TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371		ATTORNEY'S DOCKET NO. 1032404-000416
		U.S. APPLICATION NO. (If known) Unassigned
INTERNATIONAL APPLICATION NO. PCT/JP2010/061334	INTERNATIONAL FILING DATE 07/02/2010	PRIORITY DATE CLAIMED

TITLE OF INVENTION
SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF

APPLICANT(S) FOR DO/EO/US
SHIMASAKI, Koji; and SUZUKI, Masayoshi

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a submission under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a submission under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (20) indicated below.
4. ☐ The US has been elected (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☒ A preliminary amendment.
13. ☒ An Application Data Sheet under 37 CFR 1.76.
14. ☒ A substitute specification.
15. ☐ A power of attorney and/or change of address letter.
16. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.2 and 37 CFR 1.821-1.825.
17. ☐ A second copy of the published International Application under 35 U.S.C. 154(d)(4).
18. ☐ A second copy of the English language translation of the International Application under 35 U.S.C. 154(d)(4).
19. ☒ Other Items or information:

General Authorization for Petitions for Extensions of Time and Payment of Fees
Marked-Up Specification
Form PCT/IB/308 (Second Notice)
Form PCT/ISA/210
Form PCT/ISA/237

U.S. APPLICATION NO. (If known)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NO.
Unassigned	PCT/JP2010/061334	1032404-000416

The following fees have been submitted:		CALCULATIONS	PTO USE ONLY
20. ☒	Basic National fee (37 CFR 1.492(a)) (1631) $ 390	$ 390.00	
21. ☒	Examination fee (37 CFR 1.492(c)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) (1643) $ 0 All other situations (1633) $ 250	$ 250.00	
22. ☒	Search fee (37 CFR 1.492(b)) If the written opinion of the ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) (1640) $ 0 Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority (1641) $ 120 International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB (1642) $ 500 All other situations (1632) $ 650	$ 500.00	
	TOTAL OF 20, 21 AND 22 =	**$ 1,140.00**	
☐	Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)). The fee is $ **320** (1681) for each additional 50 sheets of paper or fraction thereof.		

Total Sheets		Extra Sheets		Number of each additional 50 or fraction thereof (round **up** to a whole number)	RATE	
29	-100 =		/50 =		x $ 320	$

☐ Surcharge of $ **130** (1617) for furnishing any of the search fee, examination fee, or the oath or declaration after the date of commencement of the national stage (37 CFR 1.492(h)).	$

CLAIMS	NUMBER FILED		NUMBER EXTRA	RATE	
Total claims	6	- 20 =	0	x $ 62 (1615)	$
Independent Claims	1	- 3 =	0	x $ 250 (1614)	$
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+ $ 460 (1616)	$
				TOTAL OF ABOVE CALCULATIONS =	**$**
☐ Applicant claims small entity status. See 37 CFR 1.27. Fees above are reduced by 1/2.					
				SUBTOTAL =	**$ 1,140.00**
Processing fee of $ **130** (1618) for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(i)). +					
				TOTAL NATIONAL FEE =	**$ 1,140.00**
				TOTAL FEES ELECTRONICALLY PAID =	**$ 1,140.00**
				Amount to be refunded:	$
				Amount to be charged:	$

a. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-4800.

b. ☒ Charge $ 1,140.00 to credit card. Filing fee being paid electronically concurrent with filing of application.

NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the International Application to pending status.

SEND ALL CORRESPONDENCE TO:

Buchanan Ingersoll & Rooney PC
Customer Number **2 1 8 3 9**
703.836.6620

Date: December 24, 2012

SIGNATURE

James A. LaBarre — NAME

28632 — REGISTRATION NO.

Jinko Ex. 1002 - 2/580

Attorney Docket No. 1032404-000416

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)	
	)	
Koji SHIMASAKI et al.	)	Group Art Unit: Unassigned
	)	
Application No.: Unassigned	)	Confirmation No.: Unassigned
	)	
Filed: December 24, 2012	)	
	)	
For: SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF	)	
	)	
	)	

GENERAL AUTHORIZATION FOR PETITIONS FOR EXTENSIONS OF TIME AND PAYMENT OF FEES

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In accordance with 37 C.F.R. § 1.136(a)(3), the U.S. Patent and Trademark Office is hereby provided with a general authorization to treat any concurrent or future reply requiring a petition for an extension of time for its timely submission as containing a request therefor for the appropriate length of time.

The Commissioner is hereby authorized to charge any appropriate fees that may be required by this paper, or any other submissions in this application, and to credit any overpayment, to Deposit Account No. 02-4800.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date: December 24, 2012

By: _____
James A. LaBarre
Registration No. 28632

Customer Number 21839
703.836.6620

Patent
Attorney's Docket No. 1032404-000416

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	Group Art Unit: Unassigned
Koji SHIMASAKI et al.	Confirmation No.: Unassigned
Application No.: Unassigned	
Filed: December 24, 2012	
For: SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF	

PRELIMINARY AMENDMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Prior to examination of the above-captioned patent application, kindly amend the application as follows.

AMENDMENTS TO THE SPECIFICATION:

Please replace the title with the following amended title:

--SOLAR ~~CELL~~ BATTERY MODULE AND ~~METHOD FOR~~ MANUFACTURING ~~SAME~~ METHOD THEREOF--.

Kindly replace pages 1-23 of the original specification with pages 1-25 of the attached substitute specification. Also attached is a marked-up copy of the original specification showing changes that have been made in the substitute specification.

AMENDMENTS TO THE ABSTRACT:

Please replace the original Abstract with the following amended Abstract of the Disclosure. This new Abstract of the Disclosure is also set forth on a separate sheet attached to the end of this Preliminary Amendment:

ABSTRACT OF THE DISCLOSURE

A solar battery module ~~that improves an output without increasing a cross-sectional area of an interconnector is provided. The solar battery module~~ includes: a plurality of solar battery cells ~~(20)~~, a plain shape of each being a substantial rectangle, and a ratio of a short side length ~~(S)~~ and a long side length ~~(L)~~ of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and a light-receiving-surface lead (an interconnector) ~~(4)~~ that electrically connects the light-receiving-surface bus electrodes of one of the solar battery cells ~~(20)~~ to the rear-surface bus electrodes of adjacent one of the solar battery cells ~~(20)~~.

AMENDMENTS TO THE CLAIMS:

The following listing of claims will replace all prior versions and listings of claims in this application.

LISTING OF CLAIMS:

1. (Currently Amended) A solar battery module comprising:

a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and

an interconnector that electrically connects the light-receiving-surface bus electrodes of a first one of the solar battery cells to the rear-surface bus electrodes of an adjacent second one of the solar battery cells, wherein a predetermined number of the solar battery cells are serially connected to each other, thereby configuring a cell string, n columns of the cell strings are connected in parallel, and the n-column parallel-connected cell strings are further serially connected, thereby configuring an entire cell array.

Claims 2-3 Cancelled

4. (Currently Amended) The solar battery module according to ~~claim 2~~ claim 1, wherein a predetermined number of the solar battery cells are serially connected, thereby configuring a cell string, two columns of the cell strings are connected in parallel, and the two-column parallel-connected cell strings are further serially connected, thereby configuring an entire cell array.

5. (Original) The solar battery module according to claim 1, wherein the light-receiving-surface bus electrodes of the solar battery cell are formed at positions that are line-symmetrical with respect to a line passing through a middle point of a side perpendicular to an extended line of the light-receiving-surface bus electrodes and parallel to the light-receiving-surface bus electrodes.

6. (Currently Amended) The solar battery module according to ~~claim 5~~ claim 1, wherein the light-receiving-surface bus electrodes of the solar battery cell are formed at positions that are line-symmetrical with respect to a line passing through a middle point of a side parallel to the light-receiving-surface bus electrodes and perpendicular to the light-receiving-surface bus electrodes.

7. (Original) The solar battery module according to claim 1, wherein each of the solar battery cells includes an area where the light-receiving-surface bus electrodes and the rear-surface bus electrodes are not formed within a predetermined dimension from an edge toward a central direction of the cell at an outer circumferential edge portion thereof.

8. (Currently Amended) ~~A manufacturing method of a solar battery module comprising the steps of:~~ The solar battery module according to claim 1, which is obtained by dividing a basic solar battery cell with a plane shape thereof being a substantial square, which includes n light-receiving-surface electrode areas in each of which a plurality of light-receiving-surface bus electrodes parallel to a side of the substantial square and a plurality of grid electrodes perpendicular to the light-receiving-surface bus electrodes are provided on a light-receiving surface side and includes rear-surface bus electrodes each at a position on a non-light-receiving

surface side corresponding to each of the light-receiving-surface bus electrodes into n along respective boundaries of the n light-receiving-surface electrode areas~~, thereby obtaining divided solar battery cells, each having a plain of a substantial rectangle with a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or higher than 2); and~~

~~electrically connecting the light-receiving-surface bus electrodes of a first one of the divided solar battery cells to the rear-surface bus electrodes of a second adjacent one of the divided solar battery cells by an interconnector~~.

AMENDMENTS TO THE DRAWINGS:

The attached sheet of drawings includes changes to Figs. 3 and 6. These sheets, which include Figs. 3-6, replace the original sheets including Figs. 3-6. In Figure 3, identifier 3 has been changed to 14.

Attachment: Replacement Sheets

REMARKS

By way of the foregoing amendment, the title has been amended to be consistent with the title on the front of the application and the abstract has been amended to conform with conventional U.S. format. Claims 1, 4, 6 and 8 have been amended to delete multiple dependencies and to clarify the scope of the subject matter for which protection is sought and claims 2-3 have been cancelled without disclaimer or prejudice. No new matter has been introduced by these changes.

Submitted with this Preliminary Amendment is a substitute specification. A marked-up copy of the original specification showing the changes incorporated into the substitute specification is also attached. No new matter has been introduced by these changes.

It is requested that the application be examined on the basis of the amendments presented herein. Early and favorable consideration of this application is respectfully requested.

Should any questions arise in connection with this application, it is respectfully requested that the undersigned be contacted at the number indicated below.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date: December 24, 2012

By: _____
James A. LaBarre
Registration No. 28632

Customer No. 21839
(703) 836-6620

ABSTRACT OF THE DISCLOSURE

A solar battery module includes: a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and a light-receiving-surface lead (an interconnector) that electrically connects the light-receiving-surface bus electrodes of one of the solar battery cells to the rear-surface bus electrodes of adjacent one of the solar battery cells.

FIG.3

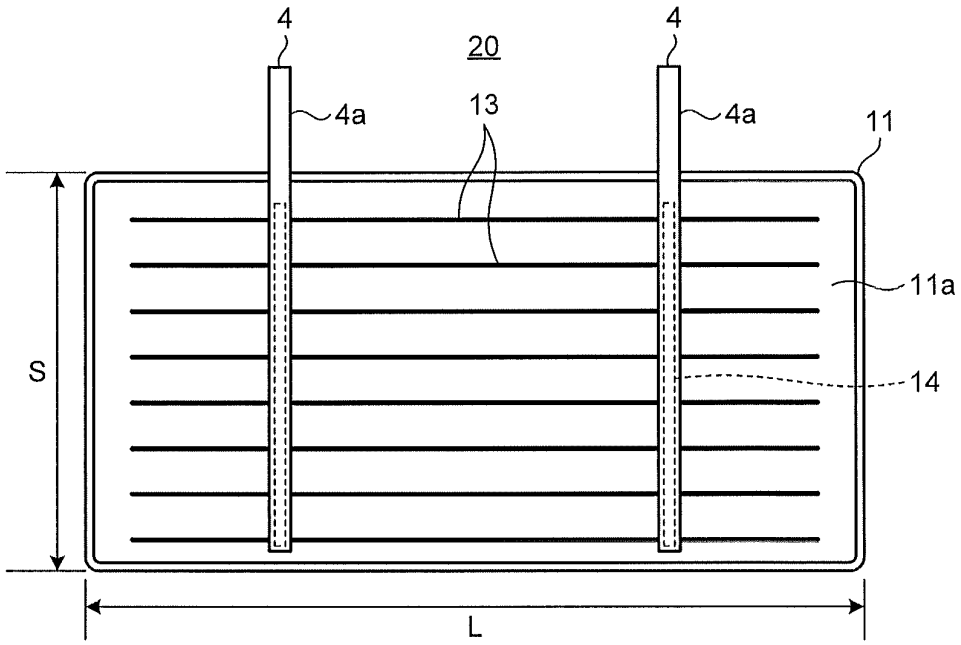


FIG.4

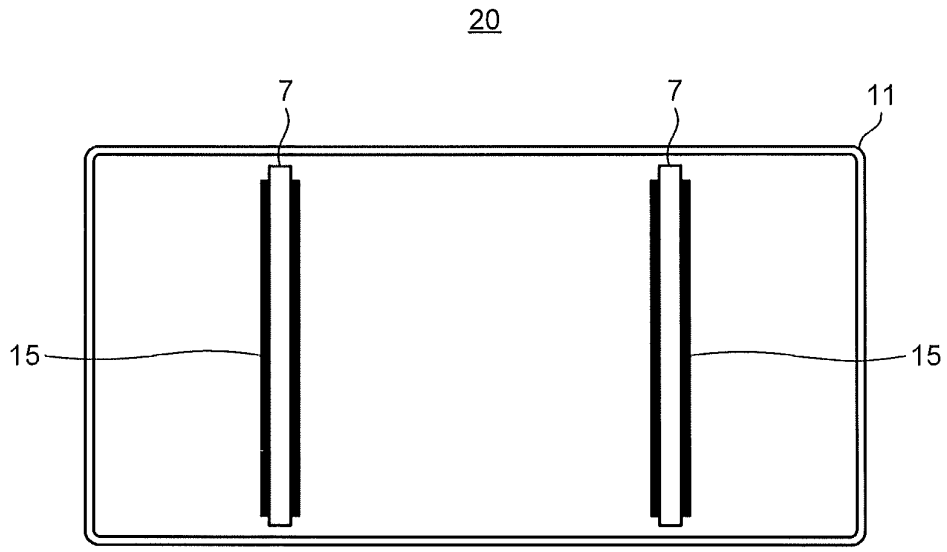


FIG.5

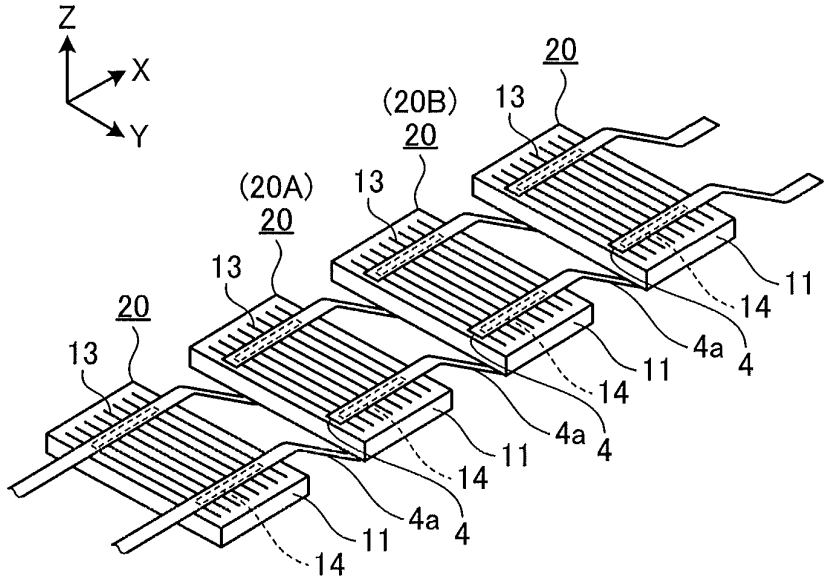
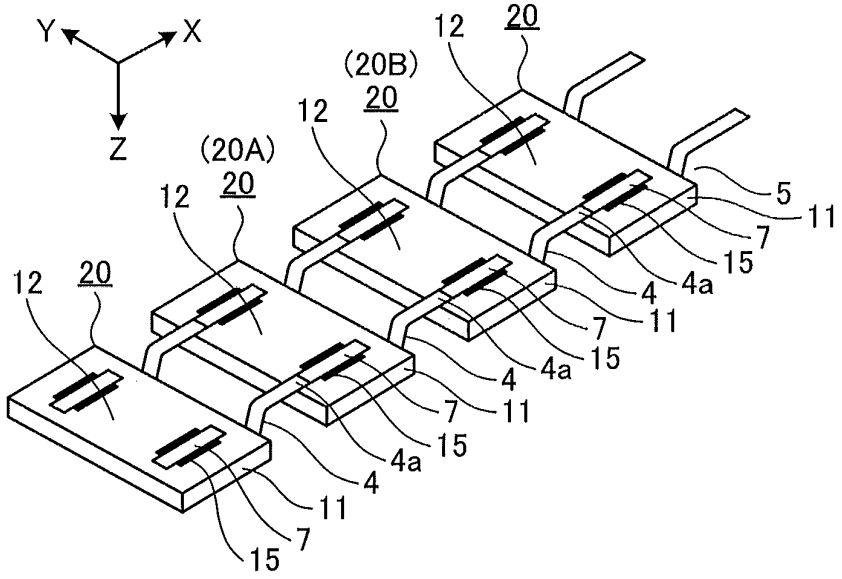

Z
X
Y
20
(20B)
20
13
(20A)
20
13
20
13
11
14
4a
4
11
14
4a
4
11
14
4a
4

FIG.6


Y
X
Z
12
20
(20B)
20
12
(20A)
20
12
12
20
5
11
7
15
4a
4
11
7
15
4a
4
11
7
15
4a
4
11
7
15

DESCRIPTION

SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF

Field

[0001] The present invention relates to a solar battery module, a plurality of which are arranged and installed on a roof or the like in a solar power generation system that converts light energy of the sun and the like into electric energy, and to a manufacturing method thereof.

Background

[0002] Power generation performance of a crystal solar battery module that uses a wafer made of silicon serving as a main material is improved by improvement in performance of a solar battery cell serving as a power generation element.

[0003] However, with improvement in efficiency of a cell, an electric current is increased and a resistance loss at a wiring member (an interconnector) that is mainly made of copper and connects cells to each other at the time of modularization is also increased. Accordingly, performance after modularization is not improved for an amount corresponding to an amount of the improvement in the performance of a cell, but is reduced for an amount of increase in the resistance loss at the interconnector.

[0004] As a remedy for this problem, there has been conventionally proposed a technique of reducing a resistance loss by increasing a cross-sectional area of an interconnector (see Patent Literature 1, for example).

Citation List

Patent Literature

[0005] Patent Literature 1: Japanese Patent Application Laid-open No. H11-251613

Summary

Technical Problem

[0006] However, to increase the cross-sectional area of the interconnector as conventionally proposed, a width or a thickness of the interconnector needs to be increased. If the width is increased, a light-receiving area of a cell is reduced and a power generation amount is also reduced. Accordingly, increasing the thickness is generally conceived. However, by an influence of heat applied when the interconnector is solder-joined to an electrode on a cell, residual stress generated in the cell is increased and thus the probability that the cell is broken is increased and a yield is deteriorated.

[0007] The present invention has been achieved in view of the above problems, and an object of the present invention is to provide a solar battery module that can improve an output without increasing a cross-sectional area of an interconnector, and a manufacturing method thereof.

Solution to Problem

[0008] In order to solve the afore-mentioned problems, a solar battery module according to one aspect of the present invention is constructed in such a manner as to include: a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and a ratio of a short side length

and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and an interconnector that electrically connects the light-receiving-surface bus electrodes of a first one of the solar battery cells to the rear-surface bus electrodes of an adjacent second one of the solar battery cells.

[0009] In order to solve the afore-mentioned problems, a manufacturing method of a solar battery module according to another aspect of the present invention includes the steps of: dividing a basic solar battery cell with a plane shape thereof being a substantial square, which includes n light-receiving-surface electrode areas in each of which a plurality of light-receiving-surface bus electrodes parallel to a side of the substantial square and a plurality of grid electrodes perpendicular to the light-receiving-surface bus electrodes are provided on a light-receiving surface side and includes rear-surface bus electrodes each at a position on a non-light-receiving surface side corresponding to each of the light-receiving-surface bus electrodes, into n along respective boundaries of the n light-receiving-surface electrode areas, thereby obtaining divided solar battery cells, each having a plain of a substantial rectangle with a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or higher than 2); and electrically connecting the light-

receiving-surface bus electrodes of a first one of the divided solar battery cells to the rear-surface bus electrodes of a second adjacent one of the divided solar battery cells by an interconnector.

Advantageous Effects of Invention

[0010] According to the solar battery module of the present invention, because an electric current flowing in the interconnector that serially connects plural cells to each other can be reduced, a resistance loss can be reduced and an output of the solar battery module can be improved. A polycrystalline wafer or a mono-crystalline wafer serving as a substrate of a cell is generally of a square shape, and a cell can be easily obtained by cutting this wafer into half.

[0011] According to the manufacturing method of a solar battery module of the present invention, a first solar battery cell is divided into n along respective boundaries of n light-receiving-surface electrode areas, thereby obtaining a second solar battery cell in which a ratio of a short side length and a long side length of a substantial rectangle is 1/n:1 (n is an integer equal to or larger than 2), and light-receiving bus electrodes of the second solar battery cell are electrically connected to rear-surface bus electrodes of an adjacent solar battery cell by an interconnector. Accordingly, a solar battery module with a resistance loss being reduced can be easily produced.

Brief Description of Drawings

[0012] FIG. 1 is a perspective view of a solar battery module and depicts a state in which a frame member is being

attached to a solar battery panel.

FIG. 2 is a perspective view of a state in which a cell array formed by sequentially connecting a plurality of solar battery cells is sealed with a lead in the solar battery panel.

FIG. 3 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell.

FIG. 4 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell.

FIG. 5 is a perspective view of a state in which the solar battery cells are serially connected to each other, as viewed from above.

FIG. 6 is a perspective view of the state in which the solar battery cells are serially connected to each other, as viewed from below.

FIG. 7 is an exploded perspective view of the solar battery cell and depicts a state in which components are stacked.

FIG. 8 is a cross-sectional view of a connection state of two adjacent solar battery cells.

FIG. 9 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell used for a solar battery module according to a second embodiment of the present invention.

FIG. 10 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell.

FIG. 11 is a top view of a state in which the solar battery cells are connected according to the second embodiment.

FIG. 12 is a schematic diagram of a method of connection in a cell array according to the second embodiment.

FIG. 13 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell used for a solar battery module according to a third embodiment of the present invention.

FIG. 14 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell.

FIG. 15 is a schematic diagram of a method of connection in a cell array according to the third embodiment.

Description of Embodiments

[0013] Exemplary embodiments of a solar battery module and a manufacturing method thereof according to the present invention will be explained below in detail with reference to the accompanying drawings. The present invention is not limited to the embodiments.

[0014] First embodiment.

FIG. 1 is a perspective view of a solar battery module and depicts a state in which a frame member is being attached to a solar battery panel. FIG. 2 is a perspective view of a state in which a cell array formed by sequentially connecting a plurality of solar battery cells is sealed with a lead in the solar battery panel. FIG. 3 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell. FIG. 4 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell. FIG. 5 is a perspective view of a state in which the solar battery cells are serially connected to each other, as viewed from above. FIG. 6 is a perspective view of

the state in which the solar battery cells are serially connected to each other, as viewed from below. FIG. 7 is an exploded perspective view of the solar battery cell and depicts a state in which components are stacked. FIG. 8 is a cross-sectional view of a connection state of two adjacent solar battery cells.

[0015] A solar battery module 90 has a flat-plate-shaped solar battery panel 70 and a frame member 80 that surrounds outer edge of the solar battery panel 70 over the whole circumference thereof (FIG. 1). The solar battery panel 70 is configured by sealing a plurality of solar battery cells 20 arranged vertically and horizontally with a resin, covering a light-receiving-surface side thereof with a front-surface cover material 3 such as glass with translucency, and covering a rear surface side (a non-light-receiving surface side) thereof with a rear-surface cover material 10 (FIGS. 7 and 8).

[0016] The solar battery cells 20 are connected serially to each other in an X direction as a first direction in the drawings with a light-receiving surface lead (an interconnector) 4 and a rear surface lead (an interconnector) 7 (FIGS. 5 to 7). However, at ends of the solar battery panel 70, some solar battery cells are connected to each other in a Y direction. As the light-receiving surface lead 4 and the rear surface lead 7, band-shaped copper foil to which solder is supplied (coated or applied), generally called a tab line is used. A cell array 5 formed by sequentially connecting the solar battery cells 20 with the leads 4 and 7 is sealed within the solar battery panel 70 with a resin 8 (FIG. 2).

[0017] The frame member 80 is produced by extrusion molding of aluminum or the like and covers the outer edge of the solar battery panel 70 over the whole circumference with a U-shaped portion having a U-shaped cross section (FIG. 1). The frame member 80 is fixed via a butyl sealing material or a silicon adhesive to the solar battery panel ~~20~~70 to reinforce the solar battery panel ~~20~~70 and serves to attach the solar battery panel ~~20~~70 to a stand provided on a construction such as a residence or a building, the ground, or a structure.

[0018] The solar battery panel 70 is configured by stacking the translucent front-surface cover material (glass) 3, a cell arrangement layer 9 in which the solar battery cells 20, and the light-receiving surface lead 4 and the rear surface lead 7 serially connecting the solar battery cells 20 to each other are sealed by the resin 8 (8a, 8b) such as EVA (ethylene vinyl acetate), and a back sheet 10 (the rear-surface cover material) that is made of PET (polyethylene terephthalate), PVF (polyvinyl fluoride), or the like and has excellent weather resistance in this order from the light-receiving surface side (FIGS. 7 and 8).

[0019] As shown in FIGS. 3 and 4, the solar battery cell 20 according to the present embodiment has a substantially-rectangular plane shape and a ratio of a short side length S and a long side length L of the rectangular is 1/2:1. A conventional solar battery cell is generally a 156 mm × 156 mm square or a 125 mm × 125 mm square. However, because the solar battery cell 20 according to the present embodiment is produced by dividing a solar battery cell produced in a square of the dimension mentioned above into two in the first

direction at the time of connection (the direction in which a light-receiving-surface bus electrode (a light-receiving-surface lead-connection electrode) 14 extends), the solar battery cell 20 has the shape as mentioned above.

[0020] The solar battery cell 20 is configured as follows by using p-type silicon having a thickness of about 150 to 300 micrometers as a substrate. An n-type diffusion layer (an impurity-layer diffusion layer, not shown) is formed by phosphorous diffusion on a front surface side of a p-type silicon substrate 11 serving as a p-type layer. An antireflection film 11a (FIG. 3) made of a silicon nitride film for preventing reflection of incident light to improve a conversion efficiency is further provided by surface treatment, so that a light-receiving surface of the solar battery cell 20 is provided. On a rear-surface side of the p-type silicon substrate (hereinafter, simply "substrate") 11, a p+ layer (not shown) containing high-density impurities is formed and a rear-surface collecting electrode 12 made of aluminum is further provided over a substantially entire rear surface to reflect the incident light and extract electric power.

[0021] A grid electrode 13 that is a thin electrode made of silver and the light-receiving-surface bus electrode (the light-receiving-surface lead-connection electrode) 14 that is made of silver as the grid electrode 13 and has a predetermined width are formed on the light receiving surface of the substrate 11 as a light-receiving-surface side electrode that extracts electric energy converted from the incident light, and these electrodes are electrically connected to the n-type diffusion layer at bottom surfaces

thereof. Two light-receiving-surface bus electrodes 14 are formed in parallel along the first direction as the direction of connecting the solar battery cells 20. A large number of the grid electrodes 13 are formed thin in a direction perpendicular to the light-receiving-surface bus electrode 14. The grid electrode 13 is formed as thin as possible and to be all over the light-receiving surface (the front surface) to extract electric power generated at the light receiving surface with no waste. When sunlight hits the solar battery cell 20, the light-receiving-surface side shown in FIG. 3 becomes a negative (-) electrode and the rear-surface side shown in FIG. 4 becomes a positive (+) electrode. The light-receiving-surface bus electrode 14 is provided so that the light-receiving surface lead 4 is connected thereto for further externally extracting electric energy collected by the grid electrode 13 (FIG. 3). While the light-receiving-surface bus electrode 14 is shown as being narrower than the light-receiving surface lead 4 in FIGS. 3 and 5, this is for showing a state in which the light-receiving-surface bus electrode 14 overlaps the light-receiving surface lead 4 to be easily understood and the light-receiving-surface bus electrode 14 and the light-receiving surface lead 4 practically have the same width.

[0022] Meanwhile, the rear-surface collecting electrode 12 made of aluminum is provided on the rear surface of the substrate 11 to cover the substantially entire rear surface. A rear-surface bus electrode (a rear-surface lead-connection electrode) 15 made of silver is formed at a position on the rear surface of the substrate 11 corresponding to the grid electrode 13 (at a position where the rear-surface bus

electrode 15 overlaps the grid electrode 13 in a thickness direction of the substrate 11) to extend in the first direction as the direction of connecting the solar battery cells 20. The rear-surface bus electrode 15 is provided so that the rear surface lead 7 is connected thereto for further externally extracting electric energy collected by the rear-surface collecting electrode 12 (FIG. 4). While the rear-surface bus electrode 15 is shown as being wider than the rear surface lead 7 in FIGS. 4 and 6, this is for showing a state in which the rear-surface bus electrode 15 overlaps the rear surface lead 7 and the rear-surface bus electrode 15 and the rear surface lead 7 practically have the same width.

[0023] The rear surface of the substrate 11 can be covered by a silver electrode over its ~~front~~ entire surface. However, because costs are increased, the rear-surface bus electrode 15 made of silver is particularly provided only at a position where the rear surface lead 7 is connected as explained above. In addition to the rear-surface bus electrode 15 formed in a line shape as in the present embodiment, the rear-surface bus electrode 15 can be provided discretely in a dotted manner (in a stepping-stone manner). According to the present embodiment, before the solar battery cells produced in a square as explained above are connected one another with the light-receiving surface lead 4 and the rear surface lead 7, each of the solar battery cells is divided into two in the direction in which the light-receiving-surface bus electrode 14 extends, so that the rectangular solar battery cell 20 with the ratio of the short side length S and the long side length L being 1/2:1 is obtained.

[0024] To obtain the divided solar battery cell 20,

predetermined processes are first performed to form the light-receiving-surface bus electrode 14, the grid electrode 13, the rear-surface collecting electrode 12, and the rear-surface bus electrode 15 on the square substrate 11, thereby producing a solar battery cell (a first solar battery cell) serving as a base. At this time, a light-receiving-surface electrode area and a rear-surface electrode area where the electrodes are formed, respectively, are each formed into two areas in a divided manner along a division line. By cutting the solar battery cell along the division line, the rectangular solar battery cell 20 as mentioned above is obtained. While the solar battery cell 20 according to the present embodiment is obtained by dividing the solar battery cell produced in a square into two, the solar battery cell can be divided into a larger number (n) such as three or four. When the solar battery cell 20 is divided into n, the light-receiving-surface electrode area and the rear-surface electrode area are formed into n areas in advance in a divided manner.

[0025] In the solar battery cell 20 with such a configuration, when sunlight is irradiated from the light-receiving surface side (the antireflection film side) of the solar battery cell 20 to reach an internal pn junction surface (a junction surface of the p-type layer and the n-type diffusion layer), holes and electrons coalesced on the pn junction surface are separated from each other. The separated electrons move toward the n-type diffusion layer. Meanwhile, the separated holes move toward the p+ layer. Accooirdingly, a potential difference is generated between the n-type diffusion layer and the p+ layer so that a

potential of the p+ layer is higher. Consequently, a front-surface electrode connected to the n-type diffusion layer becomes a negative electrode and a rear-surface electrode connected to the p+ layer becomes a positive electrode. When an external circuit (not shown) is connected to this solar battery cell 20, an electric current flows therein and the solar battery cell 20 performs an operation as a solar battery. While an output voltage of one solar battery cell is small, plural solar battery cells 20 are connected in series or in parallel to each other in the solar battery module 90, so that the output voltage is increased to a usable voltage.

[0026] Serial connection of the solar battery cells 20 is achieved by, in plural solar battery cells arranged in the first direction, electrically connecting the light-receiving-surface bus electrode 14 of a first solar battery cell 20 (20A) to the rear-surface bus electrode 15 of a second solar battery cell 20 (20B) adjacent to the first solar battery cell 20 (20A) with the band-shaped leads 4 and 7 (FIGS. 5 to 8).

[0027] According to the present embodiment, the leads 4 and 7 are provided separately as the light-receiving surface lead 4 and the rear surface lead 7, respectively. Among the leads, the light-receiving surface lead 4 extends on the light-receiving-surface bus electrode 14 to be solder-joined (mechanically and electrically connected) to the light-receiving-surface bus electrode 14. The light-receiving surface lead 4 has an extended portion 4a formed to be longer than the solar battery cell 20. When the light-receiving surface lead 4 is solder-joined to the light-receiving-

surface bus electrode 14, the extended portion 4a protrudes toward one end side (FIGS. 3, 5, and 9).

[0028] The rear surface lead 7 extends on the rear-surface bus electrode 15 to be solder-joined (mechanically and electrically connected) to the rear-surface bus electrode 15. To serially connect the first solar battery cell 20 (20A) to the second solar battery cell 20 (20B), the light-receiving surface lead 4 of the first solar battery cell 20 (20A) is solder-joined to the rear surface lead 7 of the second solar battery cell 20 (20B). That is, the extended portion 4a of the light-receiving surface lead 4 of the first solar battery cell 20 (20A) is slipped under the rear surface side of the adjacent second solar battery cell 20 (20B) to be solder-joined to the rear surface lead 7 solder-joined to the rear-surface bus electrode 15. While only connection of the first solar battery cell 20 (20A) and the second solar battery cell 20 (20B) adjacent to each other is explained, the same connection is practically repeated, so that plural solar battery cells 20 are serially connected to each other. While the leads are provided separately as the light-receiving surface lead 4 and the rear surface lead 7 in the present embodiment as explained above, the leads can be one continuous lead.

[0029] The light-receiving surface lead 4 is placed to be superimposed on the light-receiving-surface bus electrode 14 and the rear surface lead 7 is placed to be superimposed on the rear-surface bus electrode 15. The light-receiving surface lead 4 and the rear surface lead 7 are then pressed against the solar battery cell 20 partially or over the entire length while being heated. Because the light-

receiving surface lead 4 and the rear surface lead 7 are coated with solder, the solder melts by heating and the leads 4 and 7 are solder-joined to the bus electrodes 14 and 15, respectively, by being pressed in this state. The first solar battery cell 20 (20A) and the second solar battery cell 20 (20B) are then arranged, the extension portion 4a of the light-receiving surface lead 4 of the first solar battery cell 20 (20A) is slipped under the rear surface side of the second solar battery cell 20 (20B) to be superimposed on an end of the rear surface lead 7, and the light-receiving surface lead 4 and the rear surface lead 7 are solder-joined to each other by being pressed while heated. Connection of the light-receiving surface lead 4 and the rear surface lead 7 to the solar battery cell 20 and connection of the light-receiving surface lead 4 to the rear surface lead 7 can be simultaneously performed at the same step.

[0030] The cell array 5 having plural solar battery cells 20 serially connected to each other as explained above is sealed between the front-surface cover material (glass) 3 and the back sheet 10 (the rear-surface cover material) with the resins 8a and 8b, so that the solar battery panel 70 is formed as shown in FIG. 7. The frame member 80 is attached to this solar battery panel 70 as shown in FIG. 1 and output cables (a positive electrode and a negative electrode) (not shown) are connected via a terminal box (not shown) to the solar battery panel 70, thereby configuring the solar battery module 90. The output voltage of the solar battery module 90 is a value corresponding to voltages of the plural solar battery cells 20 serially connected to each other.

[0031] According to the solar battery module with such a

configuration, an electric current per one solar battery cell 20 can be halved by dividing the solar battery cell 20 into two, and thus a resistance loss caused by electrical connection can be reduced. Accordingly, a solar battery module with a higher output than that of a solar battery module that incorporates therein a conventional square solar battery cell which is not divided can be provided.

[0032] Second embodiment.

FIG. 9 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell used for a solar battery module according to a second embodiment of the present invention. FIG. 10 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell. FIG. 11 is a top view of a state in which the solar battery cells are connected according to the second embodiment. FIG. 12 is a schematic diagram of a method of connection in a cell array according to the second embodiment. A solar battery cell 21 according to the present embodiment is produced by dividing a square solar battery cell into two in the direction that the light-receiving-surface bus electrode 14 extends, and the ratio of the short side length S and the long side length L is 1/2:1 as in the first embodiment (FIG. 9).

[0033] The solar battery cell 21 according to the present embodiment, as shown in FIG. 9, has four light-receiving-surface bus electrodes 14 extending parallel to the short side on the light-receiving surface side and each of the light-receiving-surface bus electrodes 14 is joined to the light-receiving surface lead 4. On the rear surface side, a rear-surface bus electrode (a rear-surface lead connection

electrode) 15B made of silver is provided at a position corresponding to the light-receiving-surface bus electrode 14 (at a position where the rear-surface bus electrode 15B overlaps the light-receiving-surface bus electrode 14 in a thickness direction of the substrate 11) in the first direction as the direction that solar battery cells are connected to each other in a dotted manner (in a stepping-stone manner) along the lead in four columns. The rear surface lead 7 is joined to the rear-surface bus electrodes 15B of each column. Plural solar battery cells 21 are sequentially connected in series so that the four light-receiving-surface bus electrodes 14 are connected to the four-column rear-surface bus electrodes 15B with the light-receiving surface lead 4 and the rear surface lead 7 as in the first embodiment.

[0034] As shown in FIGS. 11 and 12, a predetermined number of the solar battery cells 21 are serially connected to each other, thereby forming a first cell string 17 (17A). The solar battery cells 21 of the same number are serially connected to each other, thereby forming a second cell string 17 (17B). An end portion of the first cell string 17 (17A) and an end portion of the second cell string 17 (17B) are joined to each other by a string connector 16, thereby forming a first parallel-connected cell string 18 (18A). Further, the first parallel-connected cell string 18 (18A) and a second parallel-connected cell string 18 (18B) connected as the first parallel-connected cell string 18 (18A) are serially connected to each other by the string connector 16 (FIG. 12). A predetermined number of columns of the column-connected cell strings 18 are serially connected

to each other in the same manner.

[0035] The cell array 5 with the plural solar battery cells 21 being serially connected to each other as explained above is sealed between the front-surface cover material (glass) 3 and the back sheet 10 (the rear-surface cover material) with the resins 8a and 8b as shown in FIG. 7, so that the solar battery panel 70 is formed. The frame member 80 is then attached to this solar battery panel 70 as shown in FIG. 1 and output cables (the positive electrode and the negative electrode) (not shown) are further connected via a terminal box (not shown) to the solar battery panel 70, so that the solar battery module 90 is configured.

[0036] While the first parallel-connected cell string 18 (18A) is serially connected to the second parallel-connected cell string 18 (18B) in FIG. 12, the light-receiving surface lead 4 joined to the light-receiving-surface bus electrode 14 of an end cell (a cell at a position that is the nearest to the string connector 16) of the first parallel-connected cell string 18 (18A) is specifically connected to the string connector 16 and this string connector 16 is connected to the rear surface lead 7 joined to the rear-surface bus electrode 15B of a head cell (a cell at a position that is the nearest to the string connector 16) of the second parallel-connected cell string 18 (18B). That is, because the cell strings 18 need to be connected to each other electrically in series by considering polarities, the first parallel-connected cell string 18 (18A) and the second parallel-connected cell string 18 (18B) electrically differ in their orientations.

[0037] Also the solar battery cell 21 according to the present embodiment can be formed by dividing a cell obtained

by performing predetermined processes upon a substantially-square p-type silicon substrate whose vertical and horizontal sides have the same length into two. Because the area of the cell is halved, a power generation current is halved, and thus an electric current flowing in the leads 4 and 7 is halved as compared to a case of a square cell. Consequently, a resistance loss (W) of the leads 4 and 7 can be reduced to 1/4 according to a relationship W=(electrical resistance of leads 4 and 7)×(flowing current)^2 and thus the output of the solar battery module can be improved.

[0038] When the arrangement (the connection) of cells in a module is considered, with respect to characteristics of a module in a case of serially connecting all halved cells, an electric current is halved and a voltage is doubled as compared to characteristics of a module having the same external dimension in which non-divided cells are all serially connected.

[0039] When assuming that the voltage of one non-divided cell is V, the t thereof is I, and 60 non-divided cells are serially connected to each other, thereby configuring a module, the voltage of the module is 60×V and the electric current thereof is I. On the other hand, the voltage of a halved cell is V and the electric current thereof is 0.5×I. Accordingly, in a module configured by serially connecting 120 halved cells (because the external dimension of the module is the same, the number of halved cells to be used becomes twice), the voltage is 120×V and the electric current is 0.5×I. That is, because electrical output characteristics of modules are different, consideration is required, for example, the arrangement of modules on a roof (the number of

serial/parallel connected modules on a roof) needs to be significantly changed with respect to a method of connecting to an inverter.

[0040] When a parallel-connected cell string having two cell strings each of which is formed by serially connecting a predetermined number of halved cells being connected in parallel to each other is configured and all the parallel-connected cell strings are serially connected to each other as explained above, electrical output characteristics of the resultant module is the voltage of 60×V and the electric current of I, which are equivalent to those of the module having all non-divided cells serially connected to each other. Accordingly, with respect to the method of connecting to an inverter, consideration is not required, for example, arrangement of modules on a roof (the number of serial/parallel connected modules on a roof) does not need to be changed significantly. Further, when a module formed by the conventional non-divided cells is broken in an existing solar power generation system, a module formed by the halved cells can be used as an alternative product because their characteristics are the same.

[0041] As explained above, the resistance loss caused by the leads 4 and 7 is reduced due to the halved current value in the module formed by the halved cells. The above explanations have been made while ignoring the resistance loss for easy understanding.

[0042] Third embodiment.

FIG. 13 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell used for a solar battery module according to a third

embodiment of the present invention. FIG. 14 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell. FIG. 15 is a schematic diagram of a method of connection in a cell array according to the third embodiment.

[0043] A solar battery cell 22 according to the present embodiment is produced by dividing a square solar battery cell into two in the direction that the light-receiving-surface bus electrode 14 extends and the ratio of the short side length S and the long side length L is 1/2:1 as in the first embodiment. The solar battery cell 22 is formed in such a shape that at an end portion on one lateral side, a corner formed between a long side and a short side at each of both ends of the long side is cut by about 45°. Other configurations of the third embodiment are identical to those of the second embodiment. This corner-cut solar battery cell 22 with its corners being cut similarly configures a solar battery module instead of the solar battery cell 21 according to the second embodiment.

[0044] The corner-cut solar battery cell 22 is formed in such a pattern that the light-receiving-surface bus electrode 14 and the rear-surface bus electrode 15B are line-symmetrical with respect to an imaginary central line CL passing through a middle point of the long side and parallel to the short side.

[0045] The halved cells are arranged in a module to match directions of long sides or short sides of the substantial rectangles. At this time, when the light-receiving-surface bus electrode 14 of a certain cell and the rear-surface bus electrode 15B of an adjacent cell are in the same straight

line, these cells can be connected to each other at the shortest distance by the leads 4 and 7 and a connecting operation thereof is easy. In a case of the solar battery cell 22 formed in such a manner that the light-receiving-surface bus electrodes 14 and the rear-surface bus electrodes 15B are line-symmetrical with respect to the imaginary center line CL as explained above, the light-receiving-surface bus electrodes 14 on the light-receiving surface side and the rear-surface bus electrodes 15B are in the same straight lines even when the cell is rotated by 180° or not, and thus the cells can be connected to each other by extending the leads 4 and 7. That is, an operation of matching directions of arranging cells to cause the light-receiving-surface bus electrodes 14 and the rear-surface bus electrodes 15B to be in the same straight lines is not required.

[0046] As shown in FIG. 15, in the cell array 5 according to the present embodiment, when the corner-cut solar battery cells 22 are serially connected to each other, thereby forming the cell strings 17A and 17B, the corner-cut solar battery cells 22 are connected to change orientations of adjacent solar battery cells 22 by 180° (to cause long sides with their corners not being cut to face to each other, for example), thereby configuring the cell array 5.

[0047] Generally, a mono-crystalline silicon substrate often has corners with a corner-cut portion of about 45° because of size restriction of an ingot serving as a material for the substrate. Accordingly, when cells are arranged in a module with the substrate divided into two, the corner-cut portions appear alternatively such as on an upper side, a lower side, ··· of arranged cells. For example, to arrange

cells in such a manner that the corner-cut portions are always on the upper side, a lower-half one of a cell divided into two needs to be arranged after being rotated by 180°. At that time, if the light-receiving-surface bus electrodes 14 and the rear-surface bus electrodes 15B are in the same straight lines even when the lower-half side cell is rotated by 180°, the cells can be serially connected to each other by the leads 4 and 7. This is possible in the solar battery cell 22 according to the present embodiment formed in such a manner that the light-receiving-surface bus electrodes 14 and the rear-surface bus electrodes 15B are line-symmetrical with respect to the imaginary center line CL passing through the middle point of the long sides and parallel to the short sides as mentioned above.

[0048] Fourth embodiment.

When a conventional substantially-square cell is divided into two, thereby forming two substantially-rectangular cells, no light-receiving-surface bus electrode, no grid electrode, and no rear-surface bus electrode are formed in advance in an area with a predetermined width along a line of dividing the original substantially-square cell. That is, an area where these electrodes do not exist is formed at a circumferential edge portion of the halved substantially-rectangular cell.

[0049] According to the solar battery cell produced as explained above, because no electrode is formed at the circumferential edge portion of the halved substantially-rectangular cell, it is possible to suppress a reduction in characteristics of the cell caused by damages of a divided end generated at the time of dividing. Further, by preventing thermal stress at the time of joining leads

(interconnectors) from propagating to the cell end, breakage of cells at the time of modularization can be suppressed. Because the circumferential edge portion of a cell can capture secondary light reflected by a rear-surface cover material of the module, an effect of improving characteristics of the module is also provided.

Industrial Applicability

[0050] As described above, the solar battery module according to the present invention is useful to be applied to a solar battery module, a plurality of which are arranged and installed on a roof or the like in a solar power generation system that converts light energy such as sunlight into electric energy, and particularly is suitable to be applied to a solar battery module that includes a plurality of solar battery cells each having a plurality of light-receiving-surface bus electrodes parallel to a short side of a substantial rectangle on a light receiving surface and having a rear-surface bus electrode at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes.

Reference Signs List

[0051] 3 front-surface cover material (glass)
4 light-receiving surface lead (interconnector)
4a extension portion
5 cell array
7 rear surface lead (interconnector)
8, 8a, 8b resin (sealing material)
9 cell arrangement layer

10 rear-surface cover material

11 p-type silicon substrate

12 rear-surface collecting electrode

13 grid electrode

14 light-receiving-surface bus electrode (light-receiving-surface lead-connection electrode)

15, 15B rear-surface bus electrode (rear-surface lead-connection electrode)

16 string connector

17, 17A, 17B cell string

20, 20A, 20B, 21, 22 solar battery cell

70 solar battery panel

80 frame member

90 solar battery module

DESCRIPTION

SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF

Field

[0001] The present invention relates to a solar battery module, a plurality of which are arranged and installed on a roof or the like in a solar power generation system that converts light energy of the sun and the like into electric energy, and to a manufacturing method thereof.

Background

[0002] Power generation performance of a crystal solar battery module that uses a wafer made of silicon serving as a main material is improved by improvement in performance of a solar battery cell serving as a power generation element.

[0003] However, with improvement in efficiency of a cell, an electric current is increased and a resistance loss at a wiring member (an interconnector) that is mainly made of copper and connects cells to each other at the time of modularization is also increased. Accordingly, performance after modularization is not improved for an amount corresponding to an amount of the improvement in the performance of a cell, but is reduced for an amount of increase in the resistance loss at the interconnector.

[0004] As a remedy for this problem, there has been conventionally proposed a technique of reducing a resistance loss by increasing a cross-sectional area of an interconnector (see Patent Literature 1, for example).

Citation List

Patent Literature

[0005] Patent Literature 1: Japanese Patent Application Laid-open No. H11-251613

Summary

Technical Problem

[0006] However, to increase the cross-sectional area of the interconnector as conventionally proposed, a width or a thickness of the interconnector needs to be increased. If the width is increased, a light-receiving area of a cell is reduced and a power generation amount is also reduced. Accordingly, increasing the thickness is generally conceived. However, by an influence of heat applied when the interconnector is solder-joined to an electrode on a cell, residual stress generated in the cell is increased and thus the probability that the cell is broken is increased and a yield is deteriorated.

[0007] The present invention has been achieved in view of the above problems, and an object of the present invention is to provide a solar battery module that can improve an output without increasing a cross-sectional area of an interconnector, and a manufacturing method thereof.

Solution to Problem

[0008] In order to solve the afore-mentioned problems, a solar battery module according to one aspect of the present invention is constructed in such a manner as to include: a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and a ratio of a short side length

and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and an interconnector that electrically connects the light-receiving-surface bus electrodes of a first one of the solar battery cells to the rear-surface bus electrodes of an adjacent second one of the solar battery cells.

[0009] In order to solve the afore-mentioned problems, a manufacturing method of a solar battery module according to another aspect of the present invention includes the steps of: dividing a basic solar battery cell with a plane shape thereof being a substantial square, which includes n light-receiving-surface electrode areas in each of which a plurality of light-receiving-surface bus electrodes parallel to a side of the substantial square and a plurality of grid electrodes perpendicular to the light-receiving-surface bus electrodes are provided on a light-receiving surface side and includes rear-surface bus electrodes each at a position on a non-light-receiving surface side corresponding to each of the light-receiving-surface bus electrodes, into n along respective boundaries of the n light-receiving-surface electrode areas, thereby obtaining divided solar battery cells, each having a plain of a substantial rectangle with a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or higher than 2); and electrically connecting the light-

receiving-surface bus electrodes of a first one of the divided solar battery cells to the rear-surface bus electrodes of a second adjacent one of the divided solar battery cells by an interconnector.

Advantageous Effects of Invention

[0010] According to the solar battery module of the present invention, because an electric current flowing in the interconnector that serially connects plural cells to each other can be reduced, a resistance loss can be reduced and an output of the solar battery module can be improved. A polycrystalline wafer or a mono-crystalline wafer serving as a substrate of a cell is generally of a square shape, and a cell can be easily obtained by cutting this wafer into half.

[0011] According to the manufacturing method of a solar battery module of the present invention, a first solar battery cell is divided into n along respective boundaries of n light-receiving-surface electrode areas, thereby obtaining a second solar battery cell in which a ratio of a short side length and a long side length of a substantial rectangle is 1/n:1 (n is an integer equal to or larger than 2), and light-receiving bus electrodes of the second solar battery cell are electrically connected to rear-surface bus electrodes of an adjacent solar battery cell by an interconnector. Accordingly, a solar battery module with a resistance loss being reduced can be easily produced.

Brief Description of Drawings

[0012] FIG. 1 is a perspective view of a solar battery module and depicts a state in which a frame member is being

attached to a solar battery panel.

FIG. 2 is a perspective view of a state in which a cell array formed by sequentially connecting a plurality of solar battery cells is sealed with a lead in the solar battery panel.

FIG. 3 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell.

FIG. 4 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell.

FIG. 5 is a perspective view of a state in which the solar battery cells are serially connected to each other, as viewed from above.

FIG. 6 is a perspective view of the state in which the solar battery cells are serially connected to each other, as viewed from below.

FIG. 7 is an exploded perspective view of the solar battery cell and depicts a state in which components are stacked.

FIG. 8 is a cross-sectional view of a connection state of two adjacent solar battery cells.

FIG. 9 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell used for a solar battery module according to a second embodiment of the present invention.

FIG. 10 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell.

FIG. 11 is a top view of a state in which the solar battery cells are connected according to the second embodiment.

FIG. 12 is a schematic diagram of a method of connection in a cell array according to the second embodiment.

FIG. 13 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell used for a solar battery module according to a third embodiment of the present invention.

FIG. 14 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell.

FIG. 15 is a schematic diagram of a method of connection in a cell array according to the third embodiment.

Description of Embodiments

[0013] Exemplary embodiments of a solar battery module and a manufacturing method thereof according to the present invention will be explained below in detail with reference to the accompanying drawings. The present invention is not limited to the embodiments.

[0014] First embodiment.

FIG. 1 is a perspective view of a solar battery module and depicts a state in which a frame member is being attached to a solar battery panel. FIG. 2 is a perspective view of a state in which a cell array formed by sequentially connecting a plurality of solar battery cells is sealed with a lead in the solar battery panel. FIG. 3 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell. FIG. 4 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell. FIG. 5 is a perspective view of a state in which the solar battery cells are serially connected to each other, as viewed from above. FIG. 6 is a perspective view of

the state in which the solar battery cells are serially connected to each other, as viewed from below. FIG. 7 is an exploded perspective view of the solar battery cell and depicts a state in which components are stacked. FIG. 8 is a cross-sectional view of a connection state of two adjacent solar battery cells.

[0015] A solar battery module 90 has a flat-plate-shaped solar battery panel 70 and a frame member 80 that surrounds outer edge of the solar battery panel 70 over the whole circumference thereof (FIG. 1). The solar battery panel 70 is configured by sealing a plurality of solar battery cells 20 arranged vertically and horizontally with a resin, covering a light-receiving-surface side thereof with a front-surface cover material 3 such as glass with translucency, and covering a rear surface side (a non-light-receiving surface side) thereof with a rear-surface cover material 10 (FIGS. 7 and 8).

[0016] The solar battery cells 20 are connected serially to each other in an X direction as a first direction in the drawings with a light-receiving surface lead (an interconnector) 4 and a rear surface lead (an interconnector) 7 (FIGS. 5 to 7). However, at ends of the solar battery panel 70, some solar battery cells are connected to each other in a Y direction. As the light-receiving surface lead 4 and the rear surface lead 7, band-shaped copper foil to which solder is supplied (coated or applied), generally called a tab line is used. A cell array 5 formed by sequentially connecting the solar battery cells 20 with the leads 4 and 7 is sealed within the solar battery panel 70 with a resin 8 (FIG. 2).

[0017] The frame member 80 is produced by extrusion molding of aluminum or the like and covers the outer edge of the solar battery panel 70 over the whole circumference with a U-shaped portion having a U-shaped cross section (FIG. 1). The frame member 80 is fixed via a butyl sealing material or a silicon adhesive to the solar battery panel 70 to reinforce the solar battery panel 70 and serves to attach the solar battery panel 70 to a stand provided on a construction such as a residence or a building, the ground, or a structure.

[0018] The solar battery panel 70 is configured by stacking the translucent front-surface cover material (glass) 3, a cell arrangement layer 9 in which the solar battery cells 20, and the light-receiving surface lead 4 and the rear surface lead 7 serially connecting the solar battery cells 20 to each other are sealed by the resin 8 (8a, 8b) such as EVA (ethylene vinyl acetate), and a back sheet 10 (the rear-surface cover material) that is made of PET (polyethylene terephthalate), PVF (polyvinyl fluoride), or the like and has excellent weather resistance in this order from the light-receiving surface side (FIGS. 7 and 8).

[0019] As shown in FIGS. 3 and 4, the solar battery cell 20 according to the present embodiment has a substantially-rectangular plane shape and a ratio of a short side length S and a long side length L of the rectangular is 1/2:1. A conventional solar battery cell is generally a 156 mm × 156 mm square or a 125 mm × 125 mm square. However, because the solar battery cell 20 according to the present embodiment is produced by dividing a solar battery cell produced in a square of the dimension mentioned above into two in the first direction at the time of connection (the direction in which a

light-receiving-surface bus electrode (a light-receiving-surface lead-connection electrode) 14 extends), the solar battery cell 20 has the shape as mentioned above.

[0020] The solar battery cell 20 is configured as follows by using p-type silicon having a thickness of about 150 to 300 micrometers as a substrate. An n-type diffusion layer (an impurity-layer diffusion layer, not shown) is formed by phosphorous diffusion on a front surface side of a p-type silicon substrate 11 serving as a p-type layer. An antireflection film 11a (FIG. 3) made of a silicon nitride film for preventing reflection of incident light to improve a conversion efficiency is further provided by surface treatment, so that a light-receiving surface of the solar battery cell 20 is provided. On a rear-surface side of the p-type silicon substrate (hereinafter, simply "substrate") 11, a p+ layer (not shown) containing high-density impurities is formed and a rear-surface collecting electrode 12 made of aluminum is further provided over a substantially entire rear surface to reflect the incident light and extract electric power.

[0021] A grid electrode 13 that is a thin electrode made of silver and the light-receiving-surface bus electrode (the light-receiving-surface lead-connection electrode) 14 that is made of silver as the grid electrode 13 and has a predetermined width are formed on the light receiving surface of the substrate 11 as a light-receiving-surface side electrode that extracts electric energy converted from the incident light, and these electrodes are electrically connected to the n-type diffusion layer at bottom surfaces thereof. Two light-receiving-surface bus electrodes 14 are

formed in parallel along the first direction as the direction of connecting the solar battery cells 20. A large number of the grid electrodes 13 are formed thin in a direction perpendicular to the light-receiving-surface bus electrode 14. The grid electrode 13 is formed as thin as possible and to be all over the light-receiving surface (the front surface) to extract electric power generated at the light receiving surface with no waste. When sunlight hits the solar battery cell 20, the light-receiving-surface side shown in FIG. 3 becomes a negative (-) electrode and the rear-surface side shown in FIG. 4 becomes a positive (+) electrode. The light-receiving-surface bus electrode 14 is provided so that the light-receiving surface lead 4 is connected thereto for further externally extracting electric energy collected by the grid electrode 13 (FIG. 3). While the light-receiving-surface bus electrode 14 is shown as being narrower than the light-receiving surface lead 4 in FIGS. 3 and 5, this is for showing a state in which the light-receiving-surface bus electrode 14 overlaps the light-receiving surface lead 4 to be easily understood and the light-receiving-surface bus electrode 14 and the light-receiving surface lead 4 practically have the same width.

[0022] Meanwhile, the rear-surface collecting electrode 12 made of aluminum is provided on the rear surface of the substrate 11 to cover the substantially entire rear surface. A rear-surface bus electrode (a rear-surface lead-connection electrode) 15 made of silver is formed at a position on the rear surface of the substrate 11 corresponding to the grid electrode 13 (at a position where the rear-surface bus electrode 15 overlaps the grid electrode 13 in a thickness

direction of the substrate 11) to extend in the first direction as the direction of connecting the solar battery cells 20. The rear-surface bus electrode 15 is provided so that the rear surface lead 7 is connected thereto for further externally extracting electric energy collected by the rear-surface collecting electrode 12 (FIG. 4). While the rear-surface bus electrode 15 is shown as being wider than the rear surface lead 7 in FIGS. 4 and 6, this is for showing a state in which the rear-surface bus electrode 15 overlaps the rear surface lead 7 and the rear-surface bus electrode 15 and the rear surface lead 7 practically have the same width.

[0023] The rear surface of the substrate 11 can be covered by a silver electrode over its entire surface. However, because costs are increased, the rear-surface bus electrode 15 made of silver is particularly provided only at a position where the rear surface lead 7 is connected as explained above. In addition to the rear-surface bus electrode 15 formed in a line shape as in the present embodiment, the rear-surface bus electrode 15 can be provided discretely in a dotted manner (in a stepping-stone manner). According to the present embodiment, before the solar battery cells produced in a square as explained above are connected one another with the light-receiving surface lead 4 and the rear surface lead 7, each of the solar battery cells is divided into two in the direction in which the light-receiving-surface bus electrode 14 extends, so that the rectangular solar battery cell 20 with the ratio of the short side length S and the long side length L being 1/2:1 is obtained.

[0024] To obtain the divided solar battery cell 20, predetermined processes are first performed to form the

light-receiving-surface bus electrode 14, the grid electrode 13, the rear-surface collecting electrode 12, and the rear-surface bus electrode 15 on the square substrate 11, thereby producing a solar battery cell (a first solar battery cell) serving as a base. At this time, a light-receiving-surface electrode area and a rear-surface electrode area where the electrodes are formed, respectively, are each formed into two areas in a divided manner along a division line. By cutting the solar battery cell along the division line, the rectangular solar battery cell 20 as mentioned above is obtained. While the solar battery cell 20 according to the present embodiment is obtained by dividing the solar battery cell produced in a square into two, the solar battery cell can be divided into a larger number (n) such as three or four. When the solar battery cell 20 is divided into n, the light-receiving-surface electrode area and the rear-surface electrode area are formed into n areas in advance in a divided manner.

[0025] In the solar battery cell 20 with such a configuration, when sunlight is irradiated from the light-receiving surface side (the antireflection film side) of the solar battery cell 20 to reach an internal pn junction surface (a junction surface of the p-type layer and the n-type diffusion layer), holes and electrons coalesced on the pn junction surface are separated from each other. The separated electrons move toward the n-type diffusion layer. Meanwhile, the separated holes move toward the p+ layer. Accooirdingly, a potential difference is generated between the n-type diffusion layer and the p+ layer so that a potential of the p+ layer is higher. Consequently, a front-

surface electrode connected to the n-type diffusion layer becomes a negative electrode and a rear-surface electrode connected to the p+ layer becomes a positive electrode. When an external circuit (not shown) is connected to this solar battery cell 20, an electric current flows therein and the solar battery cell 20 performs an operation as a solar battery. While an output voltage of one solar battery cell is small, plural solar battery cells 20 are connected in series or in parallel to each other in the solar battery module 90, so that the output voltage is increased to a usable voltage.

[0026] Serial connection of the solar battery cells 20 is achieved by, in plural solar battery cells arranged in the first direction, electrically connecting the light-receiving-surface bus electrode 14 of a first solar battery cell 20 (20A) to the rear-surface bus electrode 15 of a second solar battery cell 20 (20B) adjacent to the first solar battery cell 20 (20A) with the band-shaped leads 4 and 7 (FIGS. 5 to 8).

[0027] According to the present embodiment, the leads 4 and 7 are provided separately as the light-receiving surface lead 4 and the rear surface lead 7, respectively. Among the leads, the light-receiving surface lead 4 extends on the light-receiving-surface bus electrode 14 to be solder-joined (mechanically and electrically connected) to the light-receiving-surface bus electrode 14. The light-receiving surface lead 4 has an extended portion 4a formed to be longer than the solar battery cell 20. When the light-receiving surface lead 4 is solder-joined to the light-receiving-surface bus electrode 14, the extended portion 4a protrudes

toward one end side (FIGS. 3, 5, and 9).

[0028] The rear surface lead 7 extends on the rear-surface bus electrode 15 to be solder-joined (mechanically and electrically connected) to the rear-surface bus electrode 15. To serially connect the first solar battery cell 20 (20A) to the second solar battery cell 20 (20B), the light-receiving surface lead 4 of the first solar battery cell 20 (20A) is solder-joined to the rear surface lead 7 of the second solar battery cell 20 (20B). That is, the extended portion 4a of the light-receiving surface lead 4 of the first solar battery cell 20 (20A) is slipped under the rear surface side of the adjacent second solar battery cell 20 (20B) to be solder-joined to the rear surface lead 7 solder-joined to the rear-surface bus electrode 15. While only connection of the first solar battery cell 20 (20A) and the second solar battery cell 20 (20B) adjacent to each other is explained, the same connection is practically repeated, so that plural solar battery cells 20 are serially connected to each other. While the leads are provided separately as the light-receiving surface lead 4 and the rear surface lead 7 in the present embodiment as explained above, the leads can be one continuous lead.

[0029] The light-receiving surface lead 4 is placed to be superimposed on the light-receiving-surface bus electrode 14 and the rear surface lead 7 is placed to be superimposed on the rear-surface bus electrode 15. The light-receiving surface lead 4 and the rear surface lead 7 are then pressed against the solar battery cell 20 partially or over the entire length while being heated. Because the light-receiving surface lead 4 and the rear surface lead 7 are

coated with solder, the solder melts by heating and the leads 4 and 7 are solder-joined to the bus electrodes 14 and 15, respectively, by being pressed in this state. The first solar battery cell 20 (20A) and the second solar battery cell 20 (20B) are then arranged, the extension portion 4a of the light-receiving surface lead 4 of the first solar battery cell 20 (20A) is slipped under the rear surface side of the second solar battery cell 20 (20B) to be superimposed on an end of the rear surface lead 7, and the light-receiving surface lead 4 and the rear surface lead 7 are solder-joined to each other by being pressed while heated. Connection of the light-receiving surface lead 4 and the rear surface lead 7 to the solar battery cell 20 and connection of the light-receiving surface lead 4 to the rear surface lead 7 can be simultaneously performed at the same step.

[0030] The cell array 5 having plural solar battery cells 20 serially connected to each other as explained above is sealed between the front-surface cover material (glass) 3 and the back sheet 10 (the rear-surface cover material) with the resins 8a and 8b, so that the solar battery panel 70 is formed as shown in FIG. 7. The frame member 80 is attached to this solar battery panel 70 as shown in FIG. 1 and output cables (a positive electrode and a negative electrode) (not shown) are connected via a terminal box (not shown) to the solar battery panel 70, thereby configuring the solar battery module 90. The output voltage of the solar battery module 90 is a value corresponding to voltages of the plural solar battery cells 20 serially connected to each other.

[0031] According to the solar battery module with such a configuration, an electric current per one solar battery cell

20 can be halved by dividing the solar battery cell 20 into two, and thus a resistance loss caused by electrical connection can be reduced. Accordingly, a solar battery module with a higher output than that of a solar battery module that incorporates therein a conventional square solar battery cell which is not divided can be provided.

[0032] Second embodiment.

FIG. 9 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell used for a solar battery module according to a second embodiment of the present invention. FIG. 10 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell. FIG. 11 is a top view of a state in which the solar battery cells are connected according to the second embodiment. FIG. 12 is a schematic diagram of a method of connection in a cell array according to the second embodiment. A solar battery cell 21 according to the present embodiment is produced by dividing a square solar battery cell into two in the direction that the light-receiving-surface bus electrode 14 extends, and the ratio of the short side length S and the long side length L is 1/2:1 as in the first embodiment (FIG. 9).

[0033] The solar battery cell 21 according to the present embodiment, as shown in FIG. 9, has four light-receiving-surface bus electrodes 14 extending parallel to the short side on the light-receiving surface side and each of the light-receiving-surface bus electrodes 14 is joined to the light-receiving surface lead 4. On the rear surface side, a rear-surface bus electrode (a rear-surface lead connection electrode) 15B made of silver is provided at a position

corresponding to the light-receiving-surface bus electrode 14 (at a position where the rear-surface bus electrode 15B overlaps the light-receiving-surface bus electrode 14 in a thickness direction of the substrate 11) in the first direction as the direction that solar battery cells are connected to each other in a dotted manner (in a stepping-stone manner) along the lead in four columns. The rear surface lead 7 is joined to the rear-surface bus electrodes 15B of each column. Plural solar battery cells 21 are sequentially connected in series so that the four light-receiving-surface bus electrodes 14 are connected to the four-column rear-surface bus electrodes 15B with the light-receiving surface lead 4 and the rear surface lead 7 as in the first embodiment.

[0034] As shown in FIGS. 11 and 12, a predetermined number of the solar battery cells 21 are serially connected to each other, thereby forming a first cell string 17 (17A). The solar battery cells 21 of the same number are serially connected to each other, thereby forming a second cell string 17 (17B). An end portion of the first cell string 17 (17A) and an end portion of the second cell string 17 (17B) are joined to each other by a string connector 16, thereby forming a first parallel-connected cell string 18 (18A). Further, the first parallel-connected cell string 18 (18A) and a second parallel-connected cell string 18 (18B) connected as the first parallel-connected cell string 18 (18A) are serially connected to each other by the string connector 16 (FIG. 12). A predetermined number of columns of the column-connected cell strings 18 are serially connected to each other in the same manner.

[0035] The cell array 5 with the plural solar battery cells 21 being serially connected to each other as explained above is sealed between the front-surface cover material (glass) 3 and the back sheet 10 (the rear-surface cover material) with the resins 8a and 8b as shown in FIG. 7, so that the solar battery panel 70 is formed. The frame member 80 is then attached to this solar battery panel 70 as shown in FIG. 1 and output cables (the positive electrode and the negative electrode) (not shown) are further connected via a terminal box (not shown) to the solar battery panel 70, so that the solar battery module 90 is configured.

[0036] While the first parallel-connected cell string 18 (18A) is serially connected to the second parallel-connected cell string 18 (18B) in FIG. 12, the light-receiving surface lead 4 joined to the light-receiving-surface bus electrode 14 of an end cell (a cell at a position that is the nearest to the string connector 16) of the first parallel-connected cell string 18 (18A) is specifically connected to the string connector 16 and this string connector 16 is connected to the rear surface lead 7 joined to the rear-surface bus electrode 15B of a head cell (a cell at a position that is the nearest to the string connector 16) of the second parallel-connected cell string 18 (18B). That is, because the cell strings 18 need to be connected to each other electrically in series by considering polarities, the first parallel-connected cell string 18 (18A) and the second parallel-connected cell string 18 (18B) electrically differ in their orientations.

[0037] Also the solar battery cell 21 according to the present embodiment can be formed by dividing a cell obtained by performing predetermined processes upon a substantially-

square p-type silicon substrate whose vertical and horizontal sides have the same length into two. Because the area of the cell is halved, a power generation current is halved, and thus an electric current flowing in the leads 4 and 7 is halved as compared to a case of a square cell. Consequently, a resistance loss (W) of the leads 4 and 7 can be reduced to 1/4 according to a relationship W=(electrical resistance of leads 4 and 7)×(flowing current)^2 and thus the output of the solar battery module can be improved.

[0038] When the arrangement (the connection) of cells in a module is considered, with respect to characteristics of a module in a case of serially connecting all halved cells, an electric current is halved and a voltage is doubled as compared to characteristics of a module having the same external dimension in which non-divided cells are all serially connected.

[0039] When assuming that the voltage of one non-divided cell is V, the t thereof is I, and 60 non-divided cells are serially connected to each other, thereby configuring a module, the voltage of the module is 60×V and the electric current thereof is I. On the other hand, the voltage of a halved cell is V and the electric current thereof is 0.5×I. Accordingly, in a module configured by serially connecting 120 halved cells (because the external dimension of the module is the same, the number of halved cells to be used becomes twice), the voltage is 120×V and the electric current is 0.5×I. That is, because electrical output characteristics of modules are different, consideration is required, for example, the arrangement of modules on a roof (the number of serial/parallel connected modules on a roof) needs to be

significantly changed with respect to a method of connecting to an inverter.

[0040] When a parallel-connected cell string having two cell strings each of which is formed by serially connecting a predetermined number of halved cells being connected in parallel to each other is configured and all the parallel-connected cell strings are serially connected to each other as explained above, electrical output characteristics of the resultant module is the voltage of 60×V and the electric current of I, which are equivalent to those of the module having all non-divided cells serially connected to each other. Accordingly, with respect to the method of connecting to an inverter, consideration is not required, for example, arrangement of modules on a roof (the number of serial/parallel connected modules on a roof) does not need to be changed significantly. Further, when a module formed by the conventional non-divided cells is broken in an existing solar power generation system, a module formed by the halved cells can be used as an alternative product because their characteristics are the same.

[0041] As explained above, the resistance loss caused by the leads 4 and 7 is reduced due to the halved current value in the module formed by the halved cells. The above explanations have been made while ignoring the resistance loss for easy understanding.

[0042] Third embodiment.

FIG. 13 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell used for a solar battery module according to a third embodiment of the present invention. FIG. 14 is a rear view

of a state in which a rear-surface bus electrode is joined to the solar battery cell. FIG. 15 is a schematic diagram of a method of connection in a cell array according to the third embodiment.

[0043] A solar battery cell 22 according to the present embodiment is produced by dividing a square solar battery cell into two in the direction that the light-receiving-surface bus electrode 14 extends and the ratio of the short side length S and the long side length L is 1/2:1 as in the first embodiment. The solar battery cell 22 is formed in such a shape that at an end portion on one lateral side, a corner formed between a long side and a short side at each of both ends of the long side is cut by about 45°. Other configurations of the third embodiment are identical to those of the second embodiment. This corner-cut solar battery cell 22 with its corners being cut similarly configures a solar battery module instead of the solar battery cell 21 according to the second embodiment.

[0044] The corner-cut solar battery cell 22 is formed in such a pattern that the light-receiving-surface bus electrode 14 and the rear-surface bus electrode 15B are line-symmetrical with respect to an imaginary central line CL passing through a middle point of the long side and parallel to the short side.

[0045] The halved cells are arranged in a module to match directions of long sides or short sides of the substantial rectangles. At this time, when the light-receiving-surface bus electrode 14 of a certain cell and the rear-surface bus electrode 15B of an adjacent cell are in the same straight line, these cells can be connected to each other at the

shortest distance by the leads 4 and 7 and a connecting operation thereof is easy. In a case of the solar battery cell 22 formed in such a manner that the light-receiving-surface bus electrodes 14 and the rear-surface bus electrodes 15B are line-symmetrical with respect to the imaginary center line CL as explained above, the light-receiving-surface bus electrodes 14 on the light-receiving surface side and the rear-surface bus electrodes 15B are in the same straight lines even when the cell is rotated by 180° or not, and thus the cells can be connected to each other by extending the leads 4 and 7. That is, an operation of matching directions of arranging cells to cause the light-receiving-surface bus electrodes 14 and the rear-surface bus electrodes 15B to be in the same straight lines is not required.

[0046] As shown in FIG. 15, in the cell array 5 according to the present embodiment, when the corner-cut solar battery cells 22 are serially connected to each other, thereby forming the cell strings 17A and 17B, the corner-cut solar battery cells 22 are connected to change orientations of adjacent solar battery cells 22 by 180° (to cause long sides with their corners not being cut to face to each other, for example), thereby configuring the cell array 5.

