemical bath deposition (CBD). For example, the buffer layer 400 may include CdS, ZnS, InS, and In-Se-Zn(O, OH), but the embodiment is not limited thereto. The thickness of the buffer layer 400 may be in the range of about 50 nm to about 150 nm, and the energy bandgap of the buffer layer 400 may be in the range of about 2.2 eV to about 2.4 eV.

[24] In addition, zinc oxide is deposited on the buffer layer 400 through a sputtering process, thereby forming the high resistance buffer layer 500. The high resistance buffer layer 500 may include zinc oxide (i-ZnO) which is not doped with impurities. The energy bandgap of the high resistance buffer layer 500 may be in the range of about 3.1 eV to about 3.3 eV. In addition, the high resistance buffer layer 500 may be omitted.

[25] Referring to FIG. 3, a second perforation hole P2 is formed in the light absorbing layer 300, the buffer layer 400, and the high resistance buffer layer 500. In other words, the second perforation hole P2 is formed through the light absorbing layer 300, the buffer layer 400, and the high resistance buffer layer 500. The second perforation hole P2 may be mechanically formed, and the width of the second perforation hole P2 may be in the range of about 80 ㎛ to about 200 ㎛, but the embodiment is not limited thereto. A portion of the back electrode layer 200 is exposed by the second perforation hole P2.

[26] Referring to FIG. 4, the front electrode layer 600 is formed by laminating a transparent conductive material on the high resistance buffer layer 500.

[27] The front electrode layer 600 may have the characteristic of the N type semiconductor. In this case, the front electrode layer 600 may form an N type semiconductor layer together with the buffer layer 400 to form a PN junction with the light absorbing layer 300 which is a P type semiconductor layer. For example, the front electrode layer 600 may include Al-doped zinc oxide (AZO). The front electrode layer 600 may have a thickness of about 100 nm to about 500 nm.

[28] For example, the front electrode layer 600 may be formed through the RF sputtering process using the ZnO target, the reactive sputtering process using the Zn target or the organic metal chemical deposition process.

[29] In addition, the front electrode layer 600 may be formed together with the connection wiring 700. In other words, when the transparent conductive material is laminated on the high resistance buffer layer 500, the transparent conductive material is gap-filled in the second perforation hole P2, thereby forming the connection wiring 700. Therefore, the connection wiring 700 electrically connects the back electrode layer 200 with the front electrode layer 600.

[30] Referring to FIG. 5, the front electrode layer 600 is perforated by third perforation holes P3. The third perforation holes P3 may be mechanically formed to expose a portion of the back electrode layer 200. For example, the width of the third perforation hole P3 may be in the range of about 80 ㎛ to about 200 ㎛, but the embodiment is not limited thereto. The front electrode layer 600 may be divided into a plurality of front electrodes by the third through holes P3, thereby defining a plurality of solar cells C1, C2, C3, …, and CN.

[31] Referring to FIG. 6, the light path conversion part 800 is formed between adjacent solar cells among the solar cells C1, C2, C3, ..., and CN. In more detail, light path conversion parts 800 may be formed in the third perforation holes P3.

[32] The light path conversion part 800 selectively seals the back electrode layer 200 exposed through the third perforation hole P3 before forming the polymer layer 900, thereby preventing the back electrode layer 200 from being delaminated and improving the reliability.

[33] The light path conversion part 800 may include one selected from the group consisting of ethylene-vinyl acetate (EVA), polycarbonate (PC), polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polyamide (PA), polyester (PET), and the combination thereof. In more detail, the light path conversion part 800 may include ethylene-vinyl acetate (EVA) or polycarbonate (PC), but the embodiment is not limited thereto.

[34] The light path conversion part 800 includes ceramic particles 810. In more detail, the light path convert part 800 may include a plurality of ceramic particles 800, but the embodiment is not limited thereto.

[35] The ceramic particles 810 may include at least one of TiO, Al_2O_3, SiO_2, Ta_3O_2 and ZrO. In more detail, the ceramic particles 810 may include TiO particles.