[0047] Generally, a mono-crystalline silicon substrate often has corners with a corner-cut portion of about 45° because of size restriction of an ingot serving as a material for the substrate. Accordingly, when cells are arranged in a module with the substrate divided into two, the corner-cut portions appear alternatively such as on an upper side, a lower side, ··· of arranged cells. For example, to arrange cells in such a manner that the corner-cut portions are

always on the upper side, a lower-half one of a cell divided into two needs to be arranged after being rotated by 180°. At that time, if the light-receiving-surface bus electrodes 14 and the rear-surface bus electrodes 15B are in the same straight lines even when the lower-half side cell is rotated by 180°, the cells can be serially connected to each other by the leads 4 and 7. This is possible in the solar battery cell 22 according to the present embodiment formed in such a manner that the light-receiving-surface bus electrodes 14 and the rear-surface bus electrodes 15B are line-symmetrical with respect to the imaginary center line CL passing through the middle point of the long sides and parallel to the short sides as mentioned above.

[0048] Fourth embodiment.

When a conventional substantially-square cell is divided into two, thereby forming two substantially-rectangular cells, no light-receiving-surface bus electrode, no grid electrode, and no rear-surface bus electrode are formed in advance in an area with a predetermined width along a line of dividing the original substantially-square cell. That is, an area where these electrodes do not exist is formed at a circumferential edge portion of the halved substantially-rectangular cell.

[0049] According to the solar battery cell produced as explained above, because no electrode is formed at the circumferential edge portion of the halved substantially-rectangular cell, it is possible to suppress a reduction in characteristics of the cell caused by damages of a divided end generated at the time of dividing. Further, by preventing thermal stress at the time of joining leads (interconnectors) from propagating to the cell end, breakage

of cells at the time of modularization can be suppressed. Because the circumferential edge portion of a cell can capture secondary light reflected by a rear-surface cover material of the module, an effect of improving characteristics of the module is also provided.

Industrial Applicability

[0050] As described above, the solar battery module according to the present invention is useful to be applied to a solar battery module, a plurality of which are arranged and installed on a roof or the like in a solar power generation system that converts light energy such as sunlight into electric energy, and particularly is suitable to be applied to a solar battery module that includes a plurality of solar battery cells each having a plurality of light-receiving-surface bus electrodes parallel to a short side of a substantial rectangle on a light receiving surface and having a rear-surface bus electrode at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes.

Reference Signs List

[0051] 3 front-surface cover material (glass)
4 light-receiving surface lead (interconnector)
4a extension portion
5 cell array
7 rear surface lead (interconnector)
8, 8a, 8b resin (sealing material)
9 cell arrangement layer
10 rear-surface cover material

11 p-type silicon substrate

12 rear-surface collecting electrode

13 grid electrode

14 light-receiving-surface bus electrode (light-receiving-surface lead-connection electrode)

15, 15B rear-surface bus electrode (rear-surface lead-connection electrode)

16 string connector

17, 17A, 17B cell string

20, 20A, 20B, 21, 22 solar battery cell

70 solar battery panel

80 frame member

90 solar battery module

APPLICATION DATA SHEET

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Applicant Information

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Representative Information

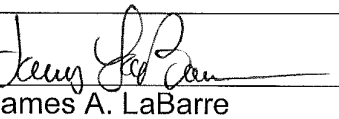
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DESCRIPTION

SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF

Field

[0001] The present invention relates to a solar battery module, a plurality of which are arranged and installed on a roof or the like in a solar power generation system that converts light energy of the sun and the like into electric energy, and to a manufacturing method thereof.

Background

[0002] Power generation performance of a crystal solar battery module that uses a wafer made of silicon serving as a main material is improved by improvement in performance of a solar battery cell serving as a power generation element.

[0003] However, with improvement in efficiency of a cell, an electric current is increased and a resistance loss at a wiring member (an interconnector) that is mainly made of copper and connects cells to each other at the time of modularization is also increased. Accordingly, performance after modularization is not improved for an amount corresponding to an amount of the improvement in the performance of a cell, but is reduced for an amount of increase in the resistance loss at the interconnector.

[0004] As a remedy for this problem, there has been conventionally proposed a technique of reducing a resistance loss by increasing a cross-sectional area of an interconnector (see Patent Literature 1, for example).

Citation List

Patent Literature

[0005] Patent Literature 1: Japanese Patent Application Laid-open No. H11-251613

Summary

Technical Problem

[0006] However, to increase the cross-sectional area of the interconnector as conventionally proposed, a width or a thickness of the interconnector needs to be increased. If the width is increased, a light-receiving area of a cell is reduced and a power generation amount is also reduced. Accordingly, increasing the thickness is generally conceived. However, by an influence of heat applied when the interconnector is solder-joined to an electrode on a cell, residual stress generated in the cell is increased and thus the probability that the cell is broken is increased and a yield is deteriorated.

[0007] The present invention has been achieved in view of the above problems, and an object of the present invention is to provide a solar battery module that can improve an output without increasing a cross-sectional area of an interconnector, and a manufacturing method thereof.

Solution to Problem

[0008] In order to solve the afore-mentioned problems, a solar battery module according to one aspect of the present invention is constructed in such a manner as to include: a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-

surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and an interconnector that electrically connects the light-receiving-surface bus electrodes of a first one of the solar battery cells to the rear-surface bus electrodes of an adjacent second one of the solar battery cells.

[0009] In order to solve the afore-mentioned problems, a manufacturing method of a solar battery module according to another aspect of the present invention includes the steps of: dividing a basic solar battery cell with a plane shape thereof being a substantial square, which includes n light-receiving-surface electrode areas in each of which a plurality of light-receiving-surface bus electrodes parallel to a side of the substantial square and a plurality of grid electrodes perpendicular to the light-receiving-surface bus electrodes are provided on a light-receiving surface side and includes rear-surface bus electrodes each at a position on a non-light-receiving surface side corresponding to each of the light-receiving-surface bus electrodes, into n along respective boundaries of the n light-receiving-surface electrode areas, thereby obtaining divided solar battery cells, each having a plain of a substantial rectangle with a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or higher than 2); and electrically connecting the light-receiving-surface bus electrodes of a first one of the divided solar battery cells to the rear-surface bus electrodes of a second adjacent one of the divided solar battery cells by an interconnector.

Advantageous Effects of Invention

[0010] According to the solar battery module of the present invention, because an electric current flowing in the interconnector that serially connects plural cells to each other can be reduced, a resistance loss can be reduced and an output of the solar battery module can be improved. A polycrystalline wafer or a mono-crystalline wafer serving as a substrate of a cell is generally of a square shape, and a cell can be easily obtained by cutting this wafer into half.

[0011] According to the manufacturing method of a solar battery module of the present invention, a first solar battery cell is divided into n along respective boundaries of n light-receiving-surface electrode areas, thereby obtaining a second solar battery cell in which a ratio of a short side length and a long side length of a substantial rectangle is 1/n:1 (n is an integer equal to or larger than 2), and light-receiving bus electrodes of the second solar battery cell are electrically connected to rear-surface bus electrodes of an adjacent solar battery cell by an interconnector. Accordingly, a solar battery module with a resistance loss being reduced can be easily produced.

Brief Description of Drawings

[0012] FIG. 1 is a perspective view of a solar battery module and depicts a state in which a frame member is being attached to a solar battery panel.

FIG. 2 is a perspective view of a state in which a cell array formed by sequentially connecting a plurality of solar battery cells is sealed with a lead in the solar battery panel.

FIG. 3 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell.

FIG. 4 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell.

FIG. 5 is a perspective view of a state in which the solar battery cells are serially connected to each other, as viewed from above.

FIG. 6 is a perspective view of the state in which the solar battery cells are serially connected to each other, as viewed from below.

FIG. 7 is an exploded perspective view of the solar battery cell and depicts a state in which components are stacked.

FIG. 8 is a cross-sectional view of a connection state of two adjacent solar battery cells.

FIG. 9 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell used for a solar battery module according to a second embodiment of the present invention.

FIG. 10 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell.

FIG. 11 is a top view of a state in which the solar battery cells are connected according to the second embodiment.

FIG. 12 is a schematic diagram of a method of connection in a cell array according to the second embodiment.

FIG. 13 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell used for a solar battery module according to a third embodiment of the present invention.

FIG. 14 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell.

FIG. 15 is a schematic diagram of a method of connection in a cell array according to the third

embodiment.

Description of Embodiments

[0013] Exemplary embodiments of a solar battery module and a manufacturing method thereof according to the present invention will be explained below in detail with reference to the accompanying drawings. The present invention is not limited to the embodiments.

[0014] First embodiment.

FIG. 1 is a perspective view of a solar battery module and depicts a state in which a frame member is being attached to a solar battery panel. FIG. 2 is a perspective view of a state in which a cell array formed by sequentially connecting a plurality of solar battery cells is sealed with a lead in the solar battery panel. FIG. 3 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell. FIG. 4 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell. FIG. 5 is a perspective view of a state in which the solar battery cells are serially connected to each other, as viewed from above. FIG. 6 is a perspective view of the state in which the solar battery cells are serially connected to each other, as viewed from below. FIG. 7 is an exploded perspective view of the solar battery cell and depicts a state in which components are stacked. FIG. 8 is a cross-sectional view of a connection state of two adjacent solar battery cells.

[0015] A solar battery module 90 has a flat-plate-shaped solar battery panel 70 and a frame member 80 that surrounds outer edge of the solar battery panel 70 over the whole circumference thereof (FIG. 1). The solar battery panel 70 is configured by sealing a plurality of solar battery cells

20 arranged vertically and horizontally with a resin, covering a light-receiving-surface side thereof with a front-surface cover material 3 such as glass with translucency, and covering a rear surface side (a non-light-receiving surface side) thereof with a rear-surface cover material 10 (FIGS. 7 and 8).

[0016] The solar battery cells 20 are connected serially to each other in an X direction as a first direction in the drawings with a light-receiving surface lead (an interconnector) 4 and a rear surface lead (an interconnector) 7 (FIGS. 5 to 7). However, at ends of the solar battery panel 70, some solar battery cells are connected to each other in a Y direction. As the light-receiving surface lead 4 and the rear surface lead 7, band-shaped copper foil to which solder is supplied (coated or applied), generally called a tab line is used. A cell array 5 formed by sequentially connecting the solar battery cells 20 with the leads 4 and 7 is sealed within the solar battery panel 70 with a resin 8 (FIG. 2).

[0017] The frame member 80 is produced by extrusion molding of aluminum or the like and covers the outer edge of the solar battery panel 70 over the whole circumference with a U-shaped portion having a U-shaped cross section (FIG. 1). The frame member 80 is fixed via a butyl sealing material or a silicon adhesive to the solar battery panel 20 to reinforce the solar battery panel 20 and serves to attach the solar battery panel 20 to a stand provided on a construction such as a residence or a building, the ground, or a structure.

[0018] The solar battery panel 70 is configured by stacking the translucent front-surface cover material (glass) 3, a cell arrangement layer 9 in which the solar battery cells 20, and the light-receiving surface lead 4

and the rear surface lead 7 serially connecting the solar battery cells 20 to each other are sealed by the resin 8 (8a, 8b) such as EVA (ethylene vinyl acetate), and a back sheet 10 (the rear-surface cover material) that is made of PET (polyethylene terephthalate), PVF (polyvinyl fluoride), or the like and has excellent weather resistance in this order from the light-receiving surface side (FIGS. 7 and 8).

[0019] As shown in FIGS. 3 and 4, the solar battery cell 20 according to the present embodiment has a substantially-rectangular plane shape and a ratio of a short side length S and a long side length L of the rectangular is 1/2:1. A conventional solar battery cell is generally a 156 mm × 156 mm square or a 125 mm × 125 mm square. However, because the solar battery cell 20 according to the present embodiment is produced by dividing a solar battery cell produced in a square of the dimension mentioned above into two in the first direction at the time of connection (the direction in which a light-receiving-surface bus electrode (a light-receiving-surface lead-connection electrode) 14 extends), the solar battery cell 20 has the shape as mentioned above.

[0020] The solar battery cell 20 is configured as follows by using p-type silicon having a thickness of about 150 to 300 micrometers as a substrate. An n-type diffusion layer (an impurity-layer diffusion layer, not shown) is formed by phosphorous diffusion on a front surface side of a p-type silicon substrate 11 serving as a p-type layer. An antireflection film 11a (FIG. 3) made of a silicon nitride film for preventing reflection of incident light to improve a conversion efficiency is further provided by surface treatment, so that a light-receiving surface of the solar battery cell 20 is provided. On a rear-surface side of the p-type silicon substrate (hereinafter, simply

"substrate") 11, a p+ layer (not shown) containing high-density impurities is formed and a rear-surface collecting electrode 12 made of aluminum is further provided over a substantially entire rear surface to reflect the incident light and extract electric power.

[0021] A grid electrode 13 that is a thin electrode made of silver and the light-receiving-surface bus electrode (the light-receiving-surface lead-connection electrode) 14 that is made of silver as the grid electrode 13 and has a predetermined width are formed on the light receiving surface of the substrate 11 as a light-receiving-surface side electrode that extracts electric energy converted from the incident light, and these electrodes are electrically connected to the n-type diffusion layer at bottom surfaces thereof. Two light-receiving-surface bus electrodes 14 are formed in parallel along the first direction as the direction of connecting the solar battery cells 20. A large number of the grid electrodes 13 are formed thin in a direction perpendicular to the light-receiving-surface bus electrode 14. The grid electrode 13 is formed as thin as possible and to be all over the light-receiving surface (the front surface) to extract electric power generated at the light receiving surface with no waste. When sunlight hits the solar battery cell 20, the light-receiving-surface side shown in FIG. 3 becomes a negative (-) electrode and the rear-surface side shown in FIG. 4 becomes a positive (+) electrode. The light-receiving-surface bus electrode 14 is provided so that the light-receiving surface lead 4 is connected thereto for further externally extracting electric energy collected by the grid electrode 13 (FIG. 3). While the light-receiving-surface bus electrode 14 is shown as being narrower than the light-receiving surface lead 4 in FIGS. 3 and 5, this is for showing a state in which the

light-receiving-surface bus electrode 14 overlaps the light-receiving surface lead 4 to be easily understood and the light-receiving-surface bus electrode 14 and the light-receiving surface lead 4 practically have the same width.

[0022] Meanwhile, the rear-surface collecting electrode 12 made of aluminum is provided on the rear surface of the substrate 11 to cover the substantially entire rear surface. A rear-surface bus electrode (a rear-surface lead-connection electrode) 15 made of silver is formed at a position on the rear surface of the substrate 11 corresponding to the grid electrode 13 (at a position where the rear-surface bus electrode 15 overlaps the grid electrode 13 in a thickness direction of the substrate 11) to extend in the first direction as the direction of connecting the solar battery cells 20. The rear-surface bus electrode 15 is provided so that the rear surface lead 7 is connected thereto for further externally extracting electric energy collected by the rear-surface collecting electrode 12 (FIG. 4). While the rear-surface bus electrode 15 is shown as being wider than the rear surface lead 7 in FIGS. 4 and 6, this is for showing a state in which the rear-surface bus electrode 15 overlaps the rear surface lead 7 and the rear-surface bus electrode 15 and the rear surface lead 7 practically have the same width.

[0023] The rear surface of the substrate 11 can be covered by a silver electrode over its front surface. However, because costs are increased, the rear-surface bus electrode 15 made of silver is particularly provided only at a position where the rear surface lead 7 is connected as explained above. In addition to the rear-surface bus electrode 15 formed in a line shape as in the present embodiment, the rear-surface bus electrode 15 can be provided discretely in a dotted manner (in a stepping-stone

manner). According to the present embodiment, before the solar battery cells produced in a square as explained above are connected one another with the light-receiving surface lead 4 and the rear surface lead 7, each of the solar battery cells is divided into two in the direction in which the light-receiving-surface bus electrode 14 extends, so that the rectangular solar battery cell 20 with the ratio of the short side length S and the long side length L being 1/2:1 is obtained.

[0024] To obtain the divided solar battery cell 20, predetermined processes are first performed to form the light-receiving-surface bus electrode 14, the grid electrode 13, the rear-surface collecting electrode 12, and the rear-surface bus electrode 15 on the square substrate 11, thereby producing a solar battery cell (a first solar battery cell) serving as a base. At this time, a light-receiving-surface electrode area and a rear-surface electrode area where the electrodes are formed, respectively, are each formed into two areas in a divided manner along a division line. By cutting the solar battery cell along the division line, the rectangular solar battery cell 20 as mentioned above is obtained. While the solar battery cell 20 according to the present embodiment is obtained by dividing the solar battery cell produced in a square into two, the solar battery cell can be divided into a larger number (n) such as three or four. When the solar battery cell 20 is divided into n, the light-receiving-surface electrode area and the rear-surface electrode area are formed into n areas in advance in a divided manner.

[0025] In the solar battery cell 20 with such a configuration, when sunlight is irradiated from the light-receiving surface side (the antireflection film side) of the solar battery cell 20 to reach an internal pn junction

surface (a junction surface of the p-type layer and the n-type diffusion layer), holes and electrons coalesced on the pn junction surface are separated from each other. The separated electrons move toward the n-type diffusion layer. Meanwhile, the separated holes move toward the p+ layer. Accooirdingly, a potential difference is generated between the n-type diffusion layer and the p+ layer so that a potential of the p+ layer is higher. Consequently, a front-surface electrode connected to the n-type diffusion layer becomes a negative electrode and a rear-surface electrode connected to the p+ layer becomes a positive electrode. When an external circuit (not shown) is connected to this solar battery cell 20, an electric current flows therein and the solar battery cell 20 performs an operation as a solar battery. While an output voltage of one solar battery cell is small, plural solar battery cells 20 are connected in series or in parallel to each other in the solar battery module 90, so that the output voltage is increased to a usable voltage.

[0026] Serial connection of the solar battery cells 20 is achieved by, in plural solar battery cells arranged in the first direction, electrically connecting the light-receiving-surface bus electrode 14 of a first solar battery cell 20 (20A) to the rear-surface bus electrode 15 of a second solar battery cell 20 (20B) adjacent to the first solar battery cell 20 (20A) with the band-shaped leads 4 and 7 (FIGS. 5 to 8).

[0027] According to the present embodiment, the leads 4 and 7 are provided separately as the light-receiving surface lead 4 and the rear surface lead 7, respectively. Among the leads, the light-receiving surface lead 4 extends on the light-receiving-surface bus electrode 14 to be solder-joined (mechanically and electrically connected) to

the light-receiving-surface bus electrode 14. The light-receiving surface lead 4 has an extended portion 4a formed to be longer than the solar battery cell 20. When the light-receiving surface lead 4 is solder-joined to the light-receiving-surface bus electrode 14, the extended portion 4a protrudes toward one end side (FIGS. 3, 5, and 9).

[0028] The rear surface lead 7 extends on the rear-surface bus electrode 15 to be solder-joined (mechanically and electrically connected) to the rear-surface bus electrode 15. To serially connect the first solar battery cell 20 (20A) to the second solar battery cell 20 (20B), the light-receiving surface lead 4 of the first solar battery cell 20 (20A) is solder-joined to the rear surface lead 7 of the second solar battery cell 20 (20B). That is, the extended portion 4a of the light-receiving surface lead 4 of the first solar battery cell 20 (20A) is slipped under the rear surface side of the adjacent second solar battery cell 20 (20B) to be solder-joined to the rear surface lead 7 solder-joined to the rear-surface bus electrode 15. While only connection of the first solar battery cell 20 (20A) and the second solar battery cell 20 (20B) adjacent to each other is explained, the same connection is practically repeated, so that plural solar battery cells 20 are serially connected to each other. While the leads are provided separately as the light-receiving surface lead 4 and the rear surface lead 7 in the present embodiment as explained above, the leads can be one continuous lead.

[0029] The light-receiving surface lead 4 is placed to be superimposed on the light-receiving-surface bus electrode 14 and the rear surface lead 7 is placed to be superimposed on the rear-surface bus electrode 15. The light-receiving surface lead 4 and the rear surface lead 7

are then pressed against the solar battery cell 20 partially or over the entire length while being heated. Because the light-receiving surface lead 4 and the rear surface lead 7 are coated with solder, the solder melts by heating and the leads 4 and 7 are solder-joined to the bus electrodes 14 and 15, respectively, by being pressed in this state. The first solar battery cell 20 (20A) and the second solar battery cell 20 (20B) are then arranged, the extension portion 4a of the light-receiving surface lead 4 of the first solar battery cell 20 (20A) is slipped under the rear surface side of the second solar battery cell 20 (20B) to be superimposed on an end of the rear surface lead 7, and the light-receiving surface lead 4 and the rear surface lead 7 are solder-joined to each other by being pressed while heated. Connection of the light-receiving surface lead 4 and the rear surface lead 7 to the solar battery cell 20 and connection of the light-receiving surface lead 4 to the rear surface lead 7 can be simultaneously performed at the same step.

[0030] The cell array 5 having plural solar battery cells 20 serially connected to each other as explained above is sealed between the front-surface cover material (glass) 3 and the back sheet 10 (the rear-surface cover material) with the resins 8a and 8b, so that the solar battery panel 70 is formed as shown in FIG. 7. The frame member 80 is attached to this solar battery panel 70 as shown in FIG. 1 and output cables (a positive electrode and a negative electrode) (not shown) are connected via a terminal box (not shown) to the solar battery panel 70, thereby configuring the solar battery module 90. The output voltage of the solar battery module 90 is a value corresponding to voltages of the plural solar battery cells 20 serially connected to each other.

[0031] According to the solar battery module with such a configuration, an electric current per one solar battery cell 20 can be halved by dividing the solar battery cell 20 into two, and thus a resistance loss caused by electrical connection can be reduced. Accordingly, a solar battery module with a higher output than that of a solar battery module that incorporates therein a conventional square solar battery cell which is not divided can be provided.

[0032] Second embodiment.

FIG. 9 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell used for a solar battery module according to a second embodiment of the present invention. FIG. 10 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell. FIG. 11 is a top view of a state in which the solar battery cells are connected according to the second embodiment. FIG. 12 is a schematic diagram of a method of connection in a cell array according to the second embodiment. A solar battery cell 21 according to the present embodiment is produced by dividing a square solar battery cell into two in the direction that the light-receiving-surface bus electrode 14 extends, and the ratio of the short side length S and the long side length L is 1/2:1 as in the first embodiment (FIG. 9).

[0033] The solar battery cell 21 according to the present embodiment, as shown in FIG. 9, has four light-receiving-surface bus electrodes 14 extending parallel to the short side on the light-receiving surface side and each of the light-receiving-surface bus electrodes 14 is joined to the light-receiving surface lead 4. On the rear surface side, a rear-surface bus electrode (a rear-surface lead connection electrode) 15B made of silver is provided at a position corresponding to the light-receiving-surface bus

electrode 14 (at a position where the rear-surface bus electrode 15B overlaps the light-receiving-surface bus electrode 14 in a thickness direction of the substrate 11) in the first direction as the direction that solar battery cells are connected to each other in a dotted manner (in a stepping-stone manner) along the lead in four columns. The rear surface lead 7 is joined to the rear-surface bus electrodes 15B of each column. Plural solar battery cells 21 are sequentially connected in series so that the four light-receiving-surface bus electrodes 14 are connected to the four-column rear-surface bus electrodes 15B with the light-receiving surface lead 4 and the rear surface lead 7 as in the first embodiment.

[0034] As shown in FIGS. 11 and 12, a predetermined number of the solar battery cells 21 are serially connected to each other, thereby forming a first cell string 17 (17A). The solar battery cells 21 of the same number are serially connected to each other, thereby forming a second cell string 17 (17B). An end portion of the first cell string 17 (17A) and an end portion of the second cell string 17 (17B) are joined to each other by a string connector 16, thereby forming a first parallel-connected cell string 18 (18A). Further, the first parallel-connected cell string 18 (18A) and a second parallel-connected cell string 18 (18B) connected as the first parallel-connected cell string 18 (18A) are serially connected to each other by the string connector 16 (FIG. 12). A predetermined number of columns of the column-connected cell strings 18 are serially connected to each other in the same manner.

[0035] The cell array 5 with the plural solar battery cells 21 being serially connected to each other as explained above is sealed between the front-surface cover material (glass) 3 and the back sheet 10 (the rear-surface

cover material) with the resins 8a and 8b as shown in FIG. 7, so that the solar battery panel 70 is formed. The frame member 80 is then attached to this solar battery panel 70 as shown in FIG. 1 and output cables (the positive electrode and the negative electrode) (not shown) are further connected via a terminal box (not shown) to the solar battery panel 70, so that the solar battery module 90 is configured.

[0036] While the first parallel-connected cell string 18 (18A) is serially connected to the second parallel-connected cell string 18 (18B) in FIG. 12, the light-receiving surface lead 4 joined to the light-receiving-surface bus electrode 14 of an end cell (a cell at a position that is the nearest to the string connector 16) of the first parallel-connected cell string 18 (18A) is specifically connected to the string connector 16 and this string connector 16 is connected to the rear surface lead 7 joined to the rear-surface bus electrode 15B of a head cell (a cell at a position that is the nearest to the string connector 16) of the second parallel-connected cell string 18 (18B). That is, because the cell strings 18 need to be connected to each other electrically in series by considering polarities, the first parallel-connected cell string 18 (18A) and the second parallel-connected cell string 18 (18B) electrically differ in their orientations.

[0037] Also the solar battery cell 21 according to the present embodiment can be formed by dividing a cell obtained by performing predetermined processes upon a substantially-square p-type silicon substrate whose vertical and horizontal sides have the same length into two. Because the area of the cell is halved, a power generation current is halved, and thus an electric current flowing in the leads 4 and 7 is halved as compared to a case of a

square cell. Consequently, a resistance loss (W) of the leads 4 and 7 can be reduced to 1/4 according to a relationship W=(electrical resistance of leads 4 and 7)×(flowing current)^2 and thus the output of the solar battery module can be improved.

[0038] When the arrangement (the connection) of cells in a module is considered, with respect to characteristics of a module in a case of serially connecting all halved cells, an electric current is halved and a voltage is doubled as compared to characteristics of a module having the same external dimension in which non-divided cells are all serially connected.

[0039] When assuming that the voltage of one non-divided cell is V, the t thereof is I, and 60 non-divided cells are serially connected to each other, thereby configuring a module, the voltage of the module is 60×V and the electric current thereof is I. On the other hand, the voltage of a halved cell is V and the electric current thereof is 0.5×I. Accordingly, in a module configured by serially connecting 120 halved cells (because the external dimension of the module is the same, the number of halved cells to be used becomes twice), the voltage is 120×V and the electric current is 0.5×I. That is, because electrical output characteristics of modules are different, consideration is required, for example, the arrangement of modules on a roof (the number of serial/parallel connected modules on a roof) needs to be significantly changed with respect to a method of connecting to an inverter.

[0040] When a parallel-connected cell string having two cell strings each of which is formed by serially connecting a predetermined number of halved cells being connected in parallel to each other is configured and all the parallel-connected cell strings are serially connected to each other

as explained above, electrical output characteristics of the resultant module is the voltage of 60×V and the electric current of I, which are equivalent to those of the module having all non-divided cells serially connected to each other. Accordingly, with respect to the method of connecting to an inverter, consideration is not required, for example, arrangement of modules on a roof (the number of serial/parallel connected modules on a roof) does not need to be changed significantly. Further, when a module formed by the conventional non-divided cells is broken in an existing solar power generation system, a module formed by the halved cells can be used as an alternative product because their characteristics are the same.

[0041] As explained above, the resistance loss caused by the leads 4 and 7 is reduced due to the halved current value in the module formed by the halved cells. The above explanations have been made while ignoring the resistance loss for easy understanding.

[0042] Third embodiment.

FIG. 13 is a top view of a state in which a light-receiving-surface bus electrode is joined to a solar battery cell used for a solar battery module according to a third embodiment of the present invention. FIG. 14 is a rear view of a state in which a rear-surface bus electrode is joined to the solar battery cell. FIG. 15 is a schematic diagram of a method of connection in a cell array according to the third embodiment.

[0043] A solar battery cell 22 according to the present embodiment is produced by dividing a square solar battery cell into two in the direction that the light-receiving-surface bus electrode 14 extends and the ratio of the short side length S and the long side length L is 1/2:1 as in the first embodiment. The solar battery cell 22 is formed in

such a shape that at an end portion on one lateral side, a corner formed between a long side and a short side at each of both ends of the long side is cut by about 45°. Other configurations of the third embodiment are identical to those of the second embodiment. This corner-cut solar battery cell 22 with its corners being cut similarly configures a solar battery module instead of the solar battery cell 21 according to the second embodiment.

[0044] The corner-cut solar battery cell 22 is formed in such a pattern that the light-receiving-surface bus electrode 14 and the rear-surface bus electrode 15B are line-symmetrical with respect to an imaginary central line CL passing through a middle point of the long side and parallel to the short side.

[0045] The halved cells are arranged in a module to match directions of long sides or short sides of the substantial rectangles. At this time, when the light-receiving-surface bus electrode 14 of a certain cell and the rear-surface bus electrode 15B of an adjacent cell are in the same straight line, these cells can be connected to each other at the shortest distance by the leads 4 and 7 and a connecting operation thereof is easy. In a case of the solar battery cell 22 formed in such a manner that the light-receiving-surface bus electrodes 14 and the rear-surface bus electrodes 15B are line-symmetrical with respect to the imaginary center line CL as explained above, the light-receiving-surface bus electrodes 14 on the light-receiving surface side and the rear-surface bus electrodes 15B are in the same straight lines even when the cell is rotated by 180° or not, and thus the cells can be connected to each other by extending the leads 4 and 7. That is, an operation of matching directions of arranging cells to cause the light-receiving-surface bus electrodes 14 and the

rear-surface bus electrodes 15B to be in the same straight lines is not required.

[0046] As shown in FIG. 15, in the cell array 5 according to the present embodiment, when the corner-cut solar battery cells 22 are serially connected to each other, thereby forming the cell strings 17A and 17B, the corner-cut solar battery cells 22 are connected to change orientations of adjacent solar battery cells 22 by 180° (to cause long sides with their corners not being cut to face to each other, for example), thereby configuring the cell array 5.

[0047] Generally, a mono-crystalline silicon substrate often has corners with a corner-cut portion of about 45° because of size restriction of an ingot serving as a material for the substrate. Accordingly, when cells are arranged in a module with the substrate divided into two, the corner-cut portions appear alternatively such as on an upper side, a lower side, ··· of arranged cells. For example, to arrange cells in such a manner that the corner-cut portions are always on the upper side, a lower-half one of a cell divided into two needs to be arranged after being rotated by 180°. At that time, if the light-receiving-surface bus electrodes 14 and the rear-surface bus electrodes 15B are in the same straight lines even when the lower-half side cell is rotated by 180°, the cells can be serially connected to each other by the leads 4 and 7. This is possible in the solar battery cell 22 according to the present embodiment formed in such a manner that the light-receiving-surface bus electrodes 14 and the rear-surface bus electrodes 15B are line-symmetrical with respect to the imaginary center line CL passing through the middle point of the long sides and parallel to the short sides as mentioned above.

[0048] Fourth embodiment.

When a conventional substantially-square cell is divided into two, thereby forming two substantially-rectangular cells, no light-receiving-surface bus electrode, no grid electrode, and no rear-surface bus electrode are formed in advance in an area with a predetermined width along a line of dividing the original substantially-square cell. That is, an area where these electrodes do not exist is formed at a circumferential edge portion of the halved substantially-rectangular cell.

[0049] According to the solar battery cell produced as explained above, because no electrode is formed at the circumferential edge portion of the halved substantially-rectangular cell, it is possible to suppress a reduction in characteristics of the cell caused by damages of a divided end generated at the time of dividing. Further, by preventing thermal stress at the time of joining leads (interconnectors) from propagating to the cell end, breakage of cells at the time of modularization can be suppressed. Because the circumferential edge portion of a cell can capture secondary light reflected by a rear-surface cover material of the module, an effect of improving characteristics of the module is also provided.

Industrial Applicability

[0050] As described above, the solar battery module according to the present invention is useful to be applied to a solar battery module, a plurality of which are arranged and installed on a roof or the like in a solar power generation system that converts light energy such as sunlight into electric energy, and particularly is suitable to be applied to a solar battery module that includes a plurality of solar battery cells each having a plurality of

light-receiving-surface bus electrodes parallel to a short side of a substantial rectangle on a light receiving surface and having a rear-surface bus electrode at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes.

Reference Signs List

[0051] 3 front-surface cover material (glass)

4 light-receiving surface lead (interconnector)

4a extension portion

5 cell array

7 rear surface lead (interconnector)

8, 8a, 8b resin (sealing material)

9 cell arrangement layer

10 rear-surface cover material

11 p-type silicon substrate

12 rear-surface collecting electrode

13 grid electrode

14 light-receiving-surface bus electrode (light-receiving-surface lead-connection electrode)

15, 15B rear-surface bus electrode (rear-surface lead-connection electrode)

16 string connector

17, 17A, 17B cell string

20, 20A, 20B, 21, 22 solar battery cell

70 solar battery panel

80 frame member

90 solar battery module

CLAIMS

1. A solar battery module comprising:

a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and

an interconnector that electrically connects the light-receiving-surface bus electrodes of a first one of the solar battery cells to the rear-surface bus electrodes of an adjacent second one of the solar battery cells.

2. The solar battery module according to claim 1, wherein the ratio of the short side length and the long side length of the substantial rectangle of each of the solar battery cells is 1/2:1.

3. The solar battery module according to claim 1, wherein a predetermined number of the solar battery cells are serially connected, thereby configuring a cell string, n columns of the cell strings are connected in parallel, and the n-column parallel-connected cell strings are further serially connected, thereby configuring an entire cell array.

4. The solar battery module according to claim 2, wherein a predetermined number of the solar battery cells are serially connected, thereby configuring a cell string, two

columns of the cell strings are connected in parallel, and the two-column parallel-connected cell strings are further serially connected, thereby configuring an entire cell array.

5. The solar battery module according to claim 1, wherein the light-receiving-surface bus electrodes of the solar battery cell are formed at positions that are line-symmetrical with respect to a line passing through a middle point of a side perpendicular to an extended line of the light-receiving-surface bus electrodes and parallel to the light-receiving-surface bus electrodes.

6. The solar battery module according to claim 5, wherein the light-receiving-surface bus electrodes of the solar battery cell are formed at positions that are line-symmetrical with respect to a line passing through a middle point of a side parallel to the light-receiving-surface bus electrodes and perpendicular to the light-receiving-surface bus electrodes.

7. The solar battery module according to claim 1, wherein each of the solar battery cells includes an area where the light-receiving-surface bus electrodes and the rear-surface bus electrodes are not formed within a predetermined dimension from an edge toward a central direction of the cell at an outer circumferential edge portion thereof.

8. A manufacturing method of a solar battery module comprising the steps of:

dividing a basic solar battery cell with a plane shape thereof being a substantial square, which includes n light-receiving-surface electrode areas in each of which a

plurality of light-receiving-surface bus electrodes parallel to a side of the substantial square and a plurality of grid electrodes perpendicular to the light-receiving-surface bus electrodes are provided on a light-receiving surface side and includes rear-surface bus electrodes each at a position on a non-light-receiving surface side corresponding to each of the light-receiving-surface bus electrodes, into n along respective boundaries of the n light-receiving-surface electrode areas, thereby obtaining divided solar battery cells, each having a plain of a substantial rectangle with a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or higher than 2); and

electrically connecting the light-receiving-surface bus electrodes of a first one of the divided solar battery cells to the rear-surface bus electrodes of a second adjacent one of the divided solar battery cells by an interconnector.

ABSTRACT

A solar battery module that improves an output without increasing a cross-sectional area of an interconnector is provided. The solar battery module includes: a plurality of solar battery cells (20), a plain shape of each being a substantial rectangle, and a ratio of a short side length (S) and a long side length (L) of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and a light-receiving-surface lead (an interconnector) (4) that electrically connects the light-receiving-surface bus electrodes of one of the solar battery cells (20) to the rear-surface bus electrodes of adjacent one of the solar battery cells (20).

FIG.1

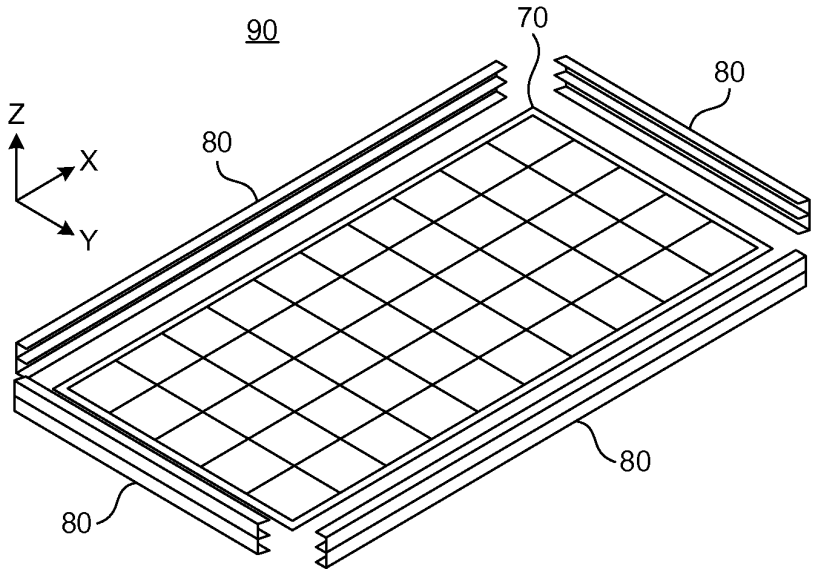


FIG.2

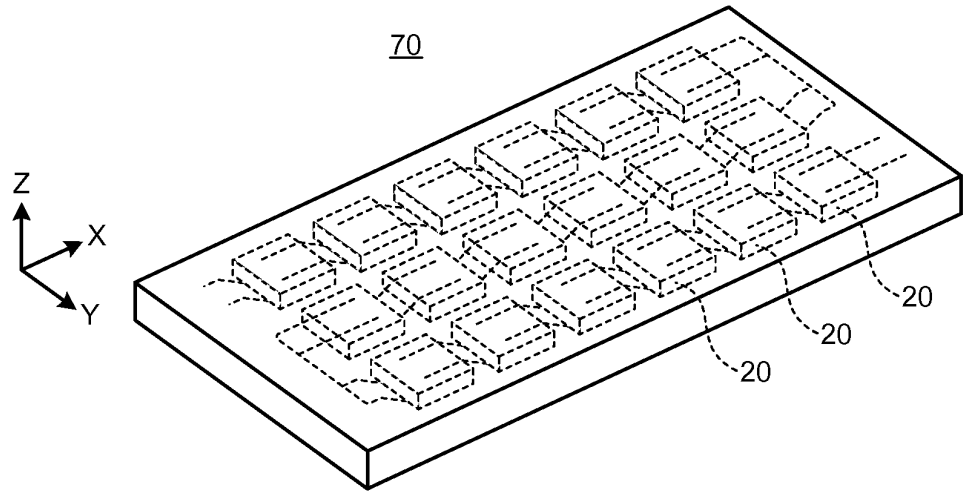


FIG.3

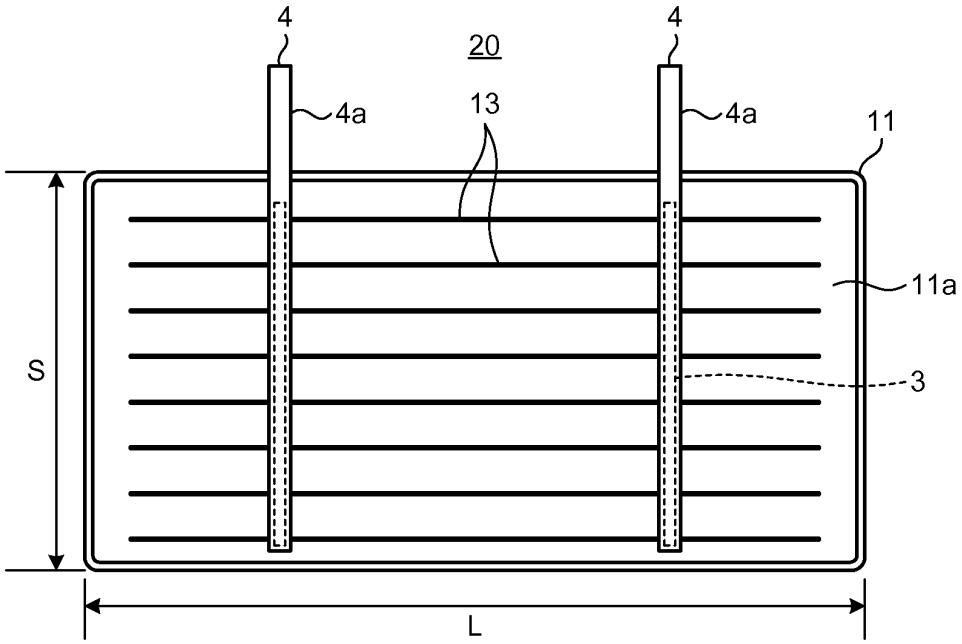


FIG.4

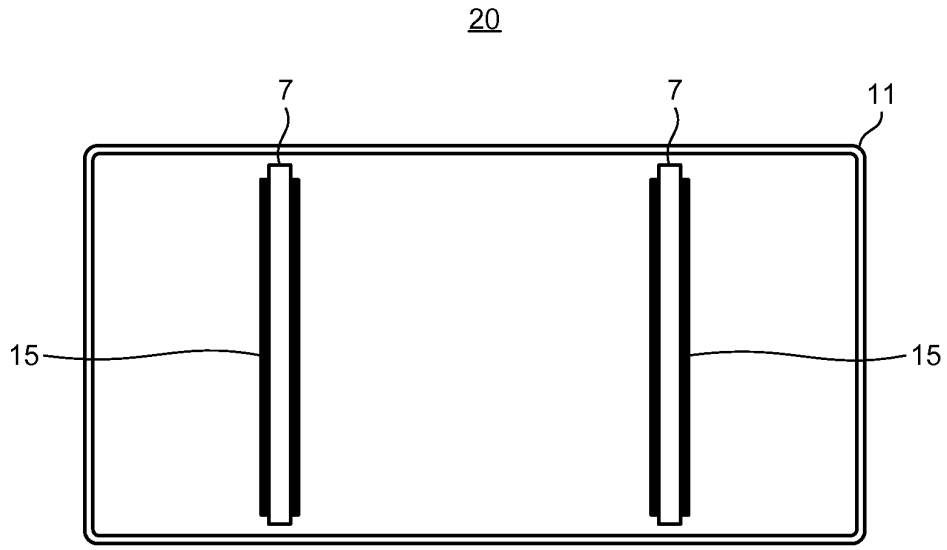


FIG.5

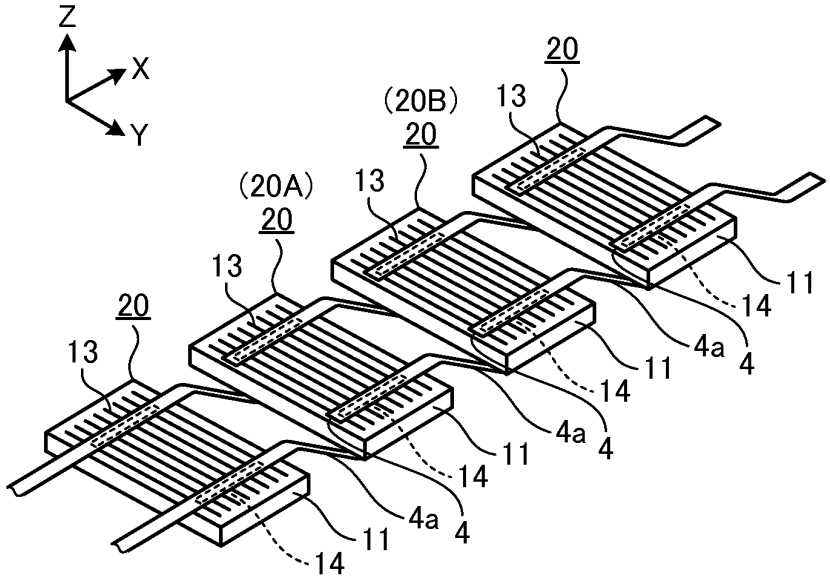

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FIG.6

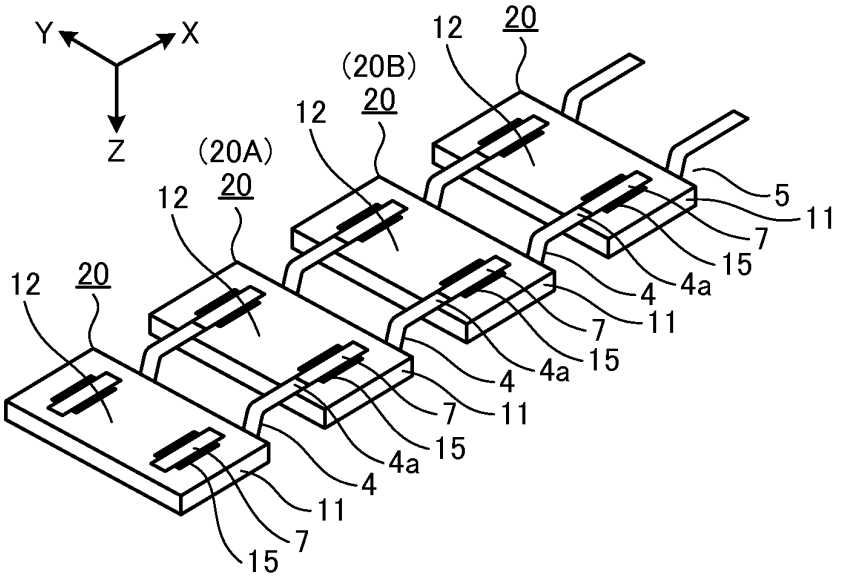

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FIG.7

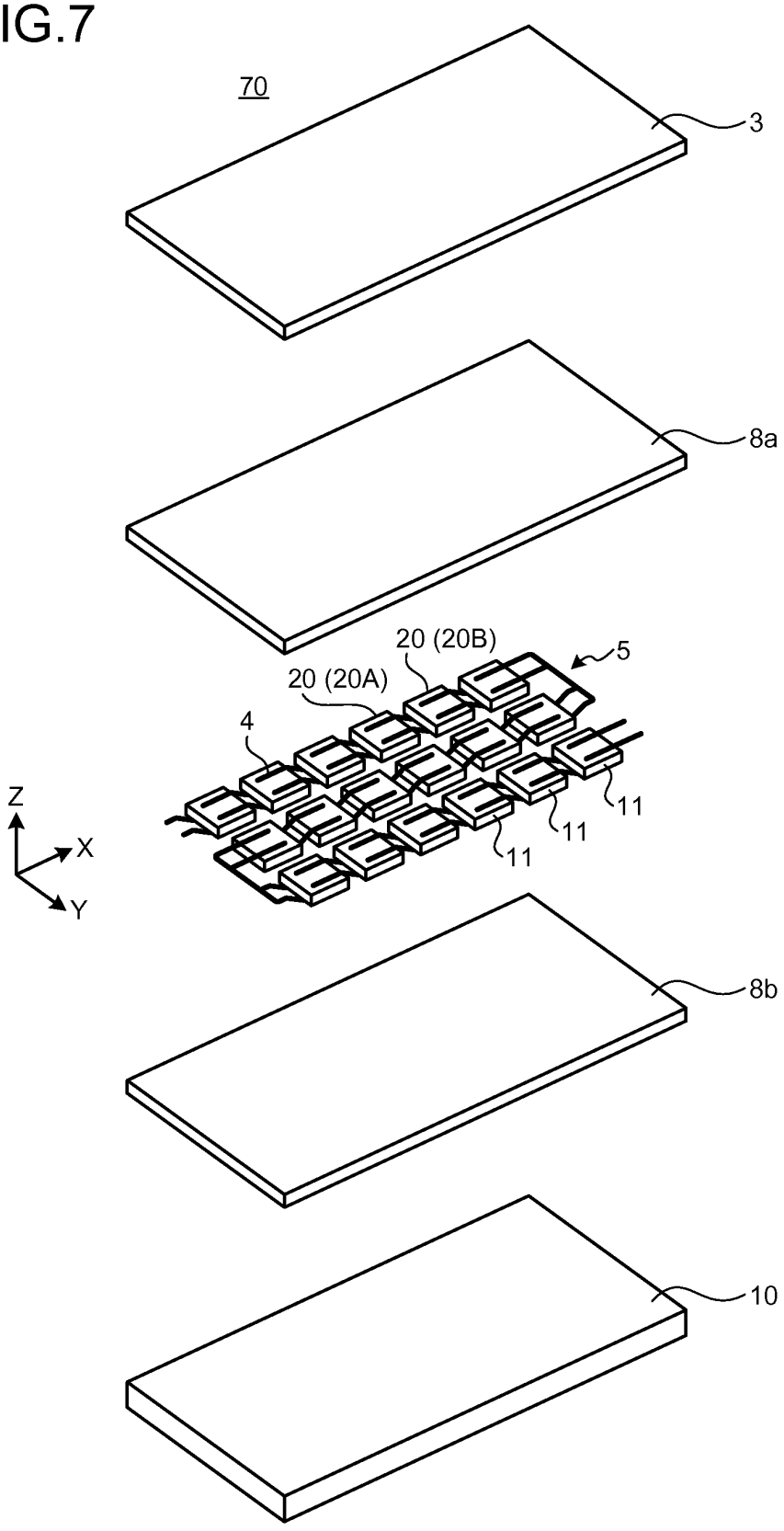


FIG.8

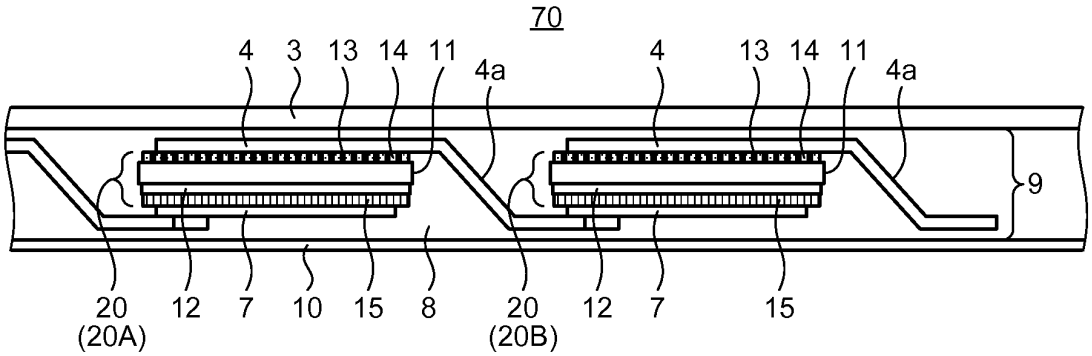

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FIG.9

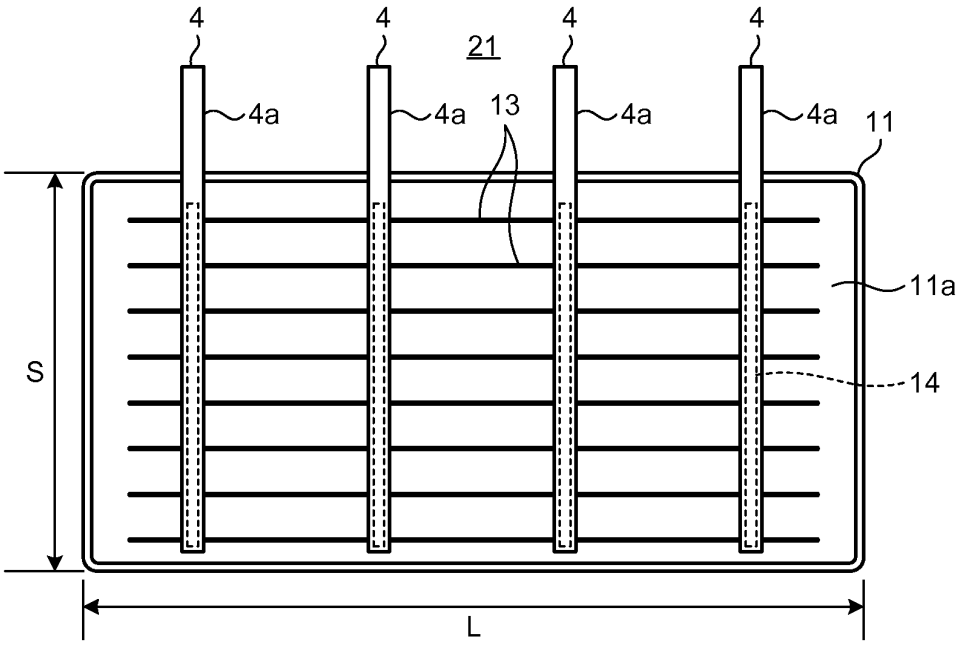

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FIG.10

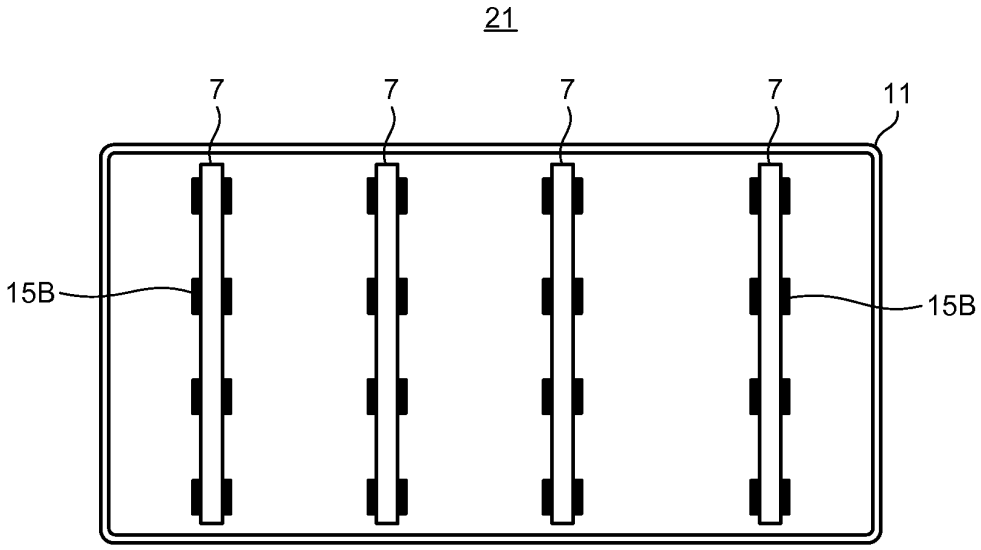


FIG.11

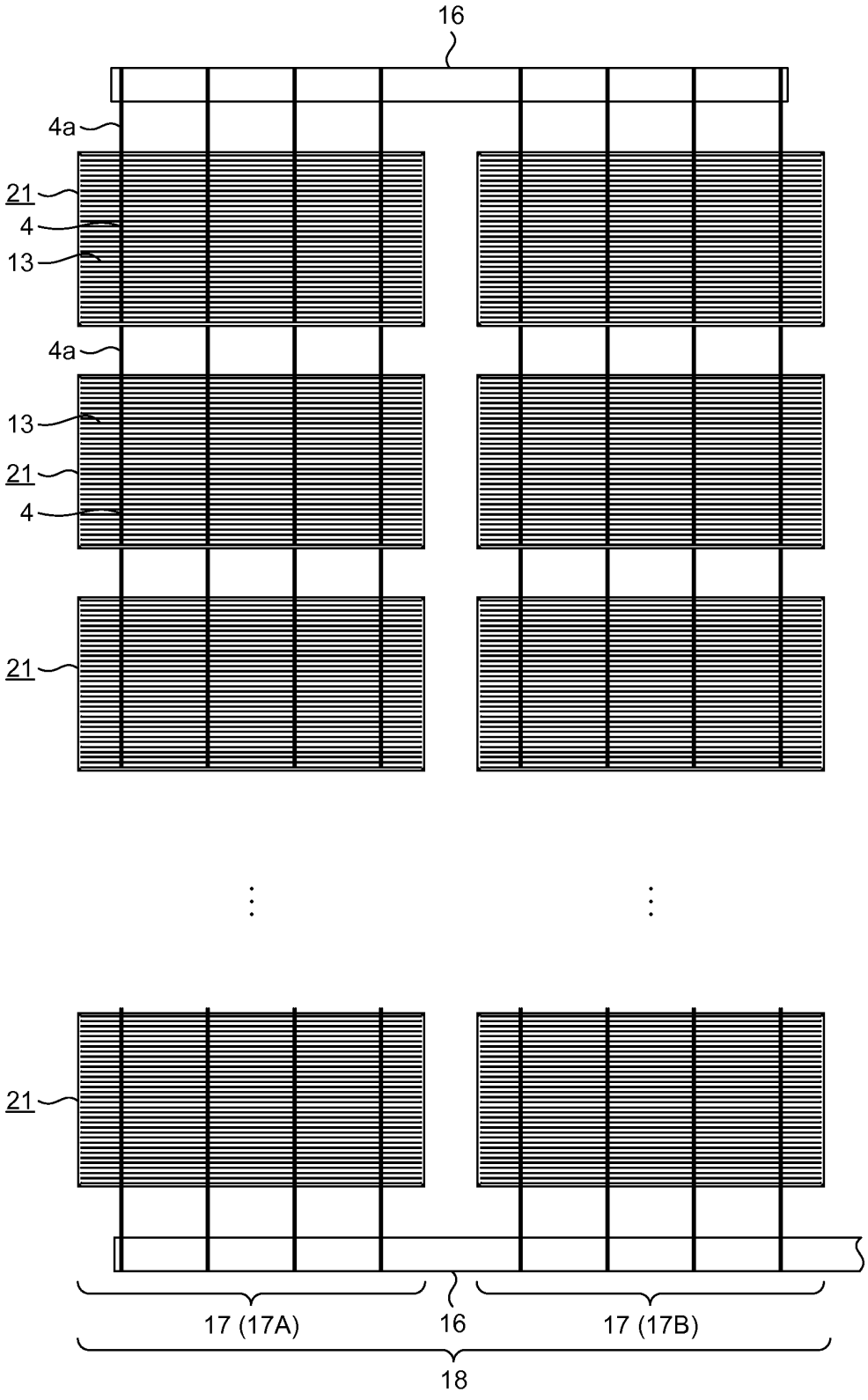


FIG.12

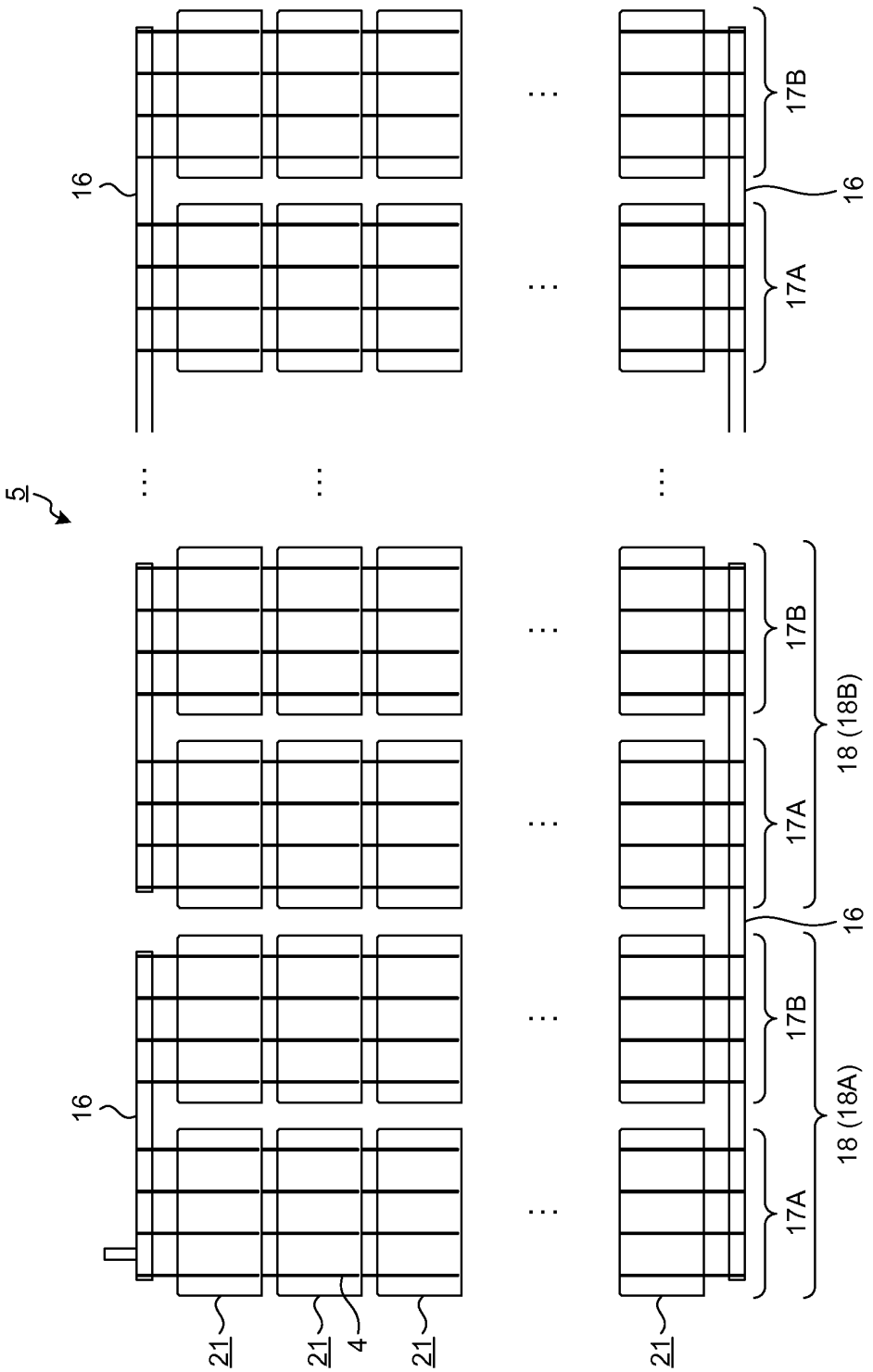


FIG.13

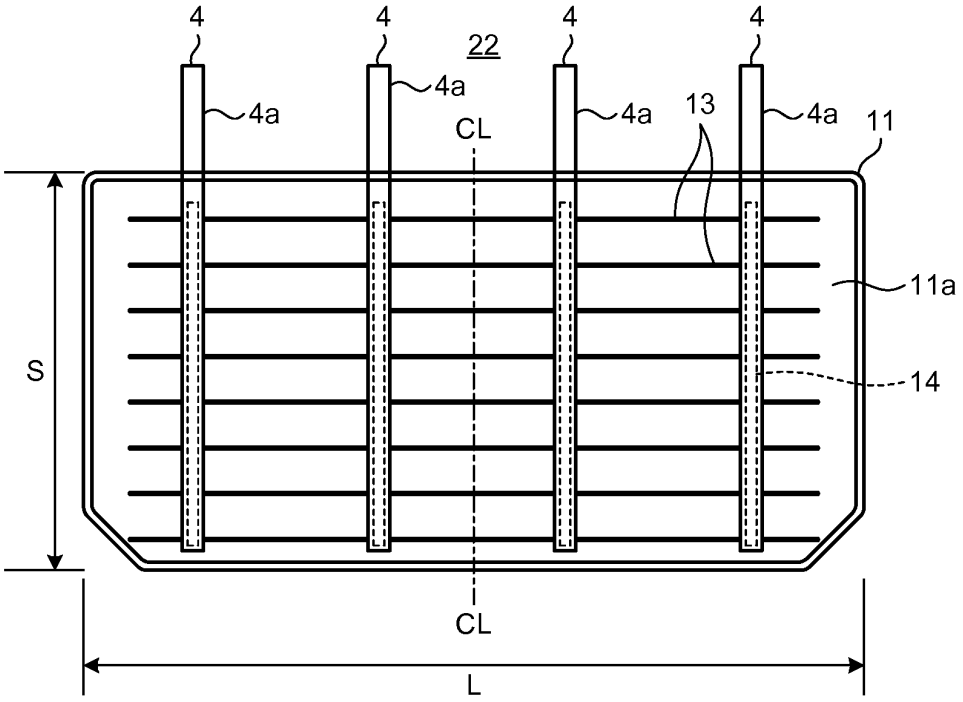


FIG.14

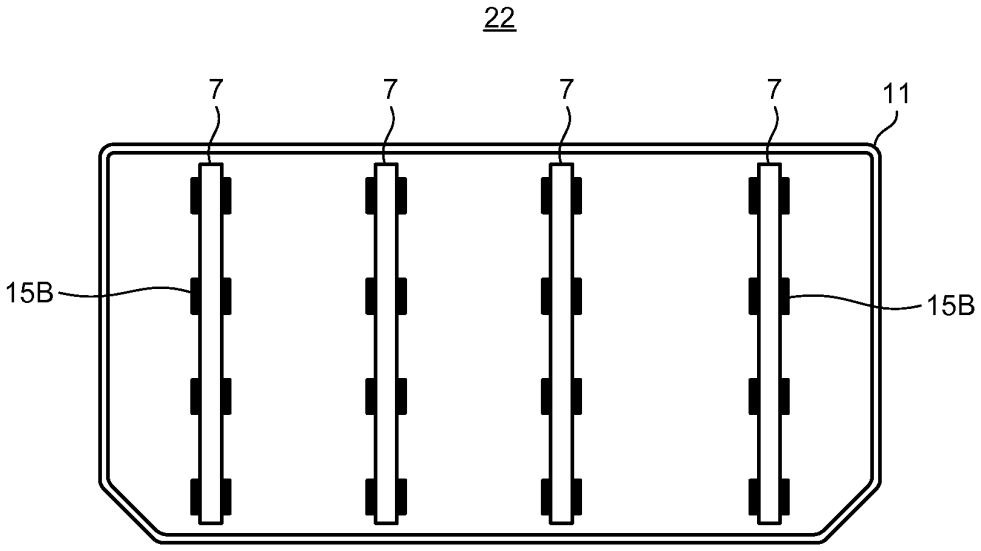
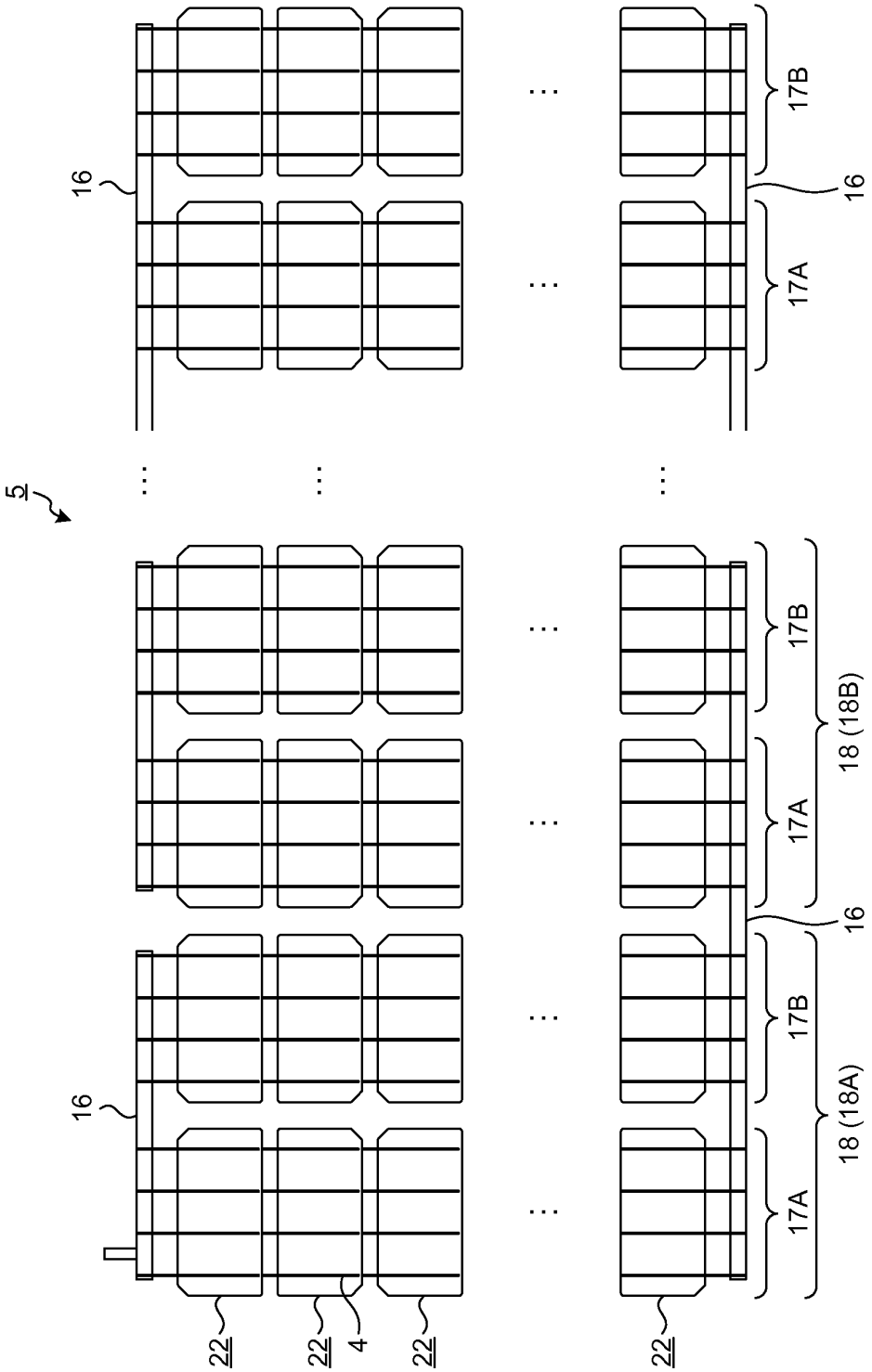


FIG.15



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Declaration and Power of Attorney for Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

私は、以下に記名された発明者として、ここに下記の通り宣言する：

As a below named inventor, I hereby declare that:

私の住所、郵便の宛先そして国籍は、私の氏名の後に記載された通りである。

My residence, post office address, and citizenship are as stated next to my name.

下記の名称の発明について、特許請求範囲に記載され、且つ特許が求められている発明主題に関して、私は、最初、最先且つ唯一の発明者である（唯一の氏名が記載されている場合）か、或いは最初、最先且つ共同発明者である（複数の氏名が記載されている場合）と信じている。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF

上記発明の明細書はここに添付されているが、下記の箱がチェックされている場合は、この限りでない：

the specification of which is attached hereto unless the following box is checked:

☐ _____ の日に出願され、

この出願の米国出願番号またはＰＣＴ国際出願番号は、

_____ であり、且つ

_____ の日に補正された出願（該当する場合）

☒ was filed on 02/Jul./2010

as United States Application Number or

PCT International Application Number

PCT/JP2010/061334 and was amended on

_____ (if applicable).

私は、上記の補正書によって補正された、特許請求範囲を含む上記明細書を検討し、且つ内容を理解していることをここに表明する。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第３７編規則１．５６に定義されている、特許性について重要な情報を開示する義務があることを認める。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

Jinko Ex. 1002 - 106/580

Japanese Language Declaration

（日本語宣言書）

私は、ここに、以下に記載した外国での特許出願または発明者証の出願、或いは米国以外の少なくとも一国を指定している米国法典第35編第365条(b)によるPCT国際出願について、同第119条(a)-(d)項又は第365条(b)項に基づいて優先権を主張するとともに、優先権を主張する本出願の出願日よりも前の出願日を有する外国での特許出願または発明者証の出願、或いはPCT国際出願については、いかなる出願も、下記の枠内をチェックすることにより示した。

I hereby claim foreign priority under Title 35, United States Code Section 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365 (a) of any PCT International application which designated at least one country other than the United States listed below and have also identified below, by checking the box, any foreign application for patent, or inventor's certificate, or PCT International application having a filing date before that of the application for which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願日／月／年)	Priority Not Claimed 優先権を主張なし
			☐
			☐

私は、ここに、下記のいかなる米国仮特許出願についても、その米国法典第35編119条(e)項の利益を主張する。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.) （出願番号）	(Filing Date) （出願日）

私は、ここに、下記のいかなる米国出願についても、その米国法典第35編第120条に基づく利益を主張し、又米国を指定するいかなるPCT国際出願についても、その同第365条(c)に基づく利益を主張する。また、本出願の各特許請求の範囲の主題が、米国法典第35編第112条第1項に規定された態様で、先行する米国出願又はPCT国際出願に開示されていない場合においては、その先行出願の出願日と本国内出願日またはPCT国際出願日との間の期間中に入手された情報で、連邦規則法典第37編規則1．56に定義された特許性に関わる重要な情報について開示義務があることを承認する。

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(Application No.) （出願番号）	(Filing Date) （出願日）	(Status Patented, Pending, Abandoned) （現況：特許許可、係属中、放棄）

私は、ここに表明された私自身の知識に係る陳述が真実であり、且つ情報と信ずることに基づく陳述が、真実であると信じられることを宣言し、さらに、故意に虚偽の陳述などを行った場合は、米国法典第18編第1001条に基づき、罰金または拘禁、若しくはその両方により処罰され、またそのような故意による虚偽の陳述は、本出願またはそれに対して発行されるいかなる特許も、その有効性に問題が生ずることを理解した上で陳述が行われたことを、ここに宣言する。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Jinko Ex. 1002 - 107/580

PTO/SB/106 (05-00)
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Japanese Language Declaration
（日本語宣言書）

委任状： 私は本出願を審査する手続を行い、且つ米国特許商標庁との全ての業務を遂行するために、記名された発明者として、下記の弁護士及び／または弁理士を任命する。（氏名及び登録番号を記載すること）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: *(list name and registration number).*

CUSTOMER NUMBER 21839
BUCHANAN INGERSOLL & ROONEY PC

CUSTOMER NUMBER 21839
BUCHANAN INGERSOLL & ROONEY PC

書類送付先

Send Correspondence to:

CUSTOMER NUMBER 21839
BUCHANAN INGERSOLL & ROONEY PC
Telephone: 703-836-6620 Facsimile: 703-836-2021

Telephone: 703-836-6620 Facsimile: 703-836-2021

直通電話連絡先：（氏名及び電話番号）

Direct Telephone Calls to:
(name and telephone number)

,

,

唯一または第一発明者氏名	Full name of sole or first inventor Koji SHIMASAKI
発明者の署名　日付	Inventor's signature　Date Koji Shimasaki　Nov. 16, 2012
住所	Residence Tokyo, Japan
国籍	Citizenship Japanese
郵便の宛先	Post Office Address c/o Mitsubishi Electric Corporation 7-3, Marunouchi 2-chome, Chiyoda-ku, TOKYO 100-8310 JAPAN

第二共同発明者がいる場合、その氏名	Full name of second joint inventor, if any Masayoshi SUZUKI
第二共同発明者の署名　日付	Second inventor's signature　Date Masayoshi Suzuki　Nov. 16. 2012
住所	Residence Tokyo, Japan
国籍	Citizenship Japanese
郵便の宛先	Post Office Address c/o Mitsubishi Electric Corporation 7-3, Marunouchi 2-chome, Chiyoda-ku, TOKYO 100-8310 JAPAN

（第三以下の共同発明者についても同様に記載し、署名をすること）

(Supply similar information and signature for third and subsequent joint inventors.)

Jinko Ex. 1002 - 108/580

WO 2012/001815
PCT/JP2010/061334

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

SECOND AND SUPPLEMENTARY NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION (TO DESIGNATED OFFICES WHICH APPLY THE 30 MONTH TIME LIMIT UNDER ARTICLE 22(1))

(PCT Rule 47.1(c))

To:

SAKAI, Hiroaki
Sakai International Patent Office, Kasumigaseki Building, 2-5, Kasumigaseki 3-chome, Chiyoda-ku, Tokyo
1006020
JAPON

Date of mailing *(day/month/year)* 08 November 2012 (08.11.2012)	
Applicant's or agent's file reference 611926WO01	**IMPORTANT NOTICE**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/JP2010/061334	02 July 2010 (02.07.2010)	

Applicant: Mitsubishi Electric Corporation et al

1. **ATTENTION**: For any designated Office(s), for which the time limit under Article 22(1), as in force from 1 April 2002 (30 months from the priority date), **does not apply**, please see Form PCT/IB/308(First Notice) issued previously.

2. Notice is hereby given that the following designated Office(s), for which the time limit under Article 22(1), as in force from 1 April 2002, **does apply**, has/have requested that the communication of the international application, as provided for in Article 20, be effected under Rule 93*bis*.1. The International Bureau has effected that communication on the date indicated below:
05 January 2012 (05.01.2012)

   AU, AZ, BY, CN, CO, DZ, EP, HU, KG, KP, KR, MD, MK, MY, MZ, NA, NG, PG, RU, SY, TM, US

   In accordance with Rule 47.1(c-*bis*)(i), those Offices will accept the present notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

3. The following designated Offices, for which the time limit under Article 22(1), as in force from 1 April 2002, **does apply**, have not requested, as at the time of mailing of the present notice, that the communication of the international application be effected under Rule 93*bis*.1 :

   AE, AG, AL, AM, AO, AP, AT, BA, BB, BG, BH, BR, BW, BZ, CA, CH, CL, CR, CU, CZ, DE, DK, DM, DO, EA, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, ID, IL, IN, IS, JP, KE, KM, KN, KZ, LA, LC, LK, LR, LS, LT, LY, MA, ME, MG, MN, MW, MX, NI, NO, NZ, OA, OM, PE, PH, PL, PT, RO, RS, SC, SD, SE, SG, SK, SL, SM, ST, SV, TH, TJ, TN, TR, TT, UA, UZ, VC, VN, ZA, ZM, ZW

   In accordance with Rule 47.1(c-*bis*)(ii), those Offices accept the present notice as conclusive evidence that the Contracting State for which that Office acts as a designated Office does not require the furnishing, under Article 22, by the applicant of a copy of the international application.

4. **TIME LIMITS for entry into the national phase**

   For the designated or elected Office(s) listed above, the applicable time limit for entering the national phase will, **subject to what is said in the following paragraph,** be **30 MONTHS** from the priority date.

   In practice, **time limits other than the 30-month time limit** will continue to apply, for various periods of time, in respect of certain of the designated or elected Office(s) listed above. For **regular updates on the applicable time limits** (30 or 31 months, or other time limit), Office by Office, refer to the *PCT Gazette*, the *PCT Newsletter* and the *PCT Applicant's Guide*, Volume II, National Chapters, all available from WIPO's Internet site, at http://www.wipo.int/pct/en/index.html.

   It is the applicant's **sole responsibility** to monitor all these time limits.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. +41 22 338 82 70

Authorized officer
Yukari Nakamura

e-mail: pt07.pct@wipo.int

Jinko Ex. 1002 - 109/580

Attorney Docket No. 1032404-000416

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)	
	)	
Koji SHIMASAKI et al.	)	Group Art Unit: Unassigned
	)	
Application No.: Unassigned	)	Confirmation No.: Unassigned
	)	
Filed: December 24, 2012	)	
	)	
For: SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF	)	
	)	
	)	

FIRST INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In accordance with the duty of disclosure as set forth in 37 C.F.R. § 1.56, the accompanying information is being submitted in accordance with 37 C.F.R. §§ 1.97 and 1.98.

The listed documents were cited in the attached International Search Report and Written Opinion of the International Searching Authority in the corresponding PCT application, and/or in the present application.

To assist the Examiner, the documents are listed on the attached citation form. It is respectfully requested that an Examiner initialed copy of this form be returned to the undersigned.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date December 24, 2012

By: _____
James A. LaBarre
Registration No. 28632

Customer Number 21839
703 836 6620

Buchanan Ingersoll & Rooney PC
Attorneys & Government Relations Professionals

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Substitute for form 1449/PTO				Complete if Known	
FIRST INFORMATION DISCLOSURE STATEMENT BY APPLICANT				*Application Number*	
				Filing Date	
				First Named Inventor	**Koji SHIMASAKI et al.**
(Use as many sheets as necessary)				*Art Unit*	
				Examiner Name	
Sheet	1	of	1	*Attorney Docket Number*	**1032404-000416**

clarify the scope of the subject matter for which protection is sought

U.S. PATENT DOCUMENTS

Examiner Initials'	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-2007/0283995 A1	12-13-2007	Okamoto et al. (Corresponds to WO 2005/096396 below)	
		US-			
		US-			
		US-			
		US-			
		US-			
		US-			
		US-			
		US-			
		US-			
		US-			

FOREIGN PATENT DOCUMENTS

Examiner Initials'	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind Code [5](if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		JP 7-106619 A	04-21-1995	Sanyo Electric Co., Ltd.		X
		JP 2006-120944 A	05-11-2006	Sharp Corp.		X
		JP 2000-164901 A	06-16-2000	Kyocera Corp.		X
		WO 2005/096396 A1	10-13-2005	Sanyo Electric Co., Ltd.		X
		JP 11-251613 A	09-17-1999	Kyocera Corp.		X

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
		International Search Report (PCT/ISA/210) issued on August 17, 2010, by the Japanese Patent Office as the International Searching Authority for International Application No. PCT/JP2010/061334.	
		Written Opinion (PCT/ISA/237) issued on August 17, 2010, by the Japanese Patent Office as the International Searching Authority for International Application No. PCT/JP2010/061334.	

Examiner Signature		Date Considered	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/061334

A. CLASSIFICATION OF SUBJECT MATTER
H01L31/042(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)
H01L31/04-31/078

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2010
Kokai Jitsuyo Shinan Koho 1971-2010 Toroku Jitsuyo Shinan Koho 1994-2010

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ①	JP 7-106619 A (Sanyo Electric Co., Ltd.), 21 April 1995 (21.04.1995), (Family: none) Machine Translation	1-8
X ②	JP 2006-120944 A (Sharp Corp.), 11 May 2006 (11.05.2006), (Family: none) Machine Translation	1-8
X ③	JP 2000-164901 A (Kyocera Corp.), 16 June 2000 (16.06.2000), (Family: none) Machine Translation	1-8
Y ④	WO 2005/096396 A1 (Sanyo Electric Co., Ltd.), 13 October 2005 (13.10.2005), & EP 1737048 A1 & CN 1938865 A & US 2007/0283995 A1 & JP 2009-49436 A & JP 4286285 B	1-8

☐ 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
23 July, 2010 (23.07.10)	17 August, 2010 (17.08.10)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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

Jinko Ex. 1002 - 112/580

ISR in Japanese

特 許 協 力 条 約

PCT

国際調査報告

（法８条、法施行規則第40、41条）
〔ＰＣＴ18条、ＰＣＴ規則43、44〕

出願人又は代理人 の書類記号　611926W001	今後の手続きについては、様式ＰＣＴ／ＩＳＡ／２２０ 及び下記５を参照すること。	
国際出願番号 ＰＣＴ／ＪＰ２０１０／０６１３３４	国際出願日 （日.月.年）　０２．０７．２０１０	優先日 （日.月.年）
出願人（氏名又は名称） 三菱電機株式会社		

国際調査機関が作成したこの国際調査報告を法施行規則第41条（ＰＣＴ18条）の規定に従い出願人に送付する。
この写しは国際事務局にも送付される。

この国際調査報告は、全部で　2　ページである。

☐ この調査報告に引用された先行技術文献の写しも添付されている。

１．国際調査報告の基礎

ａ．言語に関し、この国際調査は以下のものに基づき行った。

☑ 出願時の言語による国際出願

☐ 出願時の言語から国際調査のための言語である＿＿＿＿＿＿＿＿ 語に翻訳された、
この国際出願の翻訳文（ＰＣＴ規則12.3(a)及び23.1(b)）

ｂ．☐ この国際調査報告は、ＰＣＴ規則91の規定により国際調査機関が認めた又は国際調査機関に通知された明らかな誤りの訂正を考慮して作成した（ＰＣＴ規則43.6の2(a)）。

ｃ．☐ この国際出願は、ヌクレオチド又はアミノ酸配列を含んでいる（第Ｉ欄参照）。

２．☐ 請求の範囲の一部の調査ができない（第Ⅱ欄参照）。

３．☐ 発明の単一性が欠如している（第Ⅲ欄参照）。

４．発明の名称は

☑ 出願人が提出したものを承認する。

☐ 次に示すように国際調査機関が作成した。

＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

５．要約は

☑ 出願人が提出したものを承認する。

☐ 第Ⅳ欄に示されているように、法施行規則第47条第１項（ＰＣＴ規則38.2）の規定により国際調査機関が作成した。出願人は、この国際調査報告の発送の日から１月以内にこの国際調査機関に意見を提出することができる。

６．図面に関して

ａ．要約書とともに公表される図は、

第　3　図とする。　☑ 出願人が示したとおりである。

☐ 出願人は図を示さなかったので、国際調査機関が選択した。

☐ 本図は発明の特徴を一層よく表しているので、国際調査機関が選択した。

ｂ．☐ 要約とともに公表される図はない。

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国際調査報告

国際出願番号　ＰＣＴ／ＪＰ２０１０／０６１３３４

Ａ．　発明の属する分野の分類（国際特許分類（ＩＰＣ））

Int.Cl.　H01L31/042(2006.01)i

Ｂ．　調査を行った分野

調査を行った最小限資料（国際特許分類（ＩＰＣ））

Int.Cl.　H01L31/04-31/078

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	１９２２－１９９６年
日本国公開実用新案公報	１９７１－２０１０年
日本国実用新案登録公報	１９９６－２０１０年
日本国登録実用新案公報	１９９４－２０１０年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

Ｃ．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
X ①	JP 7-106619 A (三洋電機) 1995.04.21, (ファミリーなし)	1-8
X ②	JP 2006-120944 A (シャープ) 2006.05.11, (ファミリーなし)	1-8
X ③	JP 2000-164901 A (京セラ) 2000.06.16, (ファミリーなし)	1-8
Y ④	WO 2005/096396 A1 (三洋電機) 2005.10.13, & EP 1737048 A1 & CN 1938865 A & US 2007/0283995 A1 & JP 2009-49436 A & JP 4286285 B	1-8

☐ Ｃ欄の続きにも文献が列挙されている。

☐ パテントファミリーに関する別紙を参照。

＊　引用文献のカテゴリー

「Ａ」特に関連のある文献ではなく、一般的技術水準を示すもの

「Ｅ」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの

「Ｌ」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献（理由を付す）

「Ｏ」口頭による開示、使用、展示等に言及する文献

「Ｐ」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献

「Ｔ」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの

「Ｘ」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの

「Ｙ」特に関連のある文献であって、当該文献と他の１以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの

「＆」同一パテントファミリー文献

国際調査を完了した日	国際調査報告の発送日
２３．０７．２０１０	１７．０８．２０１０

国際調査機関の名称及びあて先
日本国特許庁（ＩＳＡ／ＪＰ）
郵便番号１００－８９１５
東京都千代田区霞が関三丁目４番３号

特許庁審査官（権限のある職員）　２Ｋ　９２０７
濱田　聖司
電話番号　０３－３５８１－１１０１　内線　３２５５

Jinko Ex. 1002 - 114/580

Written Opinion
SAKAI
AUG 18, 2010
RECEIVED

特許協力条約

発信人　日本国特許庁（国際調査機関）

代理人
酒井　宏明
様

あて名
〒100-6020
日本国東京都千代田区霞が関三丁目２番５号　霞が関ビルディング　酒井国際特許事務所

PCT
国際調査機関の見解書
（法施行規則第40条の2）
〔PCT規則43の2.1〕

発送日 (日.月.年)	17. 08. 2010
出願人又は代理人 の書類記号　611926W001	今後の手続きについては、下記２を参照すること。

国際出願番号	国際出願日	優先日
PCT／JP2010／061334	(日.月.年)　02. 07. 2010	(日.月.年)

国際特許分類（IPC）Int.Cl. H01L31/042(2006.01)i

出願人（氏名又は名称）
三菱電機株式会社

1．この見解書は次の内容を含む。
- ☑ 第Ⅰ欄　見解の基礎
- ☐ 第Ⅱ欄　優先権
- ☐ 第Ⅲ欄　新規性、進歩性又は産業上の利用可能性についての見解の不作成
- ☐ 第Ⅳ欄　発明の単一性の欠如
- ☑ 第Ⅴ欄　PCT規則43の2.1(a)(i)に規定する新規性、進歩性又は産業上の利用可能性についての見解、それを裏付けるための文献及び説明
- ☐ 第Ⅵ欄　ある種の引用文献
- ☐ 第Ⅶ欄　国際出願の不備
- ☐ 第Ⅷ欄　国際出願に対する意見

2．今後の手続き
国際予備審査の請求がされた場合は、出願人がこの国際調査機関とは異なる国際予備審査機関を選択し、かつ、その国際予備審査機関がPCT規則66.1の2(b)の規定に基づいて国際調査機関の見解書を国際予備審査機関の見解書とみなさない旨を国際事務局に通知していた場合を除いて、この見解書は国際予備審査機関の最初の見解書とみなされる。

この見解書が上記のように国際予備審査機関の見解書とみなされる場合、様式PCT／ISA／220を送付した日から3月又は優先日から22月のうちいずれか遅く満了する期限が経過するまでに、出願人は国際予備審査機関に、適当な場合は補正書とともに、答弁書を提出することができる。

さらなる選択肢は、様式PCT／ISA／220を参照すること。

3．さらなる詳細は、様式PCT／ISA／220の備考を参照すること。

見解書を作成した日
23. 07. 2010

名称及びあて先
日本国特許庁（ISA／JP）
郵便番号100－8915
東京都千代田区霞が関三丁目4番3号

特許庁審査官（権限のある職員）　2K　9207
須田　聖司
電話番号　03－3581－1101　内線　3255

様式PCT／ISA／237（表紙）（2009年7月）

国際調査機関の見解書

国際出願番号 PCT／JP2010／061334

第Ⅰ欄 見解の基礎

1．言語に関し、この見解書は以下のものに基づき作成した。

☑ 出願時の言語による国際出願

☐ 出願時の言語から国際調査のための言語である＿＿＿＿＿＿＿＿語に翻訳された、この国際出願の翻訳文
（ＰＣＴ規則12.3(a)及び23.1(b)）

2．☐ この見解書は、ＰＣＴ規則91の規定により国際調査機関が認めた又は国際調査機関に通知された明らかな誤りの訂正を考慮して作成した（ＰＣＴ規則43の2.1(b)）。

3．この国際出願で開示されたヌクレオチド又はアミノ酸配列に関して、提出された以下の配列表に基づき見解書を作成した。

a．提出手段 ☐ 紙形式

☐ 電子形式

b．提出時期 ☐ 出願時の国際出願に含まれていたもの

☐ この国際出願と共に電子形式により提出されたもの

☐ 出願後に、調査のために、この国際調査機関に提出されたもの

4．☐ さらに、複数の版の配列表又は配列表の写しを提出した場合、出願後に提出した配列の写し若しくは追加して提出した配列の写しが、出願時に提出した配列と同一である旨又は出願時の開示を超える事項を含まない旨の陳述書の提出があった。

5．補足意見：

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国際調査機関の見解書

国際出願番号 ＰＣＴ／ＪＰ２０１０／０６１３３４

第Ⅴ欄　新規性、進歩性又は産業上の利用可能性についてのＰＣＴ規則43の2.1(a)(i)に定める見解、それを裏付ける文献及び説明

1．　見解

新規性（N）	請求項	２－４	有
	請求項	１、５－８	無
進歩性（ＩＳ）	請求項		有
	請求項	１－８	無
産業上の利用可能性（ＩＡ）	請求項	１－８	有
	請求項		無

2．　文献及び説明

文献１：　JP 7-106619 A (三洋電機) 1995.04.21

（１）文献１には、小分割領域１ａ～１ｃに分割され、表面に形成された一対の接続領域部分２ａと、裏面に形成された一対の接続領域部分３ａと、を有する複数の太陽電池素子４を、電気接続部材５で接続した太陽電池が開示されている。

（２）してみれば、請求項１、５－８は文献１に対して新規性及び進歩性はない。

（３）請求項２－４は、セルの分割比や、セルの接続形態に関して文献１とは相違するが、それらはいずれも設計的事項であると考えられるので、文献１に対して進歩性はない。

Jinko Ex. 1002 - 117/580

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 07-106619
(43)Date of publication of application : 21.04.1995

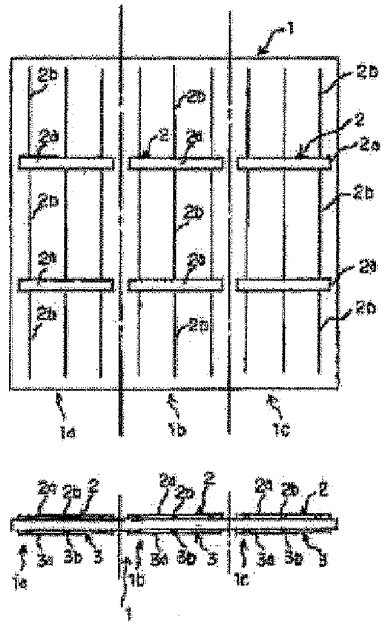
(51)Int.Cl. H01L 31/042

(21)Application number : 05-251769
(22)Date of filing : 07.10.1993

(71)Applicant : SANYO ELECTRIC CO LTD
(72)Inventor : MAEHANE MASAYOSHI
TAKAHATA YOSHINOBU
NOMURA TOSHIHIRO
MATSUKAWA YASUHARU

(54) FABRICATION OF SOLAR CELL

(57)Abstract:
PURPOSE: To provide a method for fabricating a solar cell in which short circuit is prevented when the surface electrode of a split solar cell element is connected electrically with the rear electrode of an adjacent solar cell element through an electric connection member.
CONSTITUTION: The method for fabricating a solar cell comprises a step for forming a surface electrode 2 on the light receiving side having a connecting region 2a terminating in the small power generating region Ia-1c on a semiconductor having a semiconductor junction in the proximity of the outer periphery thereof for each small power generating region Ia-1c, a step for forming a rear electrode 3, and a step for splitting the semiconductor substrate 1 for the plurality of small power generating regions 1a-1c. A step is also provided for connecting the connecting region 2a of the surface electrode 2 of solar cell element 4 comprising the split small power generating region, over the entire region thereof, with the rear electrode 3 of an adjacent solar cell element through an electric connection member.



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* NOTICES *

JPO and INPIT are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]A manufacturing method of a solar cell characterized by comprising the following.
A process of forming an acceptance surface side surface electrode which has a connection area part which carries out a termination to an inside of the latest of an outer peripheral part of these smallness electricity generation region for two or more small electricity generation regions of every of a semiconductor substrate which has semiconductor junction.
A process of forming a rear electrode.
A process of dividing the aforementioned semiconductor substrate for two or more aforementioned smallness electricity generation regions of every.
The aforementioned connection area part whole region of the aforementioned surface electrode of a solar battery element which consists of a divided small electricity generation region.
A process which carries out electrical connection by connecting the aforementioned rear electrode of an adjoining solar battery element by an electrical connection component.

[Claim 2]A manufacturing method of a solar cell characterized by comprising the following.
A process of forming an acceptance surface side surface electrode and a rear electrode which have a connection area part which carries out a termination to an inside of the latest of an outer peripheral part of these smallness electricity generation region for two or more small electricity generation regions of every of a semiconductor substrate which has semiconductor junction.
Two or more aforementioned connection area part whole region of a solar battery element consisting of the aforementioned semiconductor substrate.
A process of carrying out electrical connection of the aforementioned rear electrode of a solar battery element which adjoins this in the aforementioned electrical connection component.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

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[0001]
[Industrial Application]The present invention relates to the manufacturing method of a solar cell.
[0002]
[Description of the Prior Art]The manufacturing method of the conventional solar cell is described using Fig.6 – 8.
[0003]First, the semiconductor substrate 10 consisting of the polycrystalline silicon of the right-angled quadrangle which formed pn junction in the acceptance surface side has the three small electricity generation regions 10a–10c classified in parallel with a longitudinal side. The surface electrode 12 consisting of the pair of connection area part 12a extended in parallel the horizontal neighborhood on this semiconductor substrate 10 ranging over the three small electricity generation regions 10a–10c and two or more branch parts 12b extended to direction crossing at a right angle from these connection area parts 12a is formed. Also in the back surface of the semiconductor substrate 10, the rear electrode 13 consisting of the isomorphism–like connection area part 13a and the branch parts 13b is formed. And it crosses the whole region on the connection area part 12a of the surface electrode 12 and the rear electrode 13, and 13a, and a solder layer is formed.
[0004]Next, the semiconductor substrate 10 is divided into every small electricity generation region 10a – 10c, and the solar battery elements 14a–14c which consist of the small electricity generation regions 10a–10c are created. The one solar battery element 14b is shown in Fig.7. As shown in Fig.8, adjoin, put in order two or more divided solar battery elements 14a–14c, and Then, the connection area part 12a of the surface electrode 12 of one solar battery elements 14b and 14c, The solar cell which carried out the series connection of the solar battery elements 14a–14b is completed by carrying out electrical connection of the connection area part 13a of the rear electrode 13 of the solar battery elements 14a and 14b of another side which adjoins, respectively by the electrical connection component 15. Use is also possible as a solar battery element consisting of the one semiconductor substrate 10, without dividing the semiconductor substrate 10.
[0005]
[Problem to be solved by the invention]There were the following problems in the manufacturing method of the above conventional solar cell. For example, since the solar battery element 14b (refer to Fig.7) was formed in the portion which is placed in the middle of the semiconductor substrate 10, the connection area part 12a has extended even in the longitudinal side which is an outer peripheral part. And when connecting the electrical connection component 15 to this connection area part 12a, the solder on the connection area part 12a hangs down on the side surface of the solar battery element 14b, as the code 16 shows, and reaches and connects with the connection area part 13a of the rear electrode 13 which is placed directly under it too hastily (refer to Fig.8 (c)).
[0006]The surface electrode of a solar battery element which was made in order that the 1st invention of the present invention might solve such a problem, and was divided, It aims at providing the manufacturing method of the solar cell which prevents facing and connecting the

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divided rear electrode of a contiguity solar battery element with carrying out electrical connection in an electrical connection component too hastily.

[0007]An object of the 2nd invention of the present invention is to provide the manufacturing method of the solar cell which carried out electrical connection of the solar battery element consisting of one semiconductor substrate using the same semiconductor substrate as the 1st invention.

[0008]

[Means for solving problem]The process of forming the acceptance surface side surface electrode which has a connection area part which carries out the termination of the 1st invention of the present invention to the inside of the latest of the outer peripheral part of these smallness electricity generation region for two or more small electricity generation regions of every of the semiconductor substrate which has semiconductor junction, The process of forming a rear electrode, and the process of dividing the aforementioned semiconductor substrate for two or more aforementioned smallness electricity generation regions of every, It has the process of carrying out electrical connection, by connecting the aforementioned connection area part whole region of the aforementioned surface electrode of the solar battery element which consists of a divided small electricity generation region, and the aforementioned rear electrode of the adjoining solar battery element by an electrical connection component.

[0009]The process of forming the acceptance surface side surface electrode and rear electrode which have a connection area part which carries out the termination of the 2nd invention of the present invention to the inside of the latest of the outer peripheral part of these smallness electricity generation region for two or more small electricity generation regions of every of the semiconductor substrate which has semiconductor junction, It has the process of carrying out electrical connection of two or more aforementioned connection area part whole region of the solar battery element consisting of the aforementioned semiconductor substrate, and the aforementioned rear electrode of the solar battery element which adjoins this in the aforementioned electrical connection component.

[0010]

[Function]The present invention is carrying out electrical connection of the connection area part whole region of the divided surface electrode of a solar battery element, and the rear electrode of the adjoining solar battery element in the electrical connection component in the 1st invention for the above composition. Since the connection area part is placed at the inside of the latest of the outer peripheral part of a solar battery element at this time, it does not connect too hastily undesirably.

[0011]In the 2nd invention, the solar cell which carried out electrical connection of the solar battery element consisting of one semiconductor substrate can be manufactured, without dividing a semiconductor substrate using the same semiconductor substrate as the 1st invention.

[0012]

[Working example]Below, one working example of the 1st invention of the present invention is

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described in detail using Fig.1 - 4.

[0013]First, the semiconductor substrate 1 consisting of the polycrystalline silicon of the right-angled quadrangle which formed pn junction in the acceptance surface side has the three small electricity generation regions 1a-1c classified in parallel with a longitudinal side. In the acceptance surface on this semiconductor substrate 1, the surface electrode 2 which becomes every three small electricity generation region 1a - 1c from silver paste is formed. These surface electrodes 2 are [horizontal neighborhood of the semiconductor substrate 1] parallel, and have two or more branch-parts 2bs extended to direction crossing at a right angle from the pair of connection area part 2a in which both ends carry out a termination to the inside of the latest of the outer peripheral part of each small electricity generation region 1a-1c, and these connection area parts 2a. Also in the back surface of the semiconductor substrate 1, the rear electrode 3 consisting of the isomorphism-like connection area part 3a and the branch parts 3b is formed. And the whole region on the connection area part 2a of the surface electrode 2 and the rear electrode 3, and 3a, a dip method or an ultrasonic solder method is used, and a solder layer is formed.

[0014]The rear electrode 3 may be the paste of aluminum or silver formed throughout the back surface of the semiconductor substrate 1. In this case, the solder layer on the rear electrode 3 may be formed throughout the above-mentioned connection region 3a, the shape of isomorphism, or the rear electrode 3.

[0015]Next, the solar battery element 4 is created from the acceptance surface side of the semiconductor substrate 1 using a dicing saw by dividing the semiconductor substrate 1 into every small electricity generation region 1a - 1c (refer to Fig.2).

[0016]As shown in Fig.3, adjoin, put in order two or more divided solar battery elements 4, and The connection area part 2a of the surface electrode 2 of one solar battery element 4, By connecting the whole region with the connection area part 3a of the rear electrode 3 of the solar battery element 4 of another side which adjoins this by the electrical connection component 5 consisting of a metallic foil etc., the series connection of two or more solar battery elements 4 is carried out electrically, and a solar cell completes them.

[0017]Since the connection area part 2a is placed at the inside of the latest of the outer peripheral part of the solar battery element 4 at this time, solder does not reach [from the acceptance surface side] the outer peripheral part and side surface of the solar battery element 4. When the rear electrode 3 is formed throughout the back surface of the solar battery element 4, even if solder reaches the side surface of the solar battery element 4 from the back surface side, this solder will not contact the connection area part 2a which is placed at the inside of the latest of the outer peripheral part of the solar battery element 4. Therefore, a solar battery element does not short-circuit.

[0018]Since the connection area part 2a of the surface electrode 2 is carrying out the termination to the inside of the latest of the outer peripheral part of the solar battery element 4, As shown in Fig.4, when the adjoining interval of the solar battery element 4 becomes narrow, the electrical connection component 5 connected to the connection area part 2a of the right-

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hand side solar battery element 4 does not connect with the electrical connection component 5 connected to the connection area part 2a of the left-hand side solar battery element 4, or this too hastily undesirably. As the rear electrode 3 is shown in a figure, when it has the connection area part 3a which carries out a termination to the inside of the latest of the outer peripheral part of the solar battery element 4, the surface electrode 2 and the rear electrode 3 of the same solar battery element 4 do not short-circuit by the electrical connection component 5 during contiguity.

[0019]Next, it describes about the 2nd invention of the present invention. By the same process as the 1st invention of the above, the semiconductor substrate 1 shown in Fig.1 is created. Then, two or more solar battery elements 6 consisting of the semiconductor substrate 1 are put in order adjacently, without dividing the semiconductor substrate 1, as shown in Fig.5. And the connection area part 2a in the surface electrode 2 of one solar battery element 6, Electrical connection of 2a and the 2a is carried out using one end of the electrical connection component 5 consisting of a metallic foil etc., and electrical connection of the connection area parts 3a, 3a, and 3a of the rear electrode 3 of the solar battery element 6 which adjoins this is carried out using the other end of the electrical connection component 5. Therefore, electrical connection of the solar battery element 6 is carried out in series, and a solar cell completes it.

[0020]Here, between the lateral connection area parts 2a and 2a and 2a, space 7 and 7 is formed directly under electrical connection component 5. After the incident light from an oblique direction turns or incident light makes it reflect from the acceptance surface of the solar battery element 6 by these space 7 and 7, improvement in the characteristic can be aimed at by being reflected with the back surface of the electrical connection component 5 in space 7, and carrying out re incidence to the solar battery element 6 etc.

[0021]

[Effect of the Invention]The present invention carries out electrical connection of the connection area part whole region of the divided surface electrode of a solar battery element, and the rear electrode of the adjoining solar battery element in an electrical connection component in the 1st invention for the above composition. Since the connection area part of the surface electrode is placed at the inside of the latest of the outer peripheral part of a solar battery element at this time, it does not connect too hastily undesirably.

[0022]In addition, since the divided surface electrode of all the solar battery elements has a connection area part inside the latest of the outer peripheral part, its usable area which contributes to power generation improves rather than the conventional solar battery element to which the connection area part exists even in the outer peripheral part.

[0023]In connection resilience, the electrical connection component is working as a collector with the connection area part largely from the electrical connection component being soldered throughout the connection area part of a surface electrode.

[0024]In the 2nd invention of the present invention, electrical connection of the whole region of the connection area part of a surface electrode is carried out in the electrical connection component, without dividing a semiconductor substrate using the semiconductor substrate of the

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1st invention. That is, the 1st invention and a common semiconductor substrate can be used.
[0025]In addition, in connection resilience, the electrical connection component is working as a collector with the connection area part largely from an electrical connection component being connected throughout two or more connection area parts on one semiconductor substrate.
[0026]Improvement in the characteristic can be aimed at by a surroundings lump of incident light, re incidence, etc. to space formed directly under [between two or more connection area parts / electrical connection component].

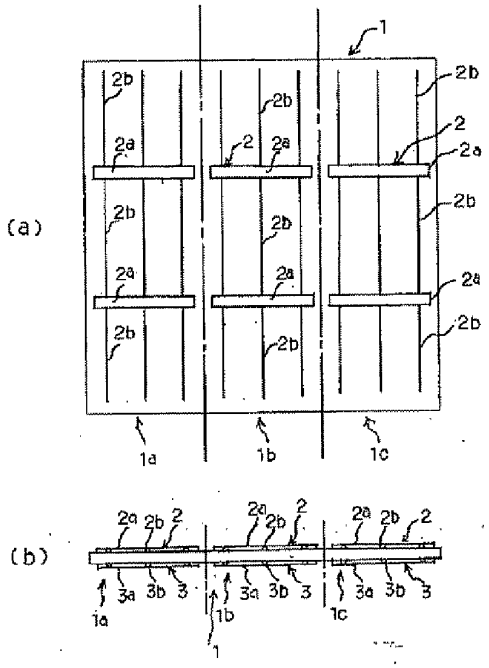
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The semiconductor substrate in one working example of the present invention is shown, (a) is a plan view and (b) is a side view.
[Drawing 2]The solar battery element in the 1st invention of the present invention is shown, (a) is a plan view and (b) is a side view.
[Drawing 3]The solar cell which carried out the series connection of the solar battery element in the 1st invention of the present invention is shown, (a) is a plan view and (b) is a side view.
[Drawing 4]In the 1st invention of the present invention, it is a side view of the solar cell which narrowed the solar battery element interval and carried out the series connection.
[Drawing 5]The solar cell which carried out the series connection of the solar battery element in the 2nd invention of the present invention is shown, (a) is a plan view and (b) is a side view.
[Drawing 6]It is a plan view of the conventional semiconductor substrate.
[Drawing 7]The conventional solar battery element is shown, (a) is a plan view and (b) is a side view.
[Drawing 8]The solar cell which carried out the series connection of the conventional solar battery element is shown, and, as for a plan view and (b), a side view and (c) of (a) are the A section enlarged drawings.
[Explanations of letters or numerals]
1 Semiconductor substrate
1a, 1b, and 1c Small electricity generation region
2 Surface electrode 2a connection area part 2b Branch parts
3 Rear electrode 3a connection area part 3b branch parts
4 Solar battery element
5 Electrical connection component
6 Solar battery element
7 Space

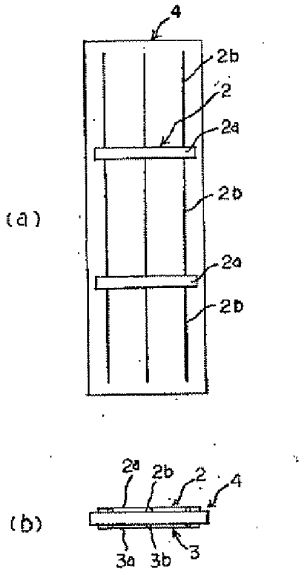
DRAWINGS

[Drawing 1]

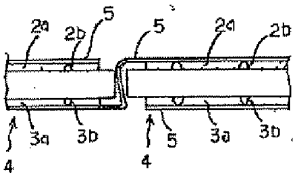
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[Drawing 2]

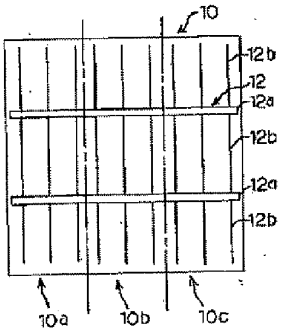


[Drawing 4]

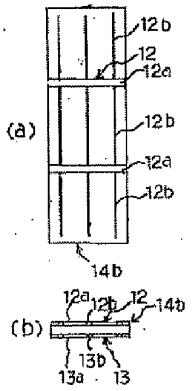


[Drawing 6]

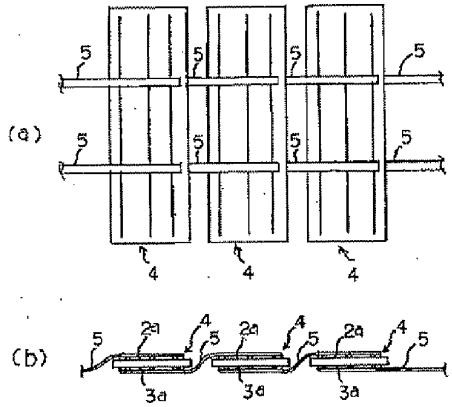
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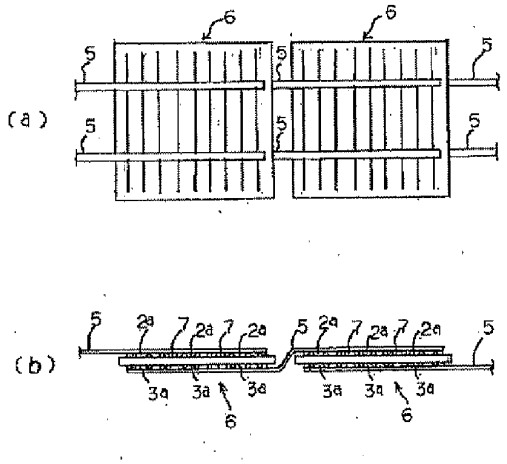
[Drawing 7]



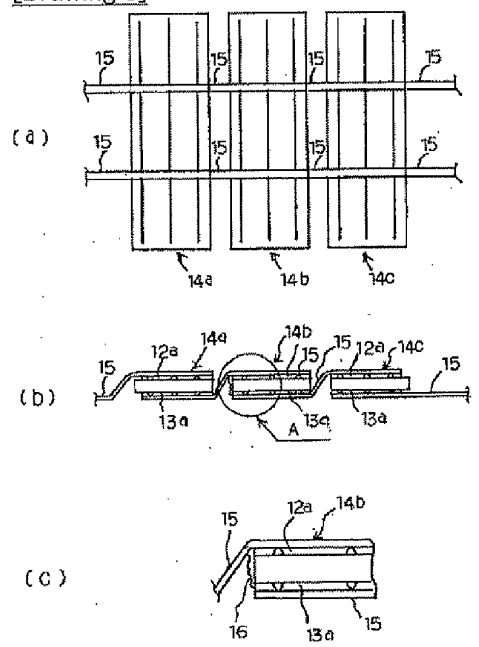
[Drawing 3]



[Drawing 5]



[Drawing 8]



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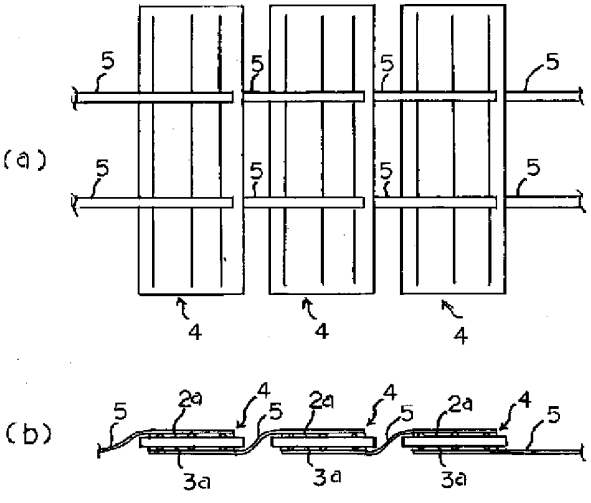
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(54)【発明の名称】　太陽電池の製造方法

(57)【要約】

【目的】　分割された太陽電池素子の表面電極と、分割された隣接太陽電池素子の裏面電極とを電気接続部材にて電気接続するに際して、短絡することを防止する太陽電池の製造方法を提供することを目的とする。

【構成】　半導体接合を有する半導体基板１の複数の小発電領域１ａ～１ｃごとに、これら小発電領域１ａ～１ｃの外周部の直近内部に終端する接続領域部分２ａを有する受光面側表面電極２を形成する工程と、裏面電極３を形成する工程と、複数の前記小発電領域１ａ～１ｃごとに前記半導体基板１を分割する工程と、分割された小発電領域からなる太陽電池素子４の前記表面電極２の前記接続領域部分２ａ全域と、隣接する太陽電池素子４の前記裏面電極３とを、電気接続部材５で接続することにより電気接続する工程とを有することを特徴とする。



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【特許請求の範囲】

【請求項１】　半導体接合を有する半導体基板の複数の小発電領域ごとに、これら小発電領域の外周部の直近内部に終端する接続領域部分を有する受光面側表面電極を形成する工程と、裏面電極を形成する工程と、複数の前記小発電領域ごとに前記半導体基板を分割する工程と、分割された小発電領域からなる太陽電池素子の前記表面電極の前記接続領域部分全域と、隣接する太陽電池素子の前記裏面電極とを、電気接続部材で接続することにより電気接続する工程とを有することを特徴とする太陽電池の製造方法。

【請求項２】　半導体接合を有する半導体基板の複数の小発電領域ごとに、これら小発電領域の外周部の直近内部に終端する接続領域部分を有する受光面側表面電極及び裏面電極を形成する工程と、前記半導体基板からなる太陽電池素子の複数の前記接続領域部分全域と、これに隣接する太陽電池素子の前記裏面電極とを前記電気接続部材にて電気接続する工程を有することを特徴とする太陽電池の製造方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、太陽電池の製造方法に関する。

【０００２】

【従来の技術】従来の太陽電池の製造方法を、図６～８を用いて説明する。

【０００３】まず、受光面側にｐｎ接合を形成した直角４角形の多結晶シリコンからなる半導体基板１０は、縦辺に並行に区分された３つの小発電領域１０ａ～１０ｃを有している。この半導体基板１０上に、３つの小発電領域１０ａ～１０ｃにまたがって、横辺に並行に延びる一対の接続領域部分１２ａと、これら接続領域部分１２ａから直交方向に延びる複数の枝部分１２ｂからなる表面電極１２を形成する。また、半導体基板１０の裏面においても、同形状の接続領域部分１３ａ、枝部分１３ｂからなる裏面電極１３を形成する。そして、表面電極１２、裏面電極１３の接続領域部分１２ａ、１３ａ上の全域にわたって、半田層を形成する。

【０００４】次に、半導体基板１０を小発電領域１０ａ～１０ｃごとに分割して、小発電領域１０ａ～１０ｃからなる太陽電池素子１４ａ～１４ｃを作成する。図７に一つの太陽電池素子１４ｂを示している。この後、図８に示すように、分割された複数の太陽電池素子１４ａ～１４ｃを隣接して並べ、一方の太陽電池素子１４ｂ、１４ｃの表面電極１２の接続領域部分１２ａと、それぞれ隣接する他方の太陽電池素子１４ａ、１４ｂの裏面電極１３の接続領域部分１３ａとを、電気接続部材１５にて、電気接続することにより、太陽電池素子１４ａ～１４ｂを直列接続した太陽電池が完成する。また、半導体基板１０を分割することなく、一つの半導体基板１０からなる太陽電池素子として、利用も可能である。

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【０００５】

【発明が解決しようとする課題】以上の従来の太陽電池の製造方法には、次のような問題点があった。例えば、太陽電池素子１４ｂ（図７参照）は、半導体基板１０の中程に位置する部分にて形成されたために、外周部である縦辺にまで、接続領域部分１２ａが延在している。そして、この接続領域部分１２ａに電気接続部材１５を接続するとき、接続領域部分１２ａ上の半田が、符号１６で示すように太陽電池素子１４ｂの側面に垂れ下がり、その直下に位置する裏面電極１３の接続領域部分１３ａに到達し、短絡してしまう（図８（ｃ）参照）。

【０００６】本発明の第１発明は、このような問題点を解決するためになされたものであり、分割された太陽電池素子の表面電極と、分割された隣接太陽電池素子の裏面電極とを電気接続部材にて電気接続するに際して、短絡することを防止する太陽電池の製造方法を提供することを目的とする。

【０００７】更に、本発明の第２発明は、第１発明と同一の半導体基板を用いて、一つの半導体基板からなる太陽電池素子を電気接続した太陽電池の製造方法を提供することを目的とする。

【０００８】

【課題を解決するための手段】本発明の第１発明は、半導体接合を有する半導体基板の複数の小発電領域ごとに、これら小発電領域の外周部の直近内部に終端する接続領域部分を有する受光面側表面電極を形成する工程と、裏面電極を形成する工程と、複数の前記小発電領域ごとに前記半導体基板を分割する工程と、分割された小発電領域からなる太陽電池素子の前記表面電極の前記接続領域部分全域と、隣接する太陽電池素子の前記裏面電極とを、電気接続部材で接続することにより電気接続する工程とを有することを特徴とする。

【０００９】また、本発明の第２発明は、半導体接合を有する半導体基板の複数の小発電領域ごとに、これら小発電領域の外周部の直近内部に終端する接続領域部分を有する受光面側表面電極及び裏面電極を形成する工程と、前記半導体基板からなる太陽電池素子の複数の前記接続領域部分全域と、これに隣接する太陽電池素子の前記裏面電極とを前記電気接続部材にて電気接続する工程を有することを特徴とする。

【００１０】

【作用】本発明は、以上の構成のため、第１発明においては、分割された太陽電池素子の表面電極の接続領域部分全域と、隣接する太陽電池素子の裏面電極とを、電気接続部材にて電気接続している。この時、接続領域部分が太陽電池素子の外周部の直近内部に位置しているので、不所望に短絡することがない。

【００１１】また、第２発明においては、第１発明と同一の半導体基板を用いて、半導体基板を分割することな

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く、一つの半導体基板からなる太陽電池素子を電気接続した太陽電池を製造することができる。

【００１２】

【実施例】以下に、本発明の第１発明の一実施例を、図１～４を用いて、詳細に説明する。

【００１３】まず、受光面側にｐｎ接合を形成した直角４角形の多結晶シリコンからなる半導体基板１は、縦辺に並行に区分された３つの小発電領域１ａ～１ｃを有している。この半導体基板１上の受光面において、３つの小発電領域１ａ～１ｃごとに、銀ペーストからなる表面電極２を形成する。これらの表面電極２は、半導体基板１の横辺に並行で両端が各小発電領域１ａ～１ｃの外周部の直近内部に終端する一対の接続領域部分２ａと、これら接続領域部分２ａから直交方向に延びる複数の枝部分２ｂを有している。また、半導体基板１の裏面においても、同形状の接続領域部分３ａ、枝部分３ｂからなる裏面電極３を形成する。そして、表面電極２、裏面電極３の接続領域部分２ａ、３ａ上の全域に、ディップ法、又は、超音波半田法を用いて、半田層を形成する。

【００１４】また、裏面電極３は、半導体基板１の裏面全域に形成されたアルミ又は銀等のペーストであってもよい。この場合、裏面電極３上における半田層は、上記接続領域３ａと同形状に、又は、裏面電極３の全域に形成してもよい。

【００１５】次に、半導体基板１の受光面側より、ダイシングソーを用いて、小発電領域１ａ～１ｃごとに半導体基板１を分割することにより、太陽電池素子４を作成する（図２参照）。

【００１６】更に、図３に示すように、分割された複数の太陽電池素子４を隣接して並べ、一方の太陽電池素子４の表面電極２の接続領域部分２ａと、これに隣接する他方の太陽電池素子４の裏面電極３の接続領域部分３ａとの全域を、金属箔等からなる電気接続部材５で接続することにより、複数の太陽電池素子４は、電気的に直列接続され、太陽電池が完成する。

【００１７】この時、接続領域部分２ａが太陽電池素子４の外周部の直近内部に位置しているので、受光面側から半田が太陽電池素子４の外周部及び側面に至らない。また、裏面電極３が、太陽電池素子４の裏面全域に形成された場合、たとえ裏面側から半田が太陽電池素子４の側面に至っても、この半田が、太陽電池素子４の外周部の直近内部に位置する接続領域部分２ａに接触することがない。従って、太陽電池素子が短絡することがない。

【００１８】また、表面電極２の接続領域部分２ａが太陽電池素子４の外周部の直近内部に終端しているので、図４に示すように、太陽電池素子４の隣接間隔が狭くなったとき、右側の太陽電池素子４の接続領域部分２ａに接続された電気接続部材５が、左側の太陽電池素子４の接続領域部分２ａ又はこれに接続された電気接続部材５と、不所望に短絡することはない。また、裏面電極３が、図に示すように、太陽電池素子４の外周部の直近内部に終端する接続領域部分３ａを有するときは、隣接間における電気接続部材５により同一太陽電池素子４の表面電極２と裏面電極３とが、短絡することもない。

【００１９】次に、本発明の第２発明について説明する。上記第１発明と同じ工程により、図１に示す半導体基板１を作成する。この後、図５に示すように、半導体基板１を分割することなく、半導体基板１よりなる複数の太陽電池素子６を隣接して並べる。そして、一方の太陽電池素子６の表面電極２における接続領域部分２ａ、２ａ、２ａを、金属箔等からなる電気接続部材５の一端を用いて電気接続し、これに隣接する太陽電池素子６の裏面電極３の接続領域部分３ａ、３ａ、３ａを、電気接続部材５の他端を用いて電気接続する。従って、太陽電池素子６は、直列に電気接続され、太陽電池が完成する。

【００２０】ここで、横方向の接続領域部分２ａ、２ａ、２ａ間において、電気接続部材５直下に空間７、７が形成される。これら空間７、７により、斜め方向からの入射光が回り込んだり、入射光が太陽電池素子６の受光面より反射させた後、空間７における電気接続部材５の裏面にて反射され、太陽電池素子６に再入射すること等により、特性向上を図ることができる。

【００２１】

【発明の効果】本発明は、以上の構成のため、第１発明においては、分割された太陽電池素子の表面電極の接続領域部分全域と、隣接する太陽電池素子の裏面電極とを、電気接続部材にて電気接続する。この時、表面電極の接続領域部分が太陽電池素子の外周部の直近内部に位置しているので、不所望に短絡することがない。

【００２２】加えて、分割された全ての太陽電池素子の表面電極は、その外周部の直近内部に接続領域部分を有しているので、外周部にまで接続領域部分が存在している従来の太陽電池素子よりも、発電に寄与する有効面積が向上する。

【００２３】更に、表面電極の接続領域部分全域に電気接続部材が半田付けされていることより、接続強度が大きく、電気接続部材が接続領域部分と共に集電極として働いている。

【００２４】本発明の第２発明においては、第１発明の半導体基板を利用して、半導体基板を分割することなく、表面電極の接続領域部分の全域を電気接続部材にて電気接続している。つまり、第１発明と共通の半導体基板を利用できる。

【００２５】加えて、一つの半導体基板上の複数の接続領域部分全域に電気接続部材が接続されることより、接続強度が大きく、電気接続部材が接続領域部分と共に集電極として働いている。

【００２６】更に、複数の接続領域部分間の電気接続部材直下に形成された空間に、入射光の回り込み、再入射

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等により特性向上を図ることができる。

【図面の簡単な説明】

【図１】本発明の一実施例における半導体基板を示し、（ａ）は平面図、（ｂ）は側面図である。

【図２】本発明の第１発明における太陽電池素子を示し、（ａ）は平面図、（ｂ）は側面図である。

【図３】本発明の第１発明における太陽電池素子を直列接続した太陽電池を示し、（ａ）は平面図、（ｂ）は側面図である。

【図４】本発明の第１発明において、太陽電池素子間隔を狭くして、直列接続した太陽電池の側面図である。

【図５】本発明の第２発明における太陽電池素子を直列接続した太陽電池を示し、（ａ）は平面図、（ｂ）は側面図である。

【図６】従来の半導体基板の平面図である。

【図７】従来の太陽電池素子を示し、（ａ）は平面図、＊（ｂ）は側面図である。

【図８】従来の太陽電池素子を直列接続した太陽電池を示し、（ａ）は平面図、（ｂ）は側面図、（ｃ）はＡ部拡大図である。

【符号の説明】

１　半導体基板

１ａ、１ｂ、１ｃ　小発電領域

２　表面電極　　２ａ　接続領域部分　　２ｂ　枝部分

３　裏面電極　　３ａ　接続領域部分　　３ｂ　枝部分

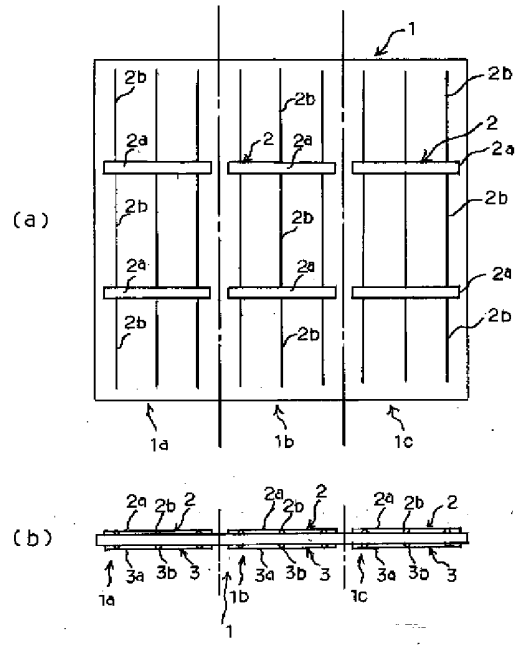
４　太陽電池素子

５　電気接続部材

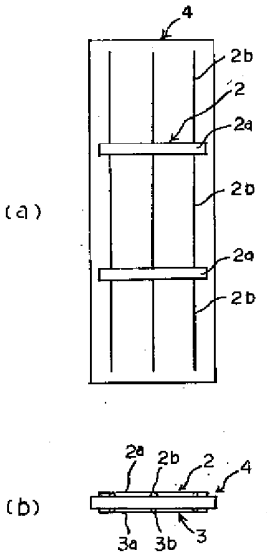
６　太陽電池素子

７　空間

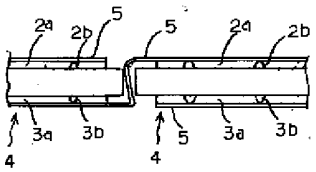
【図１】



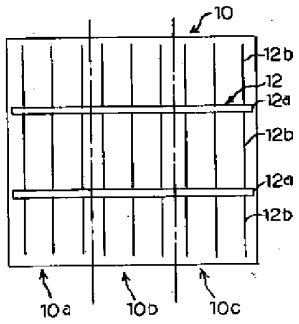
【図２】



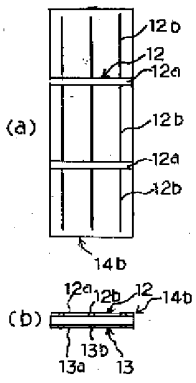
【図４】



【図６】

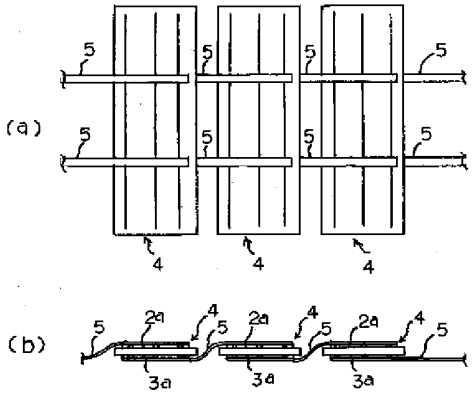


【図７】

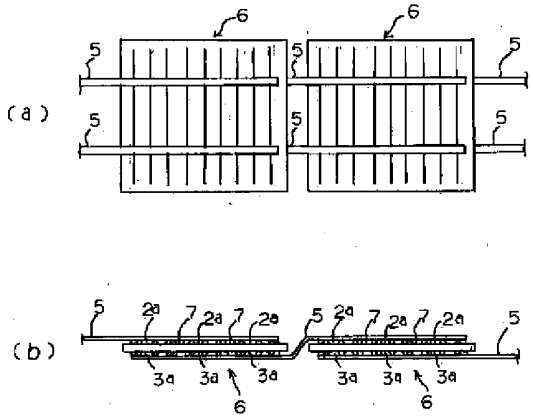


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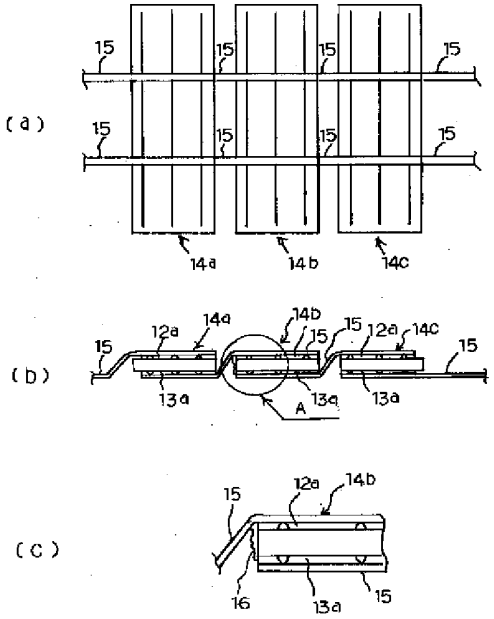
【図３】



【図５】



【図８】



フロントページの続き

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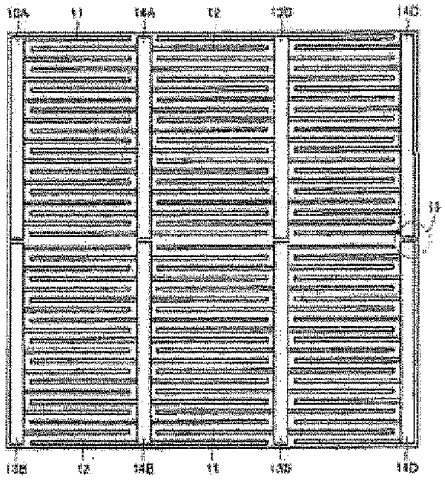
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(54) SOLAR CELL, PROCESS FOR MANUFACTURING SOLAR CELL UNIT, AND SOLAR CELL MODULE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a back bonding solar cell in which a short circuit part can be specified easily, and to provide a process for manufacturing a solar cell unit, and a solar cell module including a solar cell or a cell unit.
SOLUTION: The solar cell comprises a silicon substrate 1, and an electrode part formed on the major surface of the silicon substrate 1 wherein the electrode part has a bus bar p electrode 13, a bus bar n electrode 14 formed adjacently to the bus bar p electrode 13 at an interval on the major surface of the silicon substrate 1, a finger p electrode 11 extending from the bus bar p electrode 13 toward the bus bar n electrode 14, and a finger n electrode 12 extending from the bus bar n electrode 14 toward the bus bar p electrode 13 to reach the vicinity of the finger p electrode 11 wherein a disconnection portion 15 is formed in at least one of the bus bar p electrode 13 and the bus bar n electrode 14.



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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]
A semiconductor substrate,
It has polar zone formed on a main table surface of the aforementioned semiconductor substrate,
The aforementioned polar zone is the 1st bus part,
The 2nd bus part that vacated an interval for said 1st bus part and a position which is adjacent to, and was formed on a main table surface of the aforementioned semiconductor substrate,
The 1st finger part extended towards said 2nd bus part from said 1st bus part,
It extends towards said 1st bus part from said 2nd bus part, and has the 2nd finger part that reaches near said 1st finger part,
A photovoltaic cell by which a disconnection part was formed in at least 1 side of said 1st [the] and the 2nd bus part.
[Claim 2]
The photovoltaic cell according to claim 1 by which the aforementioned disconnection part is formed in a central part in an extending direction of said 1st [the] and the 2nd bus part.
[Claim 3]
A semiconductor substrate,
It has two or more polar zone formed on a main table surface of the aforementioned semiconductor substrate,
The aforementioned polar zone is the 1st bus part,
The 2nd bus part that vacated an interval for said 1st bus part and a position which is adjacent to, and was formed on a main table surface of the aforementioned semiconductor substrate,
The 1st finger part extended towards said 2nd bus part from said 1st bus part,
It extends towards said 1st bus part from said 2nd bus part, and has the 2nd finger part that reaches near said 1st finger part,
two or more aforementioned polar zone --- this --- a photovoltaic cell formed so that it might rank with an extending direction of the 1st and the 2nd bus part.

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[Claim 4]
The photovoltaic cell according to claim 3 with an equal interval between said 1st [the] and the 2nd bus part in two or more aforementioned polar zone.
[Claim 5]
A process of forming the 1st impurity range of the 1st conductivity type, and the 2nd impurity range of the 2nd conductivity type on a main table surface of a semiconductor substrate so that it may stand in a line alternately,
said 1st [the], the 1st which are formed on the 2nd impurity range, respectively, and the 2nd finger part -- this -- a process of forming polar zone which extends in the direction which intersects the 1st and the 2nd finger part, has a disconnection part, and includes said 1st [the], the 1st to which the 2nd finger part is connected, respectively, and the 2nd bus part,
A process of dividing the aforementioned semiconductor substrate in which the aforementioned polar zone was formed to the 1st and the 2nd semiconductor substrate in the aforementioned disconnection part,
A manufacturing method of a solar cell cell unit provided with a process of electrically connecting the polar zone formed on the 2nd semiconductor substrate, respectively with said 1st [the] divided.
[Claim 6]
A solar cell module containing at least 1 side of a solar cell cell unit manufactured by a manufacturing method of the photovoltaic cell according to any one of claims 1 to 4 and the solar cell cell unit according to claim 5.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Field of the Invention]
[0001]
Especially the present invention relates to the manufacturing method and solar cell module of the photovoltaic cell of the back surface assembling die with which the electrode was formed on the back surface of a semiconductor substrate, and a solar cell cell unit about the manufacturing method and solar cell module of a photovoltaic cell and a solar cell cell unit.
[Background of the Invention]
[0002]
In recent years from a viewpoint which solves the problem of exhaustion of an energy resource, global environment problems like the increase in CO_2 in the atmosphere, etc., Development of clean energy is desired, photovoltaics using the solar cell module especially constituted by connecting two or more photovoltaic cells is developed and put in practical use as a new energy source, and the way of development is followed.
[0003]
As a photovoltaic cell which constitutes a solar cell module, That by which an electrode is

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formed from the former, respectively on the back surface which has sunlight in the opposite side the surface (acceptance surface) top of an incident side among the main table surfaces of a silicon substrate, That (back surface assembling-die cell) in which two kinds of electrodes connected to the impurity range of a conductivity type which is mutually different only in the back surface up of a silicon substrate are formed is known.

[0004]

In the cell by which an electrode is formed on the acceptance surface of a silicon substrate, and a back surface, respectively, pn junction is formed by diffusing the impurity which serves as a conductivity type of a silicon substrate, and an opposite conductivity type, for example from the acceptance surface side of the silicon substrate of a single crystal or polycrystal. Attaining a high increase in power by the back surface field effect is also performed from the former by diffusing the impurity of the same conductivity type as a silicon substrate at high concentration from the back surface side of a silicon substrate.

[0005]

However, in the photovoltaic cell by which an electrode is formed in this way on an acceptance surface, since this electrode interrupts incident sunlight, the output of a photovoltaic cell may be deteriorated and the output of a solar cell module may be deteriorated as a result.

[0006]

On the other hand, the back surface assembling-die photovoltaic cell in which an electrode is formed is used only for the back surface up of the silicon substrate from the former. Although incident light is not interrupted by the electrode on an acceptance surface in a back surface assembling-die photovoltaic cell, since electric power can be taken out only from the back surface side of a silicon substrate, The structure of the electrode is dramatically important in view of the output improvement of the solar cell module constituted by connecting two or more photovoltaic cells and these.

[0007]

Fig.17 and Fig.18 are the figures showing an example of the conventional back surface assembling-die photovoltaic cell.Fig.17 is a cross sectional view of a photovoltaic cell, and Fig.18 is a plan of this photovoltaic cell.

[0008]

With reference to Fig.17, the passivation film 109 is formed on the main table surface by the side of the acceptance surface of the p type silicon substrate 101 (on [in Fig.17]). On the main table surface by the side of the back surface of the silicon substrate 101 (under [in Fig.17]), on both sides of the passivation film 110, alternately, the n+ impurity layer 105 and the p+ impurity layer 106 vacate a predetermined interval, and are formed. And the finger p electrode 111 is formed on the p+ impurity layer 106, and the finger n electrode 112 is formed on the n+ impurity layer 105.

[0009]

If sunlight enters into the acceptance surface of this back surface assembling-die photovoltaic cell, the carrier produced near the acceptance surface of the silicon substrate 101 will reach even the pn junction formed in the back surface, and will be collected by the finger p electrode

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111 and the finger n electrode 112 as current. This current is taken out outside and serves as an output of a solar cell module.

[0010]

a viewpoint to the finger p electrode 111 and the finger n electrode 112 which improve the output of a photovoltaic cell with reference to Fig.18 -- the back surface top of the silicon substrate 101 -- substantially -- the whole -- a wrap -- it is formed like. And the bus bar p electrode 113 (busbar electrode) which extends in the direction which intersects the end (both-the-right-and-left-ends part in Fig.18) on the back surface of the silicon substrate 101 with the finger p electrode 111, The bus bar n electrode 114 which extends in the direction which intersects the finger n electrode 112 is formed, respectively.

[0011]

Means which include vacuum evaporation of the electrode material by the electron beam heating in a high vacuum and an electrode material, for example as a formation method of the electrodes 111-114 of a photovoltaic cell mentioned above, such as screen-stencil of a paste or plating of an electrode material, are used.

[0012]

The structure of the photovoltaic cell by which the polar zone was formed on the back surface of a semiconductor substrate is described, for example in JP,2003-298078,A etc.

[Patent document 1] JP,2003-298078,A

[Description of the Invention]

[Problem to be solved by the invention]

[0013]

However, there were the following problems in the above photovoltaic cells.

[0014]

In the back surface assembling-die photovoltaic cell, p electrode and n electrode are formed on the surface (back surface) of the side with same silicon substrate. It is arranged at the interval especially with alternately narrow finger p electrode 111 and finger n electrode 112. For this reason, for example, the short circuit of the finger p electrode 111 and the finger n electrode 112 may start collapse of the photoresist pattern used at the time of vacuum evaporation, the blur at the time of screen-stencil, or an electrode by the reservoir of the solder at the time of carrying out solder dip, etc. Since this short circuit becomes a factor which generates the characteristic defect of a solar cell, it is requested that the short circuited place concerned should be reliably specified by a simple technique.

[0015]

The present invention is made in view of the above problems, and there is the object of this invention in providing the solar cell module which includes the short circuited place of an electrode for the manufacturing method of the back surface assembling-die photovoltaic cell which can be specified, and a solar cell cell unit and this photovoltaic cell, or a cell unit easily.

[Means for solving problem]

[0016]

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The photovoltaic cell concerning the present invention in one aspect of affairs, Have a semiconductor substrate and the polar zone formed on the main table surface of a semiconductor substrate, and the polar zone, The 1st bus part and the 2nd bus part that vacated the interval for the 1st bus part and the position which is adjacent to, and was formed on the main table surface of a semiconductor substrate, It has the 1st finger part extended towards the 2nd bus part from the 1st bus part, and the 2nd finger part that extends towards the 1st bus part from the 2nd bus part, and reaches near the 1st finger part, and the disconnection part is formed in at least 1 side of the 1st and the 2nd bus part.

[0017]

As for this, the short circuited place of the 1st and 2nd finger part Hazama becomes is easy to specify. The characteristic defect of a photovoltaic cell is inhibited as a result.

[0018]

As for the above-mentioned disconnection part, it is preferable to be formed in the central part in the extending direction of the 1st and the 2nd bus part.

[0019]

Thereby, the short circuited place of the 1st and 2nd finger part Hazama can be pinpointed still more efficiently.

[0020]

The photovoltaic cell concerning the present invention in other aspects of affairs, Have a semiconductor substrate and two or more polar zone formed on the main table surface of a semiconductor substrate, and the polar zone, The 1st bus part and the 2nd bus part that vacated the interval for the 1st bus part and the position which is adjacent to, and was formed on the main table surface of a semiconductor substrate, having the 1st finger part extended towards the 2nd bus part from the 1st bus part, and the 2nd finger part that extends towards the 1st bus part from the 2nd bus part, and reaches near the 1st finger part -- two or more polar zone -- this -- it is formed so that it may rank with the extending direction of the 1st and the 2nd bus part.

[0021]

Also in this aspect of affairs, the short circuited place between the 1st and the 2nd finger part becomes is easy to specify. The characteristic defect of a photovoltaic cell is inhibited as a result.

[0022]

It is preferable that the interval between the 1st and the 2nd bus part in two or more polar zone is equal here.

[0023]

Thereby, electric junction of two or more polar zone becomes easy. As a result, manufacture of a solar cell module becomes easy.

[0024]

A manufacturing method of a solar cell cell unit concerning the present invention is provided with the following.

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A process of forming the 1st impurity range of the 1st conductivity type, and the 2nd impurity range of the 2nd conductivity type on a main table surface of a semiconductor substrate so that it may stand in a line alternately.
The 1st, the 1st which are formed on the 2nd impurity range, respectively, and the 2nd finger part.
this -- a process of forming polar zone which extends in the direction which intersects the 1st and the 2nd finger part, has a disconnection part, and includes the 1st, the 1st to which the 2nd finger part is connected, respectively, and the 2nd bus part.
A process of dividing a semiconductor substrate in which polar zone was formed to the 1st and the 2nd semiconductor substrate in a disconnection part, and a process of electrically connecting the polar zone formed on the 2nd semiconductor substrate, respectively with the 1st divided.

[0025]
Thereby, the existence of the short circuit of the polar zone is checked, and after removing the part which the short circuit produced, a solar cell cell unit can be formed only using a portion without short circuit failure.
[0026]
The solar cell module concerning the present invention contains at least 1 side of the solar cell cell unit manufactured by the manufacturing method of the above-mentioned photovoltaic cell and the above-mentioned solar cell cell unit.
[0027]
In the above-mentioned photovoltaic cell, the short circuited place of the polar zone is specified easily. The above-mentioned solar cell cell unit is formed only using a portion without the short circuit failure of the polar zone. As a result, the solar cell module in which characteristic defect was inhibited is provided.
[Effect of the Invention]
[0028]
According to the present invention, the characteristic defect of a photovoltaic cell can be inhibited.
[Best Mode of Carrying Out the Invention]
[0029]
Below, it describes using Fig.16 from Fig.1 about the manufacturing method of the photovoltaic cell based on the present invention, and a solar cell cell unit, and the embodiment of a solar cell module.
[0030]
The sunlight of a semiconductor substrate [in / in an "acceptance surface" / a photovoltaic cell or a solar cell module] means the main table surface of an incident side, and the "back surface" as used in Description of this application means the near main table surface into which it is an opposite side of the acceptance surface in the above-mentioned semiconductor

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substrate, and sunlight does not enter.

[0031]

Fig.10 is a plan showing the photovoltaic cell concerning this embodiment. In the photovoltaic cell concerning this embodiment, as shown in Fig.10, the finger p electrode 11, the finger n electrode 12, the bus bar p electrode 13 (13A-13D), and the bus bar n electrode 14 (14A-14D) are formed on the back surface of a silicon substrate. As characteristic composition, the bus bar p electrode 13 and the bus bar n electrode 14 have the disconnection part 15, respectively.

[0032]

About the process from which the above-mentioned composition is obtained, it describes below.

[0033]

Fig.9 is a cross sectional view showing the portion in which the finger p electrode 11 and the finger n electrode 12 in the above-mentioned photovoltaic cell were formed. Fig.1 - Fig.8 are the cross sectional views showing the 1st - the 8th process in the manufacturing process of the photovoltaic cell shown in Fig.9, respectively.

[0034]

In the silicon substrate 1 as a semiconductor substrate produced by slicing yne God of a silicon crystal with reference to Fig.1, the damaged layer 1a is formed near [the] the surface in the case of a slice. Then, it is preferable that the damaged layer 1a is etched using an acid or alkaline solution as shown in Fig.2. A n type or a p type may be sufficient as the conductivity type of the silicon substrate 1, and it can be suitably changed also about the size and thickness of the silicon substrate 1. However, when forming the fine structure of the shape of a pyramid called a texture to the acceptance surface of the silicon substrate 1 in order to inhibit the loss by reflection of incident sunlight, it is preferable that the plane direction of the acceptance surface of the silicon substrate 1 is a degree (100).

[0035]

With reference to Fig.3, the back surface in the opposite side of the acceptance surface of the silicon substrate 1 adheres to the p type paste material 2 containing a p type impurity (for example, boron) and the n type paste material 3 containing a n type impurity (for example, phosphorus) by a predetermined pattern. And the silicon substrate 1 is heated by the temperature which is 100 degrees C - about 200 degrees C. Thereby, the organic solvent component contained in the paste material 2 and 3 evaporates. Then, the whole back surface of the silicon substrate 1 to which the paste material 2 and 3 adhered is covered with the diffusion preventing film 4. As a means to adhere the paste material 2 and 3 by a predetermined pattern, screen-stencil, ink jet printing, etc. are mentioned, for example. In order to collect efficiently the minority carriers generated in the silicon substrate 1 here, it is preferable that the p type paste material 2 and the n type paste material 3 vacate an interval alternately, and are formed along the back surface of the silicon substrate 1 as shown in Fig.3. The diffusion preventing film 4 consists of silicon oxide films etc., for example, and is formed by drying the coating liquid containing the ordinary pressure CVD (Chemical Vapor Deposition) method and silicon oxide etc.