[36] The diameter of the ceramic particles 810 may be in the range of about 50 nm to about 100 nm, but the embodiment is not limited thereto. If the diameter of the ceramic particles 810 is smaller than about 50 nm, the transmission property may be greater than the scatter-reflection property by the Rayleigh scattering. In addition, if the diameter of the ceramic particles 810 is greater than about 150 nm, the incidence of the solar light may be blocked due to the cohesion between the ceramic particles 810. In addition, the contents of the ceramic particles 810 may be in the range of about 10 wt% to about 30 wt%, but the embodiment is not limited thereto. If the contents of the ceramic particles 810 are less than about 10 wt%, the scatter-reflection caused by the ceramic particles 810 may be slightly represented. If the contents of the ceramic particles 810 are equal to or greater than about 30 wt%, the incidence of the solar light may be blocked due to the cohesion between the ceramic particles 810.

[37] The ceramic particles 810 may guide the solar light incident into the light path conversion part 800 to the light absorbing layer 300. Referring to FIG. 7, incident light L1 incident onto the light path conversion part 800 is reflected by the ceramic particles 810, so that reflected light L2 is output in all directions. The reflected light L2 by the ceramic particles 810 may be incident onto the light absorbing layer 300 around the light path conversion part 800. Accordingly, the quantity of light incident onto the light absorbing layer 300 may be increased, so that the solar cell module according to the embodiment can represent improved power generation efficiency by the ceramic

particles 810.

[38] The light path conversion part 800 including the ceramic particles 810 may be formed by mixing the ceramic particles 810 and the dispersant with the polymer material constituting the light path conversion part 800, applying the liquid-phase mixture, and performing a curing process through the heat treatment.

[39] Referring to FIG. 8, the polymer layer 900 is formed on the solar cells C1, C2, ..., and CN. In more detail, the polymer layer 900 may directly make contact with the top surface of the front electrode layer 600 and the top surface of the light path conversion part 800.

[40] The polymer layer 900 not only protects the solar cells C1, C2, ..., and CN from external physical shock and/or foreign matters, but improves the adhesive strength between the solar cells C1, C2, ..., and CN and the protective panel (not shown) on the solar cells C1, C2, ..., and CN.

[41] The polymer layer 90 may include thermo-plastic polymer or thermo-setting polymer generally known to those skilled in the art. For example, the polymer layer 900 may include one selected from the group consisting of ethylene-vinyl acetate (EVA), poly-carbonate (PC), polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polyamide (PA), polyester (PET), and the combination thereof. In more detail, the polymer layer 900 may include ethylene-vinyl acetate (EVA). In addition, the polymer layer 900 may include the same material as that of the light path conversion part 800. For example, the polymer layer 900 may include ethylene-vinyl acetate (EVA), but the embodiment is not limited thereto. In addition, the polymer layer 900 may include photo-curable polymer. For example, the photo-curable polymer may include epoxy-based resin or urethane-based resin.

[42] Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure, or characteristic in connection with other ones of the embodiments.

[43] 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 module comprising:
a plurality of solar cells;
a light path conversion part provided between solar cells and including ceramic particles; and
a polymer layer on the solar cells.

[Claim 2] The solar cell module of claim 1, wherein the ceramic particles include at least one selected from the group consisting of TiO, Al_2O_3, SiO_2, Ta_3O_2 and ZrO.

[Claim 3] The solar cell module of claim 1, wherein a diameter of each ceramic particle is in a range of 50 nm to 100 nm.

[Claim 4] The solar cell module of claim 1, wherein the ceramic particles have contents of 10 weight% to 30 weight%.

[Claim 5] The solar cell module of claim 1, wherein the light path conversion part includes ethylene-vinyl acetate (EVA) or polycarbonate (PC).

[Claim 6] The solar cell module of claim 1, wherein the light path conversion part and the polymer layer include a same material.

[Claim 7] The solar cell module of claim 1, wherein each solar cell includes a support substrate, a back electrode layer, a light absorbing layer, and a front electrode layer that are sequentially stacked on each other.

[Claim 8] The solar cell module of claim 7, wherein the ceramic particles guide a solar light, which is incident onto the light path conversion part, to the light absorbing layer.

[Claim 9] The solar cell module of claim 7, wherein the light path conversion part passes through the light absorbing layer and the front electrode layer.

[Claim 10] A method of preparing a solar cell module, the method comprising:
forming a plurality of solar cells;
forming a light path conversion part including ceramic particles between the solar cells; and
forming a polymer layer on the solar cells.

[Claim 11] The method of claim 10, wherein the forming of the solar cells comprises:
sequentially forming a back electrode layer, a light absorbing layer, and a front electrode layer on a support substrate; and
patterning the light absorbing layer and the front electrode layer.