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[0036]
Next, the silicon substrate 1 is supplied in the quartz furnace heated by the temperature of 900 degrees C – about 1000 degrees C, for example, for example, is placed in a quartz furnace for 30 minutes – 60 minutes. As it diffuses in the silicon substrate 1 and the n type impurity (phosphorus) contained in the p type impurity (boron) and the n type paste material 3 which are contained in the p type paste material 2 by this shows Fig.4. Along the back surface of the silicon substrate 1, two or more p+ impurity layers 6 and n+ impurity layers 5 open an interval alternately, and are formed. Here, since the diffusion preventing film 4 is formed in the back surface of the silicon substrate 1, the n type impurity (phosphorus) contained in the p type impurity (boron) and the n type paste material 3 which are contained in the p type paste material 2 is prevented from diffusing to the outside of the silicon substrate 1.
[0037]
Next, the silicon substrate 1 is immersed in the high-temperature-hot-water solution which contains alkali, isopropyl alcohol (IPA:Iso-Propyl Alcohol), etc., such as sodium hydroxide and a potassium hydrate, for example. The anisotropic etching in alignment with silicon crystal orientation advances by this, and as shown in Fig.5, the pyramid-like texture structure 8 is formed in the acceptance surface of the silicon substrate 1. Here, since the diffusion preventing film 4 is formed in the back surface of the silicon substrate 1, the back surface of the silicon substrate 1 is not etched.
[0038]
Next, the silicon substrate 1 is dipped in a fluoric acid solution etc. Thereby, as shown in Fig.6, the diffusion protective film 4 on the back, and the p type paste material 2 and the n type paste material 3 of the silicon substrate 1 are removed. Then, as shown in Fig.7, the passivation films 9 and 10 for inhibiting the surface recombination of a carrier are formed in the acceptance surface and back surface of the silicon substrate 1. The silicon nitride film etc. which are formed as the passivation films 9 and 10 by the silicon oxide formed, for example of thermal oxidation or plasma CVD method are used. The recombination of the carrier on the back surface of the silicon substrate 1 can be effectively inhibited by forming the passivation films 9 and 10. Here, since the refractive index becomes about 2.1 when a silicon nitride film is used as the passivation film 9 formed in an acceptance surface, this passivation film 9 can be used also as an antireflection film which inhibits a reflection of the sunlight in an acceptance surface.
[0039]
Next, in order to perform the electrical link of the p+ impurity layer 6 of the back surface of the silicon substrate 1 and the n+ impurity layer 5, and an electrode, as shown in Fig.8, the passivation film 10 formed in the back surface of the silicon substrate 1 is removed by the predetermined pattern. Here, according to the arrangement of the p+ impurity layer 6 and the n+ impurity layer 5, the removal pattern (for example, patterns, such as dot form or a form line) of the passivation film 10 is determined. As for the width of the passivation film 10 removed, it is preferable that it is smaller than the width of the p+ impurity layer 6 and the n+ impurity layer 5 so that an electrode may not be formed in any portions other than p+ impurity layer 6 and n+

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impurity layer 5.

[0040]

Next, as shown in Fig.9, while the finger p electrode 11 is formed on the p+ impurity layer 6 in accordance with the portion from which the passivation film 10 was removed, the finger n electrode 12 is formed on the n+ impurity layer 5. As a material which constitutes the finger p electrode 11 and the finger n electrode 12, it is preferable that high electrically-conductive materials, such as silver or aluminum, are used, for example. Thereby, the current generated from a photovoltaic cell can be taken out outside efficiently. As a means to form the finger p electrode 11 and the finger n electrode 12, the screen-stencil of a paste or plating of an electrode material containing vacuum evaporation of the electrode material by the electron beam heating in a high vacuum and an electrode material is mentioned, for example. It is preferable that heat treatment of 400 degrees C - about 500 degrees C is performed after adhesion of the electrode material to the silicon substrate 1. Thereby, good ohmic contact with the silicon substrate 1, the finger p electrode 11, and the finger n electrode 12 is obtained. When forming the finger electrodes 11 and 12, as shown in Fig.10, the bus bar electrodes 13 (13A-13D) and 14 (14A-14D) as a bus part which extends in the direction which intersects the finger electrodes 11 and 12 are also formed collectively.

[0041]

The above-mentioned finger p electrode 11 and the finger n electrode 12 are electrodes which mainly collect the current generated in the photovoltaic cell. The bus bar electrodes 13 and 14 are electrodes which collect the current which the finger electrode collected and are mainly used for connection with other photovoltaic cells.

[0042]

When forming the finger p electrode 11 and the finger n electrode 12, an electric short circuit may arise between these electrodes 11 and 12. The resistance between the bus bar p electrode 13 and the bus bar n electrode 14 can detect this electric short circuit. Although this resistance changes with the structure of a photovoltaic cell, or resistance of a semiconductor substrate, when it is a photovoltaic cell (defective cell) which has an electric short circuit to the value of a degree being shown for example, as for more than 100komega in the case of a normal photovoltaic cell, it shows the value of a 100-ohm or less degree.

[0043]

It is easy to detect whether the electric short circuit has arisen between the finger electrodes [in / as mentioned above / a certain photovoltaic cell] 11 and 12. However, in the conventional photovoltaic cell, when the electric short circuit has arisen, it is difficult to specify in which portion of the photovoltaic cell this electric short circuit has arisen.

[0044]

On the other hand, in the photovoltaic cell concerning this embodiment, the bus bar p electrode 13 is divided by the disconnection part 15 formed in the central part in the extending direction of this electrode 13, respectively at the bus bar p electrodes 13A and 13C and the bus bar p electrodes 13B and 13D. Similarly, the bus bar n electrode 14 is divided by the disconnection

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part 15 formed in the central part in the extending direction of this electrode 14, respectively at the bus bar n electrodes 14A and 14C and the bus bar n electrodes 14B and 14D. In the above-mentioned photovoltaic cell, a paraphrase forms two or more polar zone (the 1st and the 2nd polar zone) which has the finger electrodes 11 and 12 and the bus bar electrodes 13 and 14 along with the extending direction of the bus bar electrodes 13 and 14. Here, the interval between the bus bar electrodes 13 and 14 in the 1st and the 2nd polar zone is mutually equal. Thereby, the electrical link by the interconnector mentioned later becomes easy.

[0045]

Fig.11 is a plan showing the short circuit part 16 of the finger electrodes 11 and 12 in the photovoltaic cell shown in Fig.10.The position of the short circuit part 16 shown in Fig.11 is an example, and may produce the short circuit part 16 in any position in a photovoltaic cell.

[0046]

As shown in Fig.11, when the short circuit part 16 is between the bus bar p electrode 13C and the bus bar n electrode 14A, Between the bus bar p electrode 13A and the bus bar n electrodes 14A and between the bus bar p electrode 13C and the bus bar n electrodes 14C, And as for the resistance of Hazama of the bus bar p electrode 13D and the bus bar n electrode 14D, more than 100komega shows the value of a degree between the bus bar p electrode 13B and the bus bar n electrode 14B and between the bus bar p electrode 13D and the bus bar n electrode 14B. On the other hand, the resistance of Hazama of the bus bar p electrode 13C and the bus bar n electrode 14A shows the value of a 100-ohm or less degree. Thereby, it is grasped that the short circuit part 16 has arisen between the bus bar p electrode 13C and the bus bar n electrode 14A. By taking in this inspection to a production process, it becomes possible to, specify the portion which the short circuit part 16 in a photovoltaic cell tends to produce for example. Since generating of the short circuit part 16 originates in the problem in the pattern process for electrode formation, etc., it becomes possible to feed back the tendency of the part which the short circuit part 16 produces to the pattern process concerned etc., and to solve a problem. As a result, generating of the short circuit failure in a photovoltaic cell is inhibited.

[0047]

It becomes possible to utilize effectively the portion which the short circuit part 16 has not produced by specifying the place of the short circuit part 16 as mentioned above. Fig.12 is a plan showing the state where the photovoltaic cell shown in Fig.10 was divided into two, and Fig.13 is a plan showing the solar cell cell unit which electrically connected and formed the portions which do not have short circuit failure, after dividing into two the photovoltaic cell shown in Fig.10.With reference to Fig.12, the photovoltaic cell which has the short circuit part 16 is divided into the defective cell 17 which has the short circuit part 16 in the disconnection part 15, and the normal cell 18 which does not have the short circuit part 16. The division concerned is performed, for example using means, such as dicing. And as shown in Fig.13, the bus bar electrode 13 of the normal cell 18 and 14 are electrically connected in parallel using the interconnector 19. A part of two or more photovoltaic cells which the short circuit part 16 produced are utilized effectively by this, and a solar cell cell unit without the short circuit part 16 is formed.

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[0048]
Fig.14 is a plan showing the solar cell module containing the solar cell cell unit shown in the photovoltaic cell shown in Fig.10, and Fig.13.With reference to Fig.14, two or more photovoltaic cells and solar cell cell units which were mentioned above are electrically connected by the interconnector 19 in the solar cell module.
[0049]
Fig.15 is a plan showing one modification of a photovoltaic cell mentioned above. In the example shown in the Fig.10 mentioned above, although the disconnection part 15 is provided by only the central part of the bus bar electrodes 13 and 14, as shown in Fig.15, it becomes possible by increasing the number of the disconnection parts 15 to make pinpointing of a short circuit place into details more.For example, in the example of Fig.15, the place of the short circuit part 16 can be narrowed down even to 1/15 to the area of a photovoltaic cell. The number of parts of the disconnection part 15 can be changed suitably. For example, when the disconnection part 15 is provided between each finger electrode 11 and 12 in the bus bar electrodes 13 and 14, it becomes possible to specify the finger electrodes 11 and 12 which have caused the short circuit.

[0050]
Fig.16 is a plan showing other modifications of a photovoltaic cell mentioned above. In the example shown in the Fig.10 and Fig.15 which were mentioned above, although two or more pairs (two pairs) of bus bar electrodes 13 and 14 were provided in one photovoltaic cell, as shown in Fig.16, it is also possible to form only one pair of bus bar electrodes 13 and 14 in one photovoltaic cell.
[0051]
It is as follows when it summarizes about the contents mentioned above.
[0052]
The photovoltaic cell concerning this embodiment is a back surface assembling-die photovoltaic cell, and in one aspect of affairs, As shown in Fig.10, Fig.15, and Fig.16, have the silicon substrate 1 (semiconductor substrate) and the polar zone formed on the back surface of the silicon substrate 1 (on a main table surface), and the polar zone,The bus bar p electrode 13 (the 1st bus part) and the bus bar n electrode 14 (the 2nd bus part) which vacated the interval for the bus bar p electrode 13 and the position which is adjacent to, and was formed on the main table surface of the silicon substrate 1, The finger p electrode 11 (the 1st finger part) extended towards the bus bar n electrode 14 from the bus bar p electrode 13, It extends towards the bus bar p electrode 13 from the bus bar n electrode 14, and has the finger n electrode 12 (the 2nd finger part) which reaches near the finger p electrode 11, and the disconnection part 15 is formed in the bus bar p electrode 13 and the bus bar n electrode 14.
[0053]
As for this, the short circuited place between the finger p electrode 11 and the finger n electrode 12 becomes is easy to specify. The characteristic defect of a photovoltaic cell is inhibited as a result.

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[0054]
Typically, although the disconnection part 15 doubles the position in the extending direction of these electrodes 13 and 14 and is formed in both the bus bar p electrode 13 and the bus bar n electrode 14, Also when the disconnection part 15 is formed in either the bus bar p electrode 13 or the bus bar n electrode 14, the same effect as the above is generated.
[0055]
As for the above-mentioned disconnection part, it is preferable to be formed in the central part in the extending direction of the bus bar p electrode 13 and the bus bar n electrode 14.
[0056]
Thereby, the short circuited place between the finger p electrode 11 and the finger n electrode 12 can be pinpointed still more efficiently.
[0057]
The photovoltaic cell concerning this embodiment in other aspects of affairs, As shown in Fig.10, Fig.15, and Fig.16, have the silicon substrate 1 and two or more polar zone formed on the back surface of the silicon substrate 1, and the polar zone,The bus bar p electrode 13 and the bus bar n electrode 14 which vacated the interval for the bus bar p electrode 13 and the position which is adjacent to, and was formed on the main table surface of the silicon substrate 1, The finger p electrode 11 extended towards the bus bar n electrode 14 from the bus bar p electrode 13, It extends towards the bus bar p electrode 13 from the bus bar n electrode 14, and has the finger n electrode 12 which reaches near the finger p electrode 11, and it is formed so that two or more polar zone may be located in a line with the extending direction of the bus bar p electrode 13 and the bus bar n electrode 14.
[0058]
Also in this aspect of affairs, the short circuited place between the finger p electrode 11 and the finger n electrode 12 becomes is easy to specify. The characteristic defect of a photovoltaic cell is inhibited as a result.
[0059]
It is preferable that the interval of the bus bar p electrode 13 and the bus bar n electrode 14 in two or more polar zone is equal here.
[0060]
Thereby, electric junction of two or more polar zone becomes easy. As a result, manufacture of a solar cell module becomes easy.
[0061]
A manufacturing method of a solar cell cell unit concerning this embodiment is provided with the following.
A process of forming the p type (the 1st conductivity type) p+ impurity layer 6 (the 1st impurity range) and the n type (the 2nd conductivity type) n+ impurity layer 5 (the 2nd impurity range) on a back surface of the silicon substrate 1 so that it may stand in a line alternately (Fig.1 - Fig.6). The finger p electrode 11 and the finger n electrode 12 which are formed on the n+/p+ impurity layer 5 and 6, respectively.

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It extends in the direction which intersects the finger p electrode 11 and the finger n electrode 12, A process of forming polar zone containing the bus bar p electrode 13 and the bus bar n electrode 14 (1st [the] and the 2nd bus part) which have the disconnection part 15, and to which the finger p electrode 11 and the finger n electrode 12 are connected, respectively (Fig.7 - Fig.10).
The process (Fig.12) of dividing the silicon substrate 1 in which the polar zone was formed in the disconnection part 15 in two or more cells (the defective cell 17 and the normal cell 18: the 1 and the 2nd semiconductor substrate), A process of electrically connecting the polar zone formed, respectively on a cell (normal cell 18) distinguished from a good article among divided cells by the interconnector 19 (Fig.13).

[0062]
Thereby, the existence of the short circuit part 16 in the polar zone is checked, and after removing the part which the short circuit part 16 produced, a solar cell cell unit can be formed only using the normal cell 18 without the short circuit part 16.
[0063]
The solar cell module concerning this embodiment contains the solar cell cell unit manufactured by the manufacturing method of the above-mentioned photovoltaic cell and the above-mentioned solar cell cell unit, as shown in Fig.14. In the example shown in Fig.14, although both the above-mentioned photovoltaic cell and the solar cell cell unit are contained, a solar cell module may be formed by either the above-mentioned photovoltaic cell or the above-mentioned solar cell cell unit.
[0064]
In the above-mentioned photovoltaic cell, the generation place of the short circuit part 16 of the polar zone is specified easily. The above-mentioned solar cell cell unit is formed only using the normal cell 18 without the short circuit part 16 of the polar zone. As a result, the solar cell module in which characteristic defect was inhibited is provided.
[0065]
As mentioned above, although described about the embodiment of the invention, with all the points, the embodiment disclosed this time is illustration and should be considered not to be restrictive. The range of the present invention is shown by Claims and it is meant that Claims, an equal meaning, and all the change in within the limits are included.

[Brief Description of the Drawings]
[0066]
[Drawing 1]It is a cross sectional view showing the 1st process in the manufacturing process of the photovoltaic cell concerning one embodiment of the present invention.
[Drawing 2]It is a cross sectional view showing the 2nd process in the manufacturing process of the photovoltaic cell concerning one embodiment of the present invention.
[Drawing 3]It is a cross sectional view showing the 3rd process in the manufacturing process of

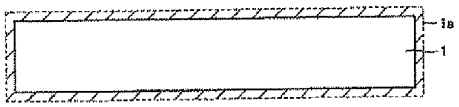
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the photovoltaic cell concerning one embodiment of the present invention.
[Drawing 4]It is a cross sectional view showing the 4th process in the manufacturing process of the photovoltaic cell concerning one embodiment of the present invention.
[Drawing 5]It is a cross sectional view showing the 5th process in the manufacturing process of the photovoltaic cell concerning one embodiment of the present invention.
[Drawing 6]It is a cross sectional view showing the 6th process in the manufacturing process of the photovoltaic cell concerning one embodiment of the present invention.
[Drawing 7]It is a cross sectional view showing the 7th process in the manufacturing process of the photovoltaic cell concerning one embodiment of the present invention.
[Drawing 8]It is a cross sectional view showing the 8th process in the manufacturing process of the photovoltaic cell concerning one embodiment of the present invention.
[Drawing 9]It is a cross sectional view showing the photovoltaic cell concerning one embodiment of the present invention.
[Drawing 10]It is a plan showing the photovoltaic cell concerning one embodiment of the present invention.
[Drawing 11]It is a plan showing the short circuited place of the polar zone in the photovoltaic cell shown in Fig.10.
[Drawing 12]It is a plan showing the state where the photovoltaic cell shown in Fig.10 was divided into two.
[Drawing 13]After dividing into two the photovoltaic cell shown in Fig.10, it is a plan showing the solar cell cell unit which electrically connected and formed the portions which do not have short circuit failure.
[Drawing 14]It is a plan showing the solar cell module containing the solar cell cell unit shown in the photovoltaic cell shown in Fig.10, and Fig.13.
[Drawing 15]It is a plan showing one modification of the photovoltaic cell shown in Fig.10.
[Drawing 16]It is a plan showing other modifications of the photovoltaic cell shown in Fig.10.
[Drawing 17]It is a cross sectional view showing the conventional photovoltaic cell.
[Drawing 18]It is a plan showing the conventional photovoltaic cell.
[Explanations of letters or numerals]
[0067]
1,101 silicon substrates, 1a damaged layer, 2 p-type paste material, 3 N type paste material and 4 A diffusion preventing film, a 5,105 n+ impurity layer, A 6,106 p+ impurity layer, 8 texture structures, and 9 and 10,109,110 Passivation film, 11,111 [A bus bar n electrode and 15 / A disconnection part and 16 / A short circuit part, 17 defective cells, 18 normal cells, and 19 / Interconnector.] A finger n electrode, and 13, 13A-13J and 113 A bus bar p electrode, and 14, 14A-14J and 114 A finger p electrode and 12,112

DRAWINGS

[Drawing 1]

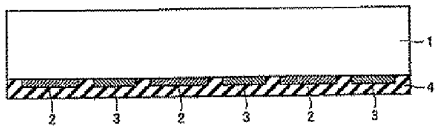
Jinko Ex. 1002 - 147/580



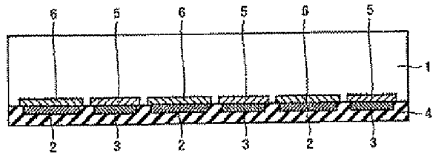
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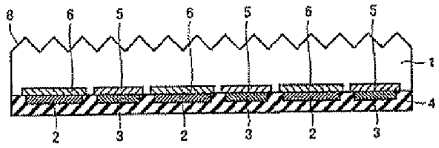
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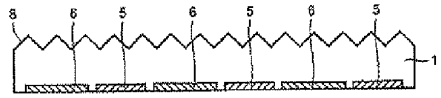
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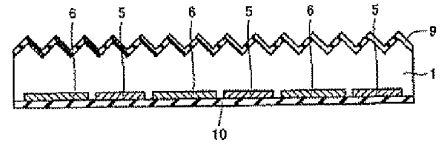
[Drawing 5]



[Drawing 6]

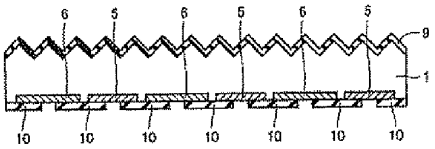


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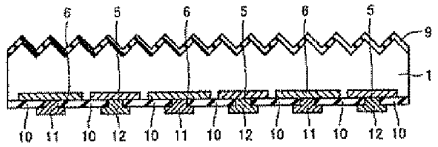


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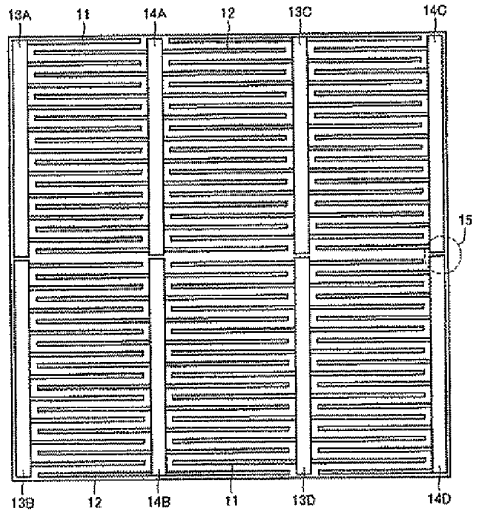
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[Drawing 9]

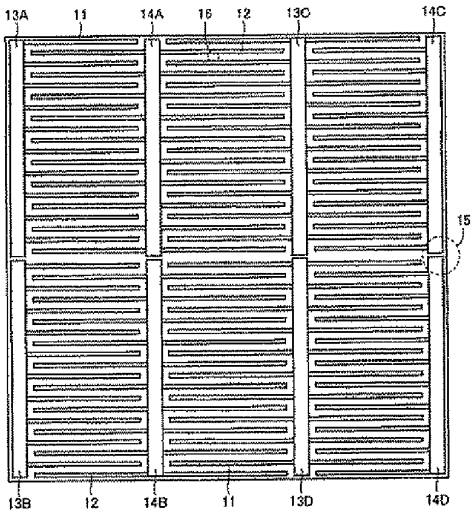


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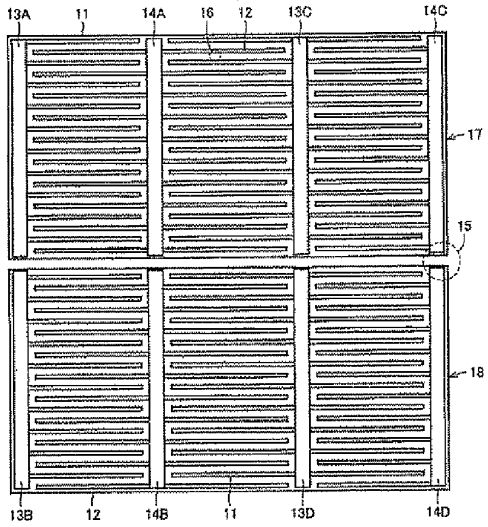


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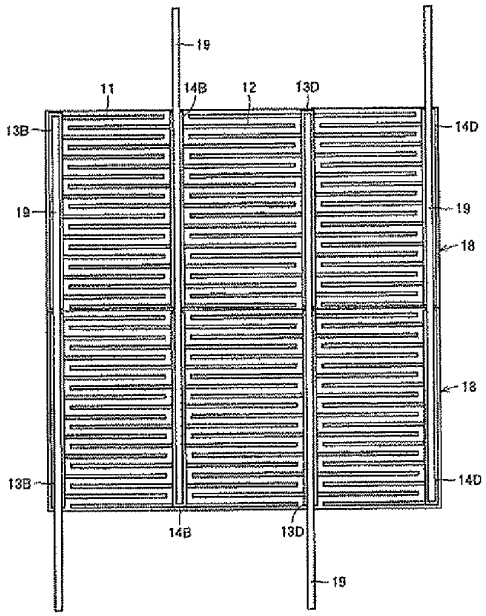


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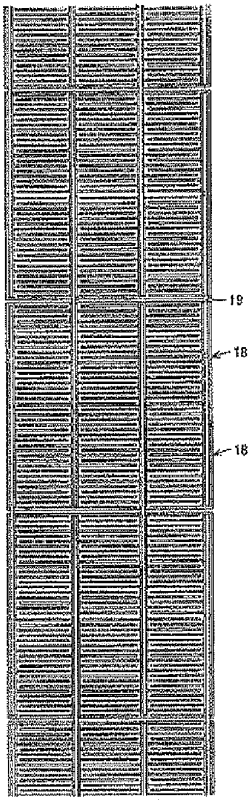


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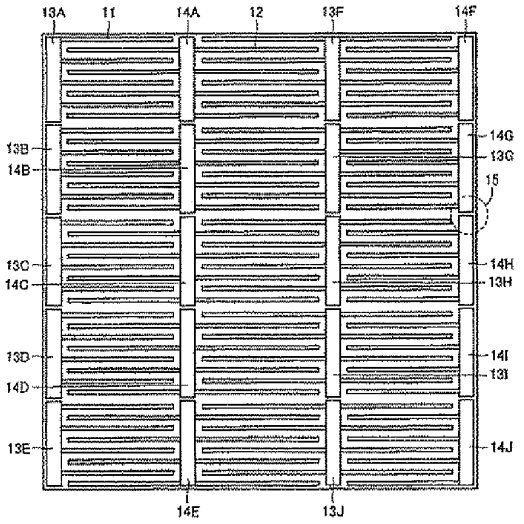


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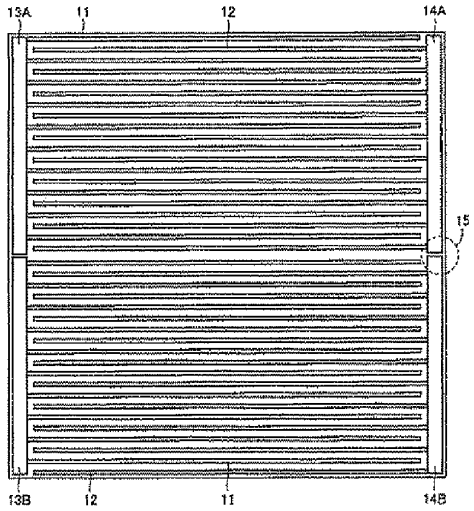


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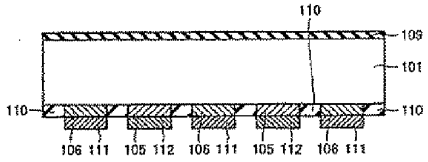
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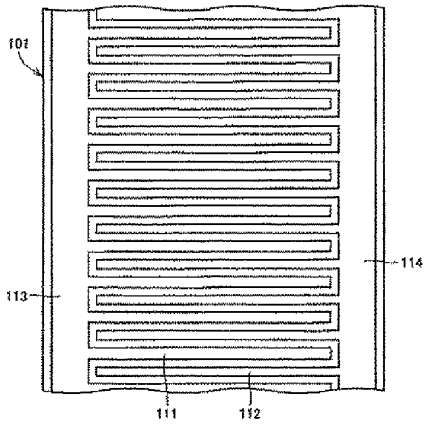


[Drawing 17]



[Drawing 18]

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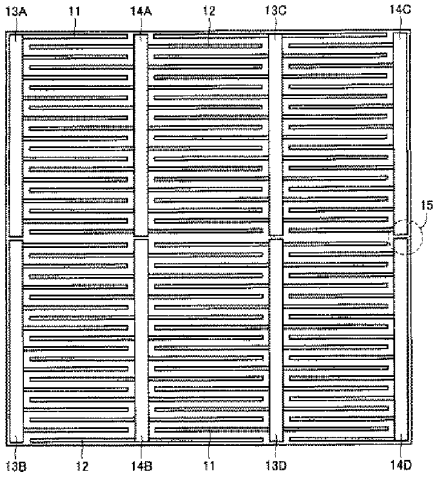
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(54)【発明の名称】太陽電池セル、太陽電池セルユニットの製造方法および太陽電池モジュール

(57)【要約】
【課題】　電極の短絡箇所を容易に特定可能な裏面接合型太陽電池セル、太陽電池セルユニットの製造方法、および該太陽電池セルまたはセルユニットを含む太陽電池モジュールを提供する。
【解決手段】　太陽電池セルは、シリコン基板１と、シリコン基板１の主表面上に形成された電極部とを備え、電極部は、バスバーｐ電極１３と、シリコン基板１の主表面上においてバスバーｐ電極１３と隣り合う位置に間隔を空けて形成されたバスバーｎ電極１４と、バスバーｐ電極１３からバスバーｎ電極１４に向けて延びるフィンガーｐ電極１１と、バスバーｎ電極１４からバスバーｐ電極１３に向けて延び、フィンガーｐ電極１１の近傍に達するフィンガーｎ電極１２とを有し、バスバーｐ電極１３およびバスバーｎ電極１４の少なくとも一方に断線部１５が形成されている。
【選択図】　図１０



【特許請求の範囲】
【請求項1】
半導体基板と、
前記半導体基板の主表面上に形成された電極部とを備え、
前記電極部は、第１母線部と、
前記半導体基板の主表面上において前記第１母線部と隣り合う位置に間隔を空けて形成された第２母線部と、
前記第１母線部から前記第２母線部に向けて延びる第１フィンガー部と、
前記第２母線部から前記第１母線部に向けて延び、前記第１フィンガー部の近傍に達する第２フィンガー部とを有し、
前記第１と第２母線部の少なくとも一方に断線部が形成された太陽電池セル。
【請求項2】
前記第１と第２母線部の延在方向における中央部に前記断線部が形成される、請求項１に記載の太陽電池セル。
【請求項3】
半導体基板と、
前記半導体基板の主表面上に形成された複数の電極部とを備え、
前記電極部は、第１母線部と、
前記半導体基板の主表面上において前記第１母線部と隣り合う位置に間隔を空けて形成された第２母線部と、
前記第１母線部から前記第２母線部に向けて延びる第１フィンガー部と、
前記第２母線部から前記第１母線部に向けて延び、前記第１フィンガー部の近傍に達する第２フィンガー部とを有し、
複数の前記電極部が該第１と第２母線部の延在方向に並ぶように形成された太陽電池セル。
【請求項4】
複数の前記電極部における前記第１と第２母線部間の間隔が等しい、請求項３に記載の太陽電池セル。
【請求項5】
半導体基板の主表面上に第１導電型の第１不純物領域と第２導電型の第２不純物領域とを交互に並ぶように形成する工程と、
前記第１と第２不純物領域上にそれぞれ形成される第１と第２フィンガー部と、該第１と第２フィンガー部と交差する方向に延在し、断線部を有し、前記第１と第２フィンガー部がそれぞれ接続される第１と第２母線部とを含む電極部を形成する工程と、
前記電極部が形成された前記半導体基板を前記断線部において第１と第２半導体基板に分断する工程と、
分断された前記第１と第２半導体基板上にそれぞれ形成された電極部どうしを電気的に接続する工程とを備えた太陽電池セルユニットの製造方法。
【請求項6】
請求項１から請求項４のいずれかに記載の太陽電池セルおよび請求項５に記載の太陽電池セルユニットの製造方法により製造された太陽電池セルユニットの少なくとも一方を含む太陽電池モジュール。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は、太陽電池セル、太陽電池セルユニットの製造方法および太陽電池モジュールに関し、特に、半導体基板の裏面上に電極が形成された裏面接合型の太陽電池セル、太陽電池セルユニットの製造方法および太陽電池モジュールに関する。
【背景技術】
【0002】

近年、エネルギー資源の枯渇の問題や大気中のCO_2増加のような地球環境問題などを解決する観点から、クリーンなエネルギーの開発が望まれており、特に、太陽電池セルを複数接続して構成される太陽電池モジュールを用いた太陽光発電が新しいエネルギー源として開発、実用化され、発展の道を歩んでいる。

【0003】

太陽電池モジュールを構成する太陽電池セルとしては、従来から、シリコン基板の主表面のうち太陽光が入射する側の面（受光面）上とその反対側にある裏面上とにそれぞれ電極が形成されるものと、シリコン基板の裏面上のみに互いに異なる導電型の不純物領域に接続される２種類の電極が形成されるもの（裏面接合型セル）とが知られている。

【0004】

シリコン基板の受光面上と裏面上とにそれぞれ電極が形成されるセルにおいては、たとえば単結晶または多結晶のシリコン基板の受光面側からシリコン基板の導電型と反対の導電型となる不純物を拡散することによってｐｎ接合が形成されている。また、シリコン基板の裏面側からシリコン基板と同じ導電型の不純物を高濃度で拡散することによって、裏面電界効果による高出力化を図ることも従来から行なわれている。

【0005】

しかしながら、このように受光面上に電極が形成される太陽電池セルにおいては、該電極が入射する太陽光を遮るため、太陽電池セルの出力が低下し、結果として太陽電池モジュールの出力が低下する場合がある。

【0006】

これに対し、シリコン基板の裏面上のみに電極が形成される裏面接合型太陽電池セルが従来から用いられている。裏面接合型太陽電池セルにおいては、受光面上で入射光が電極により遮られることはないが、シリコン基板の裏面側からしか電力を取り出すことができないため、その電極の構造は太陽電池セルおよびこれらを複数接続して構成される太陽電池モジュールの出力向上の観点から非常に重要である。

【0007】

図１７，図１８は、従来の裏面接合型太陽電池セルの一例を示した図である。なお、図１７は太陽電池セルの断面図であり、図１８は該太陽電池セルの上面図である。

【0008】

図１７を参照して、ｐ型のシリコン基板１０１の受光面側（図１７における上側）の主表面上にパッシベーション膜１０９が形成される。シリコン基板１０１の裏面側（図１７における下側）の主表面上に、ｎ＋不純物層１０５とｐ＋不純物層１０６とがパッシベーション膜１１０を挟んで交互に所定の間隔を空けて形成される。そして、ｐ＋不純物層１０６上にはフィンガーｐ電極１１１が形成され、ｎ＋不純物層１０５上にはフィンガーｎ電極１１２が形成されている。

【0009】

この裏面接合型太陽電池セルの受光面に太陽光が入射すると、シリコン基板１０１の受光面近傍で生じたキャリアが裏面に形成されたｐｎ接合にまで到達し、フィンガーｐ電極１１１およびフィンガーｎ電極１１２に電流として収集される。この電流が外部に取り出されて太陽電池モジュールの出力となる。

【0010】

図１８を参照して、太陽電池セルの出力を向上させる観点から、フィンガーｐ電極１１１とフィンガーｎ電極１１２とがシリコン基板１０１の裏面上のほぼ全体を覆うように形成されている。そして、シリコン基板１０１の裏面上における端部（図１８における左右両端部）に、フィンガーｐ電極１１１と交差する方向に延在するバスバーｐ電極１１３（ｂｕｓｂａｒ　ｅｌｅｃｔｒｏｄｅ）と、フィンガーｎ電極１１２と交差する方向に延在するバスバーｎ電極１１４とがそれぞれ形成されている。

【0011】

上述した太陽電池セルの電極１１１～１１４の形成方法としては、たとえば高真空中における電子ビーム加熱による電極材料の蒸着、電極材料を含むペーストのスクリーン印刷

または電極材料のメッキなどの手段が用いられる。

【0012】

なお、半導体基板の裏面上に電極部が形成された太陽電池セルの構造は、たとえば特開２００３－２９８０７８号公報などに記載されている。

【特許文献1】特開２００３－２９８０７８号公報

【発明の開示】

【発明が解決しようとする課題】

【0013】

しかしながら、上記のような太陽電池セルにおいては、以下のような問題があった。

【0014】

裏面接合型太陽電池セルにおいては、シリコン基板の同じ側の面（裏面）上にｐ電極とｎ電極とが形成されている。特に、フィンガーｐ電極１１１とフィンガーｎ電極１１２とは交互に狭い間隔で配置されている。このため、たとえば、蒸着時に使用するフォトレジストパターンの崩れや、スクリーン印刷時のかすれ、または、電極にハンダディップをした場合のハンダの溜まりなどにより、フィンガーｐ電極１１１とフィンガーｎ電極１１２との短絡がおこる場合がある。この短絡は、太陽電池の特性不良を発生させる要因となるため、当該短絡箇所を簡便な手法で確実に特定することが要請される。

【0015】

本発明は、上記のような問題に鑑みてなされたものであり、本発明の目的は、電極の短絡箇所を容易に特定可能な裏面接合型太陽電池セル、太陽電池セルユニットの製造方法、および該太陽電池セルまたはセルユニットを含む太陽電池モジュールを提供することにある。

【課題を解決するための手段】

【0016】

本発明に係る太陽電池セルは、１つの局面では、半導体基板と、半導体基板の主表面上に形成された電極部とを備え、電極部は、第１母線部と、半導体基板の主表面上において第１母線部と隣り合う位置に間隔を空けて形成された第２母線部と、第１母線部から第２母線部に向けて延びる第１フィンガー部と、第２母線部から第１母線部に向けて延び、第１フィンガー部の近傍に達する第２フィンガー部とを有し、第１と第２母線部の少なくとも一方に断線部が形成されている。

【0017】

これにより、第１と第２フィンガー部間の短絡箇所が特定されやすくなる。結果として、太陽電池セルの特性不良が抑制される。

【0018】

上記断線部は、第１と第２母線部の延在方向における中央部に形成されることが好ましい。

【0019】

これにより、第１と第２フィンガー部間の短絡箇所の特定をさらに効率よく行なうことができる。

【0020】

本発明に係る太陽電池セルは、他の局面では、半導体基板と、半導体基板の主表面上に形成された複数の電極部とを備え、電極部は、第１母線部と、半導体基板の主表面上において第１母線部と隣り合う位置に間隔を空けて形成された第２母線部と、第１母線部から第２母線部に向けて延びる第１フィンガー部と、第２母線部から第１母線部に向けて延び、第１フィンガー部の近傍に達する第２フィンガー部とを有し、複数の電極部が該第１と第２母線部の延在方向に並ぶように形成されている。

【0021】

この局面においても、第１と第２フィンガー部間の短絡箇所が特定されやすくなる。結果として、太陽電池セルの特性不良が抑制される。

【0022】

ここで、複数の電極部における第１と第２母線部間の間隔が等しいことが好ましい。

【0023】

これにより、複数の電極部の電気的な接合が容易になる。結果として、太陽電池モジュールの製造が容易になる。

【0024】

本発明に係る太陽電池セルユニットの製造方法は、半導体基板の主表面上に第１導電型の第１不純物領域と第２導電型の第２不純物領域とを交互に並ぶように形成する工程と、第１と第２不純物領域上にそれぞれ形成される第１と第２フィンガー部と、該第１と第２フィンガー部と交差する方向に延在し、断線部を有し、第１と第２フィンガー部がそれぞれ接続される第１と第２母線部とを含む電極部を形成する工程と、電極部が形成された半導体基板を断線部において第１と第２半導体基板に分断する工程と、分断された第１と第２半導体基板上にそれぞれ形成された電極部どうしを電気的に接続する工程とを備える。

【0025】

これにより、電極部の短絡の有無を確認し、短絡が生じた箇所を除去した後、短絡不良のない部分のみを用いて太陽電池セルユニットを形成することができる。

【0026】

本発明に係る太陽電池モジュールは、上記太陽電池セルおよび上記太陽電池セルユニットの製造方法により製造された太陽電池セルユニットの少なくとも一方を含む。

【0027】

上記太陽電池セルにおいては、容易に電極部の短絡箇所が特定される。また、上記太陽電池セルユニットは、電極部の短絡不良のない部分のみを用いて形成される。結果として、特性不良が抑制された太陽電池モジュールが提供される。

【発明の効果】

【0028】

本発明によれば、太陽電池セルの特性不良を抑制することができる。

【発明を実施するための最良の形態】

【0029】

以下に、本発明に基づく太陽電池セル、太陽電池セルユニットの製造方法および太陽電池モジュールの実施の形態について、図１から図１６を用いて説明する。

【0030】

なお、本願明細書において、「受光面」とは、太陽電池セルまたは太陽電池モジュールにおける半導体基板の太陽光が入射する側の主表面を意味し、「裏面」とは、上記半導体基板における受光面の反対側であって太陽光が入射しない側の主表面を意味する。

【0031】

図１０は、本実施の形態に係る太陽電池セルを示した上面図である。本実施の形態に係る太陽電池セルにおいては、図１０に示すように、シリコン基板の裏面上にフィンガーｐ電極１１、フィンガーｎ電極１２、バスバーｐ電極１３（１３Ａ～１３Ｄ）およびバスバーｎ電極１４（１４Ａ～１４Ｄ）が形成されている。特徴的な構成として、バスバーｐ電極１３およびバスバーｎ電極１４は、それぞれ断線部１５を有している。

【0032】

上記構成が得られるプロセスについて、以下に説明する。

【0033】

図９は、上記太陽電池セルにおけるフィンガーｐ電極１１およびフィンガーｎ電極１２が形成された部分を示した断面図である。また、図１～図８は、それぞれ、図９に示す太陽電池セルの製造工程における第１～第８工程を示す断面図である。

【0034】

図１を参照して、シリコン結晶のインゴッドをスライスして得られる半導体基板としてのシリコン基板１においては、スライスの際にその表面近傍にダメージ層１ａが形成される。そこで、酸性またはアルカリ性の溶液を用いて、図２に示すように、ダメージ層１ａがエッチングされることが好ましい。なお、シリコン基板１の導電型はｎ型でもｐ型でも

よく、シリコン基板１の大きさや厚みについても適宜変更が可能である。ただし、入射する太陽光の反射による損失を抑制するためにシリコン基板１の受光面にテクスチャと呼ばれるピラミッド状の微細構造を形成する場合には、シリコン基板１の受光面の面方位が（１００）程度であることが好ましい。

【0035】

図３を参照して、シリコン基板１の受光面の反対側にある裏面にｐ型不純物（たとえばボロン）を含むｐ型ペースト材２と、ｎ型不純物（たとえばリン）を含むｎ型ペースト材３とが所定のパターンで付着される。そして、シリコン基板１がたとえば１００℃～２００℃程度の温度に加熱される。これにより、ペースト材２，３に含まれる有機溶媒成分が蒸発する。その後、ペースト材２，３が付着したシリコン基板１の裏面全体が拡散防止膜４で覆われる。ペースト材２，３を所定のパターンで付着する手段としては、たとえばスクリーン印刷やインクジェット印刷などが挙げられる。ここで、シリコン基板１内に発生する少数キャリアを効率良く収集するため、図３に示すように、ｐ型ペースト材２とｎ型ペースト材３とがシリコン基板１の裏面に沿って交互に間隔を空けて形成されることが好ましい。また、拡散防止膜４は、たとえば酸化シリコン膜などからなり、常圧ＣＶＤ（Ｃｈｅｍｉｃａｌ　Ｖａｐｏｒ　Ｄｅｐｏｓｉｔｉｏｎ）法や酸化シリコンを含む塗布液を乾燥させることなどによって形成される。

【0036】

次に、シリコン基板１は、たとえば９００℃～１０００℃程度の温度に加熱された石英炉内に投入され、たとえば３０分～６０分間石英炉内に置かれる。これにより、ｐ型ペースト材２に含まれるｐ型不純物（ボロン）およびｎ型ペースト材３に含まれるｎ型不純物（リン）がシリコン基板１中に拡散され、図４に示すように、シリコン基板１の裏面に沿って複数のｐ＋不純物層６およびｎ＋不純物層５が交互に間隔をあけて形成される。ここで、シリコン基板１の裏面には拡散防止膜４が形成されているため、ｐ型ペースト材２に含まれるｐ型不純物（ボロン）およびｎ型ペースト材３に含まれるｎ型不純物（リン）がシリコン基板１の外部に拡散することが防止される。

【0037】

次に、シリコン基板１は、たとえば水酸化ナトリウムや水酸化カリウムなどのアルカリとイソプロピルアルコール（ＩＰＡ：Ｉｓｏ－Ｐｒｏｐｙｌ　Ａｌｃｏｈｏｌ）などとを含む高温水溶液に浸漬される。これにより、シリコン結晶方位に沿った異方性エッチングが進行し、図５に示すように、シリコン基板１の受光面にピラミッド状のテクスチャ構造８が形成される。ここで、シリコン基板１の裏面には拡散防止膜４が形成されているため、シリコン基板１の裏面はエッチングされない。

【0038】

次に、シリコン基板１はフッ酸溶液などに浸される。これにより、図６に示すように、シリコン基板１の裏面の拡散保護膜４と、ｐ型ペースト材２およびｎ型ペースト材３とが除去される。その後、図７に示すように、シリコン基板１の受光面および裏面にキャリアの表面再結合を抑制するためのパッシベーション膜９，１０が形成される。パッシベーション膜９、１０としては、たとえば熱酸化により形成されるシリコン酸化膜やプラズマＣＶＤ法により形成されるシリコン窒化膜などが用いられる。パッシベーション膜９，１０を形成することによって、シリコン基板１の裏面上におけるキャリアの再結合を有効に抑制することができる。ここで、受光面に形成されるパッシベーション膜９としてシリコン窒化膜を用いた場合には、その屈折率が２．１程度となるため、該パッシベーション膜９は、受光面における太陽光の反射を抑制する反射防止膜としても用いることができる。

【0039】

次に、シリコン基板１の裏面のｐ＋不純物層６およびｎ＋不純物層５と電極との電気的接続を行なうために、図８に示すように、シリコン基板１の裏面に形成されたパッシベーション膜１０が所定のパターンで除去される。ここで、ｐ＋不純物層６およびｎ＋不純物層５の配列に応じてパッシベーション膜１０の除去パターン（たとえばドット状またはライン状などのパターン）が決定される。また、ｐ＋不純物層６およびｎ＋不純物層５以外

の部分に電極が形成されることがないように、除去されるパッシベーション膜１０の幅は、ｐ＋不純物層６およびｎ＋不純物層５の幅よりも小さいことが好ましい。

【0040】

次に、図９に示すように、パッシベーション膜１０が除去された部分に合わせて、ｐ＋不純物層６上にフィンガーｐ電極１１が形成されるとともに、ｎ＋不純物層５上にフィンガーｎ電極１２が形成される。フィンガーｐ電極１１およびフィンガーｎ電極１２を構成する素材としては、たとえば銀またはアルミニウムなどの高導電材料が用いられることが好ましい。これにより、太陽電池セルから発生する電流を、効率よく外部に取り出すことができる。また、フィンガーｐ電極１１およびフィンガーｎ電極１２を形成する手段としては、たとえば、高真空中における電子ビーム加熱による電極材料の蒸着、電極材料を含むペーストのスクリーン印刷または電極材料のメッキなどが挙げられる。また、シリコン基板１への電極材料の付着後に４００℃～５００℃程度の熱処理が行なわれることが好ましい。これにより、シリコン基板１とフィンガーｐ電極１１およびフィンガーｎ電極１２との良好なオーミック接触が得られる。なお、フィンガー電極１１，１２を形成する際に、図１０に示すように、フィンガー電極１１，１２と交差する方向に延在する母線部としてのバスバー電極１３（１３Ａ～１３Ｄ），１４（１４Ａ～１４Ｄ）も併せて形成される。

【0041】

上記フィンガーｐ電極１１およびフィンガーｎ電極１２は、主として、太陽電池セルに発生した電流を収集する電極である。また、バスバー電極１３，１４は、フィンガー電極が収集した電流を集め、主に他の太陽電池セルとの接続に用いられる電極である。

【0042】

フィンガーｐ電極１１とフィンガーｎ電極１２とを形成する際に、該電極１１，１２間に電気的短絡が生じる場合がある。この電気的短絡は、バスバーｐ電極１３とバスバーｎ電極１４との間の抵抗値により探知できる。該抵抗値は、太陽電池セルの構造や半導体基板の抵抗値により異なるが、正常な太陽電池セルの場合にたとえば１００ｋΩ以上程度の値を示すのに対し、電気的短絡がある太陽電池セル（不良セル）の場合にたとえば１００Ω以下程度の値を示す。

【0043】

上記のようにして、ある太陽電池セルにおけるフィンガー電極１１，１２間に電気的短絡が生じているか否かを探知することは容易である。しかしながら、従来の太陽電池セルにおいては、電気的短絡が生じている場合に、太陽電池セルのどの部分で該電気的短絡が生じているかを特定することが困難である。

【0044】

これに対し、本実施の形態に係る太陽電池セルにおいては、バスバーｐ電極１３は、それぞれ該電極１３の延在方向における中央部に形成された断線部１５によって、バスバーｐ電極１３Ａ，１３Ｃと、バスバーｐ電極１３Ｂ，１３Ｄとに分断されている。同様に、バスバーｎ電極１４は、それぞれ該電極１４の延在方向における中央部に形成された断線部１５によって、バスバーｎ電極１４Ａ，１４Ｃと、バスバーｎ電極１４Ｂ，１４Ｄとに分断されている。換言すると、上記太陽電池セルにおいては、フィンガー電極１１，１２およびバスバー電極１３，１４を有する複数の電極部（第１と第２電極部）が、バスバー電極１３，１４の延在方向に並んで形成されている。ここで、第１と第２電極部におけるバスバー電極１３，１４間の間隔は互いに等しい。これにより、後述するインターコネクタによる電気的接続が容易になる。

【0045】

図１１は、図１０に示す太陽電池セルにおけるフィンガー電極１１，１２の短絡部分１６を示した上面図である。なお、図１１に示す短絡部分１６の位置は、一例であって、短絡部分１６は、太陽電池セル内における任意の位置で生じる可能性がある。

【0046】

図１１に示すように、短絡部分１６が、バスバーｐ電極１３Ｃとバスバーｎ電極１４Ａ

との間にある場合には、バスバーｐ電極１３Ａとバスバーｎ電極１４Ａとの間、および、バスバーｐ電極１３Ｃとバスバーｎ電極１４Ｃとの間、および、バスバーｐ電極１３Ｂとバスバーｎ電極１４Ｂとの間、および、バスバーｐ電極１３Ｄとバスバーｎ電極１４Ｂとの間、および、バスバーｐ電極１３Ｄとバスバーｎ電極１４Ｄとの間の抵抗値は１００ｋΩ以上程度の値を示す。一方で、バスバーｐ電極１３Ｃとバスバーｎ電極１４Ａとの間の抵抗値は１００Ω以下程度の値を示す。これにより、バスバーｐ電極１３Ｃとバスバーｎ電極１４Ａとの間に短絡部分１６が生じていることが把握される。この検査を生産工程に取り入れることにより、たとえば、太陽電池セルにおける短絡部分１６が生じやすい部分を特定することが可能になる。短絡部分１６の発生は、電極形成のためのパターニング工程などにおける問題に起因するため、短絡部分１６が生じる箇所の傾向を当該パターニング工程などにフィードバックして問題を解決することが可能になる。この結果、太陽電池セルにおける短絡不良の発生が抑制される。

【0047】

上記のように短絡部分１６の場所を特定することで、短絡部分１６が生じていない部分を有効に活用することが可能となる。図１２は、図１０に示す太陽電池セルを２つに分割した状態を示した上面図であり、図１３は、図１０に示す太陽電池セルを２つに分割した後、短絡不良のない部分どうしを電気的に接続して形成した太陽電池セルユニットを示す上面図である。図１２を参照して、短絡部分１６を有する太陽電池セルは、断線部１５において短絡部分１６を有する不良セル１７と短絡部分１６を有しない正常セル１８とに分割される。当該分割は、たとえばダイシングなどの手段を用いて行なわれる。そして、図１３に示すように、正常セル１８のバスバー電極１３，１４どうしがインターコネクタ１９を用いて電気的に並列に接続される。これにより、短絡部分１６が生じた複数の太陽電池セルの一部が有効に活用され、短絡部分１６のない太陽電池セルユニットが形成される。

【0048】

図１４は、図１０に示す太陽電池セルと図１３に示す太陽電池セルユニットとを含む太陽電池モジュールを示す上面図である。図１４を参照して、太陽電池モジュールにおいては、上述した複数の太陽電池セルおよび太陽電池セルユニットがインターコネクタ１９によって電気的に接続されている。

【0049】

図１５は、上述した太陽電池セルの１つの変形例を示した上面図である。上述した図１０に示す例においては、バスバー電極１３，１４の中央部のみに断線部１５が設けられているが、図１５に示すように、断線部１５の数を増やすことにより、短絡場所の特定をより詳細にすることが可能になる。たとえば、図１５の例では、短絡部分１６の場所を、太陽電池セルの面積に対して１／１５にまで絞りこむ事ができる。なお、断線部１５の箇所数は適宜変更が可能である。たとえば、断線部１５をバスバー電極１３，１４における各フィンガー電極１１，１２間に設けた場合には、短絡を起こしているフィンガー電極１１，１２を特定することが可能になる。

【0050】

図１６は、上述した太陽電池セルの他の変形例を示した上面図である。上述した図１０および図１５に示す例においては、１つの太陽電池セル内において複数対（２対）のバスバー電極１３，１４が設けられていたが、図１６に示すように、１つの太陽電池セル内において、１対のバスバー電極１３，１４のみを形成することも可能である。

【0051】

上述した内容について要約すると、以下のようになる。

【0052】

本実施の形態に係る太陽電池セルは、裏面接合型太陽電池セルであって、１つの局面では、図１０，図１５，図１６に示すように、シリコン基板１（半導体基板）と、シリコン基板１の裏面上（主表面上）に形成された電極部とを備え、電極部は、バスバーｐ電極１３（第１母線部）と、シリコン基板１の主表面上においてバスバーｐ電極１３と隣り合う

位置に間隔を空けて形成されたバスバーｎ電極１４（第２母線部）と、バスバーｐ電極１３からバスバーｎ電極１４に向けて延びるフィンガーｐ電極１１（第１フィンガー部）と、バスバーｎ電極１４からバスバーｐ電極１３に向けて延び、フィンガーｐ電極１１の近傍に達するフィンガーｎ電極１２（第２フィンガー部）とを有し、バスバーｐ電極１３およびバスバーｎ電極１４に断線部１５が形成されている。

【0053】

これにより、フィンガーｐ電極１１およびフィンガーｎ電極１２間の短絡箇所が特定されやすくなる。結果として、太陽電池セルの特性不良が抑制される。

【0054】

なお、断線部１５は、典型的には、バスバーｐ電極１３およびバスバーｎ電極１４の両方に該電極１３，１４の延在方向における位置を合わせて形成されるが、断線部１５をバスバーｐ電極１３およびバスバーｎ電極１４の一方のみに形成した場合も、上記と同様の効果を奏する。

【0055】

上記断線部は、バスバーｐ電極１３およびバスバーｎ電極１４の延在方向における中央部に形成されることが好ましい。

【0056】

これにより、フィンガーｐ電極１１およびフィンガーｎ電極１２間の短絡箇所の特定をさらに効率よく行なうことができる。

【0057】

本実施の形態に係る太陽電池セルは、他の局面では、図１０，図１５，図１６に示すように、シリコン基板１と、シリコン基板１の裏面上に形成された複数の電極部とを備え、電極部は、バスバーｐ電極１３と、シリコン基板１の主表面上においてバスバーｐ電極１３と隣り合う位置に間隔を空けて形成されたバスバーｎ電極１４と、バスバーｐ電極１３からバスバーｎ電極１４に向けて延びるフィンガーｐ電極１１と、バスバーｎ電極１４からバスバーｐ電極１３に向けて延び、フィンガーｐ電極１１の近傍に達するフィンガーｎ電極１２とを有し、複数の電極部がバスバーｐ電極１３およびバスバーｎ電極１４の延在方向に並ぶように形成されている。

【0058】

この局面においても、フィンガーｐ電極１１およびフィンガーｎ電極１２間の短絡箇所が特定されやすくなる。結果として、太陽電池セルの特性不良が抑制される。

【0059】

ここで、複数の電極部におけるバスバーｐ電極１３とバスバーｎ電極１４との間隔が等しいことが好ましい。

【0060】

これにより、複数の電極部の電気的な接合が容易になる。結果として、太陽電池モジュールの製造が容易になる。

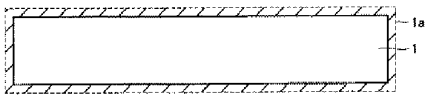
【0061】

本実施の形態に係る太陽電池セルユニットの製造方法は、シリコン基板１の裏面上にｐ型（第１導電型）のｐ＋不純物層６（第１不純物領域）とｎ型（第２導電型）のｎ＋不純物層５（第２不純物領域）とを交互に並ぶように形成する工程（図１～図６）と、ｎ＋／ｐ＋不純物層５，６上にそれぞれ形成されるフィンガーｐ電極１１およびフィンガーｎ電極１２と、フィンガーｐ電極１１およびフィンガーｎ電極１２と交差する方向に延在し、断線部１５を有し、フィンガーｐ電極１１およびフィンガーｎ電極１２がそれぞれ接続されるバスバーｐ電極１３およびバスバーｎ電極１４（第１と第２母線部）とを含む電極部を形成する工程（図７～図１０）と、電極部が形成されたシリコン基板１を断線部１５において複数のセル（不良セル１７および正常セル１８：第１と第２半導体基板）に分断する工程（図１２）と、分断されたセルのうち良品と判別されたセル（正常セル１８）上にそれぞれ形成された電極部どうしをインターコネクタ１９によって電気的に接続する工程（図１３）とを備える。

【0062】
これにより、電極部における短絡部分１６の有無を確認し、短絡部分１６が生じた箇所を除去した後、短絡部分１６のない正常セル１８のみを用いて太陽電池セルユニットを形成することができる。
【0063】
本実施の形態に係る太陽電池モジュールは、図１４に示すように、上記太陽電池セルおよび上記太陽電池セルユニットの製造方法により製造された太陽電池セルユニットを含む。図１４に示す例では、上記太陽電池セルおよび太陽電池セルユニットの両方が含まれているが、上記太陽電池セルまたは上記太陽電池セルユニットの一方のみで太陽電池モジュールが形成されてもよい。
【0064】
上記太陽電池セルにおいては、容易に電極部の短絡部分１６の発生箇所が特定される。また、上記太陽電池セルユニットは、電極部の短絡部分１６のない正常セル１８のみを用いて形成される。結果として、特性不良が抑制された太陽電池モジュールが提供される。
【0065】
以上、本発明の実施の形態について説明したが、今回開示された実施の形態は全ての点で例示であって制限的なものではないと考えられるべきである。本発明の範囲は特許請求の範囲によって示され、特許請求の範囲と均等の意味および範囲内での全ての変更が含まれることが意図される。
【図面の簡単な説明】
【0066】
【図1】本発明の１つの実施の形態に係る太陽電池セルの製造工程における第１工程を示した断面図である。
【図2】本発明の１つの実施の形態に係る太陽電池セルの製造工程における第２工程を示した断面図である。
【図3】本発明の１つの実施の形態に係る太陽電池セルの製造工程における第３工程を示した断面図である。
【図4】本発明の１つの実施の形態に係る太陽電池セルの製造工程における第４工程を示した断面図である。
【図5】本発明の１つの実施の形態に係る太陽電池セルの製造工程における第５工程を示した断面図である。
【図6】本発明の１つの実施の形態に係る太陽電池セルの製造工程における第６工程を示した断面図である。
【図7】本発明の１つの実施の形態に係る太陽電池セルの製造工程における第７工程を示した断面図である。
【図8】本発明の１つの実施の形態に係る太陽電池セルの製造工程における第８工程を示した断面図である。
【図9】本発明の１つの実施の形態に係る太陽電池セルを示した断面図である。
【図10】本発明の１つの実施の形態に係る太陽電池セルを示した上面図である。
【図11】図１０に示す太陽電池セルにおける電極部の短絡箇所を示した上面図である。
【図12】図１０に示す太陽電池セルを２つに分割した状態を示した上面図である。
【図13】図１０に示す太陽電池セルを２つに分割した後、短絡不良のない部分どうしを電気的に接続して形成した太陽電池セルユニットを示す上面図である。
【図14】図１０に示す太陽電池セルと図１３に示す太陽電池セルユニットとを含む太陽電池モジュールを示す上面図である。
【図15】図１０に示す太陽電池セルの１つの変形例を示した上面図である。
【図16】図１０に示す太陽電池セルの他の変形例を示した上面図である。
【図17】従来の太陽電池セルを示した断面図である。
【図18】従来の太陽電池セルを示した上面図である。
【符号の説明】

【0067】
１，１０１　シリコン基板、１ａ　ダメージ層、２　ｐ型ペースト材、３　ｎ型ペースト材、４　拡散防止膜、５，１０５　ｎ＋不純物層、６，１０６　ｐ＋不純物層、８　テクスチャ構造、９，１０，１０９，１１０　パッシベーション膜、１１，１１１　フィンガーｐ電極、１２，１１２　フィンガーｎ電極、１３，１３Ａ～１３Ｊ，１１３　バスバーｐ電極、１４，１４Ａ～１４Ｊ，１１４　バスバーｎ電極、１５　断線部、１６　短絡部分、１７　不良セル、１８　正常セル、１９　インターコネクタ。

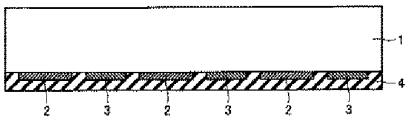
【図1】



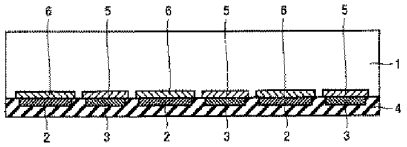
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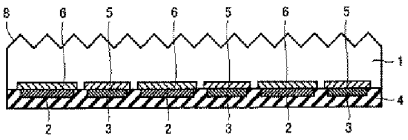
【図3】



【図4】



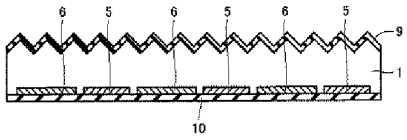
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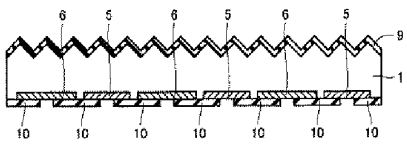
【図6】



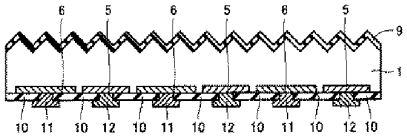
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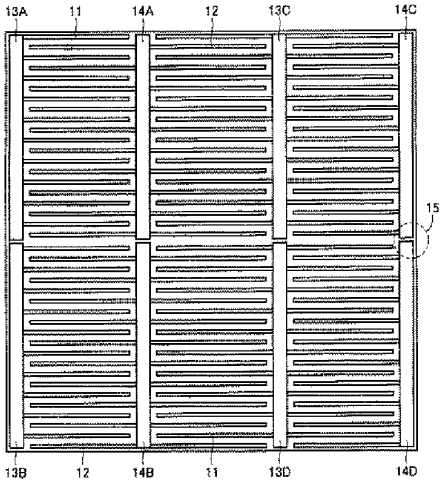
【図8】



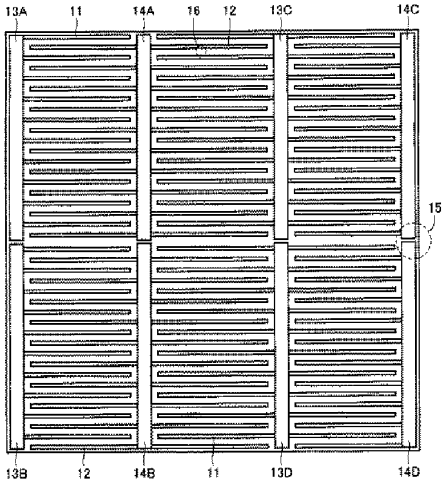
【図9】



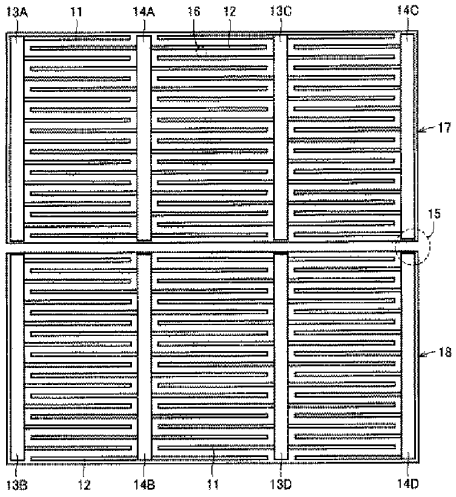
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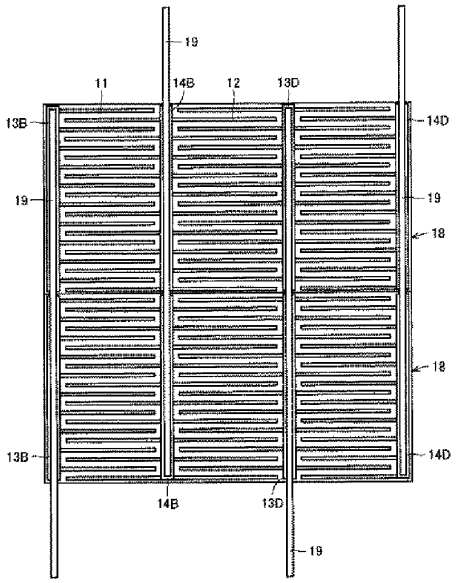
【図11】



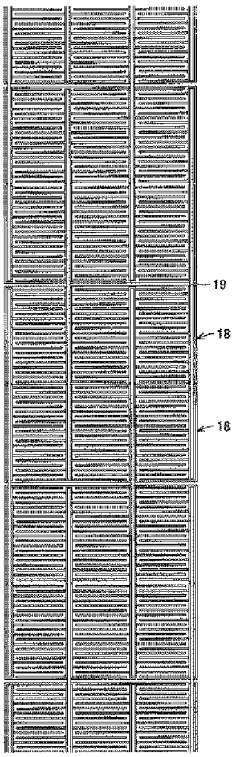
【図12】



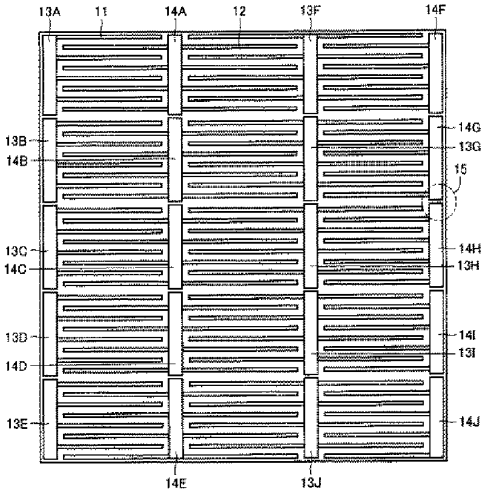
【図13】



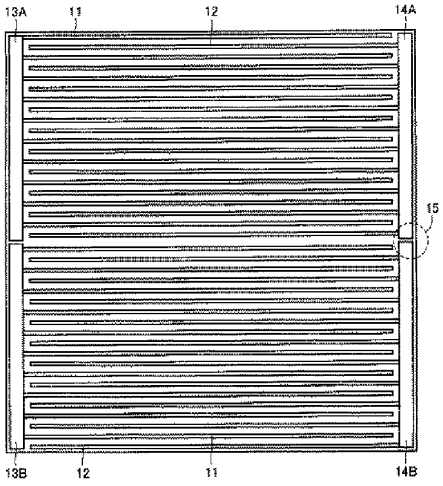
【図14】



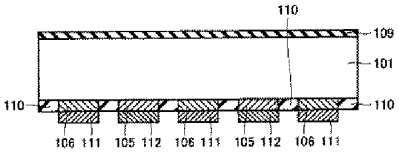
【図15】



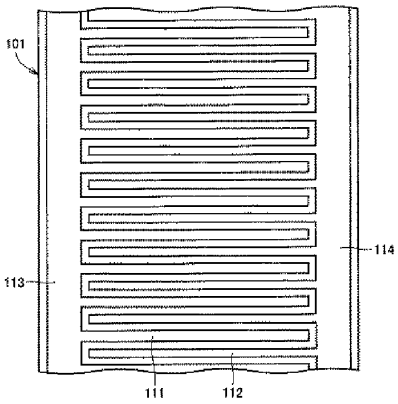
【図16】



【図17】



【図18】



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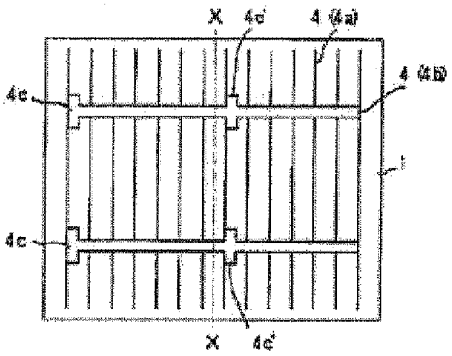
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(54) SOLAR BATTERY

(57)Abstract:
PROBLEM TO BE SOLVED: To easily connect adjacent cells when one solar cell is divided into a plurality of cells for use.
SOLUTION: A front electrode is provided on the surface side of a semiconductor substrate 1 comprising a semiconductor junction, and a backside electrode 4 where a finger part 4a and a bus-bar part 4b are provided in lattice is formed on the backside of the semiconductor substrate 1. Here, the bus-bar part 4b of the electrode 4 is provided with a plurality of wide tab parts 4c' for connecting a wiring material.



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CLAIMS

[Claim(s)]
[Claim 1]Provide a surface electrode to the surface side of a semiconductor substrate which has semiconductor junction, and. A solar cell providing two or more broad tab parts for connecting a wiring material to a bus bar part of the aforementioned rear electrode in a solar cell which formed in the back surface side of this semiconductor substrate a rear electrode which provided a finger part and a bus bar part in the shape of a lattice.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]Especially the present invention relates to the solar cell which provided the broad tab part for connecting a wiring material to the bus bar part of a rear electrode about a solar cell.
[0002]
[Description of the Prior Art]The conventional solar cell is shown in Fig.3 and Fig.4.The cross sectional view of the silicon system solar cell of the former [Fig.3] and Fig.4 are plan views.1 in Fig.3 and Fig.4 for example, in order that the semiconductor substrate of P type silicon about 500 micrometers thick and 2 may form an acceptance surface on one main surface of this semiconductor substrate 1,In order to take out negative potential from the n-type diffusion zone 2 which forms this acceptance surface, the n-type diffusion zone which diffused in a thickness of about 0.3-0.5 micrometer shallowly, and formed the n type impurity in it, and 3, The grid electrode provided at intervals of 1-5 mm by a width of about 1-2 mm, the rear electrode which provides 4 on the main surface of another side of the semiconductor substrate 1, and takes out positive potential, and 5 are the light-reflection-prevention films provided on the n-type diffusion zone 2 which forms an acceptance surface.
[0003]The surface electrode 3 by the side of an acceptance surface mainly serves as the upper and lower sides and symmetrical tandem-type form on the surface of the solar battery element

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in order to satisfy both condensing efficiency and collecting efficiency. That is, this surface electrode 3 serves as form form and two or more minute finger parts 3a for collecting the electrical and electric equipment generated inside the solar battery element by light incidence and the bus bar part 3b for taking out the collected electrical and electric equipment outside cross at right angles. It has form form and the bus bar part 4b for the rear electrode 4 to also connect two or more minute finger parts 4a and wiring materials cross at right angles. In order to improve the wiring nature at the time of connecting between elements to the rear electrode 4 with a wiring material, the tab part 3c which expanded the width of the bus bar part 3b is provided as a wiring material weld zone at the end of the bus bar part 3b.

[0004]After forming this rear electrode 4 by mainly screen-stenciling and printing conductive metal paste, such as Ag-aluminum, it is the purpose of improving the wiring nature at the time of connecting protection and two or more elements of the surface of this rear electrode 4, and covers that surface with the solder 7. The surface electrode 3 is also covered with the solder 6.

[0005]

[Problem to be solved by the invention]However, in this conventional solar cell, when using it, dividing into a required size, it is cut and used in the position of X-X-rays shown, for example in Fig.4, but as shown in Fig.5, it is necessary to make wiring connection only by the bus bar part 4b about the element 1' of the side which is not providing the tab part 4c of the element after division.Since the bus bar part 4b usually had only a width of about 1-2 mm, soldering of the wiring material 8 was difficult, and exfoliation takes place from the weld zone easily, and there was a problem that it was connected with debasement.

[0006]Although making thick the whole bus bar electrode 4b as this measure was also considered, there was a problem of becoming a cause which the excessive reservoir of solder generates at the time of covering with the solder 6.

[0007]The present invention is made in view of a problem of such a prior art, and is a thing. It is providing a solar battery element which eliminated inconvenience generated when using the purpose for plurality, dividing it.

[0008]

[Means for solving problem]To achieve the above objects, in the solar cell concerning the present invention, The surface electrode was provided to the surface side of the semiconductor substrate which has semiconductor junction, and two or more broad tab parts for connecting a wiring material to the bus bar part of the aforementioned rear electrode were provided in the solar cell which formed in the back surface side of this semiconductor substrate the rear electrode which provided the finger part and the bus bar part in the shape of a lattice.

[0009]

[Mode for carrying out the invention]Hereafter, the embodiment of the present invention is described in detail based on an accompanying drawing. Fig.1 is a cross sectional view showing the solar cell concerning the present invention. 1 in the figure for example, in order that the semiconductor substrate which comprises P type silicon about 500 micrometers thick, and 2 may

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form an acceptance surface on one main surface of this semiconductor substrate 1, In order to take out negative potential from the n-type diffusion zone 2 which forms this acceptance surface, the n-type diffusion zone which diffused in a thickness of about 0.3-0.5 micrometer shallowly, and formed the n type impurity in it, and 3, The surface electrode which provided the bus bar electrode 3b for connecting the finger electrode 3a and element comrade who formed at intervals of 1-5 mm by a width of about 1-2 mm with a wiring material in the shape of a lattice, The rear electrode which provides 4 on other main surfaces of the semiconductor substrate 1, and takes out positive potential, and 5 are the light-reflection-prevention films provided on the n-type diffusion zone 2 which forms an acceptance surface. The rear electrode 4 also provides the bus bar electrode 4b for connecting the finger electrode 4a and element comrade who formed at intervals of 1-5 mm with a wiring material in the shape of a lattice, and comprises a width of about 1-2 mm.

[0010]In the present invention, two or more broad tab parts 4c for connecting an electrode to the bus bar part 4b of the rear electrode 4 were provided. That is, the tab part 4c is similarly formed beforehand about the portion equivalent to the division end at the time of dividing conventionally the tab part 4c which was being provided only at the end of the bus bar part 4b on the back surface of an element into the size which needs an element. It is made for the position which provides the tab part 4c to become the same also in which element after the positional relationship from a division element end dividing. It becomes possible to wire by this, without causing deterioration of wiring nature, and the electrode exfoliation from a wiring section, even after dividing an element.

[0011]What is necessary is just to provide beforehand two or more tab parts 4c similarly, when dividing an element into two or more type of sizes. The form of the tab part 4c and 4c' will not be limited especially if it is the form where the bond strength of the polar zone 4 at the time of welding of the wiring material 8 is not deteriorated, but. When an immersion system performs solder covering of the polar zone 4, in order that solder may prevent riding on an excess to the wide tab part 4c of a pattern surface side product, it is desirable to provide the taper shape for pouring excessive solder into the portion which turns down to the immersion direction to melting solder.

[0012]When not using it, dividing, it is used in the state which has formed two or more tab parts 4c.

[0013]Next, it describes about the manufacturing method of the solar cell by the above-mentioned composition. First, a n type impurity is shallowly diffused to one main surface of the semiconductor substrate 1 of a P type silicon single crystal about 500 micrometers thick, the about 0.3-0.5-micrometer n-type diffusion zone 2 is formed, and it is considered as an acceptance surface. And the antireflection films 5, such as SiN_x, are formed on the n type diffused layers 2. And form in this n-type diffusion zone 2 the surface electrode 3 which screen-stencils Ag paste and has the finger part 3a and the bus bar part 3b, and. An Ag-aluminum **-strike is screen-stenciled and the rear electrode 4 which has the tab part 4c and the bus bar part 4b which has 4c' is formed in the whole back surface of the semiconductor substrate 1 in

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the finger part 4a and a predetermined position. And in the atmosphere, it calcinates about 5 minutes at 700 degrees C – 750 degrees C, it is immersed in a solder tub, and the solder layers 6 and 7 are formed on the surface electrode 3 and the rear electrode 4. These solder layers 6 and 7 are formed in a thickness of about 10–300 micrometers. When using it, dividing into two or more elements, the substrate 1 is cut and divided by laser or a diamond saw, and the surface electrode 3 of the tab part 4c of the bus bar part 4b of two or more elements and the element of another side is connected with the wiring material 8 so that the side part of tab part 4c' of the bus bar part 4b may be cut.

[0014]

[Effect of the Invention]As mentioned above, according to the solar cell concerning the present invention, since two or more broad tab parts for connecting a wiring material to the bus bar part of a rear electrode were provided, a wiring material can be welded on the same conditions as the element before dividing, also when wiring a division element, and it is not necessary to set up a complicated welding condition. The solution in question can be aimed at very easily only by changing the design of the screen pattern at the time of electrode formation. Even when there are two or more type of sizes to divide, it can respond to a corresponding section by providing two or more tab parts beforehand.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a figure showing the solar cell concerning the present invention.

[Drawing 2]It is a figure showing the state where divided the solar cell concerning the present invention and it connected.

[Drawing 3]It is a cross sectional view showing the conventional solar cell.

[Drawing 4]It is a plan view showing the conventional solar cell.

[Drawing 5]It is a figure showing the state where two or more conventional solar cells were connected.

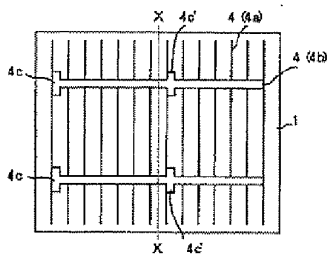
[Explanations of letters or numerals]

1 ..... semiconductor substrate, 2 ..... n-type diffusion zone, 3 ..... surface electrode, 4 ..... rear electrode, 4 a ..... finger part, 4 b ..... bus bar part, 4 c ..... tab part, 5 ..... light-reflection-prevention film

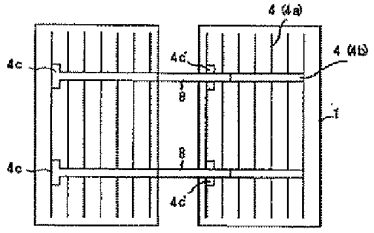
DRAWINGS

[Drawing 1]

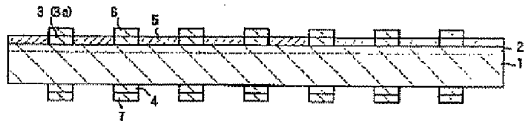
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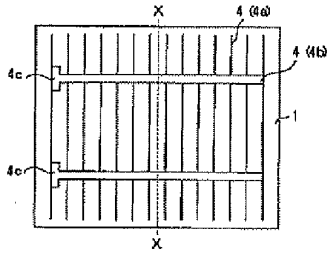
[Drawing 2]



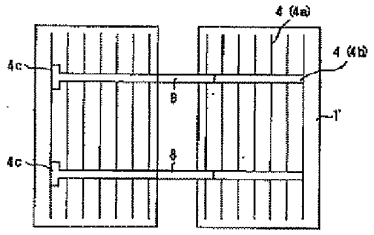
[Drawing 3]



[Drawing 4]



[Drawing 5]



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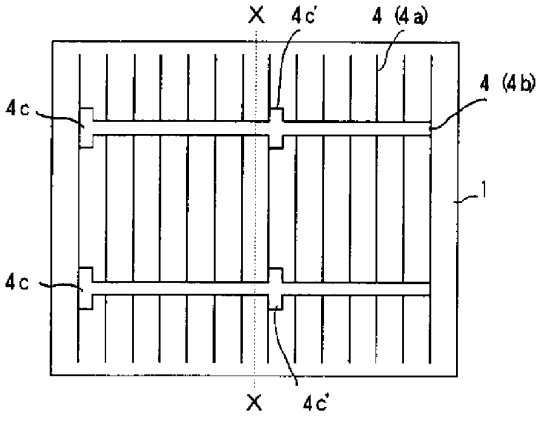
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Ｆターム(参考)　5F051 AA02 BA11 DA03 EA15 EA16
FA14 FA16 GA04

(54)【発明の名称】　太陽電池

(57)【要約】
【課題】　一つの太陽電池素子を複数に分割して使用する場合、隣接する素子同志を接続しにくいという問題があった。
【解決手段】　半導体接合部を有する半導体基板１の表面側に表面電極３を設けると共に、この半導体基板１の裏面側にフィンガー部４ａとバスバー部４ｂを格子状に設けた裏面電極４を形成した太陽電池であって、裏面電極４のバスバー部４ｂに配線材８を接続するための幅広なタブ部４ｅを複数設けた。



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【特許請求の範囲】

【請求項１】　半導体接合部を有する半導体基板の表面側に表面電極を設けると共に、この半導体基板の裏面側にフィンガー部とバスバー部を格子状に設けた裏面電極を形成した太陽電池において、前記裏面電極のバスバー部に配線材を接続するための幅広なタブ部を複数設けたことを特徴とする太陽電池。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は太陽電池に関し、特に裏面電極のバスバー部に配線材を接続するための幅広なタブ部を設けた太陽電池に関する。

【０００２】

【従来の技術】従来の太陽電池を図３および図４に示す。図３は従来のシリコン系太陽電池の断面図、図４は平面図である。図３および図４において、１は例えば５００μm程度の厚さのＰ形シリコンの半導体基板、２はこの半導体基板１の一方の主面上に受光面を形成するために、０．３～０．５μm程度の厚さにｎ形不純物を浅く拡散して形成したｎ形拡散層、３はこの受光面を形成するｎ形拡散層２からマイナス電位を取り出すために、１～２mm程度の幅で１～５mm間隔で設けられたグリッド電極、４は半導体基板１の他方の主面上に設けてプラス電位を取り出す裏面電極、５は受光面を形成するｎ形拡散層２上に設けた光反射防止膜である。

【０００３】受光面側の表面電極３は、集光効率と集電効率の両方を満足させるために、主に太陽電池素子の表面に上下、左右対称の櫛型形状となっている。すなわち、この表面電極３は、光入射により太陽電池素子内部で発生した電気を収集するための複数本の微細なフィンガー部３ａと、収集した電気を外部に取り出すためのバスバー部３ｂが直交する形状となっている。また、裏面電極４も複数本の微細なフィンガー部４ａと配線材を接続するためのバスバー部４ｂとが直交する形状となっている。また、裏面電極４には、素子間を配線材で接続する際の配線性を向上させるために、バスバー部３ｂの端部に配線材溶接部として、バスバー部３ｂの幅を広げたタブ部３ｃを設けている。

【０００４】この裏面電極４は主にＡｇ－Ａｌ等の導電性金属ペーストをスクリーン印刷して焼き付けることで形成した後、この裏面電極４の表面の保護並びに複数の素子を接続する際の配線性を向上させる目的で、その表面を半田７で被覆する。なお、表面電極３も半田６で被覆される。

【０００５】

【発明が解決しようとする課題】ところが、この従来の太陽電池では、必要な大きさに分割して使用する場合、例えば図４に示すＸ－Ｘ線の位置で切断して使用するが、図５に示すように、分割後の素子のタブ部４ｃを設けていない側の素子１’については、バスバー部４ｂのみで配線接続する必要がある。バスバー部４ｂは、通常１～２mm程度の幅しかないため、配線材８の半田付けが難しく、またその溶接部から剥離が起こりやすくなり、品質低下につながるという問題があった。

【０００６】また、この対策としてバスバー電極４ｂ全体を太くすることも考えられるが、半田６での被覆時に半田の過剰な溜まりが発生する原因になるという問題があった。

【０００７】本発明はこのような従来技術の問題点に鑑みてなされたものであり、一つの太陽電池素子を複数に分割して使用する場合に発生する不都合を解消した太陽電池素子を提供することを目的とする。

【０００８】

【課題を解決するための手段】上記目的を達成するために、本発明に係る太陽電池では、半導体接合部を有する半導体基板の表面側に表面電極を設けると共に、この半導体基板の裏面側にフィンガー部とバスバー部を格子状に設けた裏面電極を形成した太陽電池において、前記裏面電極のバスバー部に配線材を接続するための幅広なタブ部を複数設けた。

【０００９】

【発明の実施の形態】以下、本発明の実施形態を添付図面に基づき詳細に説明する。図１は本発明に係る太陽電池を示す断面図である。同図において、１は例えば５００μm程度の厚さのＰ形シリコンから成る半導体基板、２はこの半導体基板１の一方の主面上に受光面を形成するために、０．３～０．５μm程度の厚さにｎ形不純物を浅く拡散して形成したｎ形拡散層、３はこの受光面を形成するｎ形拡散層２からマイナス電位を取り出すために、１～２mm程度の幅で１～５mm間隔で形成したフィンガー電極３ａと素子同志を配線材で接続するためのバスバー電極３ｂとを格子状に設けた表面電極、４は半導体基板１の他の主面上に設けて、プラス電位を取り出す裏面電極、５は受光面を形成するｎ形拡散層２上に設けた光反射防止膜である。裏面電極４も１～２mm程度の幅で１～５mm間隔で形成したフィンガー電極４ａと素子同志を配線材で接続するためのバスバー電極４ｂとを格子状に設けて構成されている。

【００１０】本発明では、裏面電極４のバスバー部４ｂに電極を接続するための幅広なタブ部４ｃを複数設けた。すなわち、従来は素子裏面のバスバー部４ｂの端部にのみ設けていたタブ部４ｃを素子を必要とする大きさに分割した際の分割端部にあたる部分についても同様に、あらかじめタブ部４ｃを形成しておく。タブ部４ｃを設ける位置は、分割素子端面からの位置関係が分割後のいずれの素子においても同一になるようにする。このことにより、素子を分割後も配線性の低下や、配線部からの電極剥離を引き起こすことなく配線することが可能となる。

【００１１】なお、素子を複数種の大きさに分割する場

合も同様に複数個のタブ部４ｃをあらかじめ設ければよい。また、タブ部４ｃ、４ｃ’の形状は、配線材８の溶接時の電極部４の接着強度が低下しないような形状であれば特に限定されないが、電極部４の半田被覆を浸漬方式で行なう場合は、パターン面積の広いタブ部４ｃに半田が過剰に乗ることを防止するため、溶融半田への浸漬方向に対して下側になる部分に、過剰半田を流すためのテーパー形状を設けることが望ましい。

【００１２】また、分割して使用しない場合は、複数のタブ部４ｃを形成したままの状態で使用される。

【００１３】次に、上記構成による太陽電池の製造方法について説明する。まず、５００μｍ程度の厚さのＰ形シリコン単結晶の半導体基板１の一方の主面にｎ形不純物を浅く拡散して、０．３～０．５μｍ程度のｎ形拡散層２を形成して受光面とする。そして、ｎ型拡散層２上にＳｉN_xなどの反射防止膜５を形成する。そして、このｎ形拡散層２に例えばＡｇペーストをスクリーン印刷して、フィンガー部３ａとバスバー部３ｂとを有する表面電極３を形成すると共に、半導体基板１の裏面全体に例えばＡｇ－Ａｌペーストをスクリーン印刷して、フィンガー部４ａと所定位置にタブ部４ｃ、４ｃ’を有するバスバー部４ｂとを有する裏面電極４を形成する。そして、大気中で、７００℃～７５０℃で５分程度焼成し、半田槽に浸漬して表面電極３と裏面電極４上に半田層６、７を形成する。この半田層６、７は例えば１０～３００μｍ程度の厚みに形成される。複数の素子に分割して使用する場合は、バスバー部４ｂのタブ部４ｃ’の側部が切断されるように、レーザやダイヤモンドソーで基＊

＊板１を切断して分割し、複数の素子のバスバー部４ｂのタブ部４ｃと他方の素子の表面電極３を配線材８で接続する。

【００１４】

【発明の効果】以上のように、本発明に係る太陽電池によれば、裏面電極のバスバー部に配線材を接続するための幅広なタブ部を複数設けたことから、分割素子を配線する際も分割前の素子と同様の条件で配線材を溶接することができ、複雑な溶接条件を設定する必要がない。また、電極形成時のスクリーンパターンの設計を変更するだけで、非常に簡単に問題の解決を図ることができる。さらに、分割する大きさが複数種ある場合でも、あらかじめ該当箇所に複数個のタブ部を設けることで対応できる。

【図面の簡単な説明】

【図１】本発明に係る太陽電池を示す図である。

【図２】本発明に係る太陽電池を分割して接続した状態を示す図である。

【図３】従来の太陽電池を示す断面図である。

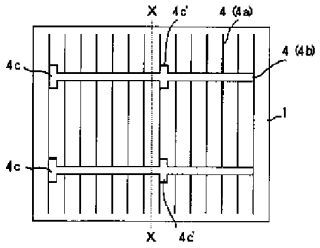
【図４】従来の太陽電池を示す平面図である。

【図５】従来の太陽電池を複数接続した状態を示す図である。

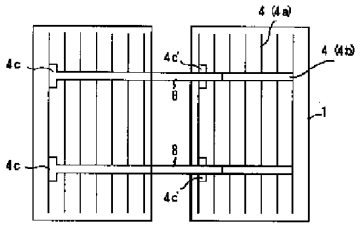
【符号の説明】

１……半導体基板、２……ｎ形拡散層、３……表面電極、４……裏面電極、４ａ……フィンガー部、４ｂ……バスバー部、４ｃ……タブ部、５……光反射防止膜

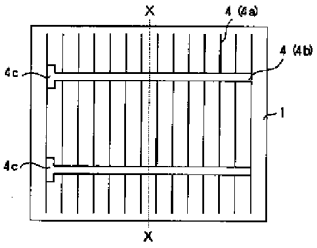
【図１】



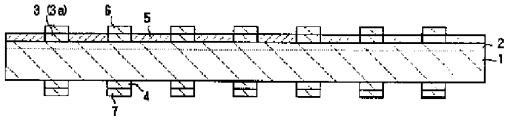
【図２】



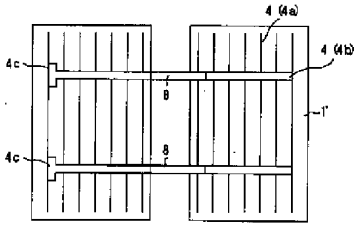
【図４】



【図３】



【図５】



(12)特許協力条約に基づいて公開された国際出願

(19) 世界知的所有権機関
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(43) 国際公開日
2005 年10 月13 日 (13.10.2005)

PCT

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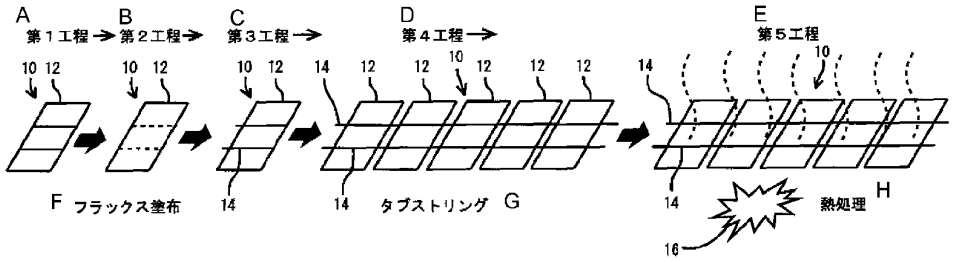
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[続葉有]

(54) Title: METHOD FOR MANUFACTURING SOLAR CELL

(54) 発明の名称: 太陽電池の製造方法



A... FIRST STEP
B... SECOND STEP
C... THIRD STEP
D... FOURTH STEP
E... FIFTH STEP
F... FLUX COATING
G... TAB STRING
H... HEAT TREATMENT

(57) Abstract: [PROBLEMS] To provide a method for manufacturing a solar cell in which residues, e.g. flux or organic matters, remaining on the cell surface are removed suitably, and power generation efficiency is enhanced significantly. [MEANS FOR SOLVING PROBLEMS] The method for manufacturing a solar cell comprises a step for coating the surface of a cell (12) with flux, a step for arranging a tab (14) across adjacent cells (12) coated with flux, a tab string step for connecting the tab (14) with the cells (12) by soldering, and a step for heating the cells (12) connected with the tab (14).

(57) 要約: 【課題】 セル表面に残ったフラックスや有機物等の残留物を好適に除去し、且つ、発電効率を大幅に向上した太陽電池の製造方法を提供する。【解決手段】 セル１２の表面にフラックスを塗布するフラックス塗布工程と、フラックスが塗布された隣接するセル１２に渡ってタブ１４を配設するタブ配設工程と、当該タブ１４をセル１２に半田付けして接続するタブストリング工程と、タブ１４が接続されたセル１２を加熱するセル加熱工程とを備える。

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明 細 書

太陽電池の製造方法

技術分野

[0001] 本発明は、太陽電池の製造方法に係り、特に複数のセルをタブ又はタブリードと称される接続部材により電気的に接続して成る太陽電池を製造する方法に関するものである。

背景技術

[0002] 近年、地球温暖化などの地球環境保全問題から、クリーンエネルギーへの期待が高まっており、太陽エネルギー(太陽光)を直接電気エネルギーに変換する太陽電池は、クリーンなエネルギー源として注目されている。例えば、太陽電池は複数の光電変換セルを備え、これら隣接するセルに銅箔から成るタブを半田付けして相互に電気的に接続することによりストリングが構成されている。このタブは、複数のセルを直列に接続するリード線となり、或いは、出力端子として使用される(特許文献1参照)。

[0003] このような太陽電池のストリング100の一般的な製造方法は、図9に示すように、先ず、複数のセル12を用意する(第1工程)。そして、複数のセル12の表面のタブ14を半田付けする部分(図中点線)に所定の温度に温められた液状のフラックスを塗布した後(第2工程)、セル12の上面及びそれに隣接するセル12の下面間に渡ってタブ14を配設する(第3工程)。次に、配設したタブ14が浮かないようにタブ14を上からセル12に押圧し、タブ14の半田付けを行う(第4工程)。

[0004] 係るタブ14をセル12の表面に半田付けする際、セル12にはフラックスに混じった有機物等が付着する。また、これら有機物やフラックスがセル12の表面に残っていると太陽電池の発電効率が低下してしまう。そこで、従来ではセル12にタブ14を半田付けした後に洗浄する洗浄工程を設け、セル12の表面のフラックスや有機物等の残留物を温水や薬品、或いは、スチームなどで洗浄して取り除いていた。

[0005] そして、このようにして洗浄された複数のセル12から成るストリング100を、裏面側の保護シート、或いは、透光性ガラスと、表面側の透光性ガラス間に配置し、充填剤(

Jinko Ex. 1002 - 179/580

EVAなど）によって封止することにより、太陽電池は製造されていた。また、セル12の表面のフラックスや有機物等の残留物を洗浄せずにそのままガラス間或いはガラスとシート間に封止する場合もあった。

特許文献1:特開2003－168811号公報

発明の開示

発明が解決しようとする課題

[0006] しかしながら、タブの半田付けを行った後に、セル表面のフラックスや有機物等の残留物を温水や薬品、或いは、スチームなどで洗浄して取り除く作業は、太陽電池の製造工程の増加を引き起こすために、太陽電池のコストアップを生起する問題があった。

[0007] また、タブの半田付けを行った後にセル表面のフラックスや有機物等の残留物を洗浄せずにガラス間、或いは、ガラスとシート間に封止した場合、セル表面にフラックスや有機物等の残留物が残っていても取り除けなくなってしまう。特に、セル表面に有機物などの残留物やフラックスがモジュール化する工程等における加熱によってガス化し多数の気泡となり残っている場合、セル表面に当たる太陽光が乱反射し、或いは、太陽光を遮ってしまうため、太陽電池の発電効率の低下を招いてしまうという問題もある。

[0008] 本発明は、係る従来技術の課題を解決するために成されたものであり、セル表面に残ったフラックスや有機物等の残留物の影響を効果的に除去し、発電効率を大幅に向上できる太陽電池の製造方法を提供することを目的とする。

課題を解決するための手段

[0009] 即ち、第1の発明は、複数のセルをタブにより電気的に接続して太陽電池を製造する方法であって、セルの表面にフラックスを塗布するフラックス塗布工程と、フラックスが塗布された隣接するセルに渡ってタブを配設するタブ配設工程と、当該タブをセルに半田付けして接続するタブストリング工程と、タブが接続されたセルを加熱するセル加熱工程とを備えたことを特徴とする。斯かるフラックスは、半田付けを良好にするためのものであり、有機物等の物質が含まれたものである。例えば斯かるフラックスには、水溶性のフラックスが用いることができる。

[0010] 第2の発明の太陽電池の製造方法は、上記セル加熱工程における加熱温度が、フラックスの沸点の温度以上であることを特徴とする。

[0011] 第2の発明の太陽電池の製造方法は、上記セル加熱工程における加熱温度が、フラックスの活性化温度以上であることを特徴とする。

[0012] 第3の発明の太陽電池の製造方法は、上記セル加熱工程における加熱温度が＋140℃以上＋160℃以下であって、加熱時間は1分以上5分間以下であることを特徴とする。

[0013] 第4の発明の太陽電池の製造方法は、上記セル加熱工程における加熱温度が＋150℃であって、加熱時間は3分間であることを特徴とする。

[0014] 第5の発明の太陽電池の製造方法は、前記セル加熱工程における加熱温度が＋160℃より高く、加熱時間は1分未満であることを特徴とする。

[0015] 第6の発明の太陽電池の製造方法は、上記セル加熱工程における加熱温度が＋200℃以上であって、加熱時間は20秒未満であることを特徴とする。

[0016] 第7の発明の太陽電池の製造方法は、上記セル加熱工程における加熱温度が＋250℃以上であって、加熱時間は10秒未満であることを特徴とする。

[0017] 第8の発明の太陽電池の製造方法は、上記各発明のセル加熱工程においては、セル全体を加熱することを特徴とする。

[0018] 第9の発明の太陽電池の製造方法は、上記各発明のセル加熱工程において、タブをセルに接続する半田の溶融を防止するための熱逃がし手段を備えたことを特徴とする。

[0019] 第10の発明の太陽電池の製造方法は、上記熱逃がし手段が、セルを搬送し、少なくともタブ部分が搬送時に接触する搬送ベルトであることを特徴とする。

[0020] 第11の発明の太陽電池の製造方法は、上記においてタブストリング工程では、搬送ベルトはタブ部分と接触せず、セル加熱工程で搬送ベルトはタブ部分と接触することを特徴とする。

[0021] 第12の発明の太陽電池の製造方法は、上記各発明のタブストリング工程において、タブに熱風を吹き付けることで半田付けを行うと共に、セル加熱工程においては、赤外線を照射してセルを加熱することを特徴とする。好ましくは赤外線を照射する手

段はランプヒータである。

発明の効果

[0022] 第1の発明の太陽電池の製造方法では、複数のセルをタブにより電気的に接続して太陽電池を製造するに当たり、セルの表面にフラックスを塗布するフラックス塗布工程と、フラックスが塗布された隣接するセルに渡ってタブを配設するタブ配設工程と、当該タブをセルに半田付けして接続するタブストリング工程と、タブが接続されたセルを加熱するセル加熱工程とを備えているので、このセル加熱工程において、例えば、第2の発明の如くフラックスの沸点の温度以上に加熱することにより、タブをセルに半田付けする際(前)に塗布したフラックスを蒸発させることができるようになる。また、例えば、第3の発明の如くセル加熱工程において、フラックスの活性化温度以上に加熱することで、例えフラックスが残留してもフラックスによる影響を無害化できる。

[0023] これにより、タブをセルに半田付けする際(前)にセルに付着したフラックスや有機物等の残留物を効果的に除去し、或いは、無害化することが可能となるので、従来のようにセル表面に塗布したフラックスや有機物等の残留物を除去するための洗浄工程を行うこと無く、残留物によってセル内部が白濁するなどの不都合も防止できるようになる。これにより、太陽電池の製造コストの低減を図りながら、太陽電池の品質向上と発電効率の改善を図ることができるようになる。

[0024] 特に、第4の発明の如くセルを＋140℃以上＋160℃以下で1分以上5分以下加熱し、好ましくは、第5の発明の如く＋150℃で3分間加熱するようにすれば、セルにタブを接続している半田が再溶融してしまう不都合も防止できる。

[0025] また、第6の発明の如くセル加熱工程における加熱温度を＋160℃より高くすれば、加熱時間を1分未満としてもフラックスを効果的に蒸発させることができる。特に、第7の発明の如くセル加熱工程における加熱温度を＋200℃以上とすれば、加熱時間を20秒未満としてもフラックスの影響を除去することができる。更に、第8の発明の如くセル加熱工程における加熱温度を＋250℃以上とすれば、加熱時間を10秒未満としてもフラックスの影響を除去することができる。このように、高温度で加熱することにより、セル加熱工程における処理時間を大幅に短縮し、生産効率の改善を図ること

ができるようになる。

[0026] 特に、係る高温度の加熱を短時間行うことにより、アニール効果によってセルの層境界面の特性が良くなり、太陽電池の特性改善も図ることができる効果がある。これは、200℃以上、更には、250℃以上の如き高温度の短時間加熱でより顕著なものとなると共に、第9の発明の如くセル加熱工程においてセル全体を加熱することによって、より均一な特性改善を図ることができるようになる。

[0027] この場合、第10の発明の如くセル加熱工程においてタブをセルに接続する半田の溶融を防止するための熱逃がし手段を設ければ、セル加熱工程における高温度の加熱によって、タブをセルに接続している半田が再溶融してしまう不都合も確実に防止できる。特に、第11の発明の如くこの熱逃がし手段を、セルを搬送し、少なくともタブ部分が搬送時に接触する搬送ベルトで兼ねることにより、格別な放熱、或いは、冷却装置を設けること無く、タブの半田再溶融を防止することができるようになり、設備コストも削減できる。

[0028] 特にこの場合、第12の発明の如くタブストリング工程では、搬送ベルトはタブ部分と接触せず、セル加熱工程で搬送ベルトはタブ部分と接触するようにすることにより、タブストリング工程ではタブ部分を最も高温にしたいために搬送ベルトからの熱の逃げを防ぎ、セル加熱工程では逆にタブ部分の温度を下げることができるようになる。

[0029] また、第13の発明の如くタブストリング工程における半田付けを、タブに熱風を吹き付けることで行うと共に、セル加熱工程においては、赤外線を照射してセルを加熱するようにすれば、タブストリング工程においてタブ部分を集中的に加熱し、セル加熱工程においてはセル全体を広く加熱することができるようになる。

[0030] これにより、タブストリング工程においてタブ以外の部分のセルに与える損傷を防止、若しくは、最小限に抑えながら確実なタブの半田付けを実現できると共に、セル加熱工程においてはセル全体を均一に加熱し、効果的なフラックスの影響を除去、或いは、それに加えてセルの特性改善を図ることができるようになるものである。

発明を実施するための最良の形態

[0031] 本発明は、太陽電池の発電効率を向上させるため、セル表面に塗布したフラックスや有機物等の残留物を洗浄せずに取り除く方法を提供するものである。フラックスや

有機物等の残留物の影響を取り除いて太陽電池の発電効率を向上させるという目的を、タブの半田付けを行った後のセルを加熱するだけの簡単な方法で実現した。

実施例 1

[0032] 次に、図面に基づき本発明の実施の形態を詳述する。図1は本発明の一実施例を示す太陽電池の製造工程図を示している。尚、この実施例は一般的な太陽電池の製造方法を示しており、この太陽電池を製造する技術については、従来より周知の技術であるため詳細な説明を省略し、主な要点を説明する。

[0033] 先ず、本発明の太陽電池のセル12は約10cm角に形成されると共に、セル12はパレット(図示せず)の長手方向に一列に並べられ着脱可能に装着され後工程の作業が行われる。太陽電池の製造方法は図1に示すように複数のセル12が分割形成された多結晶シリコン等の結晶系半導体からなるn型の結晶系シリコン基板10を用意しパレットに載置する(第1工程)。この場合、複数のセル12が形成された基板10は後述する第4工程にて図示、他の工程は単一のセル12を図示している。

[0034] 次に、分割された複数のセル12表面のタブ(接続部材)14を半田付する部分(図中点線)に所定の温度に温められた液状のフラックスを塗布し(第2工程)、隣接するセル12に渡って平行に2列のタブ14(集電極)を配設する(第3工程)。該タブ14は幅約2mmの導電性を有する銅箔等にて構成されると共にタブ14の両側には図示しないが幅約50μmの多数の分岐電極が延長して設けられている。

[0035] 次に、配設したタブ14が浮かないようにタブ14の幅に略等しい太さで耐熱性を有し半田が付かない2列の押圧具(図示せず)でタブ14をセル12に押圧し、セル12を直列にタブ14で半田付けし電気的に接続する(第4工程)。尚、押圧具は、図示しないが半田付け時タブ14を押圧し、半田付け終了後はセル12上から離れる方向に移動するように構成されている。尚、タブ14を押圧せずにセル12に半田付けできれば、必ずしも押圧具を使用しなくても差し支えない。

[0036] 該セル12の表面にフラックスを塗布した時やタブ14の半田付け時にフラックスに多数の気泡が発生する。また、タブ14の半田付けの際使用するフラックスには有機物等が混じっている。尚、セル12を直列にタブ14で半田付けして接続するために、隣接するセル12は、上面と下面(図示せず)がタブ14で接続される。

[0037] 次に、セル12を直列にタブ14で半田付けした後、セル12は下方からコイル或いは棒状の電熱ヒータ16にて＋140℃乃至＋160℃で、加熱時間は1分乃至5分間、好ましくは、セル12を＋150℃で、加熱時間は3分間にしたので、セル12に塗布したフラックスを蒸発させる(第5工程)。この場合、多結晶シリコン等の結晶系半導体からなるn型の結晶系シリコン基板10が加熱温度によって傷んだり破損して発電効率に支障が発生しない＋150℃で、加熱時間を3分間という短い時間加熱している。

[0038] これによって、従来のようにセル12表面に塗布したフラックスや有機物等の残留物を温水や薬品或いはスチームなどで洗浄して取り除かなくても、電熱ヒータ16にてセル12を加熱するだけで、半田付け時にフラックスに発生した多数の気泡は取り除かれると共に、フラックスの蒸発によりフラックスに混じった有機物等の残留物を蒸発させて取り除くことができる。従って、その後の工程でモジュール内での気泡の発生も防ぐことができる。

[0039] そして、セル12にタブ14を半田付けした後、最後にセル12表面に透光性及び耐候性を有するガラスが積層されて、太陽電池が完成する。この場合、白板強化ガラス等の透明な表面側カバー、充填材となるフィルム、電気的に直列接続されてなる半田付けした複数のセル12、充填材となるフィルムおよびポリエチレンテレフタレート(PET)等の樹脂フィルムからなる耐候性の裏面側カバーをこの順序で積層した状態で加熱し、加圧することにより、板状構成体を形成する。その後、該構成体を指示するアルミニウム等からなる金属製枠体、端子ボックス等を取り付け、太陽電池モジュールを完成するものである。尚、セル12に塗布したフラックスの蒸発は、セル12の上方からセル12表面に集中的に赤外線を照射できる反射鏡を備えた赤外線ランプにてセル12表面に赤外線を照射し、この熱によってフラックスを蒸発させるようにしても差し支えない。又、所定の温度の温風をセル12表面に吹き付けてフラックスを蒸発させるようにしても差し支えない。該温風をセル12表面に吹きつけた場合は、セル12表面の空気の対流が大きくなるのでフラックスを蒸発させる効果は絶大となり、電熱ヒータや赤外線ランプなどよりも短時間でフラックスを蒸発させることができる。

[0040] このように、基板10の表面に分割された複数のセル12を形成する工程と、分割された複数のセル12の表面にフラックスを塗布する工程と、フラックスが塗布された隣

接するセル12に渡ってタブ14を配設する工程と、当該タブ14をセル12に半田付けして接続する工程と、タブ14が接続されたセル12を電熱ヒータ16で加熱する工程とを備えているので、例えば、セル12を＋150℃で、加熱時間を3分間とすることにより、従来のようにセル12表面に塗布したフラックスを洗浄しなくても、フラックスを蒸発させて取り除くことができる。

[0041] これにより、タブ14をセル12に半田付けする際、セル12に付着した有機物等の残留物の影響を除去することが可能となる。従って、従来のように、セル12表面に塗布したフラックスや有機物等の残留物を除去するための洗浄工程が不要となり、太陽電池のコストの低減を図ることができる。

[0042] 特に、フラックスを蒸発させることによりセル12表面が白濁してしまうなどの不都合を防止することができる。従って、従来のようにフラックスの洗浄工程が無くても大幅に太陽電池の品質向上を図ることができ、然も発電効率を向上させることができる。

[0043] また、セル12を電熱ヒータ16で加熱してセル12表面に塗布したフラックスを蒸発させているので、セル12表面のフラックスの気泡を大幅に減らすことが可能となる。これにより、セル12表面に当たる太陽光の乱反射も防止することができるようになる。また、セル12表面のフラックスを蒸発させることによりセル12表面に塗布したフラックス量を殆ど無くすことができる。これにより、セル12表面に残るフラックスを極めて薄くすることができるのでセル12の太陽光の遮りも殆ど皆無となり太陽電池の発電効率を大幅に向上させることができる。

実施例 2

[0044] 次に、図面に基づき本発明のもう一つの実施形態を詳述する。図2はこの場合の実施例を示す太陽電池のストリング100の製造工程図を示している。尚、図2において図9と同一符号で示すものは同一若しくは同様の作用を奏するものとする。また、実施例では単結晶シリコンや多結晶シリコンなどの結晶型の他、アモルファスシリコンを用いた非結晶型、或いは、単結晶（結晶系基板）を基板としてその両面にシリコンの非結晶層を形成した単結晶・アモルファスハイブリッド型などの一般的なセル12（太陽電池セル）を用いた太陽電池の製造方法を示しており、これらセル12を製造する技術については、従来より周知の技術であるため詳細な説明を省略し、主な要点を

説明する。

[0045] 実施例のセル12は約10cm角に形成されており、その両面には並行に二条の集電極（幅約2mm）が設けられ、集電極の両側には多数の分岐電極（幅約50μm）が延長して設けられている。係るセル12はパレット（図示せず）の長手方向に一列に並べられて着脱可能に装着され、後の工程の作業が行われる。太陽電池の製造方法は、図2に示すようにセル12を用意し、パレットに載置する（第1工程）。

[0046] 次に、セル12表面の前記集電極の部分、即ち、接続部材としてのタブ14、14を半田付する部分（図中点線）に所定の温度に温められた液状のフラックス（水ベースの物質であり、沸点は約＋100℃であり、沸点以上で気化し、約＋200℃以上で活性化する。）を塗布する（フラックス塗布工程としての第2工程）。尚、前記タブ14は幅約2mmの導電性を有する銅箔などにて構成されており、その表面には半田が塗布されている。

[0047] 次に、タブ配設工程としての第3工程に移行する。この第3工程移行については図3及び図4を用いて説明する。図3及び図4において、3は無端ベルトから構成された搬送ベルト（搬送手段）であり、所定時間停止した後、所定距離移動すると云う間欠的な動作により、セル12を図3中向かって右方向に搬送するものである。この搬送ベルト3は、図7に示すようにタブストリング工程（半田付け位置）に位置する搬送ベルト3Aと、セル加熱工程に位置する搬送ベルト3Bとから成り、搬送ベルト3Aはセル12下面のタブ14、14を回避した位置に3条設けられ、搬送ベルト3Bは逆にセル12下面のタブ14、14に対応して接触する位置に二条設けられている。

[0048] 4は搬送ベルト3の所定の半田付け位置の上下に配置された押付装置であり、図示しない駆動手段によって上下動される二列の複数のピン4A・・、4B・・から構成されている。尚、このピン4A・・、4B・・は半田が付かないもので構成され、図3、図4に示すように配置される二条のタブ14、14の垂直上方及び下方にそれぞれ対応して配置されている。また、この押付装置4の下方に対応する位置の搬送ベルト3下側には、電気ヒータから構成されたホットプレート（下側加熱手段）6が設けられており、作業中常時通電されている。

[0049] 更に、この押付装置4と同じタブ14、14の垂直上方にそれぞれ対応する位置には

、温風ヒータ(温風式加熱手段)7、7が設けられている。各温風ヒータ7、7は、例えば通電されて発熱する電気ヒータと送風機とから構成されており、電気ヒータにて加熱された空気(熱風)を送風機にてタブ14、14部分に集中的に吹き付けるものである。

[0050] 前述の第2工程においてフラックスが塗布されたセル12は次に上記搬送ベルト3Aに載置される。次に、前記集電極に対応してタブ14が搬送ベルト3Aの進行方向における左右に二条配置される(タブ配置工程としての第3工程)。実際には、ストリング100を構成する最初のセル12の下面の集電極に対応してタブ14が二条配置され、その前部(搬送ベルト3の進行方向における前部)半分は進行方向に引き出される。そして、搬送ベルト3が所定距離移動され、セル12は前述した所定の半田付け位置に移動されて所定時間停止する。そこで、セル12の上面の集電極に対応してタブ14が配置される。

[0051] このとき、タブ14、14(最初のセル12の上面に配置されたタブ)の後部(搬送ベルト3の進行方向における後部)半分は引き出されており、その上には次のセル12が載置されることになる。また、この場合セル12は上面がプラス側、下面がマイナス側となる。

[0052] このようにセル12の上下面に二条のタブ14、14を当接させ、配置した状態で、この停止時間中、押付装置4の各ピン4A・・、4B・・が降下し、タブ14、14をセル12の上面及び下面に押し付けて浮かないように押さえる。また、タブ14を押圧せずにセル12に半田付けできれば、必ずしも押付装置4は使用しなくても差し支えない。

[0053] このようにセル12にタブ14を押し付けた状態で、温風ヒータ7、7の電気ヒータと送風機に通電して高温の熱風をタブ14、14に集中して吹き付け、タブ14、14の半田を溶融温度(+186℃～+187℃)以上で加熱する。尚、下面のタブ14、14も上面からの熱風吹き付けに伴う温度上昇による熱伝導と下面のホットプレート6からの加熱によって半田が溶融温度まで加熱される(タブストリング工程としての第4工程)。

[0054] ここで、温風ヒータ7、7からの熱風はタブ14、14に集中的に吹き付けられるので、それ以外の部分のセル12が過剰に加熱され、温度が異常に高くなってセル12に損傷が生じることは無い。また、この場合搬送ベルト3Aは下面のタブ14、14に接触していないので、このタブ部分の温度を逃がすこと無く、タブ14付近を高温として半田

の溶融を促進できる。

[0055] このように押付装置4でタブ14をセル12に押し付けながら温風ヒータ7、7から熱風を所定時間吹き付けた後、温風ヒータ7の電気ヒータ及び送風機は停止される。尚、この熱風吹きつけ後も押付装置4はピン4A・・、4B・・によりタブ14をセル12に押し付けておき、半田が冷えてタブ14がセル12に確実に接続されるまで待つ。

[0056] この間に上面のタブ14、14の後部には前述したようにセル12が載置される。その後、ピン4A・・、4B・・はセル12上から離間する方向に移動する。次に、搬送ベルト3Aが所定距離移動され、この新たに載置されたセル12が半田付け位置に移動されて再びタブ14、14がその上面に載置される。このようにしてタブ14によりセル12を直列に半田付けしてストリング100を製造する。

[0057] ここで、セル12の表面にフラックスを塗布したときやタブ14の半田付け時にフラックスがガス化し多数の気泡が発生する。また、タブ14の半田付けの際使用するフラックスには有機物等が混じっている。そこで、上記タブストリング工程(第4工程)の次に、本発明ではセル加熱工程としての第5工程を実施する。図5及び図6はこの第5工程(セル加熱工程)を示している。尚、各図中図3、図4と同一符号で示すものは同一とする。また、図7は第4工程から第5工程の搬送ベルト3の様子を示し、セル14は上記タブストリング工程の後、搬送ベルト3Aからセル加熱工程の搬送ベルト3Bに受け渡される。

[0058] 即ち、各図において前記半田付け位置よりも搬送ベルト3の進行方向側に位置する所定のセル加熱位置上方には、ランプヒータ17が配設されている。このランプヒータ17は赤外線ランプから構成されている。また、このセル加熱位置のセル12の下側には前述したホットプレート6が設けられているが、タブ14に対応する部分は加熱を防止するためにホットプレート6は削除されている構成が好ましい。

[0059] そして、前述の如く第4工程においてタブ14が半田付けされたセル12は、搬送ベルト3A、3Bによって次に前記セル加熱位置に移動される。このセル加熱位置でセル12には上方からランプヒータ17の赤外線が照射され、下方からはホットプレート6より加熱される。このランプヒータ17からの赤外線は拡散するため、赤外線はセル12の上面全体に照射されるので、セル12は全体的に加熱されることになる。

[0060] このときの加熱温度は＋140℃以上＋160℃以下で、加熱時間は1分以上5分以下の間とされ、好ましくは、セル12を＋150℃で3分間加熱する。これによって、セル12に塗布したフラックスを蒸発させる。係る加熱温度（150℃）及び加熱時間（3分間）であるために、セル12には加熱による劣化や破損が生じることも無く、発電効率にも支障が発生しない。また、＋140℃以上＋160℃以下の温度であればタブ14の半田も再溶融しない。

[0061] これによって、従来のようにセル12の表面に塗布したフラックスや有機物等の残留物を温水や薬品或いはスチームなどで洗浄して取り除かなくても、ランプヒータ17にてセル12を所定の条件で加熱することで、フラックスの蒸発によりフラックスに混じった有機物などの残留物の影響も低減できる。

[0062] このような第5工程後、白板強化ガラス等の透明な表面側カバー、充填材となるフィルム、電気的に直列接続されてなる複数のセルからなる直線状の太陽電池群（ストリング）100、100・・・、充填材となるフィルムおよびポリエチレンテレフタレート（PET）等の樹脂フィルムからなる耐候性の裏面側カバーをこの順序で積層した状態で加熱し、加圧することにより、板状構成体を形成する。その後、該構成体を指示するアルミニウム等からなる金属製枠体、端子ボックス等を取り付け、太陽電池モジュールを完成する。

[0063] このように、本発明では複数のセル12をタブ14により電気的に接続して太陽電池を製造するに当たり、セル12の表面にフラックスを塗布するフラックス塗布工程（第2工程）と、フラックスが塗布された隣接するセル12に渡ってタブ14を配設するタブ配設工程（第3工程）と、当該タブ14をセル12に半田付けして接続するタブストリング工程（第4工程）と、タブ14が接続されたセル12を加熱するセル加熱工程（第5工程）とを備えているので、このセル加熱工程において、タブ14をセル12に半田付けする際（前）に塗布したフラックスを蒸発させることができるようになる。

[0064] これにより、タブ14をセル12に半田付けする際（前）にセル12に付着したフラックスや有機物等の残留物を効果的に除去することが可能となるので、従来のようにセル12の表面に塗布したフラックスや有機物等の残留物を除去するための洗浄工程を行うこと無く、残留物によってセル12の内部が白濁するなどの不都合も防止できるよう

になる。これにより、太陽電池の製造コストの低減を図りながら、太陽電池の品質向上と発電効率の改善を図ることができるようになる。

実施例 3

[0065] 次に、本発明の更に他の実施例を説明する。上記実施例では第5工程(セル加熱工程)において、セル12を＋140℃以上＋160℃以下で1分以上5分以下加熱し、好ましくは、＋150℃で3分間加熱するようにしたが、この場合の実施例では第5工程(セル加熱工程)における加熱温度を＋160℃より高くすると共に、加熱時間は1分未満と極めて短い時間とする。

[0066] 好ましくは、加熱温度を＋200℃以上、加熱時間も20秒未満と短くする。このように、第5工程におけるセル12の加熱温度を＋160℃より高くすれば、加熱時間も1分未満という極めて短い時間でセル12のフラックスを活性化させ、蒸発させることができる。特に、加熱温度を＋200℃以上とすることで、加熱時間も20秒未満と著しい短い時間でフラックスを活性化させ、蒸発させることができる。更に、加熱温度を＋250℃以上とすることで、加熱時間も10秒未満と著しい短い時間でフラックスを活性化させ、蒸発させることができる。これにより、例えフラックスが残留してもフラックスによる影響を無害化できる。

[0067] 即ち、この実施例では係る高温度で加熱することにより、第5工程(セル加熱工程)における処理時間(タクト)を大幅に短縮し、生産効率の改善を図ることができるようになる。尚、セル加熱工程における加熱温度は、半田材の溶融抑制や太陽電池の特性の観点から＋400℃以下が好ましい。

[0068] 特に、係る高温度の加熱を短時間行うことにより、アニール効果によってセル12の層境界面の特性が良くなり、太陽電池の特性改善も図ることができる効果がある。図8は斯かるセル加熱工程における加熱温度とセル12の出力特性の変化率を示した図である。この図からも明らかな如く、＋200℃以上、更には、＋250℃以上と云う高温度の短時間加熱でよりセル12の出力特性の向上は顕著なものとなる。また、ランプヒータ17でセル12全体を広く加熱することによって、より均一な特性改善を図ることができるようになる。

[0069] この場合、下面のタブ14は搬送ベルト3Bに当接しているので、ランプヒータ17から

の熱は、各タブ14部分では熱伝導でこの搬送ベルト3Bに伝わって逃げていき、タブ14付近では温度が下がることになる。従って、第5工程(セル加熱工程)における高温度の加熱によって、タブ14をセル12に接続している半田が再溶融してしまう不都合も確実に防止できる。特に、この場合搬送ベルト3Bがタブ14部分の熱逃がし手段を兼ねるので、格別な放熱、或いは、冷却装置を設けること無く、タブ14の半田再溶融を防止することができるようになり、設備コストも削減できる。搬送ベルトには、金属製または非金属製の耐熱性を有するものが適宜使用できる。なお、加熱部の搬送は、熱伝導性が高いものが好ましい。また、実施例2と同様、タブストリング工程での搬送は、図7の3Aのようなタブに接触しない搬送ベルトを用いる方が更に好ましい。

[0070] 尚、上記各実施例、特に、実施例2では第5工程(セル加熱工程)においてランプヒータにより上からセルを加熱したが、それに限らず、温風ヒータにより上から熱風を全体に渡って吹き付けてもよく、また、電気ヒータによって下から加熱するようにしてもよい。熱風によって全体を加熱する場合には、空気の対流も生じるのでフラックスの蒸発効果を改善できる。但し、ランプヒータを使用した方が、より広い範囲を加熱できる効果がある。

[0071] また、第4工程(タブストリング工程)においては温風ヒータを使用したが、これも赤外線を照射するランプヒータによって加熱するようにしてもよい。但し、温風ヒータを用いることで、ランプヒータの場合に比してより集中的にタブを加熱できる効果がある。また、実施例3では搬送ベルトを熱逃がし手段として使用したが、それに限らず、タブの半田再溶融を防止する冷却装置や放熱板などの熱逃がし手段を別途設けてもよい。但し、実施例3のように搬送ベルトを熱逃がし手段として兼用すれば、前述した如く設備コストの削減を図ることができる。

図面の簡単な説明

[0072] [図1]本発明の一実施例を示す太陽電池の製造工程図である。

[図2]本発明の他の実施例の太陽電池の製造工程図である。

[図3]図2のタブストリング工程を説明する図である。

[図4]同じく図2のタブストリング工程を説明する図である。

[図5]図2のセル加熱工程を説明する図である。

[図6]同じく図2のセル加熱工程を説明する図である。

[図7]図2のタブストリング工程とセル加熱工程における搬送ベルトの平面図である。

[図8]セル加熱工程における加熱によるセルの出力特性の変化率を示す図である。

[図9]太陽電池の従来の製造工程図である。

請求の範囲

[1] 複数のセルを接続部材により電気的に接続して太陽電池を製造する方法であって、

前記セルの表面にフラックスを塗布するフラックス塗布工程と、

前記フラックスが塗布された隣接する前記セルに渡って前記接続部材を配設するタブ配設工程と、

当該接続部材を前記セルに半田付けして接続するタブストリング工程と、

前記接続部材が接続された前記セルを加熱するセル加熱工程とを備えたことを特徴とする太陽電池の製造方法。

[2] 前記セル加熱工程における加熱温度は、前記フラックスの沸点の温度以上であることを特徴とする請求項1に記載の太陽電池の製造方法。

[3] 前記セル加熱工程における加熱温度は、前記フラックスの活性化温度以上であることを特徴とする請求項1に記載の太陽電池の製造方法。

[4] 前記セル加熱工程における加熱温度は＋140℃以上＋160℃以下であって、加熱時間は1分以上5分間以下であることを特徴とする請求項1乃至請求項3の何れかに記載の太陽電池の製造方法。

[5] 前記セル加熱工程における加熱温度は＋150℃であって、加熱時間は3分間であることを特徴とする請求項4に記載の太陽電池の製造方法。

[6] 前記セル加熱工程における加熱温度は＋160℃より高く、加熱時間は1分未満であることを特徴とする請求項1乃至請求項3の何れかに記載の太陽電池の製造方法。

[7] 前記セル加熱工程における加熱温度は＋200℃以上であって、加熱時間は20秒未満であることを特徴とする請求項6に記載の太陽電池の製造方法。

[8] 前記セル加熱工程における加熱温度は＋250℃以上であって、加熱時間は10秒未満であることを特徴とする請求項6又は請求項7に記載の太陽電池の製造方法。

[9] 前記セル加熱工程においては、前記セル全体を加熱することを特徴とする請求項1乃至請求項8の何れかに記載の太陽電池の製造方法。

[10] 前記セル加熱工程において、前記接続部材を前記セルに接続する半田の溶融を

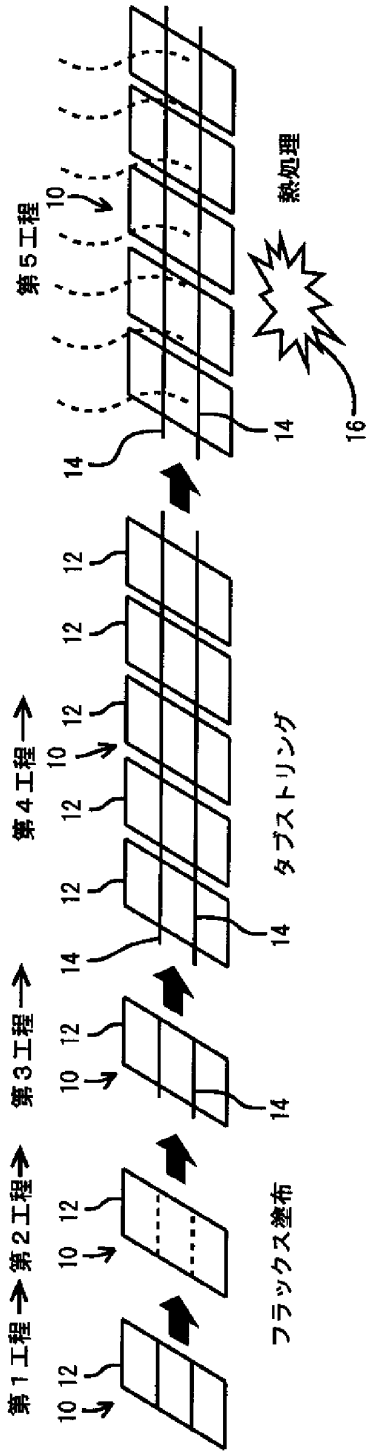
防止するための熱逃がし手段を備えたことを特徴とする請求項1乃至請求項9の何れかに記載の太陽電池の製造方法。

[11] 前記熱逃がし手段は、前記セルを搬送し、少なくとも前記接続部材部分が搬送時に接触する搬送ベルトであることを特徴とする請求項10に記載の太陽電池の製造方法。

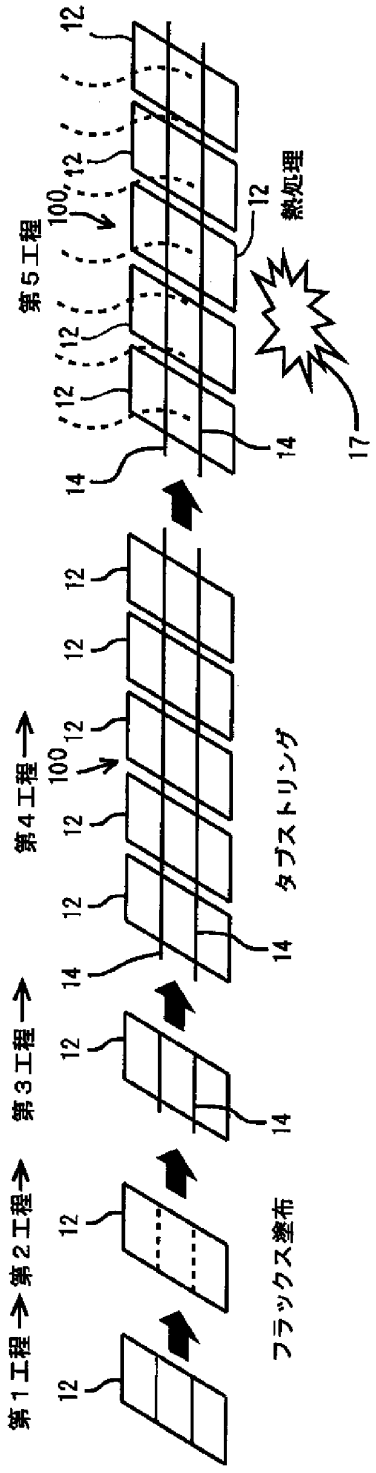
[12] 前記タブストリング工程では、前記搬送ベルトは前記接続部材部分と接触せず、前記セル加熱工程で前記搬送ベルトは前記接続部材部分と接触することを特徴とする請求項11に記載の太陽電池の製造方法。

[13] 前記タブストリング工程において、前記接続部材に熱風を吹き付けることで半田付けを行うと共に、前記セル加熱工程においては、赤外線を照射して前記セルを加熱することを特徴とする請求項1乃至請求項12の何れかに記載の太陽電池の製造方法。

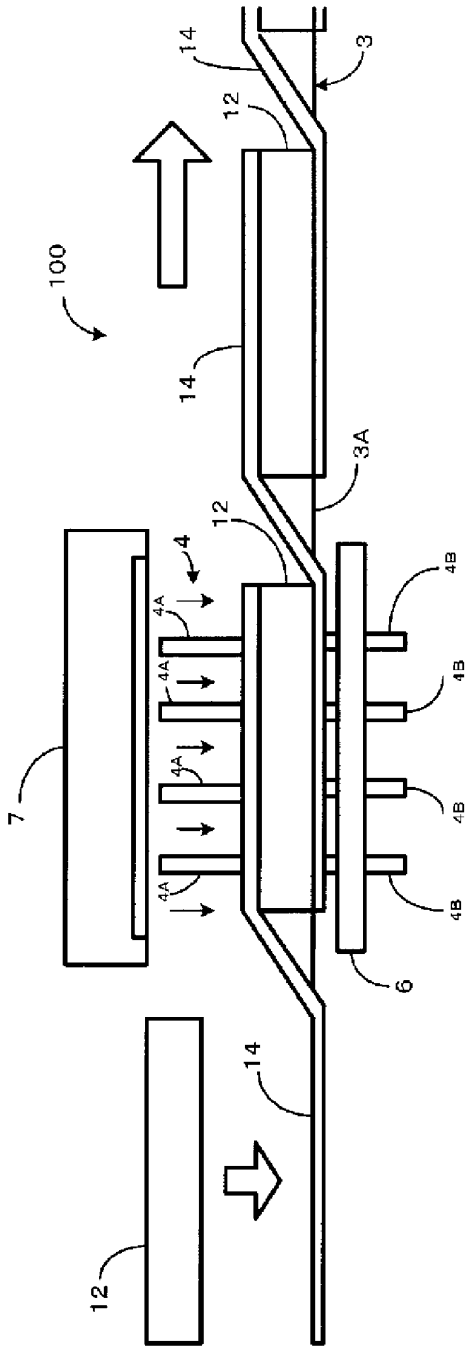
[図1]



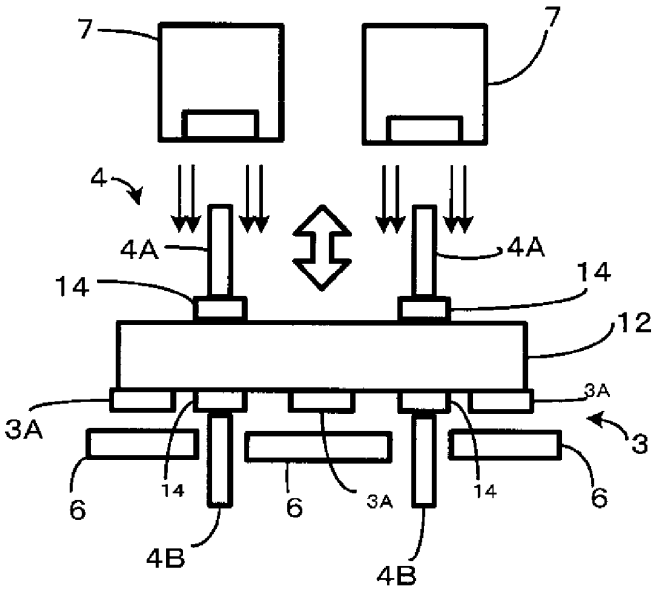
[図2]



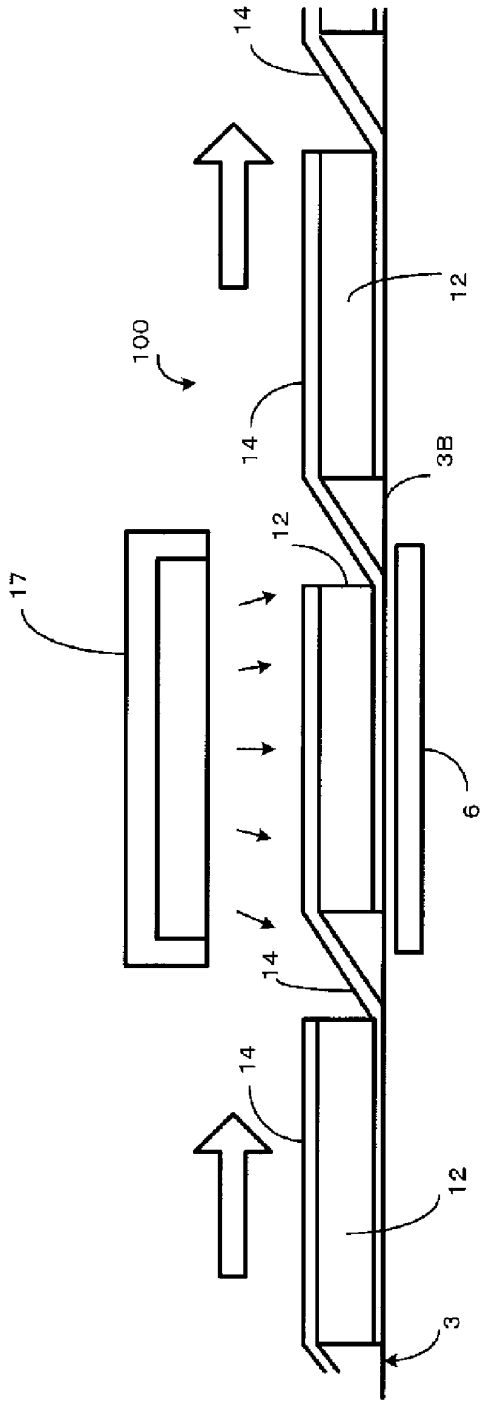
[図3]



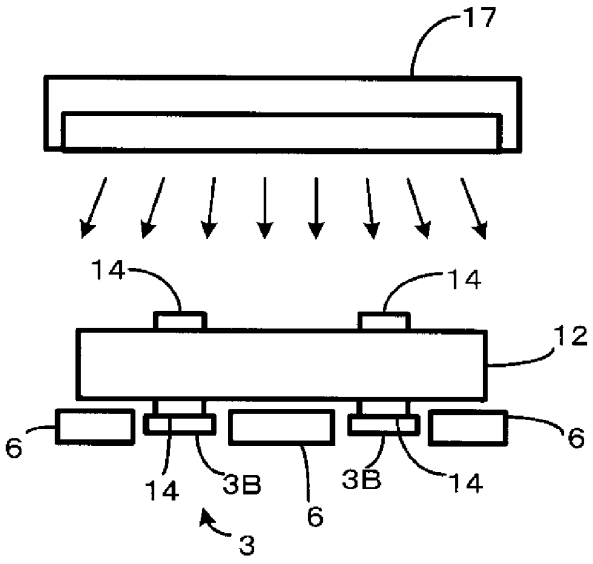
[図4]



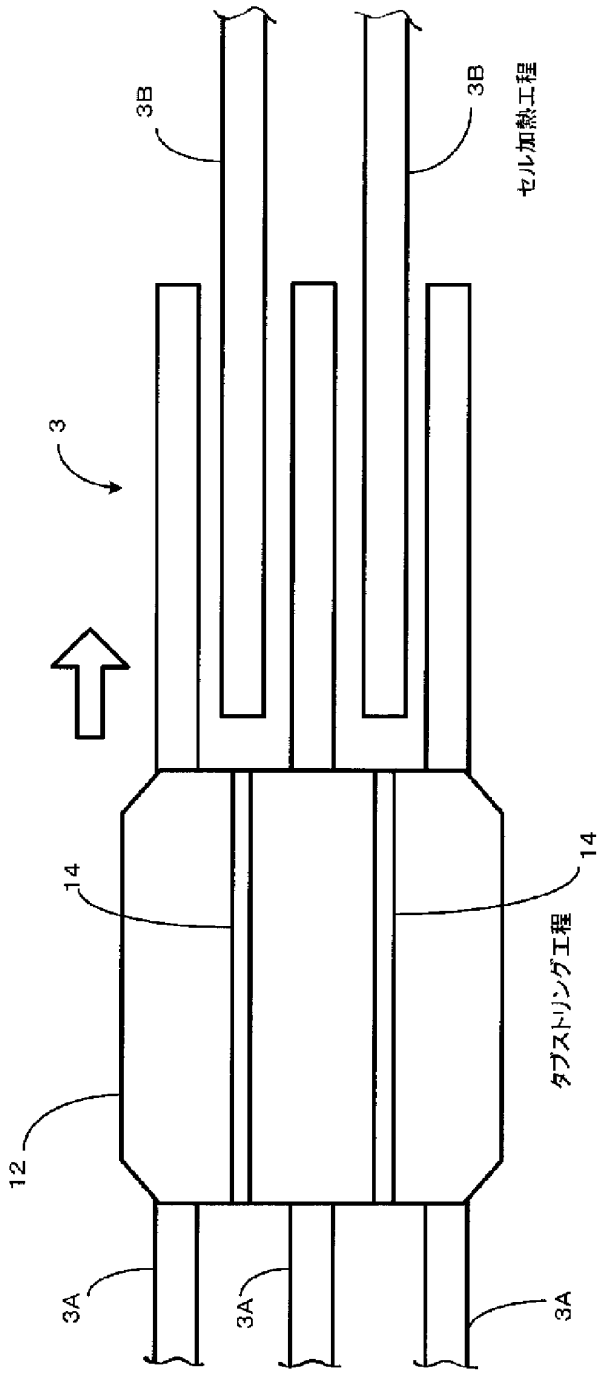
[図5]



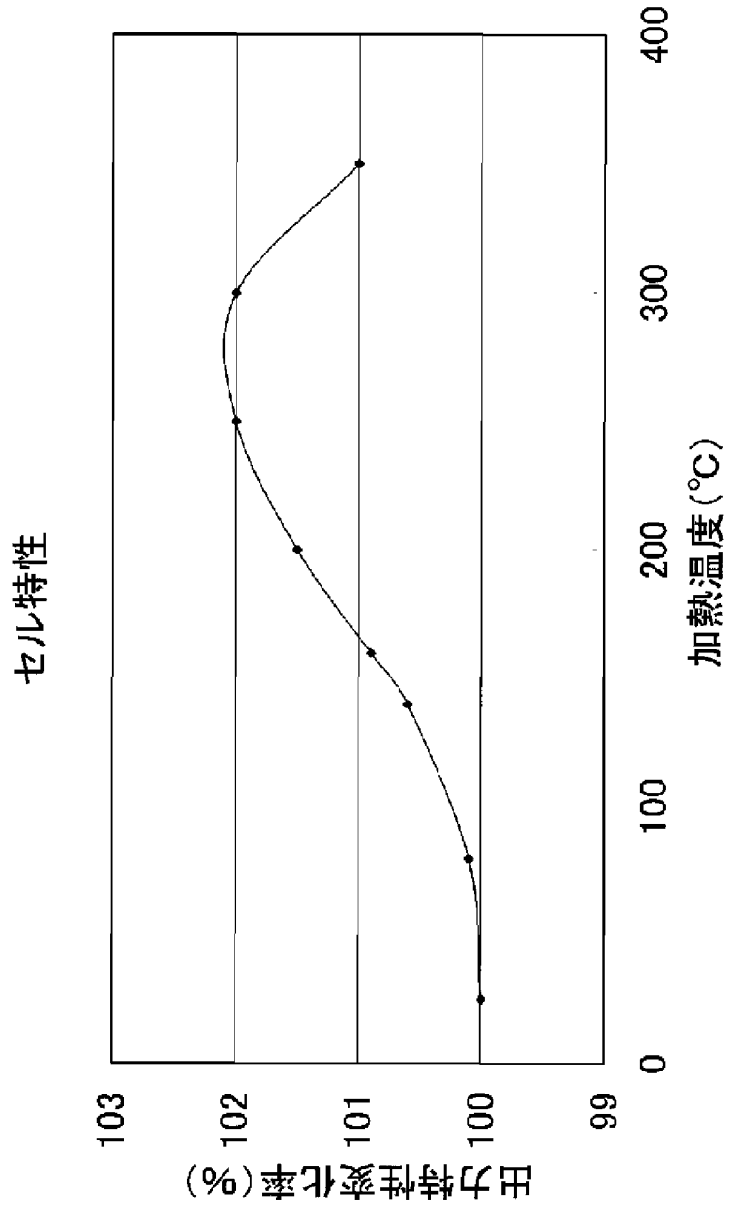
[図6]



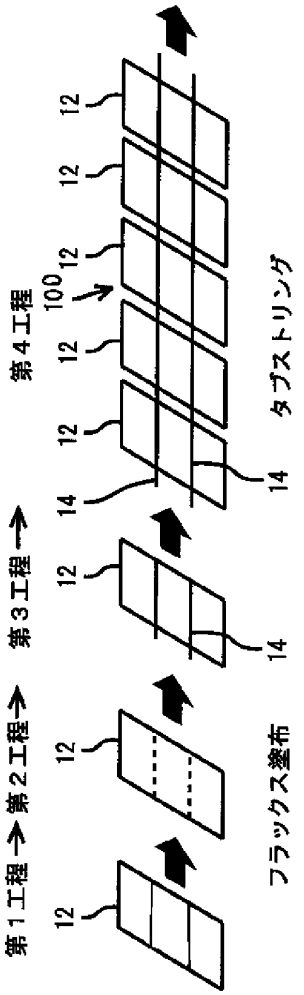
[図7]



[図8]



[図9]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/006057

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] H01L31/0224

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)
Int.Cl[7] H01L31/00-31/20, H05K3/32-3/34

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2005
Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2002-217434 A (Sharp Corp.), 02 August, 2002 (02.08.02), & US 2002/0148499 A	1-13
Y	JP 6-334203 A (Canon Inc.), 02 December, 1994 (02.12.94),	1-13
A	JP 2000-22188 A (NPC Inc.), 21 January, 2000 (21.01.00),	1-13
A	WO 02/103809 A (ASE AMERICAS INC.), 27 December, 2002 (27.12.02), & US 2003/0000568 A & EP 1396034 A & JP 2004-531893 A	1-13

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

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"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
10 May, 2005 (10.05.05)	31 May, 2005 (31.05.05)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/006057

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 5-245622 A (Senju Metal Industry Co., Ltd.), 24 September, 1993 (24.09.93), (Family: none)	1-13
Y	JP 8-222849 A (Tokyo Electron Yamanashi Ltd.), 30 August, 1996 (30.08.96), (Family: none)	1-13
E,A	JP 2005-72389 A (Kyocera Corp.), 17 March, 2005 (17.03.05),	1-13

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国際調査報告

国際出願番号　ＰＣＴ／ＪＰ２００５／００６０５７

Ａ．　発明の属する分野の分類（国際特許分類（ＩＰＣ））

Int.Cl.[7]　H01L 31/0224

Ｂ．　調査を行った分野

調査を行った最小限資料（国際特許分類（ＩＰＣ））

Int.Cl.[7]　H01L 31/00 - 31/20,　H05K 3/32－3/34

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	１９２２－１９９６年
日本国公開実用新案公報	１９７１－２００５年
日本国実用新案登録公報	１９９６－２００５年
日本国登録実用新案公報	１９９４－２００５年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

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Ｙ	ＪＰ　２００２－２１７４３４　Ａ　（シャープ株式会社） ２００２．０８．０２ ＆　ＵＳ　２００２／０１４８４９９　Ａ	１－１３
Ｙ	ＪＰ　６－３３４２０３　Ａ　（キヤノン株式会社） １９９４．１２．０２	１－１３
Ａ	ＪＰ　２０００－２２１８８　Ａ　（株式会社エヌ・ピー・シー） ２０００．０１．２１	１－１３

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「Ｏ」口頭による開示、使用、展示等に言及する文献
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「Ｔ」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
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国際調査を完了した日 １０．０５．２００５	国際調査報告の発送日 31.5.2005
国際調査機関の名称及びあて先 日本国特許庁（ＩＳＡ／ＪＰ） 郵便番号１００－８９１５ 東京都千代田区霞が関三丁目４番３号	特許庁審査官（権限のある職員）　２Ｋ　９２０７ 滋田　聖司 電話番号　０３－３５８１－１１０１　内線　３２５５

様式ＰＣＴ／ＩＳＡ／２１０（第２ページ）（２００４年１月）

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Ｃ（続き）．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求の範囲の番号
Ａ	ＷＯ　０２／１０３８０９　Ａ　（ASE AMERICAS INC.） ２００２．１２．２７ ＆　ＵＳ　２００３／０００００５６８　Ａ ＆　ＥＰ　１３９６０３４　Ａ ＆　ＪＰ　２００４－５３１８９３　Ａ	１－１３
Ｙ	ＪＰ　５－２４５６２２　Ａ　（千住金属工業株式会社） １９９３．０９．２４　（ファミリーなし）	１－１３
Ｙ	ＪＰ　８－２２２８４９　Ａ　（ソニー株式会社） １９９６．０８．３０　（ファミリーなし）	１－１３
ＥＡ	ＪＰ　２００５－７２３８９　Ａ　（京セラ株式会社） ２００５．０３．１７	１－１３

Jinko Ex. 1002 - 208/580

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 11-251613
(43)Date of publication of application : 17.09.1999

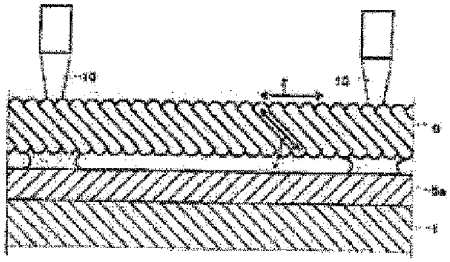
(51)Int.Cl. H01L 31/042

(21)Application number : 10-047025
(22)Date of filing : 27.02.1998

(71)Applicant : KYOCERA CORP
(72)Inventor : TAKAHASHI HIROAKI
FUKUI KENJI
SHIRASAWA KATSUHIKO

(54) SOLAR CELL DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To prevent the warpage, crack, and peel of a cell, by forming a surface electrode on one main surface of a semiconductor substrate with a semiconductor junction part by bussbar and finger parts, by providing a solar cell element with a rear surface electrode on the other main surface, and by setting the connection lead of the surface and rear surface electrodes to a twisted wire.
SOLUTION: A semiconductor junction part is formed at the interface part of N and P regions in a polycrystalline silicon semiconductor substrate 1. A bussbar part 5a for forming a surface electrode at the surface part of an N-type region and connecting a lead wire 9, and a finger part for power collection that is branched while crossing it, are provided. Two bussbars 5a are formed throughout nearly the entire area of the substrate 1 in parallel, the finger part crosses the bussbar part for forming a number of bussbars throughout nearly the entire length of the substrate 1. The bussbar part 5a of the surface and rear surface electrodes is connected by a lead wire 9. In this manner, when a twisted wire is used for the lead wire 9 for jointing to the bussbar 5a of the surface electrode by hot air or the like, expansion and contraction is made in an x direction at a specific angle to the substrate, and the expansion and contraction in a width wise direction y of the substrate 1 becomes small.



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1.This document has been translated by computer. So the translation may not reflect the original precisely.
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CLAIMS

[Claim(s)]
[Claim 1]A surface electrode which changes from a bus bar part and a finger part to the 1 main-surface side of a semiconductor substrate which has semiconductor junction is formed, A solar battery device having provided two or more solar battery elements which formed a rear electrode in other main surface side, having twisted the aforementioned lead in a solar battery device which connected two or more of these surface electrodes and rear electrodes of a solar battery element with a lead, and forming by a line.
[Claim 2]The solar battery device according to claim 1 joining the aforementioned lead to a bus bar part of the aforementioned surface electrode at two or more places.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]The present invention relates to the solar battery device to which two or more solar battery elements were especially connected by the lead about a solar battery device.
[0002]
[Description of the Prior Art]The conventional solar battery device is shown in Fig.4 (a) and (b). Fig.4 (a) is a cross sectional view and Fig.4 (b) is a plan view. As for a silicon substrate and 15 (15a), a rear electrode and 18 are leads a surface electrode and 16 (16a) 11 among Fig.4 (a) and (b). In the silicon substrate 11, the N type region 12 and the P type region 13 are formed. The surface electrode 15 (15a) is provided by the surface of the N type region 12, and the rear electrode 16 (16a) is provided by the surface of the P type region 13. This surface electrode 15 comprises the bus bar part 15a for lead connection, and the finger part 15b for current collection. The rear electrode 16 also comprises the bus bar part 16a and finger part (not shown). In order to make ohm loss small, the copper foil 17 is made with solder the bus bar part 16a of the rear electrode 16.
[0003]The lead 18 for connecting two or more solar battery elements comprises straight angle-

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like copper foil etc., A one end is arranged over the almost total length on the surface electrode 15 (15a), and it is connected to the bus bar part 15a of the surface electrode 15 by joining two or more of the places to the surface electrode 15 (15a), An another side end is soldered to the end of the bus bar part 16a of the rear electrode 16 via the copper foil 17, and is connected to the rear electrode 16.