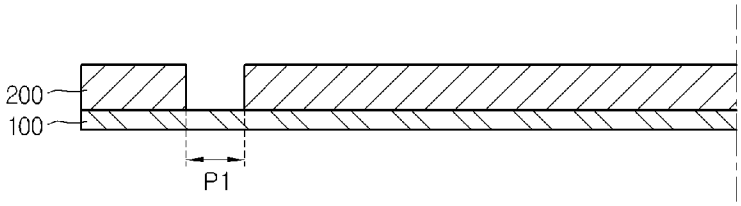
[Claim 12] The method of claim 11, wherein, in the patterning of the light absorbing layer and the front electrode layer, a third perforation hole is

formed through the light absorbing layer and the front electrode layer.

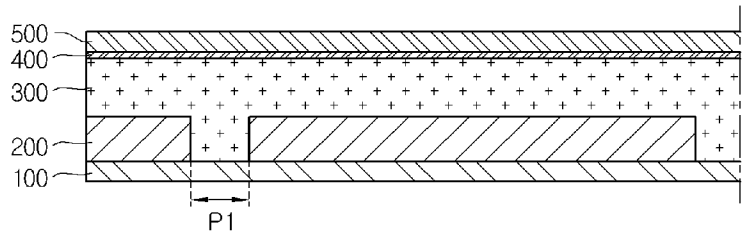
[Claim 13] The method of claim 12, wherein the light path conversion part is formed in the third perforation hole.

[Claim 14] The method of claim 11, wherein the ceramic particles guide a solar light incident onto the light path conversion part to the light absorbing layer.

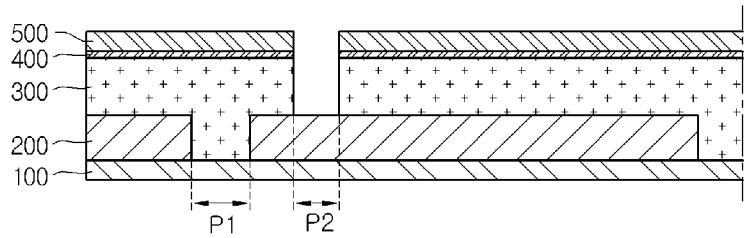
[Fig. 1]



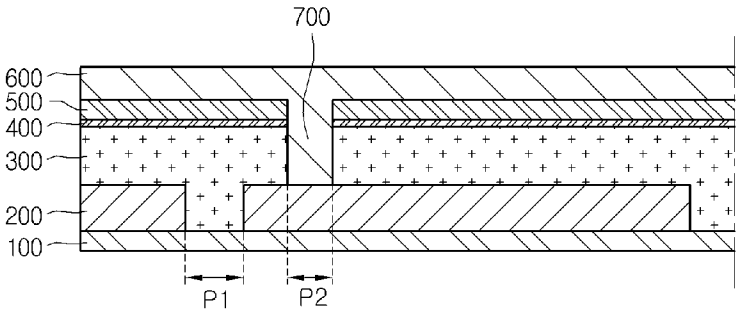
[Fig. 2]



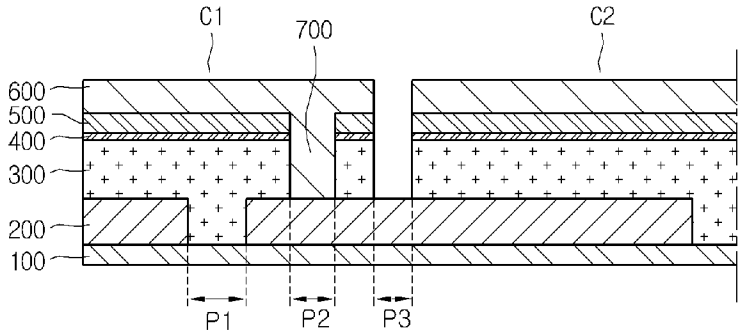
[Fig. 3]



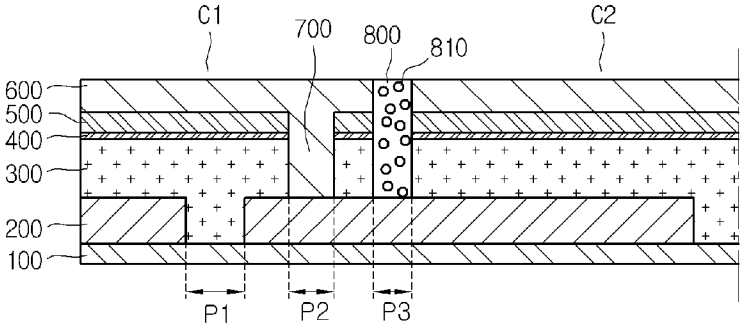
[Fig. 4]