[0004]

[Problem to be solved by the invention]In this conventional solar battery device, there was a problem that generating current increases, the bus bar part 15a of the surface electrode 15 became long in connection with the increase of the cell area of a solar battery element, therefore ohm loss increased, and conversion efficiency was deteriorated.

[0005]Although what is necessary is just to make the cross-sectional area of the lead 18 of surface electrode 15 portion, or the copper foil 17 of rear electrode 16 portion increase in order to prevent decline in conversion efficiency, the lead 18 of surface electrode 15 portion must thicken the thickness, and must make a cross-sectional area increase, in order to make it not decrease light-receiving area.

[0006]However, if the lead 18 becomes thick, when welding this lead 18 on the surface electrode 15 by a hot air or solder **, This hot air or heat of solder ** were not easily been transmitted even to the solder of surface electrode 15 portion, joining of the surface electrode 15 and the lead 18 took time, and there was a problem that the stretch by the thermal expansion of the lead 18 became largely. Where the lead 18 is extended, when it was joined to the surface electrode 15 and the lead 18 was shrunken, compression stress was applied to the silicon substrate 11, big curvature occurred in the silicon substrate 11, cell cracking, electrode peeling, etc. were induced, and there was a problem that a manufacturing yield was deteriorated.

[0007]The present invention is made in view of a problem of equipment such conventionally, and is a thing.

The purpose is to provide a solar battery device which eliminated problems, such as curvature of a cell generated by thickening increase of ohm loss generated with increase, and copper foil of a bus bar part which is the opposite measure, cell cracking, or electrode peeling.

[0008]

[Means for solving problem]To achieve the above objects, in invention concerning Claim 1, The surface electrode which changes from a bus bar part and a finger part to the 1 main-surface side of the semiconductor substrate which has semiconductor junction is formed, Two or more solar battery elements which formed the rear electrode in other main surface side were provided, and in the solar battery device which connected two or more of these surface electrodes and rear electrodes of the solar battery element with the lead, the aforementioned lead was twisted and it formed by the line.

[0009]It is desirable to join the aforementioned lead to the bus bar part of the aforementioned surface electrode in the above-mentioned invention at two or more places.

[0010]

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[Mode for carrying out the invention]Hereafter, the embodiment of invention concerning Claim 1 and Claim 2 is described in detail based on an accompanying drawing. As for Fig.1 (a), the cross sectional view and Fig.1 (b) for which one embodiment of invention concerning Claim 1 and Claim 2 is shown are a plan view, and, as for a semiconductor substrate and 5, a rear electrode and 9 are leads a surface electrode and 7 1.

[0011]The semiconductor substrate 1 comprises single crystal silicon, polycrystalline silicon, etc. about 0.3 mm thick. The N type region 2 and the P type region 3 are in this semiconductor substrate 1, and the semiconductor junction 4 is formed by the interface part of the N type region 2 and the P type region 3. By this N type region 2 arranging the silicon substrate 1 of P type all over a diffusion furnace, and heating in phosphorus oxychloride ($POCl_3$), It forms in about 0.3-0.4 micrometer in thickness by making a phosphorus atom diffuse to the surface part of the whole silicon substrate 1, and removing the diffusion zone of a lateral portion and a bottom face part after that. This semiconductor substrate 1 may be formed by single crystal gallium arsenide etc.

[0012]The surface electrode 5 is formed in the surface portion of the N type region 2. This surface electrode 5 comprises the finger part 5b for current collection which intersected the bus bar part 5a for connecting the lead 9, and this bus bar part 5a, and was formed by branching. The bus bar part 5a is formed in Futamoto parallel over the almost all region of the substrate 1, the finger part 5b intersects the bus bar part 5b, and many books are formed over the almost total length of the substrate 1. The bus bar part 5a is formed in a width of about 2 mm, and the finger part 5b is formed in a width of about 0.2 mm. Such a surface electrode 5 screen-stencils the paste which comprises glass frit, a binding material, a solvent, etc., prints it at the temperature of about 700-800 degrees C, and is formed by covering the whole with a solder layer in the end of silver dust, for example.

[0013]Although not illustrated, the antireflection film which comprises a silicon nitride film etc., for example is formed in the surface side of the substrate 1. Such an antireflection film is formed with plasma CVD method etc.

[0014]The rear electrode 7 is provided at the back surface side of the substrate 1. This rear electrode 7 also comprises finger part (not shown) by which intersects the bus bar part 7a for connecting the lead 9, and this bus bar part 7a, branches, and actual formation is carried out. The bus bar part 7a is formed in 2 parallel over the almost total length of the substrate 1, a finger part intersects the bus bar part 7a, and many books are formed over the almost all region of the substrate 1. The bus bar part 7a is formed in a width of about 5 mm, and a finger part is formed in a width of about 0.5 mm. Since the back surface side of the substrate 1 does not need to take reduction of light-receiving area into consideration, it can be formed more broadly than the bus bar part 5a of the surface electrode 5, and can reduce the ohm loss by the side of the rear electrode 7. Such a rear electrode 7 screen-stencils and prints the paste which comprises glass frit, a binding material, a solvent, etc., and is formed by covering with a solder layer in the end of silver dust, for example. The rear electrode 7 may be provided all over the back surface side of not only when it crosses and provides the bus bar part 7a and the finger part 7b, but the

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substrate 1.

[0015]The copper foil 8 is stuck on this rear electrode 7. This copper foil 8 is formed in about 5 mm in width, and about 0.1 mm in thickness. Such copper foil 8 is joined by five points at equal intervals on the bus bar part 7a of the rear electrode 7. Thus, if the bus bar part 7a and the copper foil 8 of the rear electrode 7 are joined only at two or more places, even if the length of the copper foil 8 changes with temperature changes, the copper foil 8 will not cut or curvature will not be produced in the substrate 1.

[0016]The bus bar part 5a of the surface electrode 5 and the bus bar part 7a of the rear electrode 7 are connected with the lead 9. As shown in Fig.2 (a) and (b), the closest packing of the about 90-360 small-gage wires 9a of about 0.05-0.1 mm in diameter copper is carried out to concentric circle shape, and this lead 9 is twisted by twisting, and let it be a line. Fig.2 (a) is a cross sectional view of the lead 9, and Fig.2 (b) is a side view of the lead 9.

[0017]The bus bar part 5a side of the surface electrode 5 in this lead 9 is joined by two points of the both ends in the length direction of the bus bar part 5a, as shown in Fig.3. Thus, since the lead 9 is extended in the direction x of a twist or is shrunken by it with an angle predetermined in the substrate 1 when the lead 9 is twisted, it constitutes from a line and it joins to the bus bar part 5a of the surface electrode 5 by the hot air 10 etc., The stretch in the cross direction y of the substrate 1 and shrinkage become small far compared with conventional straight angle copper foil. Therefore, even if the substrate 1 is enlarged to a 150 mm-square degree, curvature of the substrate 1 can be made small as much as possible.

[0018]

[Effect of the Invention]As mentioned above, according to invention concerning Claim 1, since the lead which connects two or more surface electrodes and rear electrodes of a solar battery element was twisted and it constituted from a line, the influence of elasticity by thermal expansion when welding a lead becomes small in the cross direction of a substrate, it has and the curvature of a cell becomes small.

[0019]According to invention concerning Claim 2, since copper foil is joined to the bus bar part of a surface electrode at two or more places, curvature of a substrate can be more effectively made small.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a figure showing the solar battery element used for the solar battery device of invention concerning Claim 1 and Claim 2, and (a) is a cross sectional view and (b) is a plan view.

[Drawing 2]It is a figure showing the lead used for the solar battery device of invention concerning Claim 1 and Claim 2, and (a) is a cross sectional view and (b) is a side view.

[Drawing 3]It is a figure showing the connection method of connection of the lead in the solar battery device concerning Claim 1 and Claim 2.

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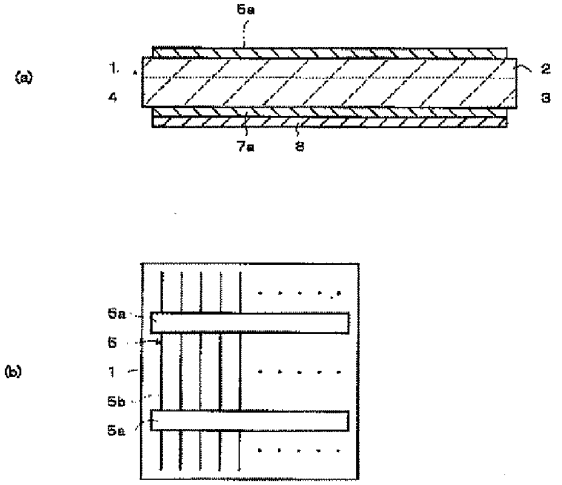
[Drawing 4]It is a figure showing the conventional solar battery device, and (a) is a cross sectional view and (b) is a plan view.

[Explanations of letters or numerals]

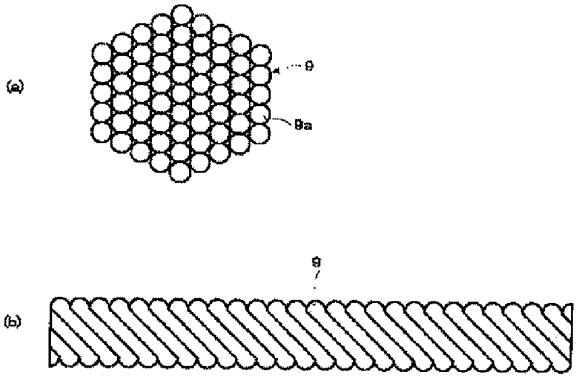
1 ..... substrate, 5 ..... surface electrode, 6 ..... copper foil by the side of a surface electrode, 7 ..... rear electrode, 8 ..... copper foil by the side of a rear electrode, 9 ..... lead

DRAWINGS

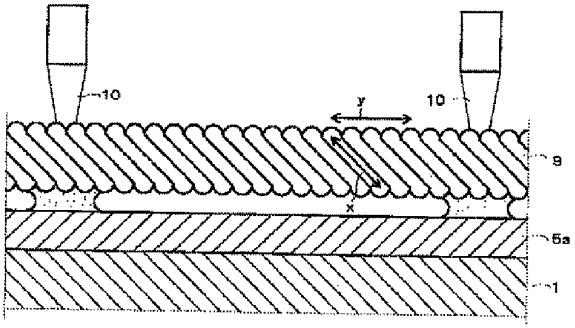
[Drawing 1]



[Drawing 2]

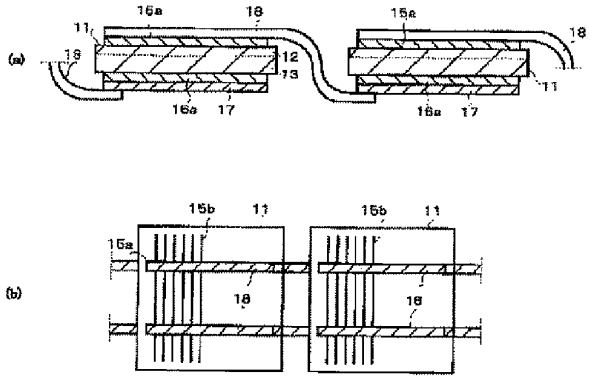


[Drawing 3]



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[Drawing 4]



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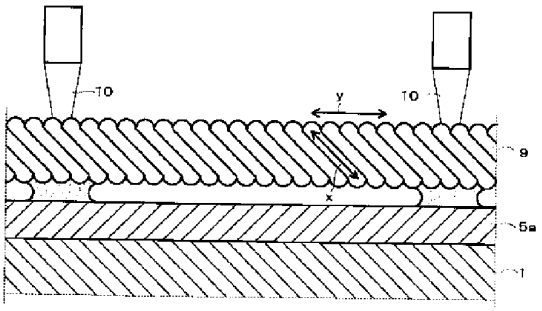
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(54)【発明の名称】　太陽電池装置

(57)【要約】

【課題】　セル面積の増大にともなって抵抗損失が増大し、その対向策としてバスバー部の銅箔を厚くすると、セルの反り、セル割れ、或いは電極剥がれが発生するという問題があった。

【解決手段】　半導体接合部を有する半導体基板の一主面側にバスバー部とフィンガー部とから成る表面電極を形成し、他の主面側に裏面電極を形成した複数の太陽電池素子を設け、この複数の太陽電池素子の表面電極と裏面電極とをリード線で接続した太陽電池装置において、前記リード線を縒り線で形成した。



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【特許請求の範囲】

【請求項１】　半導体接合部を有する半導体基板の一主面側にバスバー部とフィンガー部とから成る表面電極を形成し、他の主面側に裏面電極を形成した複数の太陽電池素子を設け、この複数の太陽電池素子の表面電極と裏面電極とをリード線で接続した太陽電池装置において、前記リード線を縒り線で形成したことを特徴とする太陽電池装置。

【請求項２】　前記リード線を前記表面電極のバスバー部に複数箇所で接合したことを特徴とする請求項１に記載の太陽電池装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は太陽電池装置に関し、特に複数の太陽電池素子がリード線によって接続された太陽電池装置に関する。

【０００２】

【従来の技術】従来の太陽電池装置を図４（ａ）（ｂ）に示す。図４（ａ）は断面図であり、図４（ｂ）は平面図である。図４（ａ）（ｂ）中、１１はシリコン基板、１５（１５ａ）は表面電極、１６（１６ａ）は裏面電極、１８はリード線である。シリコン基板１１内にはＮ型領域１２とＰ型領域１３とが形成されている。Ｎ型領域１２の表面には表面電極１５（１５ａ）が設けられ、Ｐ型領域１３の表面には裏面電極１６（１６ａ）が設けられている。この表面電極１５はリード線接続用のバスバー部１５ａと集電用のフィンガー部１５ｂとから成る。また、裏面電極１６もバスバー部１６ａとフィンガー部（不図示）とから成る。裏面電極１６のバスバー部１６ａには、抵抗損失を小さくするために銅箔１７がハンダ付されている。

【０００３】複数の太陽電池素子を接続するためのリード線１８は平角状の銅箔などから成り、一方端が表面電極１５（１５ａ）上の略全長にわたって配設され、その複数箇所を表面電極１５（１５ａ）と接合することによって表面電極１５のバスバー部１５ａに接続され、他方端が銅箔１７を介して裏面電極１６のバスバー部１６ａの端部にハンダ付けされて裏面電極１６に接続される。

【０００４】

【発明が解決しようとする課題】この従来の太陽電池装置では、太陽電池素子のセル面積の増大化に伴ない、発生電流が増加したり、また表面電極１５のバスバー部１５ａが長くなり、そのために抵抗損失が増大して変換効率が低下するという問題があった。

【０００５】変換効率の低下を防止するためには、表面電極１５部分のリード線１８や裏面電極１６部分の銅箔１７の断面積を増加させればよいが、表面電極１５部分のリード線１８は、受光面積を減少させないようにするために、その厚みを厚くして断面積を増加させなければならない。

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【０００６】ところが、リード線１８が厚くなると、このリード線１８をホットエアーやハンダ鏝で表面電極１５に溶着する際に、このホットエアーやハンダ鏝の熱が表面電極１５部分のハンダまで伝わりにくく、表面電極１５とリード線１８の溶着に時間がかかり、リード線１８の熱膨張による伸びが大きくなるという問題があった。リード線１８が伸びた状態で表面電極１５に接合されると、リード線１８が縮む際に、シリコン基板１１に圧縮応力が印加されて、シリコン基板１１に大きな反りが発生し、セル割れや電極剥がれなどを誘発し、製造歩留りが低下するという問題があった。

【０００７】本発明はこのような従来装置の問題点に鑑みてなされたものであり、セル面積の増大にともなって発生する抵抗損失の増大と、その対向策であるバスバー部の銅箔を厚くすることによって発生するセルの反り、セル割れ、或いは電極剥がれなどの問題を解消した太陽電池装置を提供することを目的とする。

【０００８】

【課題を解決するための手段】上記目的を達成するために、請求項１に係る発明では、半導体接合部を有する半導体基板の一主面側にバスバー部とフィンガー部とから成る表面電極を形成し、他の主面側に裏面電極を形成した複数の太陽電池素子を設け、この複数の太陽電池素子の表面電極と裏面電極とをリード線で接続した太陽電池装置において、前記リード線を縒り線で形成した。

【０００９】上記発明では、前記リード線を前記表面電極のバスバー部に複数箇所で接合することが望ましい。

【００１０】

【発明の実施の形態】以下、請求項１および請求項２に係る発明の実施形態を添付図面に基づき詳細に説明する。図１（ａ）は請求項１および請求項２に係る発明の一実施形態を示す断面図、図１（ｂ）は平面図であり、１は半導体基板、５は表面電極、７は裏面電極、９はリード線である。

【００１１】半導体基板１は、厚み０．３mm程度の単結晶シリコンや多結晶シリコンなどから成る。この半導体基板１内には、Ｎ型領域２とＰ型領域３があり、Ｎ型領域２とＰ型領域３との界面部分で半導体接合部４が形成される。このＮ型領域２はＰ型のシリコン基板１を拡散炉中に配置して、オキシ塩化リン（$POCl_3$）中で加熱することによって、シリコン基板１の全体の表面部にリン原子を拡散させ、その後に側面部と底面部の拡散層を除去することにより、厚み０．３～０．４μm程度に形成する。なお、この半導体基板１は単結晶ガリウム砒素などで形成してもよい。

【００１２】Ｎ型領域２の表面部分には、表面電極５が形成されている。この表面電極５は、リード線９を接続するためのバスバー部５ａとこのバスバー部５ａと交差して分岐して形成された集電用のフィンガー部５ｂとから成る。バスバー部５ａは基板１の略全域にわたって二

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本平行に形成されており、フィンガー部５ｂはバスバー部５ｂに交差して多数本が基板１の略全長にわたって形成されている。バスバー部５ａは例えば２mm程度の幅に形成され、フィンガー部５ｂは例えば０．２mm程度の幅に形成される。このような表面電極５は、例えば銀粉末、ガラスフリット、結合剤、および溶剤などから成るペーストをスクリーン印刷して７００～８００℃程度の温度で焼き付け、全体をハンダ層で被覆することにより形成される。

【００１３】基板１の表面側には、図示されていないが、例えば窒化シリコン膜などから成る反射防止膜が形成される。このような反射防止膜は例えばプラズマＣＶＤ法などで形成される。

【００１４】基板１の裏面側には裏面電極７が設けられている。この裏面電極７も、リード線９を接続するためのバスバー部７ａとこのバスバー部７ａと交差して分岐して多数本形成されるフィンガー部（不図示）とから成る。バスバー部７ａは基板１の略全長にわたって二本平行に形成されており、フィンガー部はバスバー部７ａに交差して多数本が基板１の略全域にわたって形成されている。バスバー部７ａは例えば５mm程度の幅に形成され、フィンガー部は例えば０．５mm程度の幅に形成される。基板１の裏面側は、受光面積の減少を考慮しなくてもよいことから、表面電極５のバスバー部５ａよりも幅広に形成でき、裏面電極７側での抵抗損失を低減できる。このような裏面電極７は、例えば銀粉末、ガラスフリット、結合剤、および溶剤などから成るペーストをスクリーン印刷して焼き付け、ハンダ層で被覆することにより形成される。なお、裏面電極７は、バスバー部７ａとフィンガー部７ｂを交差して設ける場合に限らず、基板１の裏面側の全面に設けてもよい。

【００１５】この裏面電極７上には銅箔８が貼りつけられている。この銅箔８は、幅５mm程度、厚み０．１mm程度に形成される。このような銅箔８を裏面電極７のバスバー部７ａ上に例えば等間隔に５点で接合する。このように裏面電極７のバスバー部７ａと銅箔８を複数箇所のみで接合すると、温度変化によって銅箔８の長さが変化しても、銅箔８が切断したり、基板１に反りを生じることがない。

【００１６】表面電極５のバスバー部５ａと裏面電極７のバスバー部７ａをリード線９で接続する。このリード線９は、図２（ａ）（ｂ）に示すように、直径０．０５～０．１mm程度の銅の細線９ａが９０～３６０本程度同心円状に最密充填され、捩じることで縒り線とされている。なお、図２（ａ）はリード線９の断面図であり、図２（ｂ）はリード線９の側面図である。

【００１７】このリード線９における表面電極５のバスバー部５ａ側は、図3 に示すように、バスバー部５ａの長さ方向における両端部の二点で接合される。このように、リード線９を縒り線で構成して、表面電極５のバスバー部５ａにホットエアー１０などで接合する場合、リード線９は縒りの方向ｘに、基板１とは所定の角度をもって延びたり縮んだりするので、基板１の幅方向ｙでの伸びや縮みは、従来の平角銅箔に比べてはるかに小さくなる。したがって、基板１が１５０mm角程度に大型化しても基板１の反りを極力小さくできる。

【００１８】

【発明の効果】以上のように、請求項１に係る発明によれば、複数の太陽電池素子の表面電極と裏面電極とを接続するリード線を縒り線で構成したことから、リード線を溶着するときの熱膨張による伸縮の影響が基板の幅方向において小さくなり、もってセルの反りが小さくなる。

【００１９】また、請求項２に係る発明によれば、銅箔を表面電極のバスバー部に複数箇所で接合することから、基板の反りをより効果的に小さくすることができる。

【図面の簡単な説明】

【図１】請求項１および請求項２に係る発明の太陽電池装置に用いられる太陽電池素子を示す図であり、（ａ）は断面図、（ｂ）は平面図である。

【図２】請求項１および請求項２に係る発明の太陽電池装置に用いられるリード線を示す図であり、（ａ）は断面図、（ｂ）は側面図である。

【図３】請求項１および請求項２に係る太陽電池装置におけるリード線の接続の接続方法を示す図である。

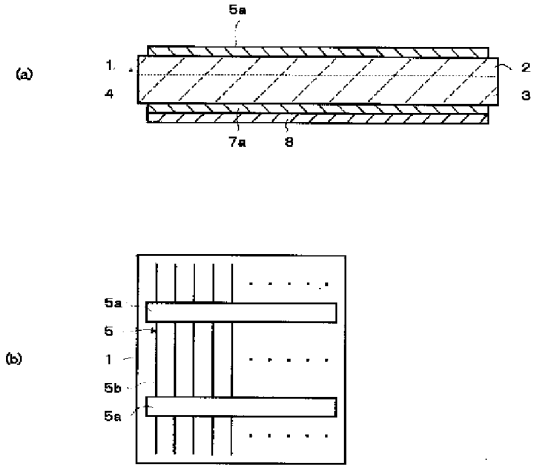
【図４】従来の太陽電池装置を示す図であり、（ａ）は断面図、（ｂ）は平面図である。

【符号の説明】

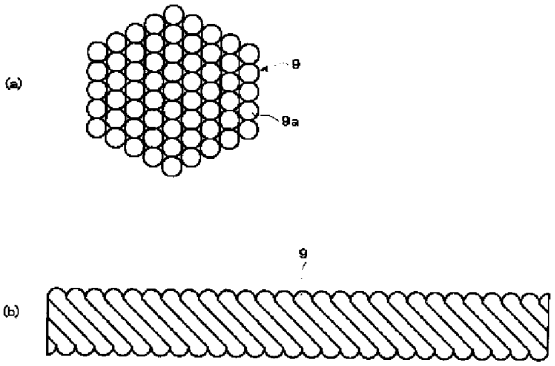
１……基板、５……表面電極、６……表面電極側の銅箔、７……裏面電極、８……裏面電極側の銅箔、９……リード線

Jinko Ex. 1002 - 218/580

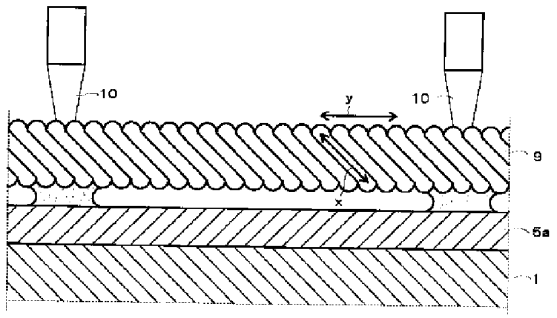
【図１】


(a)
5a
1
4
2
3
7a
8
(b)
5a
5
1
5b
5a

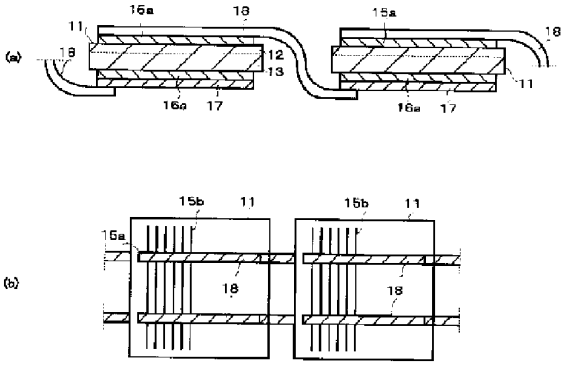
【図２】


(a)
9
9a
(b)
9

【図３】


10
y
10
9
x
5a
1

【図４】


(a)
15a
18
11
18
12
13
16a
17
15a
18
11
16a
17
(b)
15b
11
15a
18
15b
11
18

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji SHIMASAKI
Filer:	James A. LaBarre/Ashley Fernandez
Attorney Docket Number:	1032404-000416

Filed as Large Entity

U.S. National Stage under 35 USC 371 Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
National Stage Fee	1631	1	390	390
Natl Stage Search Fee - Report provided	1642	1	500	500
National Stage Exam - all other cases	1633	1	250	250
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1140**

Electronic Acknowledgement Receipt

EFS ID:	14554241
Application Number:	13806793
International Application Number:	PCT/JP2010/061334
Confirmation Number:	2289
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji SHIMASAKI
Customer Number:	21839
Filer:	James A. LaBarre/Ashley Fernandez
Filer Authorized By:	James A. LaBarre
Attorney Docket Number:	1032404-000416
Receipt Date:	24-DEC-2012
Filing Date:	
Time Stamp:	10:33:50
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$1140
RAM confirmation Number	8662
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Transmittal of New Application	NewApp_TL.pdf	154814 6694f817c8ee5f7052c49a11acdad46d5427121f	no	2
Warnings:					
Information:					
2	Authorization for Extension of Time all replies	Auth.pdf	33127 80e58401a5a87e9b57476178419e51b3960e22ab	no	1
Warnings:					
Information:					
3		PreliminaryAmendment.pdf	298419 db52d6688d65e2dd3cbdc1974e32ce39106d5a38	yes	11

Multipart Description/PDF files in .zip description

Document Description	Start	End
Preliminary Amendment	1	1
Specification	2	2
Abstract	3	3
Claims	4	6
Drawings-only black and white line drawings	7	7
Applicant Arguments/Remarks Made in an Amendment	8	8
Abstract	9	9
Drawings-only black and white line drawings	10	11

Warnings:					
Information:					
4	Applicant Arguments/Remarks Made in an Amendment	Marked_Up_Spec.pdf	88887 fa10701f098aff497c4d0b5ea6ab7c2e7e450037	no	25
Warnings:					
Information:					
5	Specification	Sub_Spec.pdf	87974 f44da62d1c79b446fe55094c1d60db6772ccda38	no	25
Warnings:					
Information:					

6	Application Data Sheet	ADS.pdf	81242 0aff97f1763b1ba32451ff54c11d061f5c3ddc96	no	4
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
7		Specification.pdf	141552 617c5273d2e97803238c4be0222d197ecd9755e7	yes	27
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Specification		1	23	
	Claims		24	26	
	Abstract		27	27	
Warnings:					
Information:					
8	Drawings-only black and white line drawings	Drawings.pdf	176436 ac51855f27fe9beb6fa34544e8f2ca09269a3178	no	10
Warnings:					
Information:					
9	Oath or Declaration filed	Declaration.pdf	274251 62d4f9e70facc4f3032eb4837d3b1577a794503f	no	3
Warnings:					
Information:					
10	Documents submitted with 371 Applications	PCT_Docs.pdf	147384 dd5ff88010367d4bb2d72b797e2eb205968cf8d5	no	1
Warnings:					
Information:					
11	Transmittal Letter	IDS_TL.pdf	33623 8e13d03d23931222250f9b70af66ee0f6c06efd5	no	1
Warnings:					
Information:					
12	Information Disclosure Statement (IDS) Form (SB08)	IDS_PTO1449.pdf	85289 60c25061cdd69e0315b8dc613e96091964f5f234	no	1
Warnings:					
Information:					

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13	Documents submitted with 371 Applications	ISR.pdf	318372 b26dfc6bf10b1044d1465dff7492609ce4248a70	no	3
Warnings:					
Information:					
14	Documents submitted with 371 Applications	WrittenOpinion.pdf	214462 c7bdcc5add639d93e192de46e915c134462fae0f	no	3
Warnings:					
Information:					
15	Foreign Reference	JP7106619.pdf	1086762 ab1da999f80d1b5d904808b5c7aef1a9b9c85e68	no	15
Warnings:					
Information:					
16	Foreign Reference	JP2006120944.pdf	3186700 ff2ce8d30fe177283b910b29848f6756383fa7c7	no	35
Warnings:					
Information:					
17	Foreign Reference	JP2000164901.pdf	671192 a5e847a3180f1c6c0b71139e9080960b1eb0d39d	no	9
Warnings:					
Information:					
18	Foreign Reference	WO2005096396.pdf	3599213 003c7a65eb9d6e8fe1ecbb1319b5d8020b86c852	no	32
Warnings:					
Information:					
19	Foreign Reference	JP11251613.pdf	783645 9a5de0e799c9c8d8321b348602ea4bca4e356472	no	11
Warnings:					
Information:					
20	Fee Worksheet (SB06)	fee-info.pdf	33165 f84ca324353f8dc180b3effcf08a2ac3a869d228	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	11496509	

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

特許協力条約に基づく国際出願願書

紙面による写し（注意　電子データが原本となります）

0	受理官庁記入欄	
0-1	国際出願番号	PCT/JP2010/061334
0-2	国際出願日	2010年 07月 02日 (02.07.2010)
0-3	(受付印)	

0-4	様式 PCT/RO/101 この特許協力条約に基づく国際出願願書は、	
0-4-1	右記によって作成された。	JPO-PAS i171
0-5	申立て 出願人は、この国際出願が特許協力条約に従って処理されることを請求する。	
0-6	出願人によって指定された受理官庁	日本国特許庁 (RO/JP)
0-7	出願人又は代理人の書類記号	611926WO01
I	発明の名称	太陽電池モジュールおよびその製造方法
II	出願人	
II-1	この欄に記載した者は	出願人である (applicant only)
II-2	右の指定国についての出願人である。	米国を除く全ての指定国 (all designated States except US)
II-4ja	名称	三菱電機株式会社
II-4en	Name:	Mitsubishi Electric Corporation
II-5ja	あて名	1008310 日本国 東京都千代田区丸の内二丁目７番３号
II-5en	Address:	7-3, Marunouchi 2-chome, Chiyoda-ku, Tokyo 1008310 Japan
II-6	国籍(国名)	日本国 JP
II-7	住所(国名)	日本国 JP
II-8	電話番号	03-3213-3421
II-9	ファクシミリ番号	03-3218-2460

特許協力条約に基づく国際出願願書

紙面による写し（注意　電子データが原本となります）

III-1	その他の出願人又は発明者	
III-1-1	この欄に記載した者は	出願人及び発明者である（applicant and inventor）
III-1-2	右の指定国についての出願人である。	米国のみ（US only）
III-1-4ja	氏名(姓名)	島崎　晃治
III-1-4en	Name (LAST, First):	SHIMASAKI, Koji
III-1-5ja	あて名	1008310 日本国 東京都千代田区丸の内二丁目７番３号　三菱電機株式会社内
III-1-5en	Address:	c/o Mitsubishi Electric Corporation, 7-3, Marunouchi 2-chome, Chiyoda-ku, Tokyo 1008310 Japan
III-1-6	国籍(国名)	
III-1-7	住所(国名)	日本国 JP
III-2	その他の出願人又は発明者	
III-2-1	この欄に記載した者は	出願人及び発明者である（applicant and inventor）
III-2-2	右の指定国についての出願人である。	米国のみ（US only）
III-2-4ja	氏名(姓名)	鈴木　成嘉
III-2-4en	Name (LAST, First):	SUZUKI, Masayoshi
III-2-5ja	あて名	1008310 日本国 東京都千代田区丸の内二丁目７番３号　三菱電機株式会社内
III-2-5en	Address:	c/o Mitsubishi Electric Corporation, 7-3, Marunouchi 2-chome, Chiyoda-ku, Tokyo 1008310 Japan
III-2-6	国籍(国名)	
III-2-7	住所(国名)	日本国 JP

特許協力条約に基づく国際出願願書

紙面による写し（注意　電子データが原本となります）

IV-1	代理人又は共通の代表者、通知のあて名 下記の者は国際機関において右記のごとく出願人のために行動する。	代理人 (agent)	
IV-1-1ja	氏名(姓名)	酒井　宏明	
IV-1-1en	Name (LAST, First):	SAKAI, Hiroaki	
IV-1-2ja	あて名	1006020 日本国 東京都千代田区霞が関三丁目２番５号　霞が関ビルディング　酒井国際特許事務所	
IV-1-2en	Address:	Sakai International Patent Office, Kasumigaseki Building, 2-5, Kasumigaseki 3-chome, Chiyoda-ku, Tokyo 1006020 Japan	
IV-1-3	電話番号	03-5512-4699	
IV-1-4	ファクシミリ番号	03-5512-4799	
IV-1-6	代理人登録番号	100089118	
V	国の指定		
V-1	この願書を用いてされた国際出願は、規則4.9(a)に基づき、国際出願の時点で拘束される全てのPCT締約国を指定し、取得しうるあらゆる種類の保護を求め、及び該当する場合には広域と国内特許の両方を求める国際出願となる。		
VI-1	優先権主張	なし (NONE)	
VII-1	特定された国際調査機関(ISA)	日本国特許庁 (ISA/JP)	
VIII	申立て	申立て数	
VIII-1	発明者の特定に関する申立て	–	
VIII-2	出願し及び特許を与えられる国際出願日における出願人の資格に関する申立て	–	
VIII-3	先の出願の優先権を主張する国際出願日における出願人の資格に関する申立て	–	
VIII-4	発明者である旨の申立て(米国を指定国とする場合)	–	
VIII-5	不利にならない開示又は新規性喪失の例外に関する申立て	–	
IX	照合欄	用紙の枚数	添付された電子データ
IX-1	願書(申立てを含む)	4	✓
IX-2	明細書	16	✓
IX-3	請求の範囲	2	✓
IX-4	要約	1	✓
IX-5	図面	10	✓
IX-7	合計	33	
	添付書類	添付	添付された電子データ
IX-8	手数料計算用紙	–	✓
IX-11	包括委任状の写し	–	✓
IX-18	PCT-SAFE 電子出願	–	–
IX-20	要約とともに提示する図の番号	3	
IX-21	国際出願の使用言語名	日本語	

特許協力条約に基づく国際出願願書

紙面による写し（注意　電子データが原本となります）

X-1	出願人、代理人又は代表者の記名押印	(PKCS7 デジタル署名)
X-1-1	氏名(姓名)	酒井　宏明
X-1-2	署名者の氏名	
X-1-3	権限	

受理官庁記入欄

10-1	国際出願として提出された書類の実際の受理の日	2010年 07月 02日 (02.07.2010)
10-2	図面	
10-2-1	受理された	
10-2-2	不足図面がある	
10-3	国際出願として提出された書類を補完する書類又は図面であってその後期間内に提出されたものの実際の受理の日（訂正日）	
10-4	特許協力条約第11条(2)に基づく必要な補完の期間内の受理の日	
10-5	出願人により特定された国際調査機関	ISA/JP
10-6	調査手数料未払いにつき、国際調査機関に調査用写しを送付していない	

国際事務局記入欄

11-1	記録原本の受理の日	

(12) 特許協力条約に基づいて公開された国際出願

(19) 世界知的所有権機関
国際事務局

(43) 国際公開日
2012 年 1 月 5 日(05.01.2012)

PCT

(10) 国際公開番号
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(22) 国際出願日: 2010 年 7 月 2 日(02.07.2010)

(25) 国際出願の言語: 日本語

(26) 国際公開の言語: 日本語

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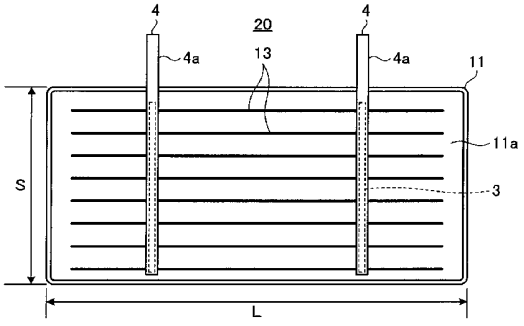
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— 国際調査報告（条約第 21 条(3)）

(54) Title: SOLAR CELL MODULE AND METHOD FOR MANUFACTURING SAME

(54) 発明の名称 : 太陽電池モジュールおよびその製造方法

[図3]



(57) Abstract: Disclosed is a solar cell module wherein output is improved without increasing the cross-sectional area of an interconnector. The solar cell module is provided with: a plurality of solar cells (20), each of which has a substantially a rectangular planar shape, the ratio of the short side length (S) to the long side length (L) of the substantially rectangular shape being 1/n:1 (n is an integer of 2 or more), a plurality of light receiving surface bus electrodes on the light receiving surface, said electrodes being parallel to the short side of the substantially rectangular shape, and rear bus electrodes at positions that correspond to the light receiving surface bus electrodes, said positions being on the non light receiving surface; and the light receiving surface-side lead line (interconnector) (4), which electrically connects together the light receiving surface bus electrodes of the solar cell (20) and the rear surface bus electrodes of adjacent other solar cell (20).

(57) 要約:

[続葉有]

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インターコネクタの断面積を増加させること無く出力を向上させる太陽電池モジュールを提供する。太陽電池モジュールは、平面形状が略長方形であり、略長方形の短辺長（Ｓ）と長辺長（Ｌ）との比が１／ｎ：１（ｎは２以上の整数）であって、受光面に略長方形の短辺に平行な複数の受光面バス電極を有し、非受光面の受光面バス電極に対応する位置に裏面バス電極を有する、複数枚の太陽電池セル（２０）と、太陽電池セル（２０）の受光面バス電極と、隣接する他の太陽電池セル（２０）の裏面バス電極とを電気的に接続する受光面側リード線（インターコネクタ）（４）とを備えている。

明　細　書

発明の名称 ： 太陽電池モジュールおよびその製造方法

技術分野

[0001] 本発明は、太陽等の光エネルギーを電気エネルギーに変換する太陽光発電システムにおいて、屋根等に複数枚並べて設置される太陽電池モジュールおよびその製造方法に関するものである。

背景技術

[0002] 主な材料としてシリコンを原料とするウエハを用いた結晶系太陽電池モジュールの発電性能は、発電素子である太陽電池セルの性能向上によってモジュールの発電性能の向上がなされている。

[0003] しかし、セルの効率向上に伴い、電流が大きくなり、モジュール化する際にセル同士を接続する主に銅からなる配線部材（インターコネクタ）での抵抗ロスが大きくなるため、モジュール化後の性能向上分としては、セルの性能向上分がそのまま増えるわけではなく、上記インターコネクタでの抵抗ロスの増加分だけ少なくなってしまう。

[0004] この改善策として、従来、インターコネクタの断面積を大きくすることにより抵抗ロスを低減する技術が提案されている（例えば、特許文献１参照）。

先行技術文献

特許文献

[0005] 特許文献1：特開平１１－２５１６１３号公報

発明の概要

発明が解決しようとする課題

[0006] しかしながら、従来提案のもののようにインターコネクタの断面積を大きくしようとする場合、幅か厚みのどちらかを大きくする必要があるが、幅を大きくするとセルの受光面積が減少し、発電量を低下させてしまうため、一般的には厚みを大きくすることが考えられるが、インターコネクタをセル上

の電極に半田接合する際に付与する熱の影響により、セルに生じる残留応力が大きくなるため、セルが破損する確率が増え歩留まりが悪くなるという問題があった。

[0007] 本発明は、上記に鑑みてなされたものであって、インターコネクタの断面積を増加させること無く出力を向上させる太陽電池モジュールおよびその製造方法を提供することを目的とする。

課題を解決するための手段

[0008] 上述した課題を解決し、目的を達成するために、本発明にかかる太陽電池モジュールは、平面形状が略長方形であり、略長方形の短辺長と長辺長との比が１／ｎ：１（ｎは２以上の整数）であって、受光面に略長方形の短辺に平行な複数の受光面バス電極を有し、非受光面の受光面バス電極に対応する位置に裏面バス電極を有する、複数枚の太陽電池セルと、第１の太陽電池セルの受光面バス電極と、隣接する第２の太陽電池セルの裏面バス電極とを電気的に接続するインターコネクタと、を備えたことを特徴とする。

[0009] 上述した課題を解決し、目的を達成するために、本発明にかかる太陽電池モジュールの製造方法は、平面形状が略正方形であり、受光面側に、略正方形の一辺に平行な複数の受光面バス電極と受光面バス電極と直交する複数のグリッド電極とが設けられた受光面電極領域をｎ箇所有し、非受光面側の受光面側バス電極に対応する位置に裏面バス電極を有する基礎の太陽電池セルを、ｎ箇所の受光面電極領域のそれぞれの境界に沿って基礎の太陽電池セルをｎ分割することによって、平面形状が略長方形であり、略長方形の短辺長と長辺長との比が１／ｎ：１（ｎは２以上の整数）である分割された太陽電池セルを得て、第１の分割された太陽電池セルの受光面バス電極と隣接する第２の分割された太陽電池セルの裏面バス電極とをインターコネクタにより電気的に接続することを特徴とする。

発明の効果

[0010] 本発明にかかる太陽電池モジュールによれば、複数のセルを直列接続するインターコネクタに流れる電流を小さくできるため、抵抗ロスを軽減するこ

とができ、太陽電池モジュールの出力を向上させることができる。また、セルの基板となる多結晶または単結晶ウエハは正方形が一般的であるが、そのウエハを半分にカットすることにより、容易にセルを得ることができるという効果を奏する。

[0011] また、本発明にかかる太陽電池モジュールの製造方法によれば、第一の太陽電池セルを、ｎ箇所の受光面電極領域のそれぞれの境界において第一の太陽電池セルをｎ分割し、略長方形の短辺長と長辺長との比が１／ｎ：１（ｎは２以上の整数）である第二の太陽電池セルを得て、第二の太陽電池セルの受光面バス電極と隣接する太陽電池セルの裏面バス電極とをインターコネクタにより電気的に接続するので、抵抗ロスを軽減する太陽電池モジュールを容易に作製することができるという効果を奏する。

図面の簡単な説明

[0012] [図1]図１は、太陽電池モジュールの斜視図であり、太陽電池パネルに枠部材を取り付ける様子を示している。

[図2]図２は、複数の太陽電池セルがリード線により順次接続されてなるセルアレイが太陽電池パネル内に封止されている様子を示す斜視図である。

[図3]図３は、太陽電池セルに受光面バス電極を接合した様子を示す上面図である。

[図4]図４は、太陽電池セルに裏面バス電極を接合した様子を示す裏面図である。

[図5]図５は、複数の太陽電池セルを直列に接続した様子を上方から見た斜視図である。

[図6]図６は、複数の太陽電池セルを直列に接続した様子を下方から見た斜視図である。

[図7]図７は、各部品を積層する状態を示す太陽電池セルの分解斜視図である。

[図8]図８は、隣接する２つの太陽電池セルの接続状態を示す断面図である。

[図9]図９は、実施の形態２の太陽電池モジュールに用いられる太陽電池セル

に受光面バス電極を接合した様子を示す上面図である。

[図10]図１０は、同じく太陽電池セルに裏面バス電極を接合した様子を示す裏面図である。

[図11]図１１は、実施の形態２の太陽電池セルを接続する様子を示す上面図である。

[図12]図１２は、実施の形態２のセルアレイの接続のされ方を示す模式図である。

[図13]図１３は、実施の形態３の太陽電池モジュールに用いられる太陽電池セルに受光面バス電極を接合した様子を示す上面図である。

[図14]図１４は、同じく太陽電池セルに裏面バス電極を接合した様子を示す裏面図である。

[図15]図１５は、実施の形態３のセルアレイの接続のされ方を示す模式図である。

発明を実施するための形態

[0013] 以下に、本発明にかかる太陽電池モジュールおよびその製造方法の実施の形態を図面に基づいて詳細に説明する。なお、この実施の形態によりこの発明が限定されるものではない。

[0014] 実施の形態１.

図１は、太陽電池モジュールの斜視図であり、太陽電池パネルに枠部材を取り付ける様子を示している。図２は、複数の太陽電池セルがリード線により順次接続されてなるセルアレイが太陽電池パネル内に封止されている様子を示す斜視図である。図３は、太陽電池セルに受光面バス電極を接合した様子を示す上面図である。図４は、太陽電池セルに裏面バス電極を接合した様子を示す裏面図である。図５は、複数の太陽電池セルを直列に接続した様子を上方から見た斜視図である。図６は、複数の太陽電池セルを直列に接続した様子を下方から見た斜視図である。図７は、各部品を積層する状態を示す太陽電池セルの分解斜視図である。図８は、隣接する２つの太陽電池セルの接続状態を示す断面図である。

[0015] 太陽電池モジュール９０は、平板状の太陽電池パネル７０とこの太陽電池パネル７０の外縁部を全周にわたって囲む枠部材８０とを有している（図１）。太陽電池パネル７０は、縦横に複数配列された太陽電池セル２０を樹脂封止し、その受光面側を透光性を有するガラスなどの表面カバー材３で覆い、裏面側（非受光面側）を裏面カバー材１０で覆って構成されている（図７，８）。

[0016] 複数の太陽電池セル２０は、受光面側リード線（インターコネクタ）４及び裏面側リード線（インターコネクタ）７により、第１の方向である図中Ｘ方向に直列に接続されている（図５～７）。ただし、太陽電池パネル７０の端部においては、Ｙ方向に接続されている箇所もある。なお、受光面側リード線４及び裏面側リード線７として、一般的にタブ線と呼ばれる半田が供給（被覆あるいは塗布）された帯状の銅箔を用いている。太陽電池パネル７０の内部には、太陽電池セル２０がリード線４，７により順次接続されてなるセルアレイ５が樹脂８により封止されている（図２）。

[0017] 枠部材８０は、アルミニウムなどの押出成型にて作製され、断面コの字形を成すコ字状部で太陽電池パネル７０の外縁部を全周にわたって覆っている（図１）。枠部材８０は、ブチル系の封止材またはシリコン系の接着剤などを介して太陽電池パネル２０に固定され、太陽電池パネル２０を補強するとともに、太陽電池パネル２０を住宅やビルなどの建物や地面や構造物に設けられた架台に取り付けるための役割を有する。

[0018] 太陽電池パネル７０は、受光面側から、透光性を有する表面カバー材（ガラス）３と、複数の太陽電池セル２０及びこれら太陽電池セル２０を直列に接続する受光面側リード線４及び裏面側リード線７がＥＶＡ（エチレンビニルアセテート）等の樹脂８（８ａ，８ｂ）で封止されたセル配置層９と、ＰＥＴ（ポリエチレンテレフタレート）やＰＶＦ（ポリビニルフルオライド）等でなる耐候性に優れたバックシート１０（裏面カバー材）とが、積層された構成となっている（図７，８）。

[0019] 図３，４に示すように本実施の形態の太陽電池セル２０は、平面形状が略

長方形であり、長方形の短辺長Ｓと長辺長Ｌとの比が１／２：１となっている。従来の太陽電池セルは、一般に１５６ｍｍ×１５６ｍｍ或いは１２５ｍｍ×１２５ｍｍの正方形であるが、本実施の形態の太陽電池セル２０は、上記寸法で正方形に作製した太陽電池セルを、接続される際の第１の方向（受光面バス電極（受光面リード接続電極）１４が延びる方向）に２分割して作製するので上記形状となっている。

[0020] 太陽電池セル２０は、およそ１５０～３００μｍほどの厚みのｐ型シリコンを基板として以下のように構成される。ｐ型層となるｐ型シリコン基板１１の表面側には、リン拡散によってｎ型拡散層（不純物層拡散層：図示せず）が形成され、さらに入射光の反射を防止して変換効率を向上させるためのシリコン窒化膜よりなる反射防止膜１１ａ（図３）が表面処理により設けられて、太陽電池セル２０の受光面となっている。また、ｐ型シリコン基板（以下、単に基板）１１の裏面側には、高濃度不純物を含んだｐ＋層（図示せず）が形成され、さらに入射光の反射及び電力の取り出しを目的として裏面のほぼ全面にわたってアルミニウムによる裏面集電電極１２が設けられている。

[0021] また、基板１１の受光面には、入射光から変換された電気エネルギーを取り出す受光面側電極として、銀で形成された細線電極であるグリッド電極１３と同じく銀で形成された所定幅の受光面バス電極（受光面リード接続電極）１４とが形成され、それぞれ底面部において上記ｎ型拡散層と電気的に接続している。受光面バス電極１４は、太陽電池セル２０の接続方向である第１の方向に沿って２本が平行に形成されている。グリッド電極１３は、受光面バス電極１４と直交する方向に多数本が細形に形成されている。グリッド電極１３は、受光面にて発電した電力を無駄なく取り出すために、できるだけ細く、また受光面（表面）の全体にわたるように形成されている。太陽光が当たることによって、図３の受光面側がマイナス（－）電極、図４の裏面側がプラス（＋）電極となる。受光面バス電極１４は、受光面側リード線４が接続されて、グリッド電極１３によって集められた電気エネルギーをさら

に外部に取り出すために設けられている（図３）。なお、図３及び図５等において、受光面バス電極１４は、受光面側リード線４より細く記載されているが、これは、受光面バス電極１４と受光面側リード線４とが重なる様子をわかりやすく表現するためであり、実際には受光面バス電極１４と受光面側リード線４とは同じ幅である。

[0022] 一方、基板１１の裏面には、裏面のほぼ全面を覆うようにしてアルミニウムでなる裏面集電電極１２が設けられている。また、基板１１の裏面のグリッド電極１３と対応した位置（グリッド電極１３と基板１１の厚さ方向に重なる位置）には、銀でなる裏面バス電極（裏面リード接続電極）１５が太陽電池セル２０の接続方向である第１の方向に延びて形成されている。裏面バス電極１５は、裏面側リード線７が接続されて、裏面集電電極１２によって集められた電気エネルギーをさらに外部に取り出すために設けられている（図４）。なお、図４及び図６等において、裏面バス電極１５は、裏面側リード線７より太く記載されているが、これは、裏面バス電極１５と裏面側リード線７とが重なる様子を表現するためであり、実際には裏面バス電極１５と裏面側リード線７とは同じ幅である。

[0023] 基板１１の裏面は、前面にわたって銀電極にて覆ってもよいがコストが嵩むため、上記のように特に裏面側リード線７を接続する箇所のみ銀製の裏面バス電極１５が設けられている。なお、裏面バス電極１５は、本実施の形態のように直線状なもののほかに、離散的にドット状（飛び石状）に設けられる場合もある。そして、本実施の形態においては、以上のようにして正方形に作製した太陽電池セルを受光面側リード線４及び裏面側リード線７にて相互に接続する前に、受光面バス電極１４が延びる方向に二分割して、短辺長Ｓと長辺長Ｌとの比が１／２：１の長方形の太陽電池セル２０を得る。

[0024] 分割された太陽電池セル２０を得るにあたっては、まず、所定の工程を行うことにより、正方形の基板１１に受光面バス電極１４、グリッド電極１３、裏面集電電極１２、及び裏面バス電極１５を形成して基礎となる太陽電池セル（第１の太陽電池セル）を作製する。このとき、これら各電極が形成さ

れる受光面電極領域と裏面電極領域は、分割する線に合わせて２つの領域に分けて形成しておく、そして、分割線に沿って切断することにより上記長方形の太陽電池セル２０を得る。なお、本実施の形態の太陽電池セル２０は、正方形に作製した太陽電池セルを二分割しているが、三分割、或いは四分割とさらに多数に分割（ｎ分割）してもよい。ｎ分割する場合には、受光面電極領域と裏面電極領域とをあらかじめｎ箇所に分けて形成しておく。

[0025] このように構成された太陽電池セル２０では、太陽光が太陽電池セル２０の受光面側（反射防止膜側）から照射されて、内部のｐｎ接合面（ｐ型層とｎ型拡散層との接合面）に到達すると、このｐｎ接合面において合体していたホールと電子が分離する。分離した電子はｎ型拡散層に向かって移動する。一方、分離したホールはｐ＋層に向かって移動する。これにより、ｎ型拡散層とｐ＋層との間に、ｐ＋層の電位が高くなるようにして電位差が発生する。その結果、ｎ型拡散層に接続した表面電極がマイナス極、ｐ＋層に接続した裏面電極がプラス極となって、外部回路（図示せず）を接続すれば電流が流れ、太陽電池としての動作を示す。太陽電池セル１枚の出力電圧は小さいが、太陽電池モジュール９０においてはこの太陽電池セル２０を複数枚直列に或いは並列に接続することにより使用しやすい電圧まで大きくしている。

[0026] 太陽電池セル２０の直列接続は、第１の方向に配列された複数の太陽電池セルにおいて、第１の太陽電池セル２０（２０Ａ）の受光面バス電極１４と、これに隣接する第２の太陽電池セル２０（２０Ｂ）の裏面バス電極１５とを帯状のリード線４，７により電気的に接続することによりなされる（図５～８）。

[0027] 本実施の形態においてリード線４，７は、受光面側リード線４と裏面側リード線７とに分割して設けられている。両リード線のうち、受光面側リード線４は、受光面バス電極１４の上に延び、当該受光面バス電極１４に半田接合（機械的及び電気的に接続）されている。なお、受光面側リード線４には、太陽電池セル２０より長さを長くされた延長部４ａが設けられており、受

光面バス電極１４上に半田接合された際、一端側に突出する（図３，５，９）。

[0028] 裏面側リード線７は、裏面バス電極１５上に延び、当該裏面バス電極１５に半田接合（機械的及び電気的に接続）されている。そして、第１の太陽電池セル２０（２０Ａ）と第２の太陽電池セル２０（２０Ｂ）とを直列接続するために、第１の太陽電池セル２０（２０Ａ）の受光面側リード線４と第２の太陽電池セル２０（２０Ｂ）の裏面側リード線７とが半田接合されている。すなわち、第１の太陽電池セル２０（２０Ａ）の受光面側リード線４の延長部４ａが、隣接する第２の太陽電池セル２０（２０Ｂ）の裏面側にもぐり込み、裏面バス電極１５上に半田接合されている裏面側リード線７に半田接合される。ここでは、隣接する２つの第１の太陽電池セル２０（２０Ａ）と第２の太陽電池セル２０（２０Ｂ）の接続のみ説明しているが、実際には、同様の接続が繰り返されて複数の太陽電池セル２０が直列に接続されている。なお、本実施の形態においては、リード線は、上記のように受光面側リード線４と裏面側リード線７とに分割して設けられているが、連続する１本のリード線とされてもよい。

[0029] 受光面側リード線４を受光面バス電極１４上に重ね合わせ、また裏面側リード線７を裏面バス電極１５上に重ね合わせてそれぞれ配置し、続いて、受光面側リード線４及び裏面側リード線７を加熱しながら部分的もしくは全長にわたり太陽電池セル２０側に押圧する。受光面側リード線４及び裏面側リード線７は半田被覆されているので加熱によりこの半田が溶け、その状態で押圧することによりリード線４，７とバス電極１４，１５とが半田接合される。次に、第１の太陽電池セル２０（２０Ａ）と第２の太陽電池セル２０（２０Ｂ）とを並べて、第１の太陽電池セル２０（２０Ａ）の受光面側リード線４の延長部４ａを第２の太陽電池セル２０（２０Ｂ）の裏面側にもぐりこませて裏面側リード線７の端部と重ね、加熱しながら押圧して半田接合する。なお、受光面側リード線４及び裏面側リード線７と太陽電池セル２０との接続と、受光面側リード線４と裏面側リード線７との接続とは同じ工程にて

同時に行なってもよい。

[0030] このようにして太陽電池セル２０が複数枚直列に接続されたセルアレイ５が、図７に示すように表面カバー材（ガラス）３とバックシート１０（裏面カバー材）との間に樹脂８ａ，８ｂで封止されて太陽電池パネル７０とされ、この太陽電池パネル７０に図１に示すように枠部材８０が取り付けられ、さらに出力用ケーブル（＋極、－極）（図示しない）が端子ボックス（図示しない）を介して接続されて、太陽電池モジュール９０が構成され、その出力電圧は太陽電池セル２０の電圧が複数枚分直列接続された値となる。

[0031] このような構成の太陽電池モジュールにおいては、太陽電池セル２０を二分割することにより、太陽電池セル２０の１枚あたりの電流を半分にすることができるため、電気接続による抵抗損失を低減できる。したがって、分割しない従来の正方形の太陽電池セルを搭載する太陽電池モジュールよりも高出力の太陽電池モジュールとすることができる。

[0032] 実施の形態２.

図９は、実施の形態２の太陽電池モジュールに用いられる太陽電池セルに受光面バス電極を接合した様子を示す上面図である。図１０は、同じく太陽電池セルに裏面バス電極を接合した様子を示す裏面図である。図１１は、実施の形態２の太陽電池セルを接続する様子を示す上面図である。図１２は、実施の形態２のセルアレイの接続のされ方を示す模式図である。本実施の形態の太陽電池セル２１は、実施の形態１のものと同じように、正方形の太陽電池セルを受光面バス電極１４が延びる方向に二分割して作製され、短辺長Ｓと長辺長Ｌとの比が１／２：１となっている（図９）。

[0033] 本実施の形態の太陽電池セル２１は、図９に示すように、受光面側において、短辺と平行に延びる受光面バス電極１４は４本が設けられており、各々に受光面側リード線４が接合されている。一方、裏面側においては、受光面バス電極１４に対応した位置（受光面バス電極１４と基板１１の厚さ方向に重なる位置）には、銀でなる裏面バス電極（裏面リード接続電極）１５Ｂが太陽電池セルの接続方向である第１の方向にリードにドット状（飛び石状）

に４列設けられている。各列の裏面バス電極１５Ｂには、裏面側リード線７が接合されている。複数の太陽電池セル２１は、４本の受光面バス電極１４と４本の裏面バス電極１５Ｂとが、受光面側リード線４と裏面側リード線７とで実施の形態１と同じように順次直列に接続される。

[0034] 図１１及び図１２に示すように、太陽電池セル２１が、所定枚数直列に接続されて第１のセルストリング１７（１７Ａ）が形成されている。また、太陽電池セル２１が、同じ枚数だけ直列に接続されて第２のセルストリング１７（１７Ｂ）が形成されている。そして、第１のセルストリング１７（１７Ａ）と第２のセルストリング１７（１７Ｂ）とが、それぞれの終端部同士をストリングコネクタ１６で接合されて、第１の並列接続のセルストリング１８（１８Ａ）を形成している。さらに、この第１の並列接続のセルストリング１８（１８Ａ）と同じように接続された第２の並列接続のセルストリング１８（１８Ｂ）とが、ストリングコネクタ１６にて直列に接続されている（図１２）。そして、同じようにして列接続のセルストリング１８の所定列数だけ直列に接続されている。

[0035] このようにして太陽電池セル２１が複数枚直列に接続されたセルアレイ５が、図７に示すように表面カバー材（ガラス）３とバックシート１０（裏面カバー材）との間に樹脂８ａ，８ｂで封止されて太陽電池パネル７０とされ、この太陽電池パネル７０に図１に示すように枠部材８０が取り付けられ、さらに出力用ケーブル（＋極、－極）（図示しない）が端子ボックス（図示しない）を介して接続されて、太陽電池モジュール９０が構成される。

[0036] なお、図１２において、第１の並列接続のセルストリング１８（１８Ａ）と第２の並列接続のセルストリング１８（１８Ｂ）とが直列に接続されているが、詳しくは第１の並列接続のセルストリング１８（１８Ａ）の終端セル（ストリングコネクタ１６に最も近い位置にあるセル）の受光面バス電極１４に接合された受光面側リード線４がストリングコネクタ１６に接続され、そのストリングコネクタ１６と第２の並列接続のセルストリング１８（１８Ｂ）の先頭セル（ストリングコネクタ１６に最も近い位置にあるセル）の裏

面バス電極１５Ｂに接合された裏面側リード線７に接続されている。すなわち、セルストリング１８同士は極性を考慮して電気的に直列に接続されなければならないため、第１の並列接続のセルストリング１８（１８Ａ）と第２の並列接続のセルストリング１８（１８Ｂ）とでは電気的に言えば方向が変わることになる。

[0037] 本実施の形態の太陽電池セル２１においても、縦横の長さが同じ略正方形のｐ型シリコン基板に所定のプロセスを経て得られるセルを二等分することによって形成することができる。セルの面積が半分になるため、発電電流が半分になり、したがってリード線４，７に流れる電流が正方形のものと較べ半分となる。その結果、リード線４，７の抵抗ロス（Ｗ）はＷ＝（リード線４，７の電気抵抗）×（流れる電流）^{2} の関係から、１／４に低減することができ、太陽電池モジュールの出力を向上させることができる。

[0038] また、モジュール内のセルの配置（接続）について考えると、二分割されたセルを全数直列接続した場合のモジュールが得られる特性は、非分割セルを全数直列接続した同一外形寸法のモジュールの特性に対して、電流が半分、電圧が２倍となる。

[0039] 一枚の非分割セルの電圧をＶ、電流をＩとし、これを６０枚直列接続してモジュールを構成したとすると、モジュール一枚の電圧は６０×Ｖ、電流はＩとなる。これに対して、二分割されたセルの電圧はＶ、電流は０．５×Ｉであるので、これを１２０枚（モジュールの外形寸法が同一なので二分割されたセルの使用枚数は倍になる）直列接続して構成したモジュールでは、その電圧は１２０×Ｖ、電流は０．５×Ｉとなる。すなわち、モジュールとしての電気出力特性が異なるため、インバータへの接続方法に対して、屋根の上へのモジュールの配置（屋根上での直・並列接続枚数）を大幅に変えなければならないなどの配慮をする必要があった。

[0040] ここで、前述したように、二分割されたセルを所定の枚数だけ直列接続したセルストリングを二組並列接続した並列セルストリングを構成し、その並列セルストリングを全て直列接続するような構成とすれば、そのモジュール

の電気出力特性は、電圧が６０×Ｖ、電流がＩとなり、非分割セルを全数直列接続したモジュールと同等の特性となる。したがって、インバータへの接続方法に対して、屋根上でのモジュール配置（屋根上での直・並列接続枚数）を大幅に変えなければならないなどの配慮をする必要がない。さらには既設の太陽光発電システムで従来の非分割セルによるモジュールが故障した場合、特性が同等なので二分割セルによるモジュールを代替品として使用することも可能である。

[0041] なお、前述したように、二分割されたセルによるモジュールは、電流値が半分になったことによりリード線４，７による抵抗ロスが低減されているが、上記の説明においては、わかりやすくするために抵抗ロス分については無視して説明している。

[0042] 実施の形態３.

図１３は、実施の形態３の太陽電池モジュールに用いられる太陽電池セルに受光面バス電極を接合した様子を示す上面図である。図１４は、同じく太陽電池セルに裏面バス電極を接合した様子を示す裏面図である。図１５は、実施の形態３のセルアレイの接続のされ方を示す模式図である。

[0043] 本実施の形態の太陽電池セル２２は、実施の形態１のものと同じように、正方形の太陽電池セルを、受光面バス電極１４が延びる方向に二分割して作製され、短辺長Ｓと長辺長Ｌとの比が１／２：１となっている。そして、太陽電池セル２２は、短手方向１側の端部にて、長辺とその両端部の短辺との間に形成された角部が略４５度にカットされたような形状となっている。その他の構成は実施の形態２と同様である。このような角部を落とされた角落とし太陽電池セル２２は、実施の形態２の太陽電池セル２１に置き換わり同じように太陽電池モジュールを構成する。

[0044] 角落とし太陽電池セル２２は、受光面バス電極１４と裏面バス電極１５Ｂが、長辺の中点を通り、短辺に平行な仮想中心線ＣＬに対して線対称となるようなパターンとして形成されている。

[0045] 二分割されたセルは略長方形の長辺あるいは短辺の方向を揃えてモジュー

ル内に配置される。その際、任意のセルの受光面バス電極１４と隣接したセルの裏面バス電極１５Ｂとが一直線上に存在すればリード線４，７によってそれらのセル同士を最短距離で接続でき、また接続作業も容易である。また上述したような、受光面バス電極１４と裏面バス電極１５Ｂが、仮想中心線ＣＬに対して線対称となるように形成されている太陽電池セル２２であれば、セルが１８０°回転された場合でもされない場合でも、受光面側の受光面バス電極１４と裏面バス電極１５Ｂとが、一直線上にあるようになるため、リード線４，７をそのまま延長することで接続することができる。すなわち、受光面バス電極１４と裏面バス電極１５Ｂとが一直線上にあるようにするために、セルの並べる方向を揃えるという作業が不要になる。

[0046] 図１５に示すように、本実施の形態のセルアレイ５においては、角落とし太陽電池セル２２を直列に接続してセルストリング１７Ａ，１７Ｂを形成する際に、隣り合う太陽電池セル２２の向きを１８０°変えて（例えば、角落としがされてない側の長辺が対向するように）接続してセルアレイ５を構成している。

[0047] 一般に、単結晶シリコン基板は、原料となるインゴットのサイズ制約から角部に略４５度の角落とし部が付くものが多い。したがって基板を二分割した状態のままモジュール内に配置すると、角落とし部が配置されたセルの上辺側、下辺側、・・・というように交互に現れることになる。角落とし部を例えば必ず上辺側に配置されるようにしようとすると、二分割したセルの下半分側のセルは１８０°回転させて配置しなければならない。その際、１８０°回転させても受光面バス電極１４と裏面バス電極１５Ｂとが一直線上にあるようにすれば、リード線４，７で直列接続することが可能となる。上述したような、受光面バス電極１４と裏面バス電極１５Ｂとが、長辺の中点を通り、短辺に平行な仮想中心線ＣＬに対して線対称となるように形成されている本実施の形態の太陽電池セル２２であれば、それが可能である。

[0048] 実施の形態４.

従来の略正方形のセルを二分割して略長方形のセルを２枚生成する場合に

おいて、元の略正方形セルを分割する線に沿った領域には所定の幅だけ受光面バス電極、グリッド電極、裏面バス電極をあらかじめ生成しないようにする。すなわち、二分割した略長方形のセルの周縁部には上記電極の存在しない領域ができる。

[0049] このように作製した太陽電池セルによれば、二分割した略長方形のセルの周縁部に電極を形成しないことにより、分割した際に生じる分割端部のダメージによりセルの特性が低下するのを抑制できるほか、リード線（インターコネクタ）接合時の熱応力がセル端部に伝播するのを防ぐことにより、モジュール化時にセルが破損するのを抑制することができる。また、セル周縁部はモジュールの裏面カバー材で反射した二次光を取り込むことができるため、モジュールの特性向上効果もある。

産業上の利用可能性

[0050] 以上のように、本発明にかかる太陽電池モジュールは、太陽等の光エネルギーを電気エネルギーに変換する太陽光発電システムにおいて、屋根等に複数枚並べて設置される太陽電池モジュールに適用されて有用なものであり、特に受光面に略長方形の短辺に平行な複数の受光面バス電極を有し、非受光面の受光面バス電極に対応する位置に裏面バス電極を有する複数枚の太陽電池セルを備えた太陽電池モジュールに適用されて最適なものである。

符号の説明

[0051] ３　表面カバー材（ガラス）

４　受光面側リード線（インターコネクタ）

４ａ　延長部

５　セルアレイ

７　裏面側リード線（インターコネクタ）

８，８ａ，８ｂ　樹脂（封止材）

９　セル配置層

１０　裏面カバー材

１１　ｐ型シリコン基板

１２　裏面集電電極

１３　グリッド電極

１４　受光面バス電極（受光面リード接続電極）

１５，１５Ｂ　裏面バス電極（裏面リード接続電極）

１６　ストリングコネクタ

１７，１７Ａ，１７Ｂ　セルストリング

２０，２０Ａ，２０Ｂ，２１，２２　太陽電池セル

７０　太陽電池パネル

８０　枠部材

９０　太陽電池モジュール

請求の範囲

[請求項1] 平面形状が略長方形であり、前記略長方形の短辺長と長辺長との比が１／ｎ：１（ｎは２以上の整数）であって、受光面に前記略長方形の短辺に平行な複数の受光面バス電極を有し、非受光面の前記受光面バス電極に対応する位置に裏面バス電極を有する、複数枚の太陽電池セルと、

第１の前記太陽電池セルの前記受光面バス電極と、隣接する第２の前記太陽電池セルの前記裏面バス電極とを電気的に接続するインターコネクタと、を備えた

ことを特徴とする太陽電池モジュール。

[請求項2] 前記太陽電池セルの略長方形の短辺長と長辺長との比は１／２：１である

ことを特徴とする請求項１に記載の太陽電池モジュール。

[請求項3] 前記太陽電池セルの所定の枚数を直列接続してセルストリングを構成し、前記セルストリングをｎ列並列接続し、さらに前記ｎ列並列接続されたセルストリングを直列接続して全体のセルアレイを構成する

ことを特徴とする請求項１に記載の太陽電池モジュール。

[請求項4] 前記太陽電池セルの所定の枚数を直列接続してセルストリングを構成し、前記セルストリングを２列並列接続し、さらに前記２列並列接続されたセルストリングを直列接続して全体のセルアレイを構成する

ことを特徴とする請求項２に記載の太陽電池モジュール。

[請求項5] 前記太陽電池セルの前記受光面バス電極は、前記受光面バス電極の延長線と直交する辺の中点を通り、前記受光面バス電極に平行な直線に対して線対称の位置に形成されている　ことを特徴とする請求項１に記載の太陽電池モジュール。

[請求項6] 前記太陽電池セルの前記受光面バス電極は、前記受光面バス電極と平行な辺の中点を通り、前記受光面バス電極に直交する直線に対して線対称の位置に形成されている

ことを特徴とする請求項５に記載の太陽電池モジュール。

[請求項7] 前記太陽電池セルは、その外周縁部に、縁からセル中心方向に向かって所定の寸法内には前記受光面バス電極、前記裏面バス電極のいずれも形成されていない領域を有する

ことを特徴とする請求項１に記載の太陽電池モジュール。

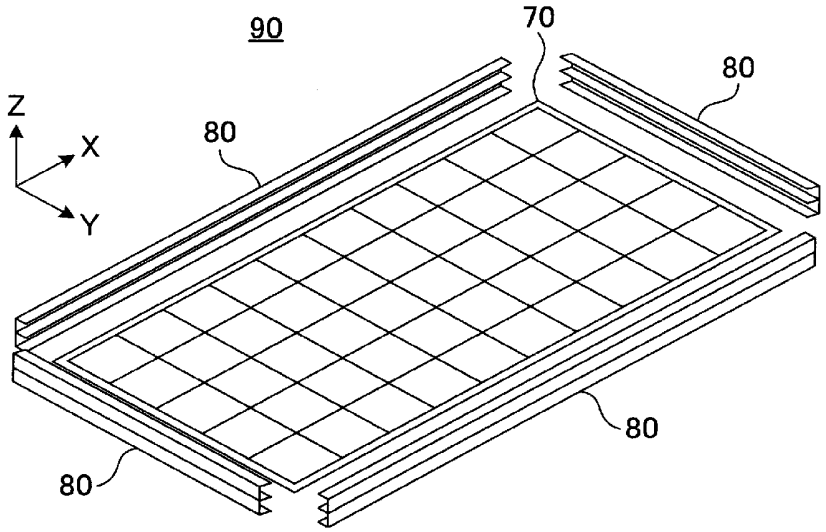
[請求項8] 平面形状が略正方形であり、受光面側に、前記略正方形の一辺に平行な複数の受光面バス電極と前記受光面バス電極と直交する複数のグリッド電極とが設けられた受光面電極領域をｎ箇所有し、非受光面側の前記受光面側バス電極に対応する位置に裏面バス電極を有する基礎の太陽電池セルを、

前記ｎ箇所の受光面電極領域のそれぞれの境界に沿って前記基礎の太陽電池セルをｎ分割することによって、平面形状が略長方形であり、前記略長方形の短辺長と長辺長との比が１／ｎ：１（ｎは２以上の整数）である分割された太陽電池セルを得て、

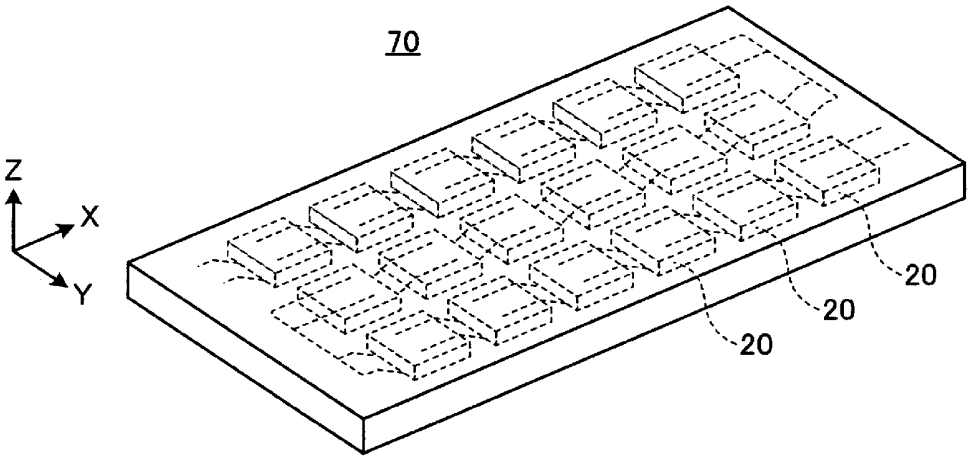
第１の前記分割された太陽電池セルの前記受光面バス電極と隣接する第２の前記分割された太陽電池セルの前記裏面バス電極とをインターコネクタにより電気的に接続する

ことを特徴とする太陽電池モジュールの製造方法。

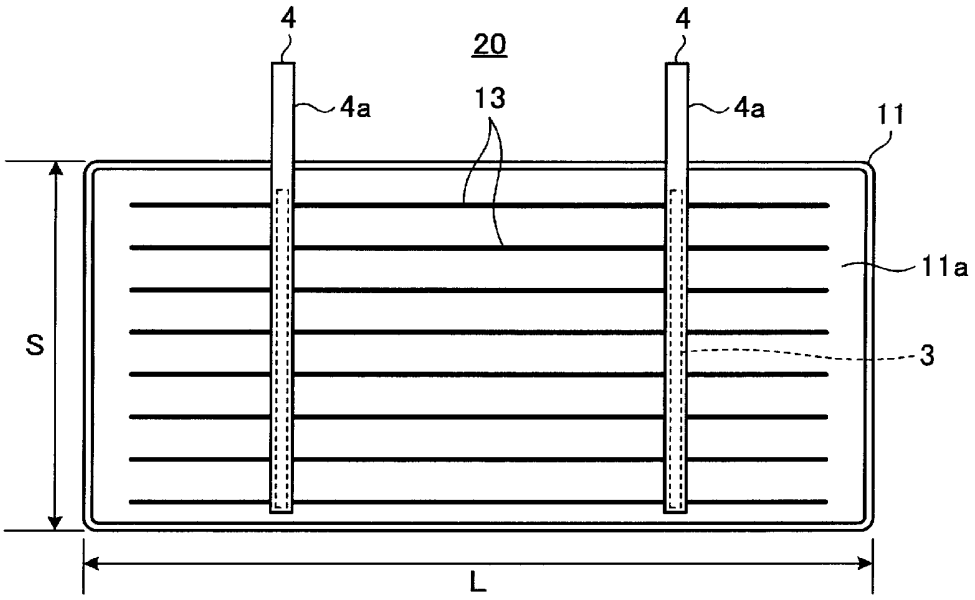
[図1]



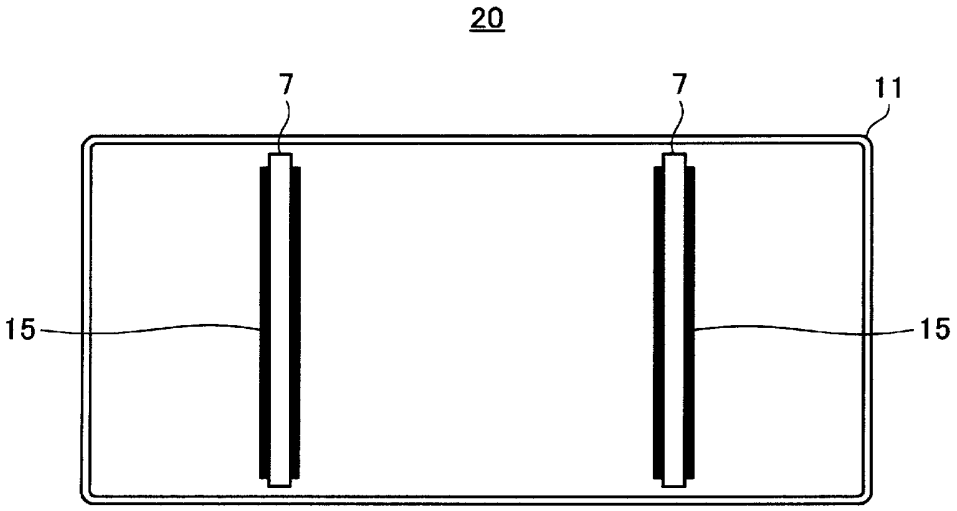
[図2]



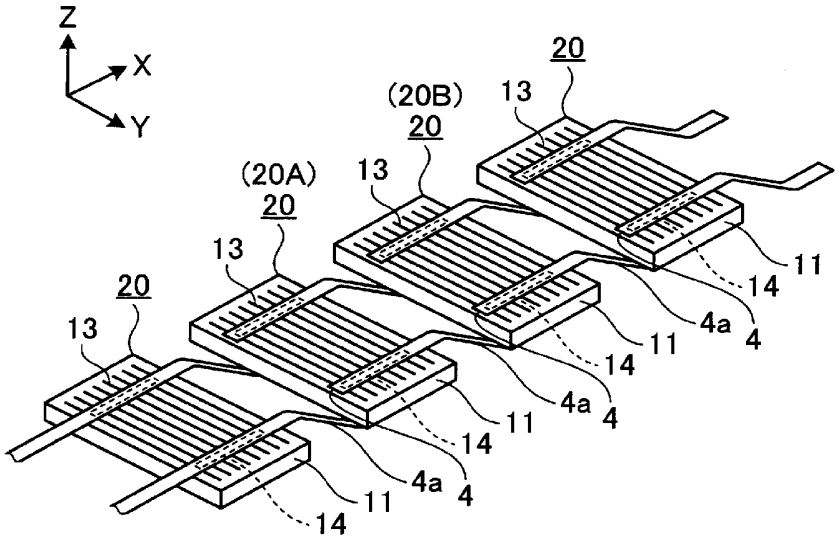
[図3]



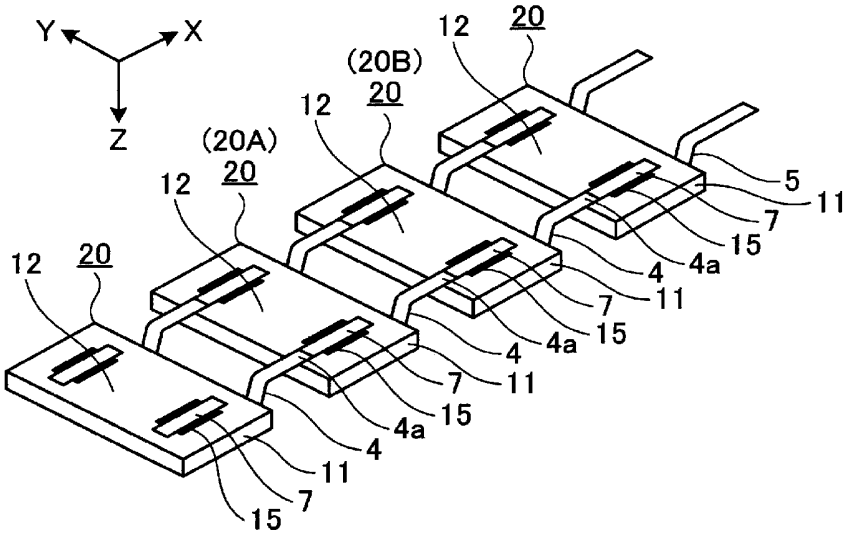
[図4]



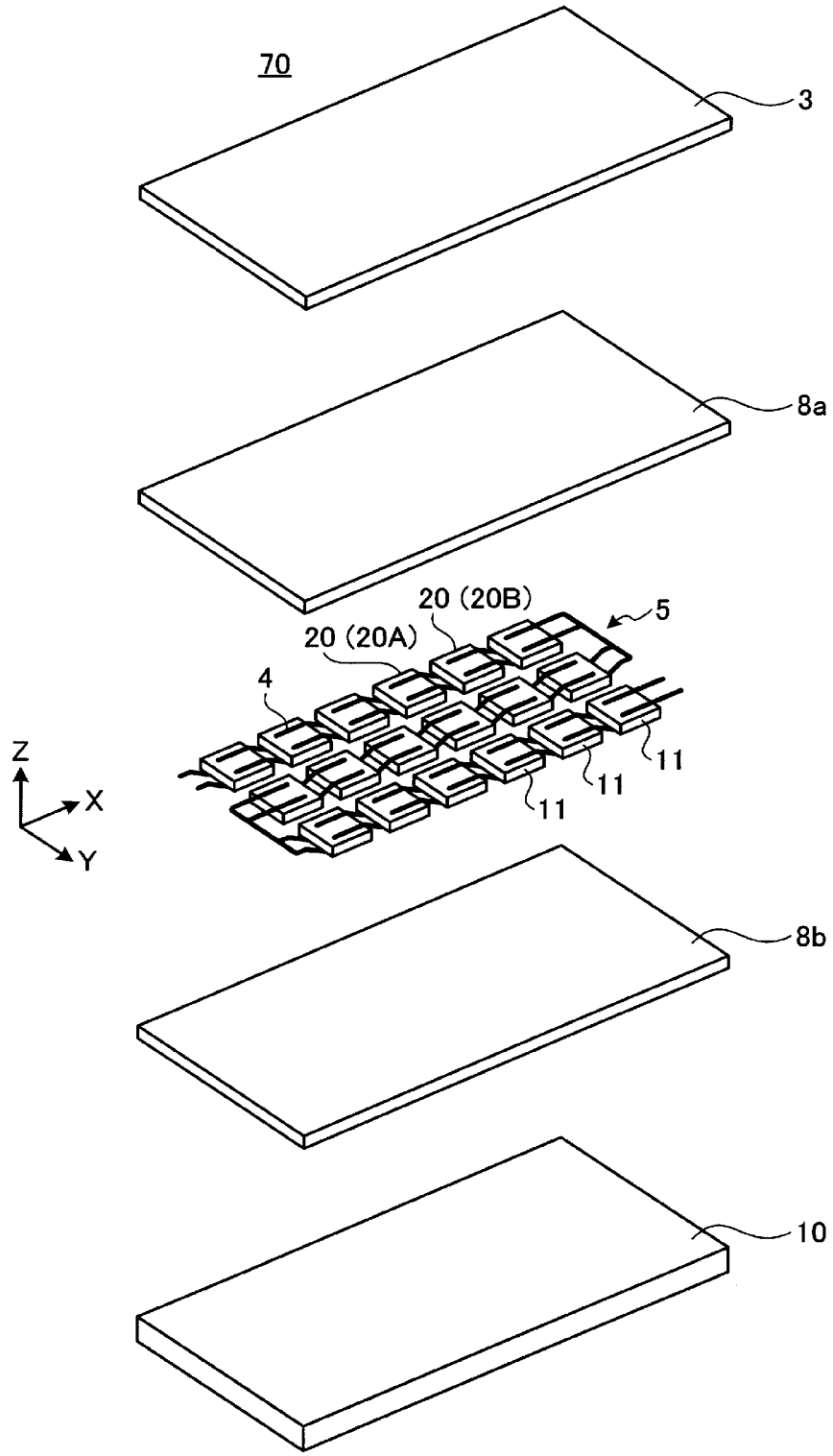
[図5]


Z
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Y
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(20B)
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(20A)
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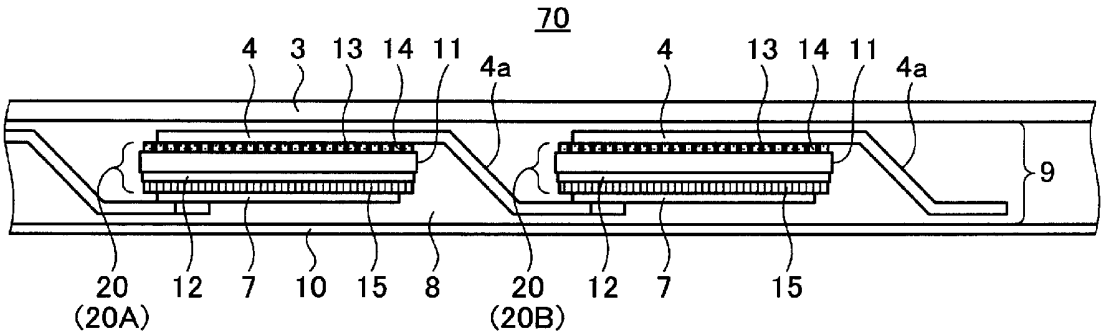
[図6]


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(20B)
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(20A)
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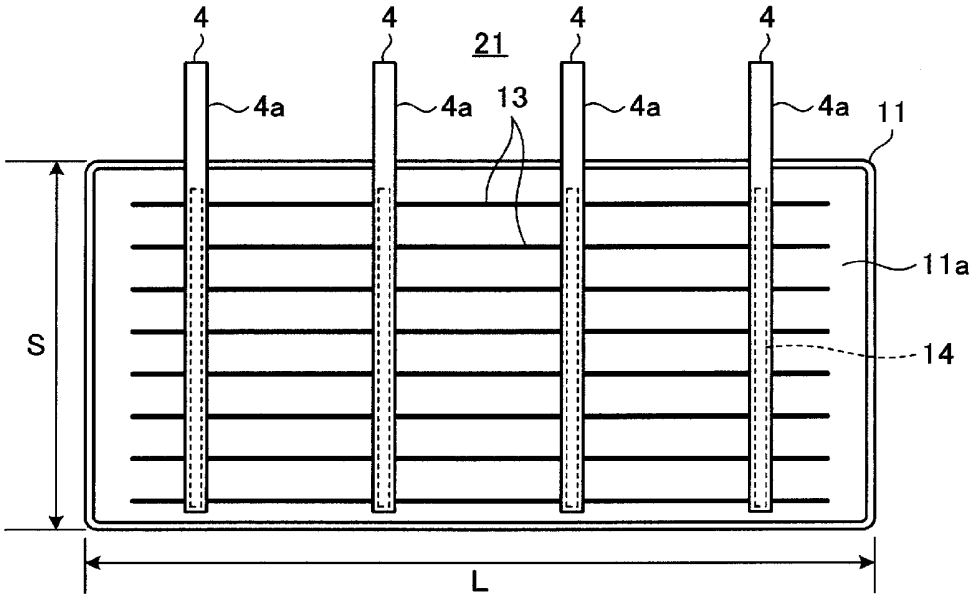
[図7]



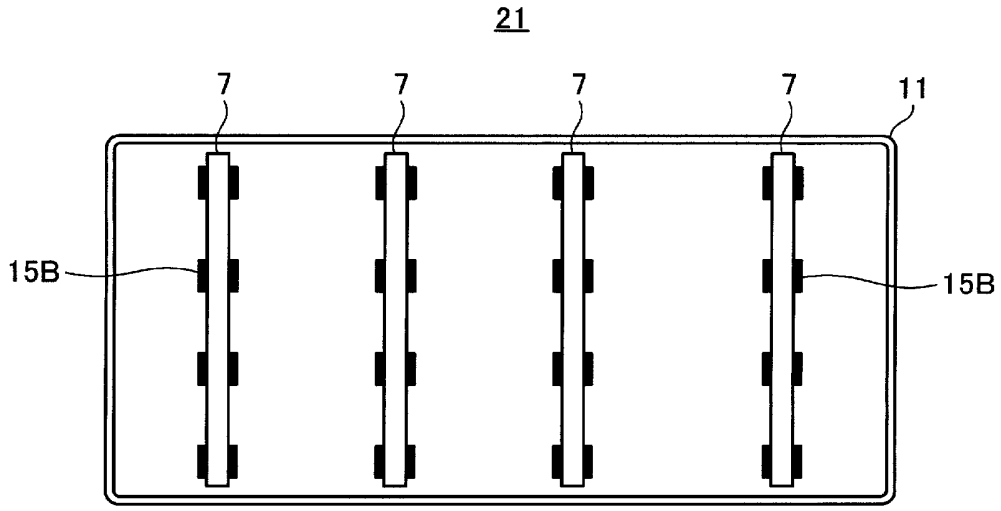
[図8]


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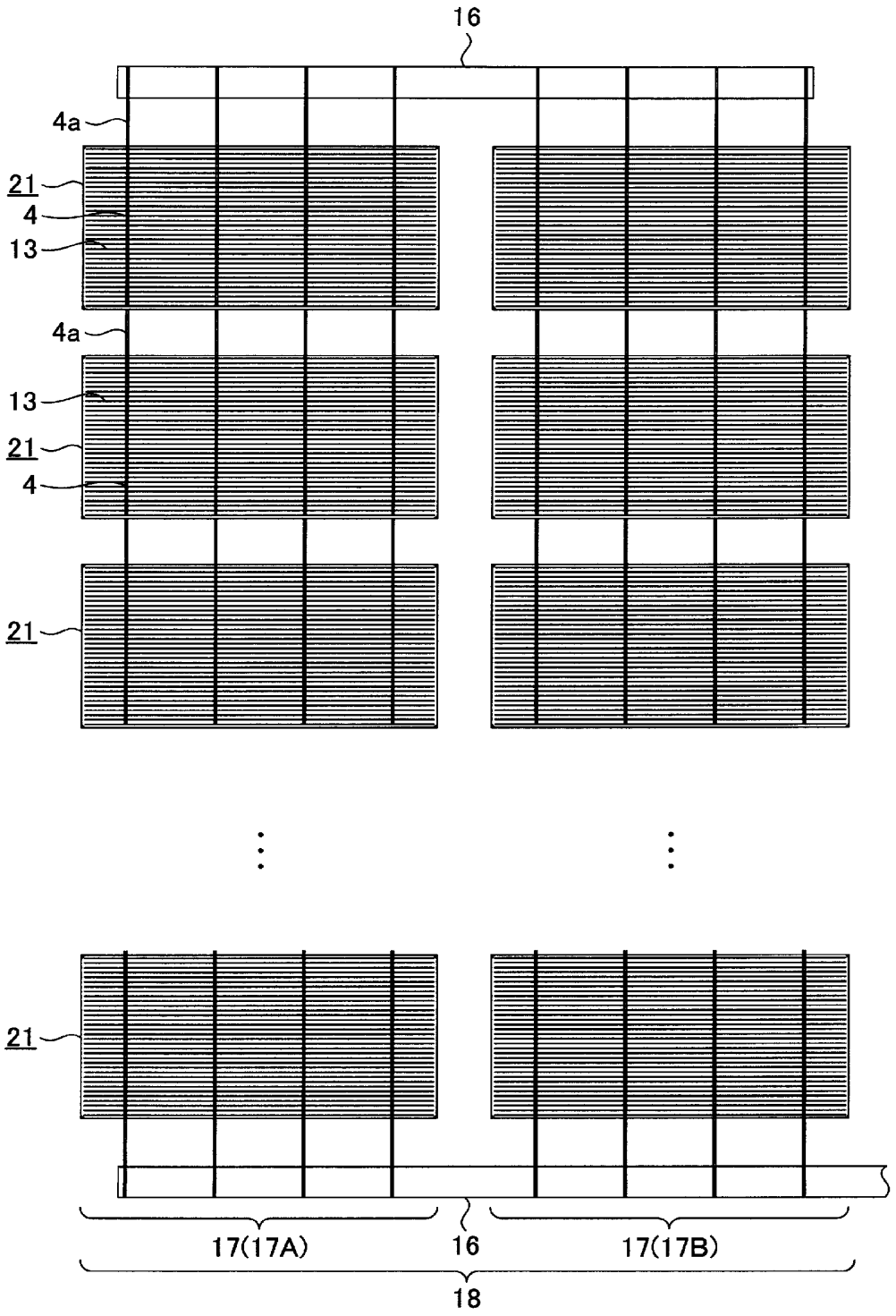
[図9]


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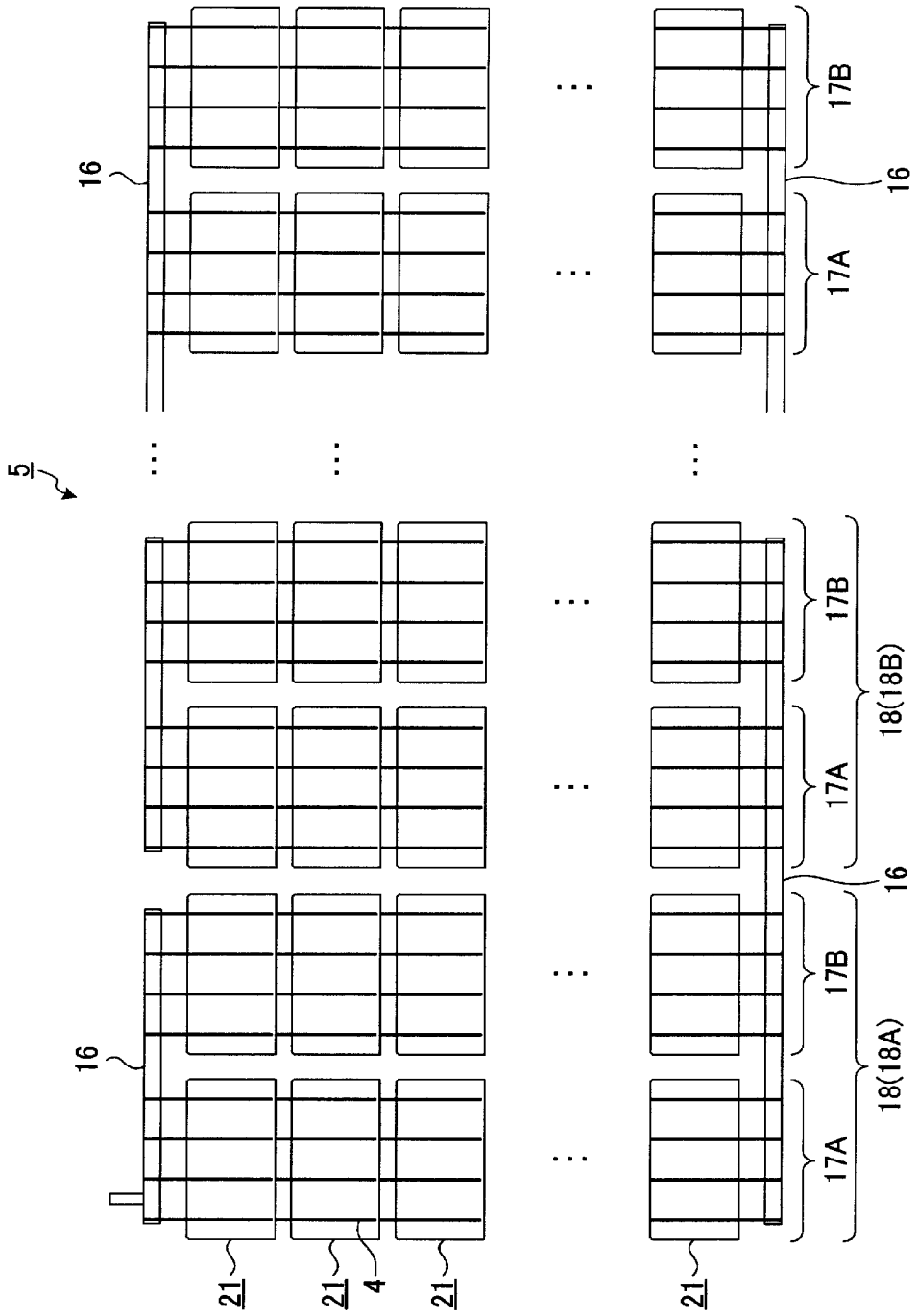
[図10]



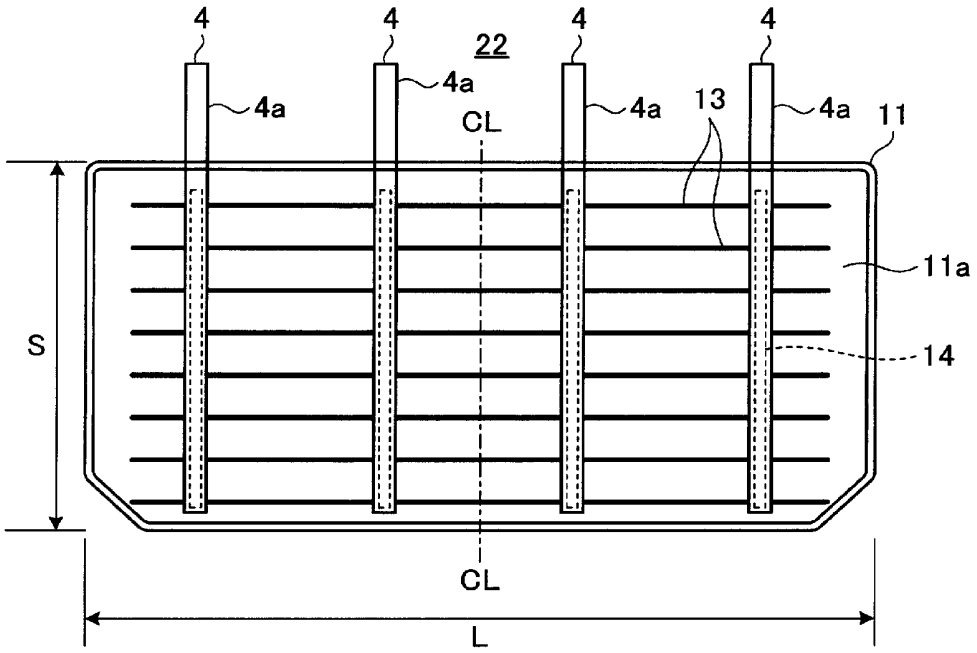
[図11]



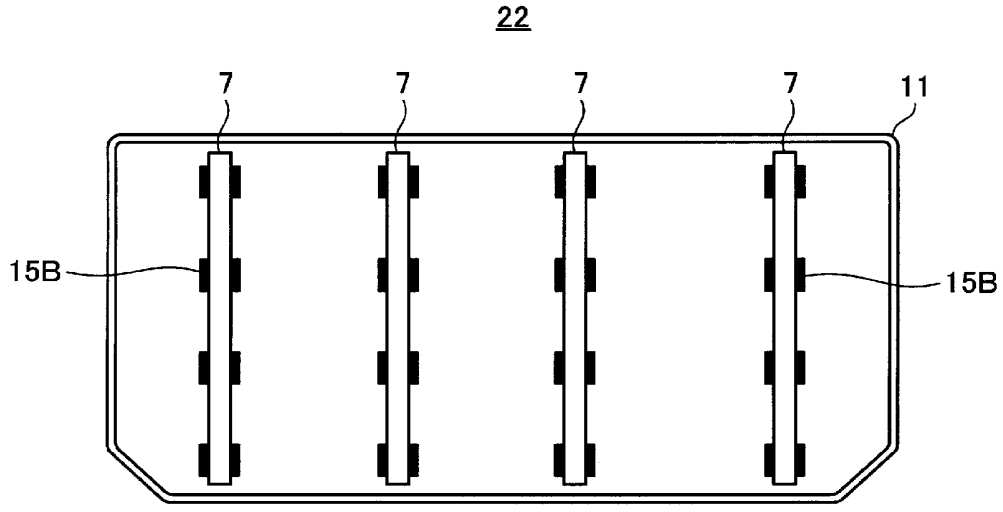
[図12]



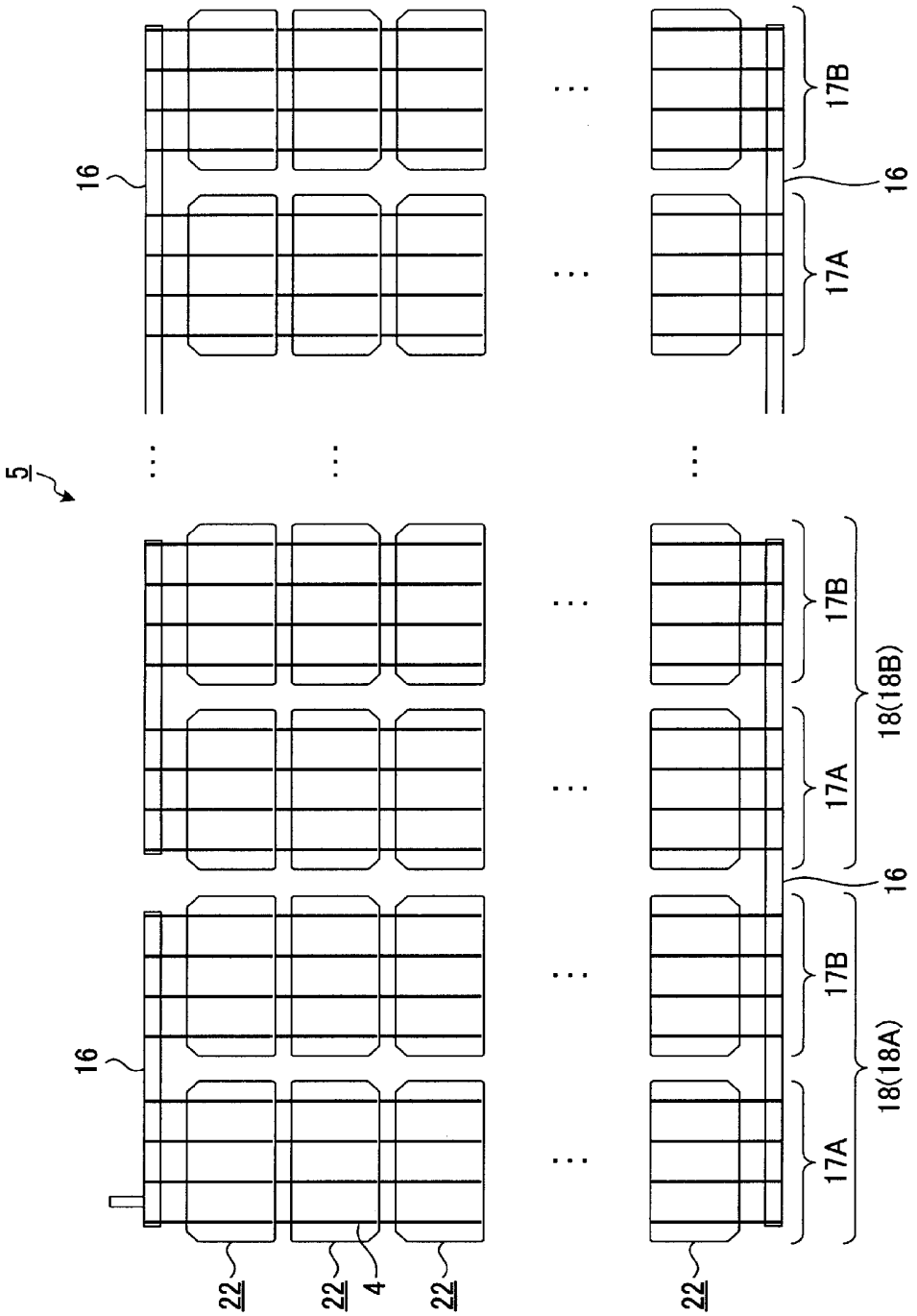
[図13]



[図14]



[図15]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/061334

A. CLASSIFICATION OF SUBJECT MATTER
H01L31/042(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)
H01L31/04-31/078

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 7-106619 A (Sanyo Electric Co., Ltd.), 21 April 1995 (21.04.1995), (Family: none)	1-8
X	JP 2006-120944 A (Sharp Corp.), 11 May 2006 (11.05.2006), (Family: none)	1-8
X	JP 2000-164901 A (Kyocera Corp.), 16 June 2000 (16.06.2000), (Family: none)	1-8
Y	WO 2005/096396 A1 (Sanyo Electric Co., Ltd.), 13 October 2005 (13.10.2005), & EP 1737048 A1 & CN 1938865 A & US 2007/0283995 A1 & JP 2009-49436 A & JP 4286285 B	1-8

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

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"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
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"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
23 July, 2010 (23.07.10)	17 August, 2010 (17.08.10)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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

国際調査報告

国際出願番号　ＰＣＴ／ＪＰ２０１０／０６１３３４

Ａ．　発明の属する分野の分類（国際特許分類（ＩＰＣ））

Int.Cl.　H01L31/042(2006.01)i

Ｂ．　調査を行った分野

調査を行った最小限資料（国際特許分類（ＩＰＣ））

Int.Cl.　H01L31/04-31/078

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	１９２２－１９９６年
日本国公開実用新案公報	１９７１－２０１０年
日本国実用新案登録公報	１９９６－２０１０年
日本国登録実用新案公報	１９９４－２０１０年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

Ｃ．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
X	JP 7-106619 A (三洋電機) 1995.04.21, (ファミリーなし)	1-8
X	JP 2006-120944 A (シャープ) 2006.05.11, (ファミリーなし)	1-8
X	JP 2000-164901 A (京セラ) 2000.06.16, (ファミリーなし)	1-8
Y	WO 2005/096396 A1 (三洋電機) 2005.10.13, & EP 1737048 A1 & CN 1938865 A & US 2007/0283995 A1 & JP 2009-49436 A & JP 4286285 B	1-8

☐　Ｃ欄の続きにも文献が列挙されている。

☐　パテントファミリーに関する別紙を参照。

＊　引用文献のカテゴリー
「Ａ」特に関連のある文献ではなく、一般的技術水準を示すもの
「Ｅ」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの
「Ｌ」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献（理由を付す）
「Ｏ」口頭による開示、使用、展示等に言及する文献
「Ｐ」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「Ｔ」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
「Ｘ」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの
「Ｙ」特に関連のある文献であって、当該文献と他の１以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの
「＆」同一パテントファミリー文献

国際調査を完了した日	国際調査報告の発送日
２３．０７．２０１０	１７．０８．２０１０

国際調査機関の名称及びあて先
日本国特許庁（ＩＳＡ／ＪＰ）
郵便番号１００－８９１５
東京都千代田区霞が関三丁目４番３号

特許庁審査官（権限のある職員）　２Ｋ　９２０７
濱田　聖司

電話番号　０３－３５８１－１１０１　内線　３２５５

Jinko Ex. 1002 - 262/580

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
13/806,793	12/24/2012	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	12/24/2012	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 6	Minus	** 20	= 0	X $ =		OR	X $62=	0
	Independent (37 CFR 1.16(h))	* 1	Minus	***3	= 0	X $ =		OR	X $250=	0
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)	OR	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/CORALIA BETANCOURT/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/806,793

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	390
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	500
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	6 minus 20 =	*			OR	x 62 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*				x 250 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1140

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

U.S. APPLICATION NUMBER NO.	FIRST NAMED APPLICANT	ATTY. DOCKET NO.
13/806,793	Koji Shimasaki	1032404-000416

21839
BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

INTERNATIONAL APPLICATION NO.	
PCT/JP2010/061334	
I.A. FILING DATE	PRIORITY DATE
07/02/2010	

CONFIRMATION NO. 2289
371 ACCEPTANCE LETTER

OC00000005852029T

Date Mailed: 01/10/2013

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office in its capacity as a Designated / Elected Office (37 CFR 1.495), has determined that the above identified international application has met the requirements of 35 U.S.C. 371, and is ACCEPTED for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above and the relevant dates are:

12/24/2012	12/24/2012
DATE OF RECEIPT OF 35 U.S.C. 371(c)(1), (c)(2) and (c)(4) REQUIREMENTS	DATE OF COMPLETION OF ALL 35 U.S.C. 371 REQUIREMENTS

A Filing Receipt (PTO-103X) will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE " FILING DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1), (c)(2) and (c)(4) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN ABOVE.** *The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363).* Once the Filing Receipt has been received, send all correspondence to the Group Art Unit designated thereon.

The following items have been received:

- Copy of the International Application filed on 12/24/2012
- English Translation of the IA filed on 12/24/2012
- Copy of the International Search Report filed on 12/24/2012
- Preliminary Amendments filed on 12/24/2012
- Information Disclosure Statements filed on 12/24/2012
- Oath or Declaration filed on 12/24/2012
- Request for Immediate Examination filed on 12/24/2012
- U.S. Basic National Fees filed on 12/24/2012

Jinko Ex. 1002 - 265/580

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

JUELETHIA A PALMER

Telephone: (571) 272-9050

FORM PCT/DO/EO/903 (371 Acceptance Notice)

Jinko Ex. 1002 - 266/580

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/806,793	12/24/2012		1140	1032404-000416	6	1

CONFIRMATION NO. 2289

21839
BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

FILING RECEIPT

OC000000058520290

Date Mailed: 01/10/2013

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Koji Shimasaki, Chiyoda-kku, JAPAN;
Masayoshi Suzuki, Chiyoda-ku, JAPAN;

Applicant(s)

Koji Shimasaki, Chiyoda-kku, JAPAN;
Masayoshi Suzuki, Chiyoda-ku, JAPAN;

Assignment For Published Patent Application

Mitsubishi Electric Corporation, Chiyoda-ku, JAPAN

Power of Attorney: The patent practitioners associated with Customer Number 21839

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/JP2010/061334 07/02/2010

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

If Required, Foreign Filing License Granted: 01/07/2013

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/806,793**

Projected Publication Date: 371 Perfected

Non-Publication Request: No

Early Publication Request: No

Jinko Ex. 1002 - 267/580

Title

SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF

Preliminary Class

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier

license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

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MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET

Substitute for Form PTO-1360
(For use with Form PTO/SB/06)

Application Number	Filing Date
13806793	

Applicant(s) Koji SHIMASAKI

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1			1			
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Total Indep	0		1		0	
Total Depend	0	↵	5	↵	0	↵
Total Claims	0		6		0	

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/806,793	12/24/2012		1140	1032404-000416	6	1

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POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

FILING RECEIPT

OC000000058520290

Date Mailed: 01/16/2013

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Masayoshi Suzuki, Chiyoda-ku, JAPAN;

Applicant(s)

Koji Shimasaki, Chiyoda-kku, JAPAN;
Masayoshi Suzuki, Chiyoda-ku, JAPAN;

Assignment For Published Patent Application

Mitsubishi Electric Corporation, Chiyoda-ku, JAPAN

Power of Attorney: The patent practitioners associated with Customer Number 21839

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/JP2010/061334 07/02/2010

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

If Required, Foreign Filing License Granted: 01/07/2013

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/806,793**

Projected Publication Date: 04/25/2013

Non-Publication Request: No

Early Publication Request: No

Jinko Ex. 1002 - 271/580

Title

SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF

Preliminary Class

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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Jinko Ex. 1002 - 272/580

license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

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The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/806,793

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	390
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	500
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	6 minus 20 =	*			OR	x 62 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*				x 250 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1140

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

U.S. APPLICATION NUMBER NO.	FIRST NAMED APPLICANT	ATTY. DOCKET NO.
13/806,793	Koji Shimasaki	1032404-000416

21839
BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

INTERNATIONAL APPLICATION NO.	
PCT/JP2010/061334	
I.A. FILING DATE	PRIORITY DATE
07/02/2010	

CONFIRMATION NO. 2289
371 ACCEPTANCE LETTER

OC00000005852029T

Date Mailed: 01/16/2013

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office in its capacity as a Designated / Elected Office (37 CFR 1.495), has determined that the above identified international application has met the requirements of 35 U.S.C. 371, and is ACCEPTED for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above and the relevant dates are:

12/24/2012	12/24/2012
DATE OF RECEIPT OF 35 U.S.C. 371(c)(1), (c)(2) and (c)(4) REQUIREMENTS	DATE OF COMPLETION OF ALL 35 U.S.C. 371 REQUIREMENTS

A Filing Receipt (PTO-103X) will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE " FILING DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1), (c)(2) and (c)(4) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN ABOVE.** *The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363).* Once the Filing Receipt has been received, send all correspondence to the Group Art Unit designated thereon.

The following items have been received:

- Copy of the International Application filed on 12/24/2012
- English Translation of the IA filed on 12/24/2012
- Copy of the International Search Report filed on 12/24/2012
- Preliminary Amendments filed on 12/24/2012
- Information Disclosure Statements filed on 12/24/2012
- Oath or Declaration filed on 12/24/2012
- Request for Immediate Examination filed on 12/24/2012
- U.S. Basic National Fees filed on 12/24/2012

Jinko Ex. 1002 - 275/580

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

JUELETHIA A PALMER

Telephone: (571) 272-9050

FORM PCT/DO/EO/903 (371 Acceptance Notice)

Jinko Ex. 1002 - 276/580

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET

Substitute for Form PTO-1360
(For use with Form PTO/SB/06)

Application Number	Filing Date
13806793	

Applicant(s) Koji SHIMASAKI

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1			1			
2				1		
3				1		
4				1		
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Total Indep	0		1		0	
Total Depend	0	↵	5	↵	0	↵
Total Claims	0		6		0	

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/806,793	12/24/2012	Koji Shimasaki	1032404-000416

CONFIRMATION NO. 2289

21839
BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

PUBLICATION NOTICE

OC000000060716864

Title:SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF

Publication No.US-2013-0098423-A1
Publication Date:04/25/2013

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Jinko Ex. 1002 - 278/580

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	13806793
	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1757
	Examiner Name	BARTON, JEFFREY THOMAS
	Attorney Docket Number	1032404-000416

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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If you wish to add additional Foreign Patent Document citation information please click the Add button								Add

NON-PATENT LITERATURE DOCUMENTS			Remove
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13806793
	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1757
	Examiner Name	BARTON, JEFFREY THOMAS
	Attorney Docket Number	1032404-000416

	1	Office Action (Notice of Rejection) dated May 21, 2013, issued in corresponding Japanese Patent Application No. 2012-522412, and an English Translation of the Office Action. (3 pages)	☒

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13806793
	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1757
	Examiner Name	BARTON, JEFFREY THOMAS
	Attorney Docket Number	1032404-000416

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/James A. LaBarre/	Date (YYYY-MM-DD)	2013-07-31
Name/Print	James A. LaBarre	Registration Number	28,632

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	16461079
Application Number:	13806793
International Application Number:	
Confirmation Number:	2289
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Customer Number:	21839
Filer:	James A. LaBarre/mich sok
Filer Authorized By:	James A. LaBarre
Attorney Docket Number:	1032404-000416
Receipt Date:	31-JUL-2013
Filing Date:	24-DEC-2012
Time Stamp:	09:52:46
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	PTO_SB08.PDF	612233 e8f74822d343253ccaa45d9e4c1a5b58a9e5ba12	no	4
Warnings:					
Information:					

A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.

2	Non Patent Literature	JPOA0521213.pdf	125990 2645e90e0250469ce1db8a788a7167bc2bd213dd	no	3

Warnings:

Information:

Total Files Size (in bytes):	738223

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/806,793	12/24/2012	Koji Shimasaki	1032404-000416	2289

21839 7590 05/09/2014

BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

EXAMINER	
GONZALEZ RAMOS, MAYLA	
ART UNIT	PAPER NUMBER
1758	

NOTIFICATION DATE	DELIVERY MODE
05/09/2014	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ADIPDOC1@BIPC.com

Jinko Ex. 1002 - 285/580

Office Action Summary	Application No. 13/806,793	Applicant(s) SHIMASAKI ET AL.	
	Examiner MAYLA GONZALEZ	Art Unit 1758	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12/24/2012*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1 and 4-8* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1 and 4-8* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *12/24/2012* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *12/24/2012, 07/31/2013*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

1. The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Status of Claims

2. **Claim(s)** 1 and 4-8 are currently pending.

3. **Claim(s)** 1, 4, 6, and 8 have been amended.

4. **Claim(s)** 2-3 have been canceled.

Claim Interpretation

Herein, the limitation “a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2)” is interpreted as the length of the long side of each solar cell being at least twice as long than the length of the short side of each solar cell.

Herein, the term “line symmetrical” is interpreted as the two halves of a cell being identical if they were to be folded/divided i.e., one half of the cell is a reflection of the other.

Claim Objections

5. Claims 5, 6, and 8 are objected to because of the following informalities:

In regards to claims 5 and 6, the recitation "…wherein the light-receiving-surface bus electrodes of the solar battery cell…” should read "…wherein the light-receiving-surface bus electrodes of ~~the~~ **each** solar battery cell...”.

In regards to claim 8, the recitation "…of the light-receiving-surface bus electrodes into n along respective boundaries of the n light-receiving surface electrode areas." should read "…of the light-receiving-surface bus electrodes into n ~~along~~ respective boundaries of the n light-receiving surface electrode areas."

Appropriate correction is required.

Claim Rejections - 35 USC § 112

6. Claims 1 and 8 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

In regards to claims 1 and 8, the term "substantial" in claims 1 and 8 is a relative term which renders the claims indefinite. The term "substantial" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. It is not clear as to what encompasses substantial rectangle and a substantial square. Clarification is required.

Claim Rejections - 35 USC § 103

7. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been

obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 1 and 4-8 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over JP 07-106619, Maehane et al in view of US 2010/0295377, Sok et al and US 5,994,641, Kardauskas.

Regarding claim 1

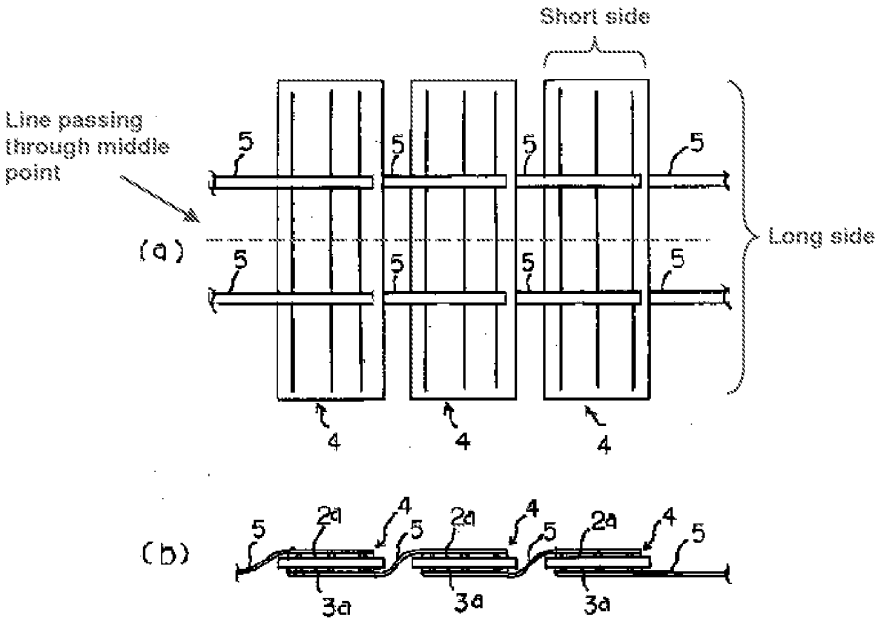
Maehane et al. teaches a solar battery module (see Figure 1-3 & [0015-0016]) comprising:

a plurality of solar battery cells (first, second and third solar battery elements, 4) (Figure 3(a) & [0016]),

a plain shape of each being a substantial rectangle (see Figure 3 wherein each solar cell element (4) is a substantial rectangle), and having a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2) since Figure 3(a) of Maehane demonstrates that the long side of each solar battery cells (4) is about three times as long as the short side of each cell (see Figure 3(a)), said plain shape including a plurality of light-receiving-surface bus electrodes (surface electrodes, 2a) parallel to the short side of the substantial rectangle on a light receiving surface (see Figure 3(b) & [0013-0016]), and including rear-surface bus electrodes (rear electrodes, 3a) each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes (see Figure 3(b) & [0013-0016]); and

an interconnector (electrical connection member, 5) that electrically connects the light-receiving-surface bus electrodes (surface electrodes, 2a) of a first one of the solar battery cells to the rear-surface bus electrodes (rear electrodes, 3a) of an adjacent second one of the solar battery cells (see Figure 3(b) & [0016]),

wherein a predetermined number of the solar battery cells (i.e., 3 solar battery element, 4) are serially connected to each other ([0016] & Figures 3a-3b), thereby configuring a cell string (see Figures 3(a)-3(b)) (instant claims 1 and 4).



Maehane et al. teaches one single column of cell strings instead of n column of cell strings.

However, the court has held that absent a showing of criticality or unexpected results the court has held that mere duplication of the essential working parts of a

device involves only routine skill in the art [MPEP 2144.04]. Therefore, absent a showing of criticality or unexpected results it would have been obvious to one ordinarily skill in the art at the time of the invention to make duplicate columns of cell strings thereby resulting in the claimed two/n-columns of cell string since the mere duplication of the essential working parts of a device involves only routine skill in the art [MPEP 2144.04].

Modified Maehane et al. is silent to the n/two-columns of the cell strings are connected in parallel, and the n/two-column parallel-connected cell strings are further serially connected, thereby configuring an entire cell array (instant claims 1 and 4).

Sok et al. teaches a solar battery module (solar/PV array) comprising series connected modules/cells which form individual strings, wherein connecting such strings in parallel allows the system to produce more current ([0002]).

Maehane et al. and Sok et al. are analogous inventions in the field of solar battery modules. It would have been obvious to one ordinarily skilled in the art at the time of the invention to electrically connect the two/n-columns of cell strings of modified Maehane et al. in parallel as taught by Sok et al. thereby allowing the system to produce more current (Sok, [0002]).

Modified Maehane et al. is silent to the n/two-column parallel-connected cell strings are further serially connected, thereby configuring an entire cell array (instant claims 1 and 4).

However, in the same field of endeavor of solar battery modules (see 1 and Abstract), Kardauskas teaches that there are a finite number of possibilities available to connect such strings i.e., parallel and/or series connection (Column 5, lines 54-59).

Therefore, because Kardauskas teaches choosing from a finite number of identified, predictable solutions i.e., series and/or parallel electrical connections, one of ordinary skill in the art would have found obvious to pursue the known options with reasonable expectation of success [see MPEP 2143]. Since Kardauskas teaches that a series connection of strings leads to the anticipated success, said electrical connection is not of innovation but of ordinary skill and common sense [see MPEP 2143].

Regarding claim 5

Modified Maehane et al. teaches the above solar battery module wherein the light-receiving-surface bus electrodes (surface electrodes, 2a) of the each solar battery cell (4) are formed at positions that are line-symmetrical (i.e., both halves of the cell look identical if it were to be folded) with respect to a line passing through a middle point of a side (i.e., long side of each cell (4) as shown in Figure 3(a) above) perpendicular to an extended line of the light-receiving-surface bus electrodes (surface electrode, 2a) and parallel to the light-receiving-surface bus electrodes (long side of the cell is parallel to the smaller side of the surface electrodes (2a) which are located beneath interconnector (5))) (see Figures 1(a) and 3(a)-3(b)).

Regarding claim 6

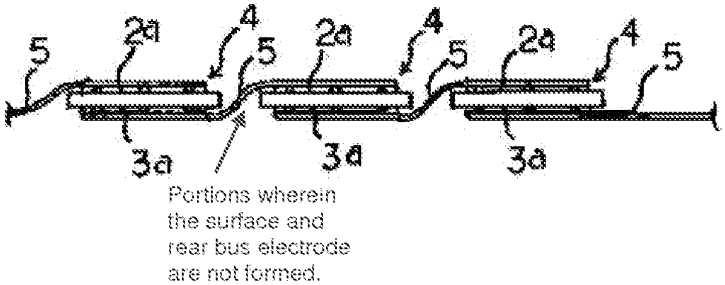
Modified Maehane et al. teaches the above solar battery module wherein the light-receiving-surface bus electrodes (surface electrodes, 2a) of the solar battery cell

are formed at positions that are line-symmetrical (i.e., both halves of the cell look identical if it were to be folded) with respect to a line passing through a middle point of a side parallel (i.e., longer side of each cell is parallel to the short side of each light-receiving-surface bus electrodes (202) which are located underneath the interconnector (5)) to the light-receiving-surface bus electrodes (surface electrodes, 2a) and perpendicular to the light-receiving-surface bus electrodes (surface electrodes, 2a) since the longer side of each cell is also perpendicular to an extended line of the light-receiving-surface bus electrodes (surface electrodes, 2a) (see Figures 1(a) and 3(a)-3(b)).

Regarding claim 7

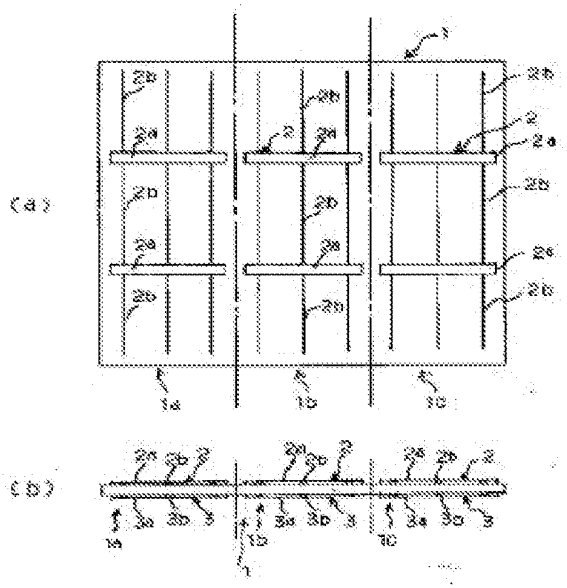
Modified Maehane et al. teaches the above solar battery module wherein each of the solar battery cells (first, second and third solar battery elements, 4) (see Figure 3(a)-3(b)) includes an area where the light-receiving-surface bus electrodes (surface electrodes, 2a) and the rear-surface bus electrodes (rear electrodes, 3a) are not formed within a predetermined dimension from an edge toward a central direction of the cell at an outer circumferential edge portion (outer boundary lines of the cells) thereof i.e., the bus electrodes are not formed at portions/areas where the cell has been divided (see figure 3(b) below and [0062-0063] of the present specification).

(b)



Regarding claim 8

Modified Maehane et al. teaches that the above solar battery module (see Figures 1-3) is obtained by dividing a basic solar battery cell with a plane shape thereof being a substantial square (see Figure 1 & [0015]), which includes n light-receiving-surface electrode areas (electricity generation regions 1a-1c) (Figures 1(a)-1(b) & [0013]) in each of which a plurality of light-receiving-surface bus electrodes (surface electrodes, 2a) parallel to a side of a substantial square (see Figure 1(a)) and a plurality of grid electrodes (branch parts, 2b) perpendicular to the light-receiving-surface bus electrodes (surface electrodes, 2a) are provided on a light-receiving surface side (see Figure 1(a) & [0013]) and includes rear-surface bus electrodes (rear electrodes, 3a) each at a position on a non-light-receiving surface side (rear surface) corresponding to each of the light-receiving-surface bus electrodes (surface electrodes, 2a) into n respective boundaries (see Figure 1(b)) of the n light-receiving-surface electrode areas (electricity generation regions 1a-1c).



Although taught by the prior art, the limitation “which is obtained by dividing a basic solar battery cell with a plane shape thereof being a substantial square” is a product by process limitation and, therefore, does not impart any additional structure to the claimed product.

Even though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process. In re Thorpe, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985) [MPEP 2113]

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAYLA GONZALEZ whose telephone number is (571)272-5054. The examiner can normally be reached on Monday through Thursday 8:30 to 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer Michener can be reached on 571-272-1424. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MAYLA GONZALEZ/
Examiner, Art Unit 1758

/JAYNE MERSHON/
Primary Examiner, Art Unit 1758

Notice of References Cited	Application/Control No. 13/806,793	Applicant(s)/Patent Under Reexamination SHIMASAKI ET AL.	
	Examiner MAYLA GONZALEZ	Art Unit 1758	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-5,994,641	11-1999	Kardauskas, Michael J.	136/246
*	B	US-2010/0295377	11-2010	Sok et al.	307/82
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N	JP 07106619 A	04-1995	Japan	MAEHANE et al.	
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13806793
Filing Date	2012-12-24
First Named Inventor	Koji SHIMASAKI et al.
Art Unit	1757
Examiner Name	BARTON, JEFFREY THOMAS
Attorney Docket Number	1032404-000416

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EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.G./

Receipt date: 07/31/2013	Application Number	13806793 13806793 - GAU: 1758
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2012-12-24
(Not for submission under 37 CFR 1.99)	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1757
	Examiner Name	BARTON, JEFFREY THOMAS
	Attorney Docket Number	1032404-000416

	1	Office Action (Notice of Rejection) dated May 21, 2013, issued in corresponding Japanese Patent Application No. 2012-522412, and an English Translation of the Office Action. (3 pages)	☒

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EXAMINER SIGNATURE

Examiner Signature	/Mayla Gonzalez Ramos/	Date Considered	05/01/2014

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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Receipt date: 07/31/2013	Application Number	13806793 13806793 - GAU: 1758
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1757
	Examiner Name	BARTON, JEFFREY THOMAS
	Attorney Docket Number	1032404-000416

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/James A. LaBarre/	Date (YYYY-MM-DD)	2013-07-31
Name/Print	James A. LaBarre	Registration Number	28,632

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	2	"13806793"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:06
S2	1361	shimasaki-koji.in. suzuki-masayoshi.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:07
S3	408896	(mitsubishi adj electric).as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:07
S4	11	S2 and ((solar photovoltaic pv) near2 module)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:07
S6	582	S3 and ((solar photovoltaic pv) near2 module)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:07
S7	53	S6 and (bus busbar busses buses (bus adj bar))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:08
S8	11	S7 and (parallel with (series serial$2))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:11

Jinko Ex. 1002 - 303/580

EAST Search History (Prior Art)

S15	9	"07106619"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:47
S16	219	"136"/$.ccls. and (cell with (series serial$2)) and (string near4 parallel near6 (series serial$2))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:53
S17	165	S16 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:53
S18	43	"136"/$.ccls. and (cell with (series serial$2)) and (string with parallel with (series serial$2) with system)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:54
S19	36	S18 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:54
S20	623	"136"/$.ccls. and (cell with (series serial$2)) and (string near4 (series serially))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:56
S21	433	S20 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:57

Jinko Ex. 1002 - 304/580

EAST Search History (Prior Art)

S22	242	S21 and (string with parallel)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:57
S24	6	"7812247".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:59
S25	307	"136"/$.ccls. and (cell with (series serial$2)) and (string with parallel with (series serial$2))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 14:07
S26	224	S25 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 14:07
S38	142	("20070059493"|"20080178928"|"5807440"|"6753065"|"5882774"|"20080006323"|"5953877"|"6232544"|"6268558"|"6574045"|"6590707"|"5807440"|"5990414"|"6538192"|"20090000221"|"20090000222"|"5662977"|"6451414"|"6565982"|"5203941"|"5284693"|"5506031"|"6180228"|"6355132"|"6467235"|"6679308"|"7118794"|"20030178058"|"6455140"|"20060266406"|"20070153354"|"20080102270"|"20080271773"|"6049035"|"6296732"|"6521038"|"7227078"|"20070054129"|"20070146624"|"5421909"|"5468532"|"6237288"|"6590705"|"6609795"|"4235643"|"20070056625"|"6538192"|"7138173"|"6459514"|"20040031518"|"5273608"|"5303525"|"5680734"|"6523316"|"6715252"|"6329046"|"5575861").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 14:32

EAST Search History (Interference)

		<This search history is empty>				

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Translated: 23:13:59 JST 04/28/2014
Dictionary: Last updated 04/11/2014 / Priority:

FULL CONTENTS

[Claim(s)]
[Claim 1]A manufacturing method of a solar cell characterized by comprising the following.
A process of forming a light receiving surface side surface electrode which has a connection area part which carries out a termination to an inside of the latest of a peripheral part of these smallness electricity generation region for two or more small electricity generation regions of every of a semiconductor substrate which has semiconductor junction.
A process of forming a rear electrode.
A process of dividing the aforementioned semiconductor substrate for two or more aforementioned smallness electricity generation regions of every.
The aforementioned connection area part whole region of the aforementioned surface electrode of a solar battery element which consists of a divided small electricity generation region.
A process which carries out electrical connection by connecting the aforementioned rear electrode of an adjoining solar battery element by an electrical connection member.

[Claim 2]A manufacturing method of a solar cell characterized by comprising the following.
A process of forming a light receiving surface side surface electrode and a rear electrode which have a connection area part which carries out a termination to an inside of the latest of a peripheral part of these smallness electricity generation region for two or more small electricity generation regions of every of a semiconductor substrate which has semiconductor junction.
Two or more aforementioned connection area part whole region of a solar battery element consisting of the aforementioned semiconductor substrate.
A process of carrying out electrical connection of the aforementioned rear electrode of a solar battery element which adjoins this in the aforementioned electrical connection member.

[Detailed Description of the Invention]
[0001]
[Industrial Application]The present invention relates to the manufacturing method of a solar cell.
[0002]
[Description of the Prior Art]The manufacturing method of the conventional solar cell is described

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using Fig.6 – 8.
[0003]First, the semiconductor substrate 10 consisting of the polycrystalline silicon of the right-angled quadrangle which formed pn junction in the light receiving surface side has the three small electricity generation regions 10a–10c classified in parallel with a longitudinal side. The surface electrode 12 consisting of the pair of connection area part 12a extended in parallel a horizontal side on this semiconductor substrate 10 ranging over the three small electricity generation regions 10a–10c and two or more branch parts 12b extended to direction crossing at a right angle from these connection area parts 12a is formed. Also in the back surface of the semiconductor substrate 10, the rear electrode 13 consisting of the isomorphism-like connection area part 13a and the branch parts 13b is formed. And it crosses the whole region on the connection area part 12a of the surface electrode 12 and the rear electrode 13, and 13a, and a solder layer is formed.
[0004]Next, the semiconductor substrate 10 is divided into every small electricity generation region 10a – 10c, and the solar battery elements 14a–14c which consist of the small electricity generation regions 10a–10c are created. The one solar battery element 14b is shown in Fig.7. As shown in Fig.8, adjoin, put in order two or more divided solar battery elements 14a–14c, and Then, the connection area part 12a of the surface electrode 12 of one solar battery elements 14b and 14c, The solar cell which carried out the series connection of the solar battery elements 14a–14b is completed by carrying out electrical connection of the connection area part 13a of the rear electrode 13 of the solar battery elements 14a and 14b of another side which adjoins, respectively by the electrical connection member 15. Use is also possible as a solar battery element consisting of the one semiconductor substrate 10, without dividing the semiconductor substrate 10.
[0005]
[Problem to be solved by the invention]There were the following problems in the manufacturing method of the above conventional solar cell. For example, since the solar battery element 14b (refer to Fig.7) was formed in the portion which is placed in the middle of the semiconductor substrate 10, the connection area part 12a has extended even in the longitudinal side which is a peripheral part. And when connecting the electrical connection member 15 to this connection area part 12a, the solder on the connection area part 12a hangs down on the side surface of the solar battery element 14b, as the code 16 shows, and reaches and connects with the connection area part 13a of the rear electrode 13 which is placed directly under it too hastily (refer to Fig.8 (c)).
[0006]The surface electrode of a solar battery element which was made in order that the 1st invention of the present invention might solve such a problem, and was divided, It aims at providing the manufacturing method of the solar cell which prevents facing and connecting the divided rear electrode of a contiguity solar battery element with carrying out electrical connection in an electrical connection member too hastily.
[0007]An object of the 2nd invention of the present invention is to provide the manufacturing method of the solar cell which carried out electrical connection of the solar battery element consisting of one semiconductor substrate using the same semiconductor substrate as the 1st invention.
[0008]
[Means for solving problem]The process of forming the light receiving surface side surface electrode which has a connection area part which carries out the termination of the 1st invention of the present invention to the inside of the latest of the peripheral part of these smallness electricity generation region for two or more small electricity generation regions of every of the semiconductor substrate which has semiconductor junction, The process of forming a rear electrode, and the process of dividing the aforementioned semiconductor substrate for two or more aforementioned smallness electricity generation regions of every, It has the process of carrying out electrical connection, by connecting the aforementioned connection area part whole region of the aforementioned surface electrode of the solar battery element which consists of a divided small electricity generation region, and the aforementioned rear electrode of the adjoining solar battery

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element by an electrical connection member.
[0009]The process of forming the light receiving surface side surface electrode and rear electrode which have a connection area part which carries out the termination of the 2nd invention of the present invention to the inside of the latest of the peripheral part of these smallness electricity generation region for two or more small electricity generation regions of every of the semiconductor substrate which has semiconductor junction, It has the process of carrying out electrical connection of two or more aforementioned connection area part whole region of the solar battery element consisting of the aforementioned semiconductor substrate, and the aforementioned rear electrode of the solar battery element which adjoins this in the aforementioned electrical connection member.
[0010]
[Function]The present invention is carrying out electrical connection of the connection area part whole region of the divided surface electrode of a solar battery element, and the rear electrode of the adjoining solar battery element in the electrical connection member in the 1st invention for the above composition. Since the connection area part is placed at the inside of the latest of the peripheral part of a solar battery element at this time, it does not connect too hastily undesirably.
[0011]In the 2nd invention, the solar cell which carried out electrical connection of the solar battery element consisting of one semiconductor substrate can be manufactured, without dividing a semiconductor substrate using the same semiconductor substrate as the 1st invention.
[0012]
[Working example]Below, one working example of the 1st invention of the present invention is described in detail using Fig.1 – 4.
[0013]First, the semiconductor substrate 1 consisting of the polycrystalline silicon of the right-angled quadrangle which formed pn junction in the light receiving surface side has the three small electricity generation regions 1a–1c classified in parallel with a longitudinal side. In the light receiving surface on this semiconductor substrate 1, the surface electrode 2 which becomes every three small electricity generation region 1a – 1c from silver paste is formed. These surface electrodes 2 are [horizontal side of the semiconductor substrate 1] parallel, and have two or more branch-parts 2bs extended to direction crossing at a right angle from the pair of connection area part 2a in which both ends carry out a termination to the inside of the latest of the peripheral part of each small electricity generation region 1a–1c, and these connection area parts 2a. Also in the back surface of the semiconductor substrate 1, the rear electrode 3 consisting of the isomorphism-like connection area part 3a and the branch parts 3b is formed. And the whole region on the connection area part 2a of the surface electrode 2 and the rear electrode 3, and 3a, a dip method or an ultrasonic solder method is used, and a solder layer is formed.
[0014]The rear electrode 3 may be the paste of aluminum or silver formed throughout the back surface of the semiconductor substrate 1. In this case, the solder layer on the rear electrode 3 may be formed throughout the above-mentioned connection region 3a, the shape of isomorphism, or the rear electrode 3.
[0015]Next, the solar battery element 4 is created from the light receiving surface side of the semiconductor substrate 1 using a dicing saw by dividing the semiconductor substrate 1 into every small electricity generation region 1a – 1c (refer to Fig.2).
[0016]As shown in Fig.3, adjoin, put in order two or more divided solar battery elements 4, and The connection area part 2a of the surface electrode 2 of one solar battery element 4, By connecting the whole region with the connection area part 3a of the rear electrode 3 of the solar battery element 4 of another side which adjoins this by the electrical connection member 5 consisting of a metallic foil etc., the series connection of two or more solar battery elements 4 is carried out electrically, and a solar cell completes them.
[0017]Since the connection area part 2a is placed at the inside of the latest of the peripheral part of the solar battery element 4 at this time, solder does not reach [from the light receiving surface side] the peripheral part and side surface of the solar battery element 4. When the rear electrode 3

is formed throughout the back surface of the solar battery element 4, even if solder reaches the side surface of the solar battery element 4 from the back surface side, this solder will not contact the connection area part 2a which is placed at the inside of the latest of the peripheral part of the solar battery element 4. Therefore, a solar battery element does not short-circuit.
[0018]Since the connection area part 2a of the surface electrode 2 is carrying out the termination to the inside of the latest of the peripheral part of the solar battery element 4, As shown in Fig.4, when the adjoining interval of the solar battery element 4 becomes narrow, the electrical connection member 5 connected to the connection area part 2a of the right-hand side solar battery element 4 does not connect with the electrical connection member 5 connected to the connection area part 2a of the left-hand side solar battery element 4, or this too hastily undesirably. As the rear electrode 3 is shown in a figure, when it has the connection area part 3a which carries out a termination to the inside of the latest of the peripheral part of the solar battery element 4, the surface electrode 2 and the rear electrode 3 of the same solar battery element 4 do not short-circuit by the electrical connection member 5 during contiguity.
[0019]Next, it describes about the 2nd invention of the present invention. By the same process as the 1st invention of the above, the semiconductor substrate 1 shown in Fig.1 is created. Then, two or more solar battery elements 6 consisting of the semiconductor substrate 1 are put in order adjacently, without dividing the semiconductor substrate 1, as shown in Fig.5. And the connection area part 2a in the surface electrode 2 of one solar battery element 6, Electrical connection of 2a and the 2a is carried out using one end of the electrical connection member 5 consisting of a metallic foil etc., and electrical connection of the connection area parts 3a, 3a, and 3a of the rear electrode 3 of the solar battery element 6 which adjoins this is carried out using the other end of the electrical connection member 5. Therefore, electrical connection of the solar battery element 6 is carried out in series, and a solar cell completes it.
[0020]Here, between the lateral connection area parts 2a and 2a and 2a, space 7 and 7 is formed directly under electrical connection member 5. After the incident light from an oblique direction turns or incident light makes it reflect from the light receiving surface of the solar battery element 6 by these space 7 and 7, improvement in the characteristic can be aimed at by being reflected with the back surface of the electrical connection member 5 in space 7, and carrying out re incidence to the solar battery element 6 etc.
[0021]
[Effect of the Invention]The present invention carries out electrical connection of the connection area part whole region of the divided surface electrode of a solar battery element, and the rear electrode of the adjoining solar battery element in an electrical connection member in the 1st invention for the above composition. Since the connection area part of the surface electrode is placed at the inside of the latest of the peripheral part of a solar battery element at this time, it does not connect too hastily undesirably.
[0022]In addition, since the divided surface electrode of all the solar battery elements has a connection area part inside the latest of the peripheral part, its usable area which contributes to power generation improves rather than the conventional solar battery element to which the connection area part exists even in the peripheral part.
[0023]In connection resilience, the electrical connection member is working as a collector with the connection area part largely from the electrical connection member being soldered throughout the connection area part of a surface electrode.
[0024]In the 2nd invention of the present invention, electrical connection of the whole region of the connection area part of a surface electrode is carried out in the electrical connection member, without dividing a semiconductor substrate using the semiconductor substrate of the 1st invention. That is, the 1st invention and a common semiconductor substrate can be used.
[0025]In addition, in connection resilience, the electrical connection member is working as a collector with the connection area part largely from an electrical connection member being

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connected throughout two or more connection area parts on one semiconductor substrate.
[0026]Improvement in the characteristic can be aimed at by a surroundings lump of incident light, re incidence, etc. to space formed directly under [between two or more connection area parts / electrical connection member].

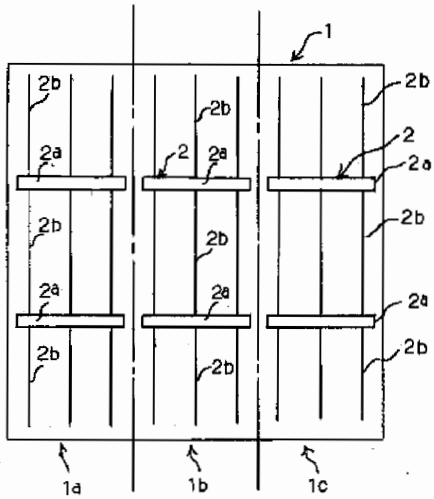
[Brief Description of the Drawings]
[Drawing 1]The semiconductor substrate in one working example of the present invention is shown, (a) is a plan view and (b) is a side view.
[Drawing 2]The solar battery element in the 1st invention of the present invention is shown, (a) is a plan view and (b) is a side view.
[Drawing 3]The solar cell which carried out the series connection of the solar battery element in the 1st invention of the present invention is shown, (a) is a plan view and (b) is a side view.
[Drawing 4]In the 1st invention of the present invention, it is a side view of the solar cell which narrowed the solar battery element interval and carried out the series connection.
[Drawing 5]The solar cell which carried out the series connection of the solar battery element in the 2nd invention of the present invention is shown, (a) is a plan view and (b) is a side view.
[Drawing 6]It is a plan view of the conventional semiconductor substrate.
[Drawing 7]The conventional solar battery element is shown, (a) is a plan view and (b) is a side view.