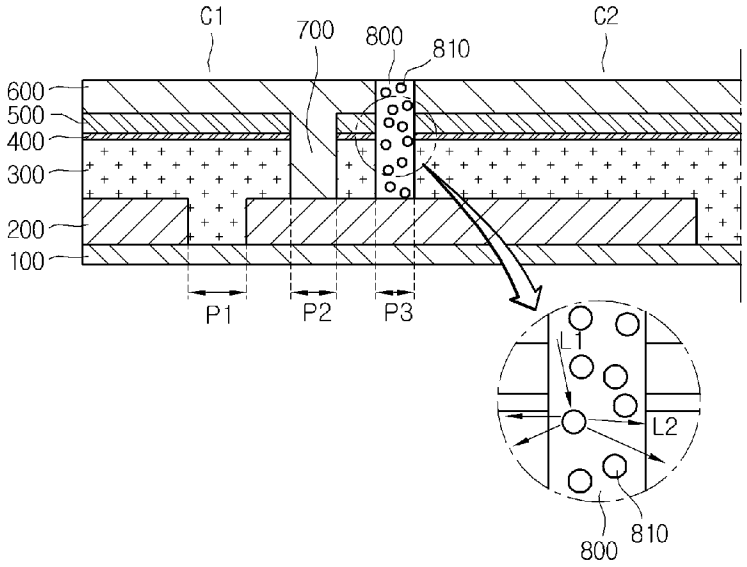
[Fig. 5]



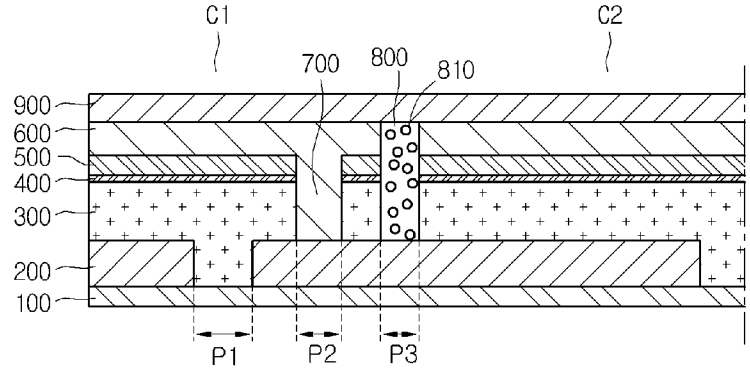
[Fig. 6]



[Fig. 7]



[Fig. 8]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2012/008710

A. CLASSIFICATION OF SUBJECT MATTER

H01L 31/042(2006.01)i, H01L 31/18(2006.01)i

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)

H01L 31/042; H01L 31/18; H01L 31/00

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

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: solar, photovoltaic, cell, battery, particle, reflection, scatter, deflection, path, light, conversion and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011-0180134 A1 (TAE HOON KIM et al.) 28 July 2011 See paragraphs [0040]-[0093] and figures 2, 8.	1-14
A	KR 10-2010-0109319 A (LG INNOTEK CO., LTD.) 08 October 2010 See paragraphs [0019]-[0058] and figure 1.	1-14
A	KR 10-2010-0109318 A (LG INNOTEK CO., LTD.) 08 October 2010 See paragraphs [0024]-[0067] and figure 1.	1-14

☐ 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 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
26 FEBRUARY 2013 (26.02.2013)	**26 FEBRUARY 2013 (26.02.2013)**

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

LEE, Sung Hyun

Telephone No. 82-42-481-8504

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2012/008710

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011-0180134 A1	28.07.2011	CN 102136503 A	27.07.2011
		EP 2348538 A2	27.07.2011
		EP 2348538 A3	23.05.2012
		JP 2011-151342 A	04.08.2011
		KR 10-2011-0086267 A	28.07.2011
		TW 201126730 A	01.08.2011
KR 10-2010-0109319 A	08.10.2010	None	
KR 10-2010-0109318 A	08.10.2010	None	