[Drawing 8]The solar cell which carried out the series connection of the conventional solar battery element is shown, and, as for a plan view and (b), a side view and (c) of (a) are the A section enlarged drawings.
[Explanations of letters or numerals]
1 Semiconductor substrate
1a, 1b, and 1c Small electricity generation region
2 Surface electrode 2a connection area part 2b Branch parts
3 Rear electrode 3a connection area part 3b branch parts
4 Solar battery element
5 Electrical connection member
6 Solar battery element
7 Space

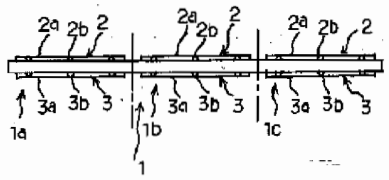
[Drawing 1]

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(a)

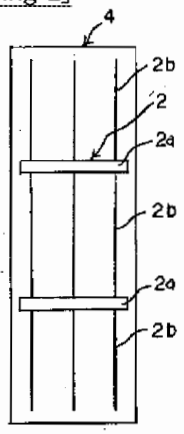


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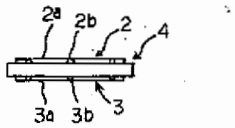


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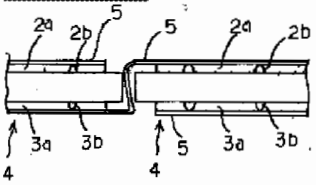
(a)



(b)

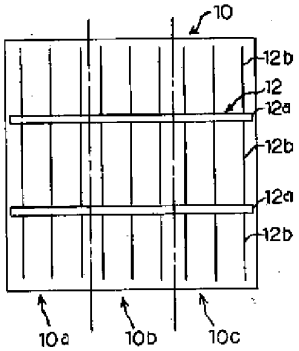


[Drawing 4]

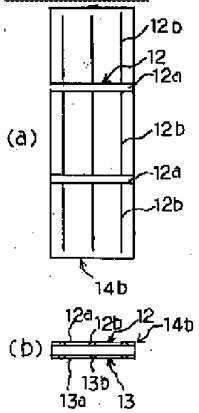


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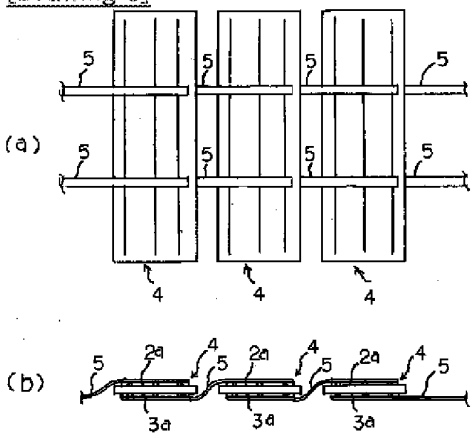
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[Drawing 7]

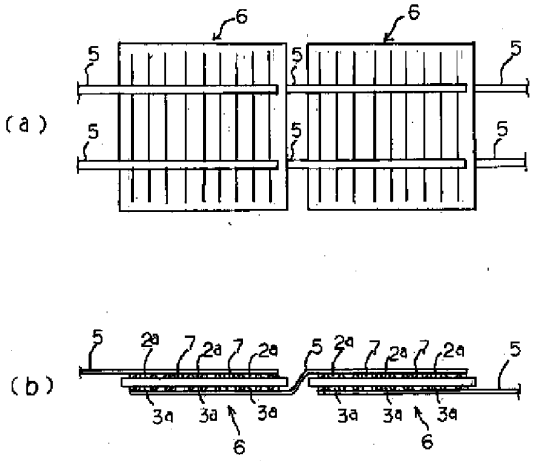


[Drawing 3]

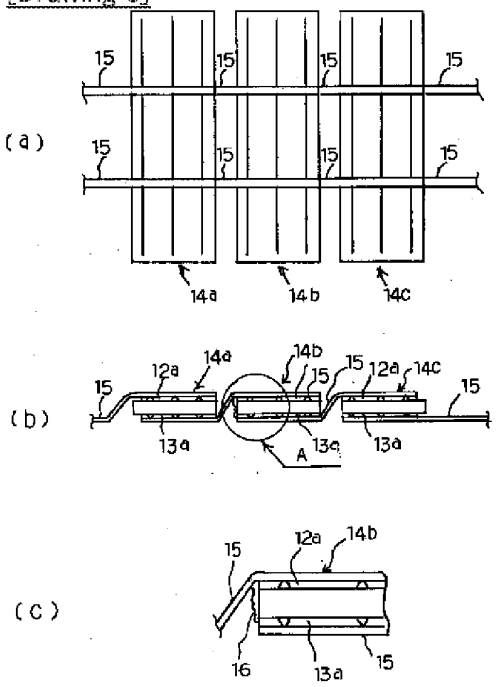


[Drawing 5]

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[Drawing 8]



[Translation done.]

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13/806,793	12/24/2012 RULE	136	1758	1032404-000416

APPLICANTS

INVENTORS

Koji Shimasaki, Chiyoda-kku, JAPAN;
Masayoshi Suzuki, Chiyoda-ku, JAPAN;

**** CONTINUING DATA ***************************

This application is a 371 of PCT/JP2010/061334 07/02/2010

**** FOREIGN APPLICATIONS ***************************

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Foreign Priority claimed	☐ Yes ☑ No	☐ Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
35 USC 119(a-d) conditions met	☐ Yes ☐ No		JAPAN	10	6	1
Verified and Acknowledged	/MAYLA GONZALEZ RAMOS/ Examiner's Signature	Initials				

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UNITED STATES

TITLE

SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13806793	SHIMASAKI ET AL.
	Examiner	Art Unit
	MAYLA GONZALEZ RAMOS	1758

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
136	243-265	4/2014	Mayla Gonzalez

SEARCH NOTES		
Search Notes	Date	Examiner
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Assignee search	4/2014	Mayla Gonzalez
Class/Subclass search	4/2014	Mayla Gonzalez
Text search	4/2014	Mayla Gonzalez
Foreign Patent search	4/2014	Mayla Gonzalez
Consulted with Jayne Mershon	4/2014	Mayla Gonzalez

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/MAYLA GONZALEZ RAMOS/ Examiner.Art Unit 1758	

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FIRST INFORMATION DISCLOSURE STATEMENT BY APPLICANT				*Application Number*	
				Filing Date	
				First Named Inventor	**Koji SHIMASAKI et al.**
(Use as many sheets as necessary)				*Art Unit*	
				Examiner Name	
Sheet	1	of	1	*Attorney Docket Number*	**1032404-000416**

clarify the scope of the subject matter for which protection is sought

U.S. PATENT DOCUMENTS

Examiner Initials'	Cite No.[1]	Document Number Number-Kind Code[2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-2007/0283995 A1	12-13-2007	Okamoto et al. (Corresponds to WO 2005/096396 below)	
		US-			
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Examiner Initials'	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind Code[5] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		JP 7-106619 A	04-21-1995	Sanyo Electric Co., Ltd.		X
		JP 2006-120944 A	05-11-2006	Sharp Corp.		X
		JP 2000-164901 A	06-16-2000	Kyocera Corp.		X
		WO 2005/096396 A1	10-13-2005	Sanyo Electric Co., Ltd.		X
		JP 11-251613 A	09-17-1999	Kyocera Corp.		X

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
		International Search Report (PCT/ISA/210) issued on August 17, 2010, by the Japanese Patent Office as the International Searching Authority for International Application No. PCT/JP2010/061334.	
		Written Opinion (PCT/ISA/237) issued on August 17, 2010, by the Japanese Patent Office as the International Searching Authority for International Application No. PCT/JP2010/061334.	

Examiner Signature	/Mayla Gonzalez Ramos/	Date Considered	05/01/2014

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.G./

N THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	**MAIL STOP AMENDMENT**
Koji SHIMASAKI et al.	Group Art Unit: 1758
Application No.: 13/806,793	Examiner: Mayla Gonzales Ramos
Filed: December 24, 2012	Confirmation No.: 2289
For: SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF	

AMENDMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In response to the Office Action dated May 9, 2014, please amend the above-identified patent application as follows:

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS:

1. (Currently Amended) A solar battery module comprising:

a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and

an interconnector that electrically connects the light-receiving-surface bus electrodes of a first one of the solar battery cells to the rear-surface bus electrodes of an adjacent second one of the solar battery cells, wherein a predetermined number of the solar battery cells are serially connected to each other, thereby configuring a cell string, n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, and the n-column parallel-connected cell strings are further serially connected to another n-column parallel-connected cell strings by a second string connector at an opposite end of the n columns, thereby configuring an entire cell array.

2-3. (Cancelled)

4. (Previously Presented) The solar battery module according to claim 1, wherein a predetermined number of the solar battery cells are serially connected, thereby configuring a cell string, two columns of the cell strings are connected in parallel, and the two-column parallel-connected cell strings are further serially connected, thereby configuring an entire cell array.

5. (Currently Amended) The solar battery module according to claim 1, wherein the light-receiving-surface bus electrodes of ~~the~~ each solar battery cell are formed at positions that are line-symmetrical with respect to a line passing through a middle point of a side perpendicular to an extended line of the light-receiving-surface bus electrodes and parallel to the light-receiving-surface bus electrodes.

6. (Currently Amended) The solar battery module according to claim 1, wherein the light-receiving-surface bus electrodes of ~~the~~ each solar battery cell are formed at positions that are line-symmetrical with respect to a line passing through a middle point of a side parallel to the light-receiving-surface bus electrodes and perpendicular to the light-receiving-surface bus electrodes.

7. (Original) The solar battery module according to claim 1, wherein each of the solar battery cells includes an area where the light-receiving-surface bus electrodes and the rear-surface bus electrodes are not formed within a predetermined dimension

from an edge toward a central direction of the cell at an outer circumferential edge portion thereof.

8. (Currently Amended) The solar battery module according to claim 1, which is obtained by dividing a basic solar battery cell with a plane shape thereof being a substantial square, which includes n light-receiving-surface electrode areas in each of which a plurality of light-receiving-surface bus electrodes parallel to a side of the substantial square and a plurality of grid electrodes perpendicular to the light-receiving-surface bus electrodes are provided on a light-receiving surface side and includes rear-surface bus electrodes each at a position on a non-light-receiving surface side corresponding to each of the light-receiving-surface bus electrodes into n ~~along~~ respective boundaries of the n light-receiving-surface electrode areas.

9. (New) The solar battery module according to claim 1, wherein the second string connector extends continuously across the entire cell array.

10. (New) The solar battery module according to claim 1, wherein the interconnector is joined to the light-receiving-surface bus electrode of a solar battery cell nearest to the second string connector of the n-column parallel-connected cell strings, and is connected to the second string connector, and the second string connector is connected to a rear surface lead at the rear-surface bus electrode of a head solar battery cell nearest the second string connector of the another n-column parallel-connected cell strings.

11. (New) The solar battery module according to claim 1,

wherein long sides of the substantial rectangle include a first long side and a second long side,

the substantial rectangle has chamfered corners on both ends of the first long side, and

wherein the first one of the solar battery cells and the second one of the solar battery cells are arranged in the cell array such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other.

12. (New) A solar battery module comprising:

a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and

an interconnector that electrically connects the light-receiving-surface bus electrodes of a first one of the solar battery cells to the rear-surface bus electrodes of an adjacent second one of the solar battery cells, wherein

long sides of the substantial rectangle include a first long side and a second long side,

the substantial rectangle has chamfered corners on both ends of the first long side, and

the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other.

REMARKS

Favorable reconsideration of this application is respectfully requested in view of the following remarks.

By this Amendment, Claims 1, 5, 6 and 8 are amended and Claims 9-12 are added. Thus, Claims 1 and 4-12 are pending in this application, with Claims 1 and 12 being the only independent claim. Support for the amendments to Claim 1 can be found, for example, in Figs. 11 and 12. Support for new Claims 9 and 10 can be found, for example, in paragraph [0050] of the published U.S. application (U.S. 2013/0098423 A1). Support for new Claims 11 and 12 can be found, for example, in Fig. 15 and paragraphs [0057] and [0060] of the published U.S. application (U.S. 2013/0098423 A1). No new matter is added. No new matter is added.

First, Claims 5, 6 and 8 are amended as suggested by the Examiner to obviate the objection to these claims. Withdrawal of the objection is thus respectfully requested.

The rejection of Claims 1 and 8 under 35 U.S.C. §112, second paragraph, is respectfully traversed. The Office Action says the word "substantial" in Claims 1 and 8 is a relative term that renders the claims indefinite because the specification does not provide a standard for ascertaining what is meant by a "substantial rectangle". Applicant disagrees with Office Action's position.

MPEP §2173.05(b) states, "The use of relative terminology in claim language, including terms of degree, does not automatically render the claim indefinite under 35 U.S.C. 112, second paragraph. See *Seattle Box Co., Inc. v. Industrial Crating & Packing, Inc.*, 731 F.2d 818 (Fed. Cir. 1984). Thus, the fact that claim language, including terms of degree, may not be precise, does not automatically render the claim

indefinite. MPEP §2173.05(b) states that acceptability of the claim language depends on *whether one of ordinary skill in the art would understand what is claimed, in light of the specification*" (emphasis added). The word "substantial" is thus not indefinite if one skilled in the art would understand what is claimed, in light of the specification. In this regard, §2175.05(b)(I) of the MPEP goes on to say that the claim is not indefinite "*if the specification provides examples or teachings that can be used to measure a degree even without a precise numerical measurement* (***e.g., a figure that provides a standard for measuring the meaning of the term of degree***). See, e.g., *Young v. Lumenis, Inc.*, 492 F.3d 1336, 1346 (Fed. Cir. 2007); *Exxon Research and Eng'g Co. v. United States*, 265 F.3d 1371, 1381 (Fed. Cir. 2001). That is, a drawing figure can provide one skilled in the art with the requisite understanding of a term of degree.

In the present case, the present disclosure provides examples that give one of ordinary skill in the art understanding as what "substantial rectangle" encompasses. For instance, Figs. 3-6, 9-12 illustrate one example of a solar battery cell being a "substantial rectangle". Another example of the solar battery cell being a "substantial rectangle" is illustrated in Figs. 13-15 of the application. These figures show a solar battery cell 22 having tapered corners at one of the long edges "L" of the rectangular cell. Even though this solar battery cell 22 has tapered corners at one edge, the specification still refers to this solar battery cell as being a substantial rectangle (see paragraph [0059] of the published U.S. application, U.S. 2013/0098423 A1). Accordingly, one of ordinary skill in the art considering the present disclosure would be able to ascertain what is meant by a "substantial rectangle".

Note also that Claim 1 defines the "ratio of a short side length and a long side length of the substantial rectangle is 1/n:1 (n is an integer equal to or larger than 2)", which results in a substantially rectangular shape. This recitation helps define that even with tapered corners as in Figs. 13-15, a solar battery cell is a substantial rectangle if the cell has a ratio of a short side length and a long side length of the solar battery cell being 1/n:1 (n is an integer equal to or larger than 2).

In view of the above, withdrawal of the rejection is respectfully requested.

Next, the Office Action rejects Claims 1 and 4-8 under 35 U.S.C. §103(a) based on Japanese Patent Application Publication No. 07-106619 to Maehane et al. ("Maehane") in view of U.S. Patent Application Publication No. 2010/0295377 A1 to Sok et al. ("Sok") and U.S. Patent No. 5,994,641 to Kardauskas. The rejection is respectfully traversed.

According to Claim 1, n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, and the n-column parallel-connected cell strings are further serially connected to another n-column parallel-connected cell strings by a second string connector at an opposite end of the n columns, thereby configuring an entire cell array.

One example of this configuration is illustrated in Fig. 12 of the present application. Fig. 12 shows that n columns of the cell strings 17A, 17B are connected in parallel by a first string connector 16 at one end of the n columns 17A, 17B (i.e., near the top of Fig. 12), and the n-column parallel-connected cell strings 17A-17B are further serially connected to another n-column parallel-connected cell strings 17A-17B by a second string connector16 at an opposite end of the n columns (i.e., near the bottom of

Fig. 12), thereby configuring an entire cell array 5. The present claims, however, are not limited by the exemplary embodiment shown in Fig. 12.

The Office Action acknowledges that Maehane fails to disclose n columns of cell strings being connected in parallel, but asserts that these features are disclosed by Sok and Kardauskas. However, Sok simply discloses that the individual strings of solar modules can be connected in parallel as shown in Fig. 2 of the reference (see paragraph [0002] of Sok). Kardauskas simply discloses interconnecting solar cells in each row in series so as to form strings, and then connecting the strings in series or in parallel, or in some series/parallel combination, as discussed in column 5, lines 54-59 of the reference. Neither of Sok and Kardauskas discloses that n columns of the cell strings are connected in parallel ***by a first string connector at one end of the n columns***, and that the n-column parallel-connected cell strings are ***further serially connected*** to another n-column parallel-connected cell strings ***by a second string connector at an opposite end of the n columns*** as defined in independent Claim 1 here.

Accordingly, the combination of Maehane, Sok and Kardauskas fails to disclose or suggest the combination of features recited in independent Claim 1. Independent Claim 1 is thus patentable over Maehane, Sok and Kardauskas for at least the above reasons.

Claims 4-8 are patentable over the applied references at least by virtue of their dependence from patentable independent Claim 1. Thus, a detailed discussion of the additional distinguishing features recited in these dependent claims is not set forth at this time. Withdrawal of the rejection is respectfully requested.

Claims 9-12 are presented for consideration and define additional distinguishing features.

Claim 9 recites that the second string connector extends continuously across the entire cell array. None of the applied references discloses or suggests this feature.

Claim 10 defines that the interconnector is joined to the light-receiving-surface bus electrode of a solar battery cell nearest to the second string connector of the n-column parallel-connected cell strings, and is connected to the second string connector, and the second string connector is connected to a rear surface lead at the rear-surface bus electrode of a head solar battery cell nearest the second string connector of the another n-column parallel-connected cell strings. None of the applied references discloses or suggests such a configuration.

Claims 11 and 12 recite that long sides of the substantial rectangle include a first long side and a second long side, the substantial rectangle has chamfered corners on both ends of the first long side, and the first one of the solar battery cells and the second one of the solar battery cells are arranged in the cell array such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other.

None of the applied references discloses or suggests such a configuration.

Claims 9-12 are thus patentable over Maehane, Sok and Kardauskas for at least these reasons.

Should any questions arise in connection with this application or should the Examiner believe that a telephone conference with the undersigned would be helpful in

resolving any remaining issues pertaining to this application the undersigned respectfully requests that he be contacted at the number indicated below.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date: July 15, 2014

By: /David R. Kemeny/
David R. Kemeny
Registration No. 57241

Customer No. 21839
703 836 6620

Electronic Acknowledgement Receipt

EFS ID:	19583641
Application Number:	13806793
International Application Number:	
Confirmation Number:	2289
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Customer Number:	21839
Filer:	David Ray Kemeny/Michele Shockey
Filer Authorized By:	David Ray Kemeny
Attorney Docket Number:	1032404-000416
Receipt Date:	15-JUL-2014
Filing Date:	24-DEC-2012
Time Stamp:	14:35:53
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		AMD.pdf	77392 4e460cd2e0c4de94733acaefa11515b127603920	yes	12

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	6
	Applicant Arguments/Remarks Made in an Amendment	7	12
Warnings:			
Information:			
	Total Files Size (in bytes):	77392	

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National Stage of an International Application under 35 U.S.C. 371
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New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/806,793	Filing Date 12/24/2012	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)		
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

		(Column 1)		(Column 2)	(Column 3)		
AMENDMENT	07/15/2014	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 10	Minus	** 20	= 0	X $80 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	X $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	**0**

		(Column 1)		(Column 2)	(Column 3)		
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/SHARON HARRIS/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13806793
Filing Date	2012-12-24
First Named Inventor	Koji SHIMASAKI et al.
Art Unit	1758
Examiner Name	Mayla Gonzales Ramos
Attorney Docket Number	1032404-000416

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	8049096	B2	2011-11-01	Yagiura et al.	corresp. to EP 1816684
	2	6262358	B1	2001-07-17	Kamimura et al.	corresp. to EP 1030376

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20120012152	A1	2012-01-19	Yagiura et al.	corresp. to EP 1816684
	2	20070175509	A1	2007-08-02	Yagiura et al.	corresp. to EP 1816684

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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	1816684	EP	A2	2007-08-08	Sanyo Electric Co., Ltd.	corresp. to US 2012/0012152, US 2007/0175509 and US 8029096	☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	13806793
	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1758
	Examiner Name	Mayla Gonzales Ramos
	Attorney Docket Number	1032404-000416

	2	1030376	EP	A1	2000-08-23	Sharp Kabushiki Kaisha	corresp. to US 6262358	☐

If you wish to add additional Foreign Patent Document citation information please click the Add button

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Japanese Notice of Rejection dated August 12, 2014 issued in the corresponding Japanese Patent Application 2013-240845 and English language translation (3 pages).	☒
	2	German Office Action dated August 12, 2014 issued in the corresponding German Patent Application 112010005717.6 and English language translation (12 pages).	☒

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	13806793
	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1758
	Examiner Name	Mayla Gonzales Ramos
	Attorney Docket Number	1032404-000416

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☒ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David R. Kemeny/	Date (YYYY-MM-DD)	3014-10-14
Name/Print	David R. Kemeny	Registration Number	57,241

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The information provided by you in this form will be subject to the following routine uses:

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 816 684 A2

(12) EUROPEAN PATENT APPLICATION

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H01L 31/05 *(2006.01)* ***H01L 31/0352*** *(2006.01)*

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(30) Priority: **01.02.2006 JP 2006025134**

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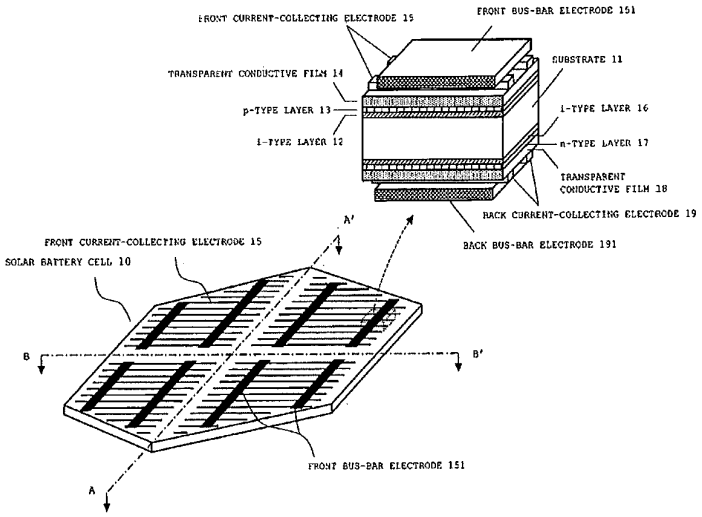
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(54) Solar battery module

(57) A solar battery cell having a hexagonal shape is divided into four at a straight line connecting between opposed apexes and a straight line connecting between middle points of opposed sides. Two of the divided cells are arranged without being turned upside down such that oblique sides thereof oppose each other; thus, a substantially rectangular-shaped unit is configured. In adjoining two units, an interconnector is routed from a front surface of one of the units to a back surface of the other unit. Thus, the two units are electrically connected to each other through the interconnector. Hence, it is unnecessary to route an interconnector from a front surface of one divided cell to a back surface of another divided cell at a portion where oblique sides of the divided cells oppose each other; therefore, it is unnecessary to secure a large clearance at the portion.

FIG. 1



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Description

[0001] *This application claims priority of* Japanese Patent Application No. 2006-25134 filed February 1, 2006.

BACKGROUND OF THE INVENTION

1. Technical Field of the Invention

[0002] The present invention relates to solar battery modules, in particular, a solar battery module suitably used when solar battery cells are efficiently placed thereon as much as possible.

2. Disclosure of Related Art

[0003] Against a backdrop of problems such as exhaustion of oil resources and global warming, recently, development and popularization of a clean energy source employing no oil resources are mentioned as a global challenge. A photovoltaic power generating system uses inexhaustible photovoltaic energy without emission of CO_2 or the like and, therefore, receives attention as a solution for such problems.

[0004] In order to protect a solar battery cell which is a power generating source from external damage and improve handleability, the photovoltaic power generating system typically uses a solar battery module including several tens of solar battery cells arranged on a plane. Herein, the solar battery module is typically formed into a rectangular shape having a side of about one meter in order to efficiently arrange solar battery cells in a certain area and to improve handleability upon transfer or installation thereof.

[0005] On the other hand, an ingot (single crystal silicon) used as a material for a substrate of a solar battery cell is formed into a cylindrical shape because of its manufacturing method. Therefore, when a substrate of a solar battery cell is obtained by slicing the ingot, the solar battery cell is inevitably formed into a circular shape. Herein, even when solar battery cells are efficiently placed on a solar battery module as much as possible, a large clearance is created between adjoining solar battery cells as illustrated in (a-1) and (a-2) of Fig. 11, for example. Consequently, there arises a problem that solar battery cells 10 to be placed on a solar battery module 20 are small in number.

[0006] In order to solve this problem, a solar battery cell 10 is formed into a square shape as illustrated in (b-1) and (b-2) of Fig. 11. Thus, solar battery cells 10 to be placed on a solar battery module 20 can be increased in number. However, there arises another problem that wasted portions (hatched portions in (b-2) of Fig. 11) from which a substrate 31 can not be obtained become large in an ingot 30, that is, the ingot 30 can not be used efficiently.

[0007] Alternatively, a solar battery cell 10 is formed into a hexagonal shape as illustrated in (c-1) and (c-2) of Fig. 11. Thus, solar battery cells 10 to be placed on a solar battery module 20 can be increased in number as compared with the case that the solar battery cell 10 is formed into a circular shape. Further, an ingot 30 can be used more efficiently as compared with the case that the solar battery cell 10 is formed into a square shape. Also in this case, however, a clearance where a solar battery cell 10 can not be placed is created in the solar battery module 20, and wasted portions from which a substrate 31 can not be obtained still remain in the ingot 30.

[0008] In order to solve these problems, JP2001-094127A discloses a solar battery module by which solar battery cells 10 to be placed thereon can be increased in number and an ingot 30 can be used efficiently. According to this prior invention, a substrate 31 is cut out from the ingot 30 so as to have a hexagonal shape which is larger than a hexagonal shape inscribed in an outer periphery of the ingot 30 and is smaller than a hexagonal shape inscribed by the outer periphery of the ingot 30 (hereinafter, a shape cut out in this manner will be referred to as an "almost hexagonal shape"), as illustrated in Fig. 12B. Thus, wasted portions from which a substrate 31 can not be obtained can be reduced in the ingot 30, that is, the ingot 30 can be used efficiently.

[0009] In this prior invention, further, a solar battery cell 10 including such a substrate 31 cut out as described above is divided into two or four at a line P-P' and/or a line Q-Q' in Fig. 12B. Then, the divided solar battery cells 10 are arranged as illustrated in Fig. 12A or 12C. Thus, a clearance where a solar battery cell 10 can not be arranged is reduced in a solar battery module 20, that is, solar battery cells 10 to be placed on the solar battery module 20 can be increased in number.

[0010] Alternatively, JP09-148601A (1997) discloses the following configuration. That is, a solar battery cell having a hexagonal shape or an almost hexagonal shape is divided into two at a straight line connecting opposed apexes or a straight line connecting two division points on opposed sides. Then, the divided solar battery cells are placed on a solar battery module. Fig. 13A illustrates the configuration of the solar battery module according to this prior invention, and Fig. 13B is a sectional view taken along a line R-R' in Fig. 13A.

[0011] According to this prior invention, solar battery cells 10 are placed on the solar battery module 20 such that identical polarities thereof are directed in a single direction. Then, an interconnector 21 connects between a front surface or a back surface of one of adjoining solar battery cells 10 and a back surface or a front surface of the other solar battery cell 10; thus, the solar battery cells 10 are electrically connected to each other.

[0012] With the configuration in JP09-148601A, however, oblique sides of divided cells oppose each other, and an interconnector is routed from a front surface of one cell to a back surface of another cell at a portion where the oblique sides of the divided cells oppose each other. Consequently, there arises a problem that a clear-

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ance at the portion becomes relatively large, so that solar battery cells to be placed on a solar battery module are reduced in number. In addition, the interconnector routed at the portion readily causes chipping or cracking of the divided cells, so that there may arise a problem that a divided cell is damaged. Further, in a case that a plurality of interconnectors are used for connection between adjoining divided cells, the interconnectors are disadvantageously bent at an oblique side of the divided cell. Consequently, a position at which an interconnector is bent in an oblique side differs for each interconnector, so that there arises a problem that connection work using an interconnector becomes complicated.

[0013] Moreover, JP2001-094127A discloses no interconnection between divided cells using an interconnector.

SUMMARY OF THE INVENTION

[0014] An object of the present invention is to provide a solar battery module having the following advantages. That is, in a case that divided solar battery cells are placed in the solar battery module as described above, solar battery cells to be placed in the solar battery module can be increased in number, the solar battery cell can be prevented from becoming chipped or cracked, and electrical connection between the solar battery cells through an interconnector can be facilitated.

[0015] According to a first aspect of the present invention, a solar battery module includes a plurality of tetragonal-shaped solar battery cells forming a substantially rectangular contour in pairs such that oblique sides of two solar battery cells oppose each other. Herein, the plurality of solar battery cells are arranged on a plane in a state that oblique sides of two solar battery cells oppose each other. Further, the solar battery cells having the oblique sides opposing each other are connected in parallel through an interconnector.

[0016] According to a second aspect of the present invention, the solar battery module according to the first aspect of the present invention includes a plurality of units each forming the substantially rectangular contour by combining two solar battery cells such that the oblique sides thereof oppose each other. Herein, the plurality of units are arranged in a matrix such that longer sides of the substantially rectangular contours thereof oppose each other and shorter sides of the substantially rectangular contours thereof oppose each other.

[0017] According to a third aspect of the present invention, the solar battery module according to the first aspect of the present invention includes a plurality of blocks each forming the substantially rectangular contour by combining two solar battery cells such that the oblique sides thereof oppose each other. Herein, the plurality of blocks are arranged such that shorter sides of the substantially rectangular contours thereof oppose each other to configure a plurality of units each having a substantially rectangular contour slenderer than the substantially rectangular contour of the block. Further, the plurality of units are arranged in a matrix such that longer sides of the substantially rectangular contours thereof oppose each other and shorter sides of the substantially rectangular contours thereof oppose each other.

[0018] According to a fourth aspect of the present invention, in the solar battery module according to the second or third aspect of the present invention, in the plurality of units, a front surface of one of adjoining two units is electrically connected to a back surface of the other unit in accordance with a predetermined electrical connection pattern in sequence.

[0019] According to a fifth aspect of the present invention, in the solar battery module according to the fourth aspect of the present invention, in a portion where shorter sides of the adjoining two units oppose each other, the interconnector is routed from a front surface of one of the units to a back surface of the other unit for electrical connection between the front surface and the back surface.

[0020] According to a sixth aspect of the present invention, in the solar battery module according to any one of the first to fifth aspects of the present invention, the solar battery cells placed on the solar battery module are identical in type to one another, and are arranged on a plane such that identical polarities thereof are directed to a single direction.

[0021] According to a seventh aspect of the present invention, a solar battery module includes a unit including a plurality of tetragonal-shaped solar battery cells forming a substantially rectangular contour in pairs such that oblique sides thereof oppose each other, and an interconnector for electrically connecting between the solar battery cells in the unit. Herein, the unit is formed into a square shape by the plurality of solar battery cells. Further, the interconnector connects between the solar battery cells configuring the unit without being routed from a front surface of one of the solar battery cells to a back surface of the other solar battery cell and vice versa at a portion where the oblique sides of the solar battery cells oppose each other.

[0022] According to an eighth aspect of the present invention, in the solar battery module according to the seventh aspect of the present invention, the plurality of solar battery cells configuring the unit are electrically connected in parallel.

[0023] The "solar battery cell" according to the respective aspects of the present invention corresponds to a divided cell 10a in the following embodiment. The "unit" according to the respective second to fifth, seventh and eighth aspects of the present invention corresponds to a unit illustrated in Figs. 3A, 3B, 10A and 10B in the following embodiment. The "unit" according to the second aspect of the present invention has a configuration illustrated in Figs. 3A and 3B, and the "unit" according to the third aspect of the present invention has a configuration illustrated in Figs. 10A and 10B. Further, the "electrical connection pattern" according to the fourth aspect of the present invention is illustrated in each of Figs. 5 to 9 in

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the following embodiment.

[0024] In the respective aspects of the present invention, the "tetragonal shape" of the solar battery cell involves a shape obtained when a hexagonal shape is divided into four at a straight line which connects a pair of opposed apexes and a straight line which is perpendicular to the straight line and connects between middle points of a pair of opposed sides, and a shape obtained when an "almost hexagonal shape" illustrated in Fig. 12B, a shape formed by replacing part of or all of arcuate portions of the "almost hexagonal shape" with a straight line and a shape formed by slightly changing the "almost hexagonal shape" in side or angle is divided into four at a line P-P' and a line Q-Q' in Fig. 12B.

[0025] According to the present invention, it is unnecessary to secure a large clearance at a portion where oblique sides of two divided cells oppose each other as illustrated in Figs. 13A and 13B; therefore, it is possible to increase the number of divided cells to be placed in a solar battery module. In addition, it is unnecessary to route an interconnector from a front surface one divided cell to a back surface of another divided cell at a portion where oblique sides of the divided cells oppose each other; therefore, it is possible to prevent the divided cells at the portion from becoming chipped or cracked.

[0026] The other effects and significances of the present invention will become more apparent from the following detailed description of an embodiment of the present invention. However, the following embodiment is by way of illustration and example only; therefore, terms of respective constituent elements are not limited to those described in the following embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The foregoing and other objects and novel features will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings. In which:

Fig. 1 illustrates a configuration of a solar battery cell according to one embodiment;
Fig. 2 illustrates a sectional structure of the solar battery cell according to the embodiment;
Figs. 3A and 3B illustrate a connection form between divided cells and a connection form between units according to the embodiment;
Fig. 4 illustrates a layout of the units according to the embodiment;
Fig. 5 illustrates one unit connection pattern according to the embodiment;
Fig. 6 illustrates another unit connection pattern according to the embodiment;
Fig. 7 illustrates still another unit connection pattern according to the embodiment;
Fig. 8 illustrates yet another unit connection pattern according to the embodiment;
Fig. 9 illustrates yet another unit connection pattern according to the embodiment;
Fig. 10A and 10B illustrate modifications of the connection form between the divided cells and the connection form between the units according to the embodiment;
Fig. 11 illustrates a configuration in the prior invention;
Figs. 12A to 12C illustrate configurations in the prior invention; and
Figs. 13A and 13B illustrate configurations in the prior invention.

DESCRIPTION OF PREFERRED EMBODIMENT

[0028] Hereinafter, description will be given of an embodiment of the present invention with reference to the drawings.

[0029] A lower left side of Fig. 1 illustrates a configuration of a solar battery cell which is not divided into four yet. As illustrated in the lower left side of Fig. 1, the solar battery cell 10 has a hexagonal shape when being seen from a plan view. In the solar battery cell 10, front current-collecting electrodes 15 and front bus-bar electrodes 151 are formed on a front surface and back current-collecting electrodes 19 and back bus-bar electrodes 191 are formed on a back surface.

[0030] An upper right side of Fig. 1 illustrates a sectional structure of the solar battery cell 10, which corresponds to a portion shown by dotted lines in the lower left side of Fig. 1. As illustrated in the upper right side of Fig. 1, the solar battery cell 10 includes a substrate 11, an i-type layer 12, a p-type layer 13, a transparent electrode film 14, the front current-collecting electrodes 15, an i-type layer 16, an n-type layer 17, a transparent conductive film 18, and the back current-collecting electrodes 19.

[0031] The substrate 11 is an n-type single-crystal silicon substrate. The i-type layer 12 made of intrinsic amorphous silicon and the p-type layer 13 made of p-type amorphous silicon are laminated in this order on a front surface of the substrate 11. Further, the transparent conductive film 14 is laminated on the p-type layer 13, and the front current-collecting electrodes 15 arranged linearly are formed on the transparent conductive film 14. The front bus-bar electrodes 151 are formed on the front current-collecting electrodes 15 so as to intersect the front current-collecting electrodes 15. On the other hand, the i-type layer 16 made of intrinsic amorphous silicon and the n-type layer 17 made of n-type amorphous silicon are laminated in this order on a back surface of the substrate 11. Further, the transparent conductive film 18 is laminated on the n-type layer 17, and the back current-collecting electrodes 19 arranged linearly are formed on the transparent conductive film 18. The back bus-bar electrodes 191 are formed on the back current-collecting electrodes 19 so as to intersect the back current-collecting electrodes 19. In Fig. 1, the front current-collecting electrode 15 and the front bus-bar electrode 151 are

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formed independently of each other. However, these electrodes may be formed integrally with each other as illustrated in Fig. 2. In Fig. 1, similarly, the back current-collecting electrode 19 and the back bus-bar electrode 191 are formed independently of each other. However, these electrodes may be formed integrally with each other as illustrated in Fig. 2.

[0032] In the solar battery cell 10 according to the embodiment, light from the front surface and light from the back surface are incident onto the substrate 11. Therefore, an optical electromotive force is generated irrespective of a light incident direction. Each of the i-type layers 12 and 16 has a thickness of about 100 angstroms. Each of the p-type layer 13 and the n-type layer 17 has a thickness of about 100 angstroms. Each of the transparent conductive films 14 and 18 is made of a translucent material such as ITO, ZnO or SnO_2. Each of the front current-collecting electrode 15, the back current-collecting electrode 19, the front bus-bar electrode 151 and the back bus-bar electrode 191 is made of a conductive metal material obtained by, for example, curing an Ag paste.

[0033] Fig. 1 illustrates the solar battery cell 10 having a hexagonal shape when being seen from a plan view. However, as illustrated in Fig. 12B, the solar battery cell 10 may have an almost hexagonal shape. As described above, further, the solar battery cell 10 is formed of a combination of a crystalline semiconductor material with an amorphous semiconductor material. In addition, the solar battery cell 10 may be of a double-sided incident type, which is formed of only one of a crystalline semiconductor material and an amorphous semiconductor material. Alternatively, the solar battery cell 10 may be of a single-sided incident type, wherein the back current-collecting electrodes 19 are not formed into a comb shape as illustrated in Fig. 1, but are formed into a uniform plane.

[0034] The solar battery cell 10 illustrated in Fig. 1 is divided into four trapezoidal parts at a straight line (line A-A' in Fig. 1) connecting two apexes and a straight line (line B-B' in Fig. 1) connecting two division points on opposed two sides. Two of the divided four parts are combined with each other without being turned upside down; thus, one cell unit (hereinafter, referred to as "unit") is configured.

[0035] Figs. 3A and 3B illustrate a configuration of a unit and a connection form between units.

[0036] More specifically, Fig. 3A is a top view of the unit, and Fig. 3B is a sectional view taken along a line C-C' in Fig. 3A. Hereinafter, each part obtained by dividing the solar battery cell 10 illustrated in Fig. 1 into four will be referred to as a "divided cell 10a".

[0037] In electrical connection between two divided cells 10a, the divided cells 10a are arranged without being turned upside down such that oblique sides thereof oppose each other without deviation. Then, two interconnectors 200 are placed on front bus-bar electrodes 151 on front surfaces of the divided cells 10a, and are electrically connected to the front bus-bar electrodes 151. Thus, the divided cells 10a are connected in parallel, so that one unit is configured.

[0038] Then, the interconnectors 200 on the front surfaces of the divided cells 10a that configure the aforementioned unit are routed to back surfaces of two divided cells 10a that configure an adjoining unit, and are electrically connected to back bus-bar electrodes 191 on the back surfaces of the divided cells 10a that configure the adjoining unit. Thus, the two units are connected in series through the interconnectors 200. Similarly, front bus-bar electrodes 151 of two divided cells 10a are electrically connected to back bus-bar electrodes 191 of two divided cells 10a through two interconnectors 200 in sequence.

[0039] For example, an interconnector 200 used herein is formed by dipping a copper plate having a thickness of about 150 μm and a width of about 2 mm into solder having no lead. Herein, a solder layer to be formed on each of front and back surfaces of the copper plate has a thickness of about 40 μm. The interconnector 200 is placed on one of a front bus-bar electrode 151 and a back bus-bar electrode 191. Then, the solder layer of the interconnector 200, which is in contact with the front bus-bar electrode 151 or the back bus-bar electrode 191, is melted by application of heat. Thus, the interconnector 200 is electrically connected to the front bus-bar electrode 151 or the back bus-bar electrode 191.

[0040] Fig. 4 illustrates a layout of units and a layout of divided cells 10a in a solar battery module. Typically, a solar battery module is manufactured as follows: a plurality of divided cells each connected to one another through interconnectors are sealed with a sealant in between a translucent front-surface protection layer and a translucent back-surface protection layer. However, the front-surface protection layer, the back-surface protection layer and the sealant are not illustrated in the following drawings. Divided cells 10a are electrically connected to one another in accordance with a predetermined electrical connection pattern. A method for configuring a unit and a method for electrically connecting between divided cells or units are already described above with reference to Figs. 3A and 3B.

[0041] Fig. 5 illustrates one electrical connection pattern.

[0042] In this electrical connection pattern, units in each left row are sequentially connected leftward in series through interconnectors from a center of a solar battery module 20, and units in each right row are sequentially connected rightward in series through interconnectors from the center of the solar battery module 20. In unit groups of odd-numbered rows counted from above, that is, unit groups of first, third, fifth, seventh and ninth rows, back surfaces of units located at a center are electrically connected to tabs 21 located at the center of the solar battery module 20, respectively, and front surfaces of rightmost and leftmost units are electrically connected to tabs 21 located at both ends of the solar battery module 20, respectively. On the other hand, in unit groups of even-numbered rows counted from above, that is, unit groups of second, fourth, sixth, eighth and tenth rows,

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front surfaces of units located at a center are electrically connected to the tabs 21 located at the center of the solar battery 20, respectively, and back surfaces of rightmost and leftmost units are electrically connected to the tabs 21 located at the both ends of the solar battery module 20, respectively.

[0043] In the tabs 21 located at the center of the solar battery module 20, the uppermost tab 21 serves as an output terminal T1 of the solar battery module 20 and the lowermost tab 21 serves as an output terminal T2 of the solar battery module 20. In this electrical connection pattern, a bypass diode connects between adjoining tabs 21 located at the center of the solar battery module 20 in order to prevent application of reverse voltage, as shown by an arrow in Fig. 5. Herein, adjoining tabs 21 are close to each other at the position shown by an arrow in Fig. 5; therefore, a bypass diode can be readily inserted between the tabs 21. A bypass diode used herein may be interposed between a front-surface protection member and a back-surface protection member, or may be attached to a terminal box mounted to a bottom side of the back-surface protection member.

[0044] Fig. 6 illustrates another electrical connection pattern.

[0045] In this electrical connection pattern, units in each row are sequentially connected rightward in series from a left end of a solar cell module 20. In unit groups of odd-numbered rows counted from above, that is, unit groups of first, third, fifth, seventh and ninth rows, back surfaces of leftmost units are electrically connected to tabs 21 located at the left end of the solar battery module 20, and front surfaces of rightmost units are electrically connected to tabs 21 located at a right end of the solar battery module 20. On the other hand, in unit groups of even-numbered rows counted from above, that is, unit groups of second, fourth, sixth, eighth and tenth rows, front surfaces of leftmost units are electrically connected to the tabs 21 located at the left end of the solar battery module 20, and back surfaces of rightmost units are electrically connected to the tabs 21 located at the right end of the solar battery module 20. In this electrical connection pattern, accordingly, units from an upper leftmost one to a lower leftmost one in Fig. 6 are sequentially connected in series.

[0046] In the tabs 21 located at the left end of the solar battery module 20, the uppermost tab 21 serves as an output terminal T1 of the solar battery module 20 and the lowermost tab 21 serves as an output terminal T2 of the solar battery module 20. In this electrical connection pattern, a bypass diode connects between adjoining tabs 21 located at the left end of the solar battery module 20 in order to prevent application of reverse voltage, as shown by an arrow in Fig. 6. Herein, as in the case illustrated in Fig. 5, adjoining tabs 21 are close to each other at the position shown by an arrow in Fig. 6; therefore, a bypass diode can be readily inserted between the tabs 21. A bypass diode used herein may be interposed between a front-surface protection member and a back-surface protection member, or may be attached to a terminal box mounted to a bottom side of the back-surface protection member.

[0047] Fig. 7 illustrates still another electrical connection pattern.

[0048] In this electrical connection pattern, units in each row are sequentially connected leftward in series from a right end of a solar battery cell 20. In unit groups of first, second, third and fourth rows counted from above, back surfaces of rightmost units are electrically connected to tabs 21 located at the right end of the solar battery module 20, respectively, and front surfaces of leftmost units are electrically connected to tabs 21 located at a left end of the solar battery module 20, respectively. On the other hand, in unit groups of fifth, sixth, seventh and eighth rows counted from above, front surfaces of rightmost units are electrically connected to the tabs 21 located at the right end of the solar battery module 20, respectively, and back surfaces of leftmost units are electrically connected to the tabs 21 located at the left end of the solar battery module 20, respectively. In this electrical connection pattern, accordingly, there is configured a solar battery module of a four parallel type wherein unit groups of first, second, third and fourth rows are connected in parallel, respectively, and unit groups of fifth, sixth seventh and eighth rows are connected in parallel, respectively.

[0049] Herein, the upper tab 21 located at the right end of the solar battery module 20 serves as an output terminal T1 of the solar battery module 20 and the lower tab 21 located at the right end of the solar battery module 20 serves as an output terminal T2 of the solar battery module 20. In this electrical connection pattern, a bypass diode connects between the upper and lower tabs 21 located at the right end of the solar battery module 20 in order to prevent application of reverse voltage, as shown by an arrow in Fig. 7. Herein, as in the cases illustrated in Figs. 5 and 6, the tabs 21 are close to each other at the position shown by the arrow in Fig. 7; therefore, the bypass diode can be readily inserted between the tabs 21. In addition, there is required only one bypass diode herein, resulting in simplification of a configuration. A bypass diode used herein may be interposed between a front-surface protection member and a back-surface protection member, or may be attached to a terminal box mounted to a bottom side of the back-surface protection member.

[0050] Fig. 8 illustrates yet another electrical connection pattern.

[0051] In this electrical connection pattern, units in each row are sequentially connected rightward in series from a left end of a solar battery module 20. In unit groups of first, second, fifth and sixth rows counted from above, back surfaces of leftmost units are electrically connected to tabs 21 located at the left end of the solar battery module 20, respectively, and front surfaces of rightmost units are electrically connected to tabs 21 located at a right end of the solar battery module 20, respectively. On the

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other hand, in unit groups of third, fourth, seventh and eighth rows counted from above, front surfaces of leftmost units are electrically connected to the tabs 21 located at the left end of the solar battery module 20, respectively, and back surfaces of rightmost units are electrically connected to the tabs 21 located at the right end of the solar battery module 20, respectively. In this electrical connection pattern, accordingly, there is configured a solar battery module of a two parallel type wherein unit groups of first and second rows are connected in parallel, unit groups of third and fourth rows are connected in parallel, unit groups of fifth and sixth rows are connected in parallel and unit groups of seventh and eighth rows are connected in parallel.

[0052] In the three tabs 21 located at the left end of the solar battery module 20, the upper and lower tabs 21 serve as output terminals T1 and T2 of the solar battery module 20, respectively. In this electrical connection pattern, a bypass diode connects between the tabs 21 located at the left end of the solar battery module 20 in order to prevent application of reverse voltage, as shown by an arrow in Fig. 8. Herein, as in the cases illustrated in Figs. 5, 6 and 7, adjoining tabs 21 are close to each other at the position shown by an arrow in Fig. 8; therefore, a bypass diode can be readily inserted between the tabs 21. In addition, there are required only two bypass diodes herein, resulting in simplification of a configuration. A bypass diode used herein may be interposed between a front-surface protection member and a back-surface protection member, or may be attached to a terminal box mounted to a bottom side of the back-surface protection member.

[0053] Fig. 9 illustrates yet another electrical connection pattern. In the aforementioned respective electrical connection patterns, a combination of divided cells 10a is arranged in a lateral direction to configure one unit as illustrated in Figs. 5 to 8. In this electrical connection pattern, on the other hand, a combination of divided cells 10a is arranged in a vertical direction to configure one unit as illustrated in Fig. 9.

[0054] In this electrical connection pattern, units in each column are sequentially connected downwardly in series from a top end of a solar battery module 20. In unit groups of first, second, fifth, sixth, ninth, tenth, thirteenth, fourteenth, seventeenth and eighteenth columns counted from left, back surfaces of uppermost units are electrically connected to tabs 21 located at the top end of the solar battery module 20, respectively, and front surfaces of lowermost units are electrically connected to tabs 21 located at a bottom end of the solar battery module 20. On the other hand, in unit groups of third, fourth, seventh, eighth, eleventh, twelfth, fifteenth, sixteenth, nineteenth and twentieth columns counted from left, front surfaces of uppermost units are electrically connected to the tabs 21 located at the top end of the solar battery module 20, respectively, and back surfaces of lowermost units are electrically connected to the tabs 21 located at the bottom end of the solar battery module 20, respectively. In this electrical connection pattern, accordingly, there is configured a solar battery module wherein unit groups of first and second columns are connected in parallel, unit groups of third and fourth columns are connected in parallel, unit groups of fifth and sixth columns are connected in parallel, unit groups of seventh and eighth columns are connected in parallel, unit groups of ninth and tenth columns are connected in parallel, unit groups of eleventh and twelfth columns are connected in parallel, unit groups of thirteenth and fourteenth columns are connected in parallel, unit groups of fifteenth and sixteenth columns are connected in parallel, unit groups of seventeenth and eighteenth columns are connected in parallel and unit groups of nineteenth and twentieth columns are connected in parallel.

[0055] In the tabs 21 located at the top end of the solar battery module 20, the leftmost tab 21 serves as an output terminal T1 of the solar battery module 20 and the rightmost tab 21 serves as an output terminal T2 of the solar battery module 20. In this electrical connection pattern, a bypass diode connects between tabs 21 located at the top end of the solar battery module 20 in order to prevent application of reverse voltage, as shown by an arrow in Fig. 9. Herein, as in the cases illustrated in Figs. 5, 6, 7 and 8, adjoining tabs 21 are close to each other at the position shown by an arrow in Fig. 9; therefore, a bypass diode can be readily inserted between the tabs 21. A bypass diode used herein may be interposed between a front-surface protection member and a back-surface protection member, or may be attached to a terminal box mounted to a bottom side of the back-surface protection member.

[0056] According to the aforementioned embodiment, it is possible to exhibit the following effects.

(1) It is unnecessary to route an interconnector 200 from a back surface of one divided cell 10a to a front surface of another divided cell 10a and vice versa at a portion where oblique sides of the divided cells 10a oppose each other. Therefore, it is unnecessary to secure a large clearance at the portion, so that it is possible to effectively increase the number of solar battery cells to be placed on a solar battery module.

(2) It is unnecessary to route an interconnector 200 from a back surface of one divided cell 10a to a front surface of another divided cell 10a and vice versa at a portion where oblique sides of the divided cells 10a oppose each other. Therefore, it is possible to prevent the divided cells 10a at the portion from becoming chipped or cracked.

(3) As illustrated in Figs. 3A and 3B, adjoining units are electrically connected to each other as follows: two interconnectors 200 are routed from a front surface of one of the units to a back surface of the other unit at a portion where two sides perpendicular to an extending direction of the interconnector 200 oppose each other. Therefore, the two interconnectors 200 can be bent at a substantially identical position in the

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extending direction thereof upon electrical connection between the two units. Hence, it is possible to enhance workability upon connection between two units through the interconnectors 200. Thus, it is possible to enhance a yield upon manufacturing of a solar battery module.

(4) In the electrical connection pattern illustrated in Fig. 5 or 9, the divided cells 10a placed on the solar battery module 20 have the front surfaces ("+" surfaces) directed in a single direction. Therefore, it is possible to configure a solar battery module 20 by using divided cells 10a of one type. Herein, the divided cells 10a can be sequentially placed on the solar battery module 20 in accordance with an electrical connection pattern without taking a type and an orientation of the divided cell 10a into consideration. Therefore, it is possible to facilitate work performed upon manufacturing of the solar battery module 20. Hence, it is possible to enhance a yield upon manufacturing of the solar battery module 20.

(5) As illustrated in Figs. 3A and 3B, further, two divided cells 10a are connected in parallel to configure one unit. This case makes it possible to suppress a rise in voltage by about half in one unit as compared with a case that two divided cells 10a are connected in series to configure one unit. As illustrated in Figs. 5 to 9, accordingly, it is possible to lessen the frequency of inserting a bypass diode, leading to simplification of the configuration of a solar battery module and improved workability.

(6) According to the electrical connection patterns illustrated in Figs. 5 to 9, since insertion positions of bypass diodes are close to each other, an operation of inserting the bypass diode can be simplified. In particular, according to the electrical connection patterns illustrated in Figs. 7 and 8, the number of bypass diodes to be inserted can be suppressed.

[0057] The present invention is not limited to the aforementioned embodiment, and can be modified variously.

[0058] In the aforementioned embodiment, a combination of two divided cells 10a configures one unit. Alternatively, as illustrated in Figs. 10A and 10B, a combination of four divided cells 10a may configure one unit. The number of divided cells 10a for configuring one unit is changeable optionally.

[0059] In the aforementioned embodiment, a tab 21 is disposed outside an arrangement region of a divided cell. However, such a tab 21 may be disposed at various positions such as a back surface of a divided cell.

[0060] The number of units arranged in a solar battery module is not limited to that illustrated in each of Figs. 5 to 9, and may be varied appropriately. In the case illustrated in Fig. 6, for example, if the number of rows of units is an even number, output terminals T1 and T2 can be led out from a single side; however, if the number of the rows is an odd number, the output terminals T1 and T2 are led out from diagonal positions of opposed sides, causing difficulty in placement of a terminal box. Therefore, the number of units to be arranged may be determined appropriately in consideration of such points.

[0061] The present invention is applicable to not only a solar battery module receiving sunlight from a single side thereof, but also a solar battery module receiving sunlight from both sides thereof.

[0062] The embodiment of the present invention may be variously and appropriately modified within a scope of technical ideas in the following claims of the invention.

Claims

1. A solar battery module comprising:

   a plurality of tetragonal-shaped solar battery cells forming a substantially rectangular contour in pairs such that oblique sides of two solar battery cells oppose each other, wherein
   the plurality of solar battery cells are arranged on a plane in a state that oblique sides of two solar battery cells oppose each other, and the solar battery cells having the oblique sides opposing each other are connected in parallel through an interconnector.

2. The solar battery module according to claim 1, comprising:

   a plurality of units each forming the substantially rectangular contour by combining two solar battery cells such that the oblique sides thereof oppose each other, wherein
   the plurality of units are arranged in a matrix such that longer sides of the substantially rectangular contours thereof oppose each other and shorter sides of the substantially rectangular contours thereof oppose each other.

3. The solar battery module according to claim 2, wherein

   in the plurality of units, a front surface of one of adjoining two units is electrically connected to a back surface of the other unit in accordance with a predetermined electrical connection pattern in sequence.

4. The solar battery module according to claim 3, wherein

   in a portion where shorter sides of the adjoining two units oppose each other, the interconnector is routed from a front surface of one of the units to a back surface of the other unit for electrical connection between the front surface and the back surface.

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5. The solar battery module according to claim 1, comprising:

a plurality of blocks each forming the substantially rectangular contour by combining two solar battery cells such that the oblique sides thereof oppose each other, wherein
the plurality of blocks are arranged such that shorter sides of the substantially rectangular contours thereof oppose each other to configure a plurality of units each having a substantially rectangular contour slenderer than the substantially rectangular contour of the block, and
the plurality of units are arranged in a matrix such that longer sides of the substantially rectangular contours thereof oppose each other and shorter sides of the substantially rectangular contours thereof oppose each other.

6. The solar battery module according to claim 5, wherein

in the plurality of units, a front surface of one of adjoining two units is electrically connected to a back surface of the other unit in accordance with a predetermined electrical connection pattern in sequence.

7. The solar battery module according to claim 6, wherein

in a portion where shorter sides of the adjoining two units oppose each other, the interconnector is routed from a front surface of one of the units to a back surface of the other unit for electrical connection between the front surface and the back surface.

8. The solar battery module according to any one of claims 1 to 7, wherein

the solar battery cells placed on the solar battery module are identical in type to one another, and are arranged on a plane such that identical polarities thereof are directed to a single direction.

9. A solar battery module comprising:

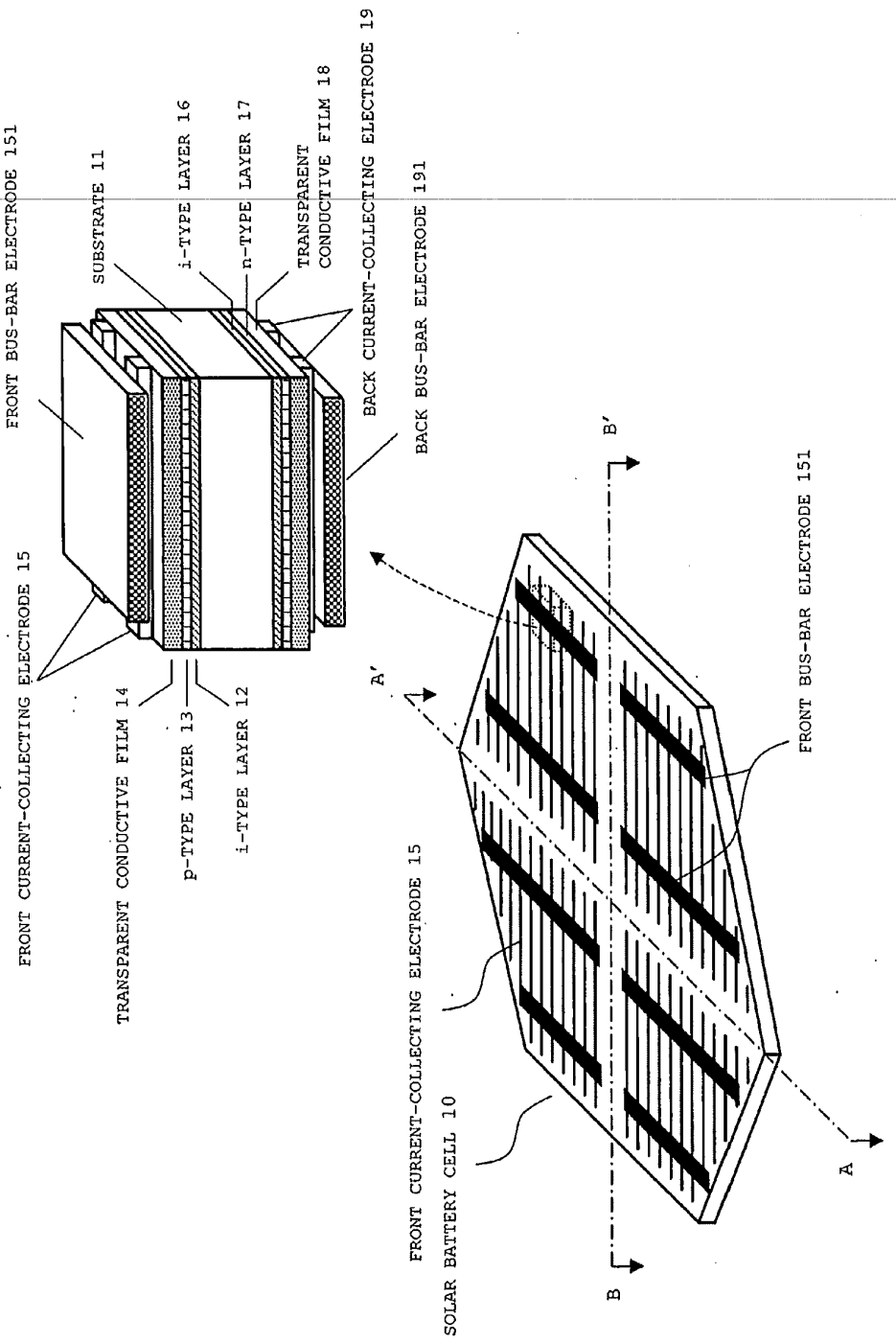
a unit including a plurality of tetragonal-shaped solar battery cells forming a substantially rectangular contour in pairs such that oblique sides thereof oppose each other; and
an interconnector for electrically connecting between the solar battery cells in the unit, wherein
the unit is formed into a square shape by the plurality of solar battery cells, and
the interconnector connects between the solar battery cells configuring the unit without being routed from a front surface of one of the solar battery cells to a back surface of the other solar battery cell and vice versa at a portion where the oblique sides of the solar battery cells oppose each other.

10. The solar battery module according to claim 9, wherein

the plurality of solar battery cells configuring the unit are electrically connected in parallel.

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FIG. 1



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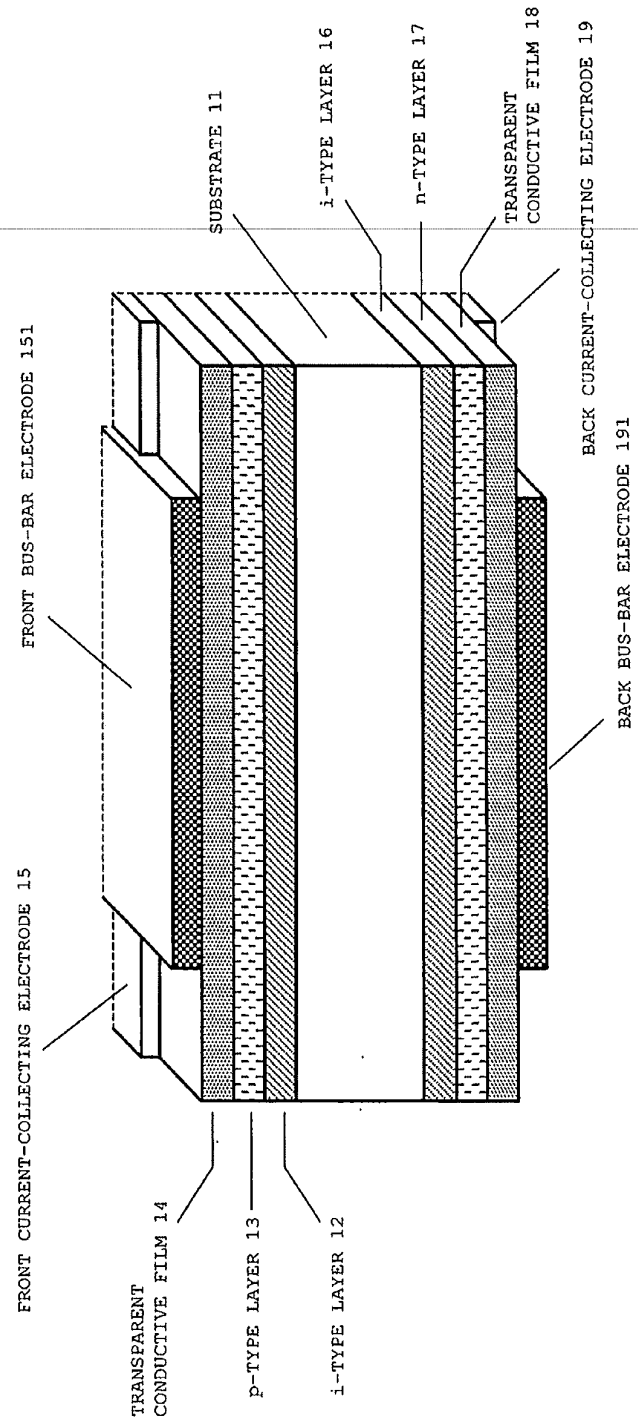
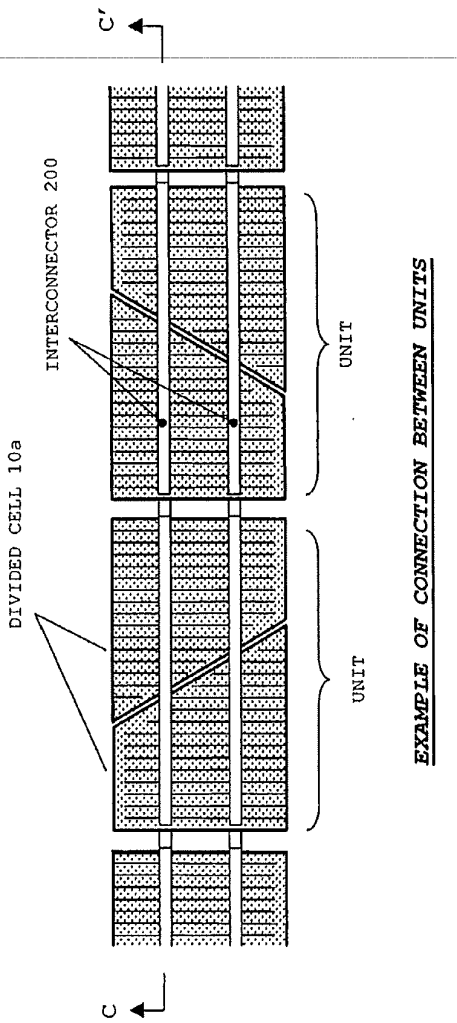


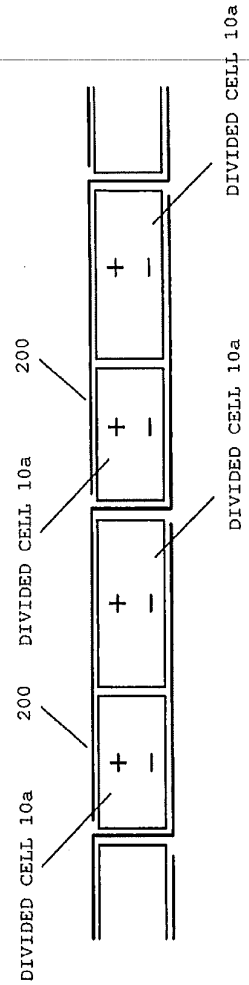
FIG. 2

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EXAMPLE OF CONNECTION BETWEEN UNITS

FIG. 3A



SECTIONAL VIEW TAKEN ALONG LINE C-C'

FIG. 3B

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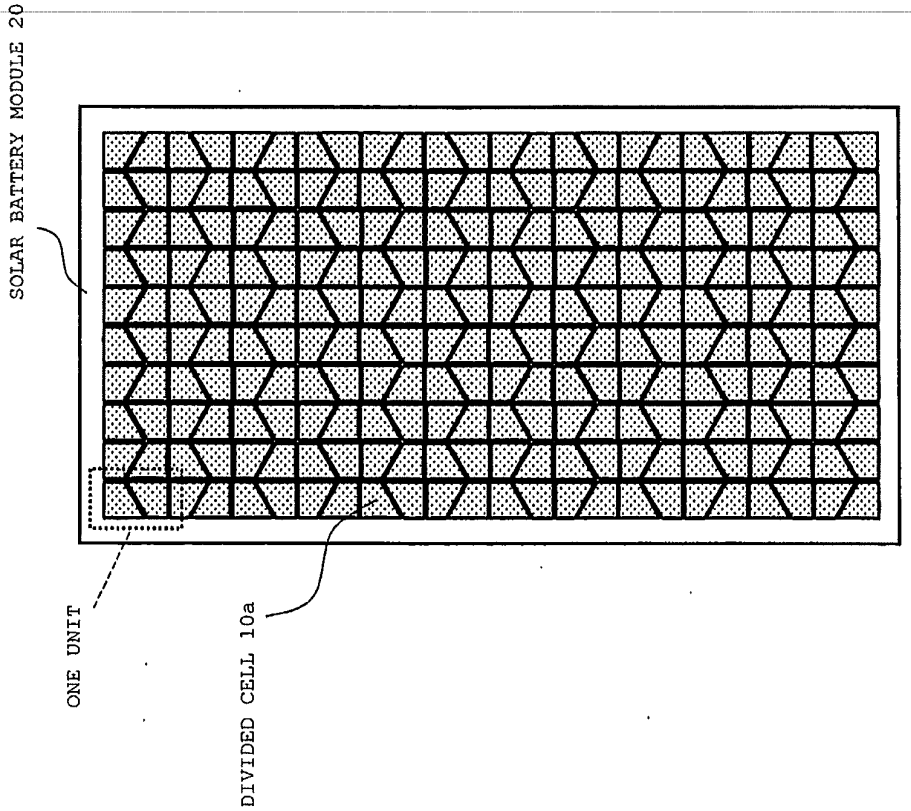


FIG. 4

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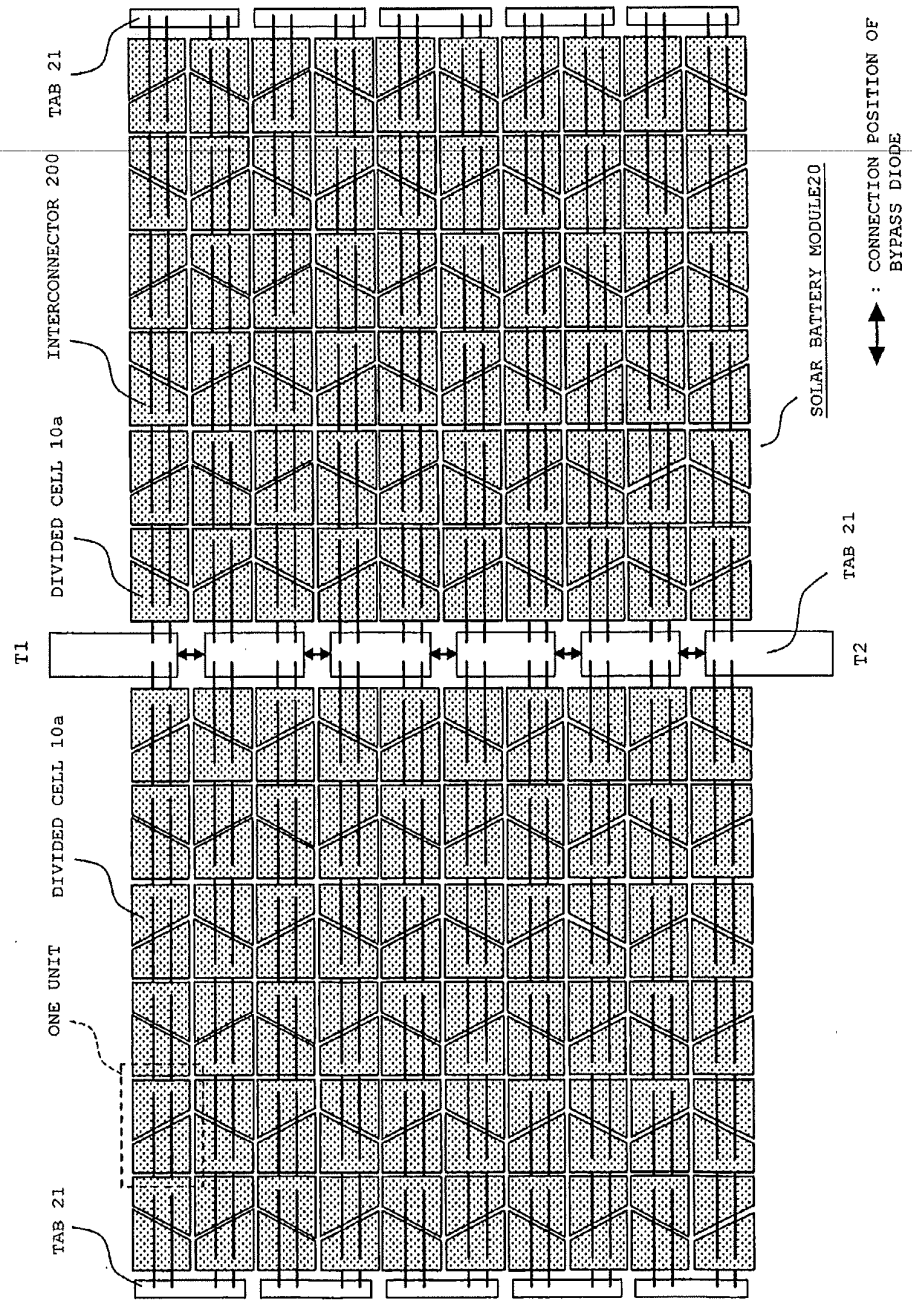


FIG.5

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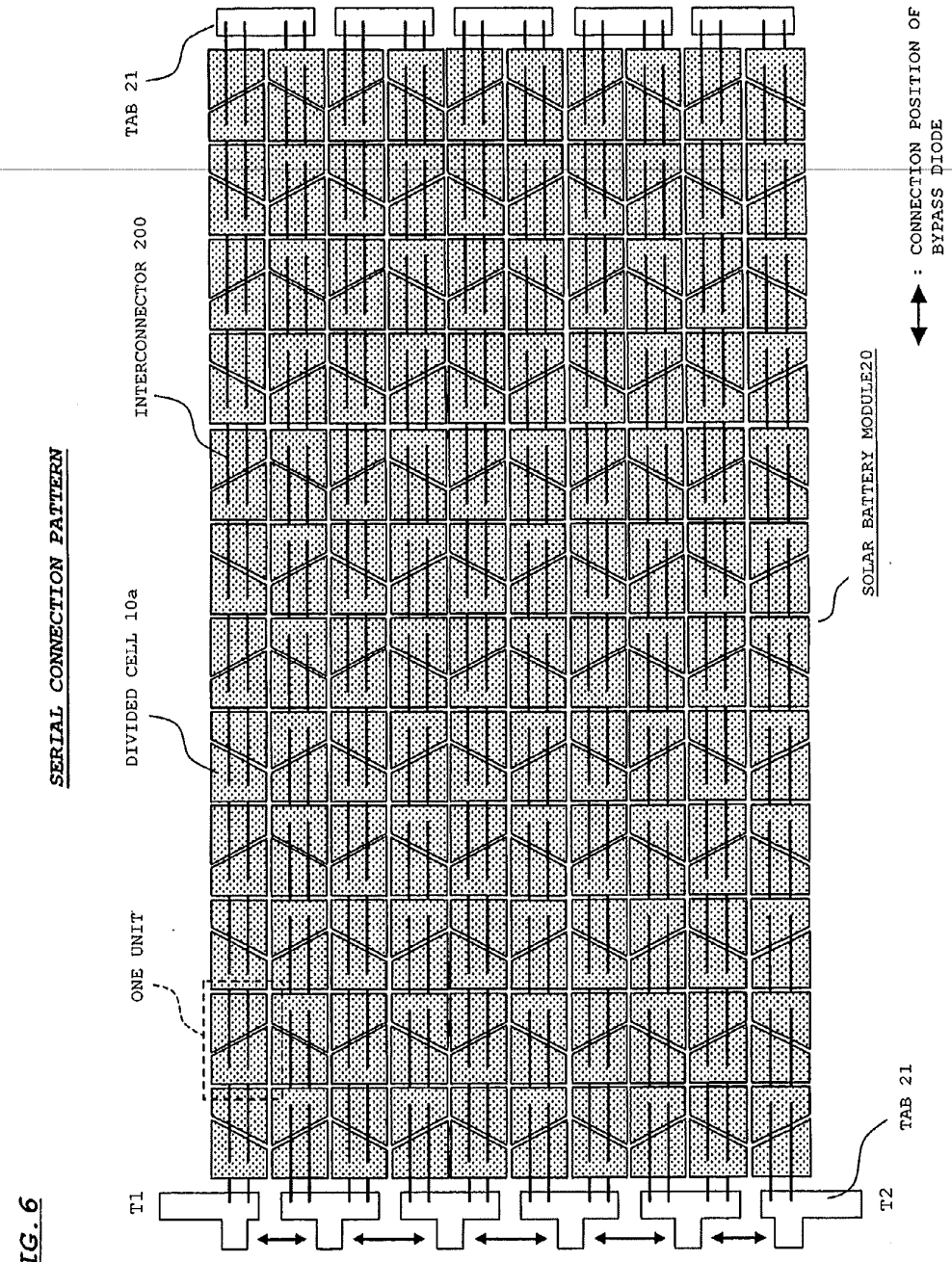
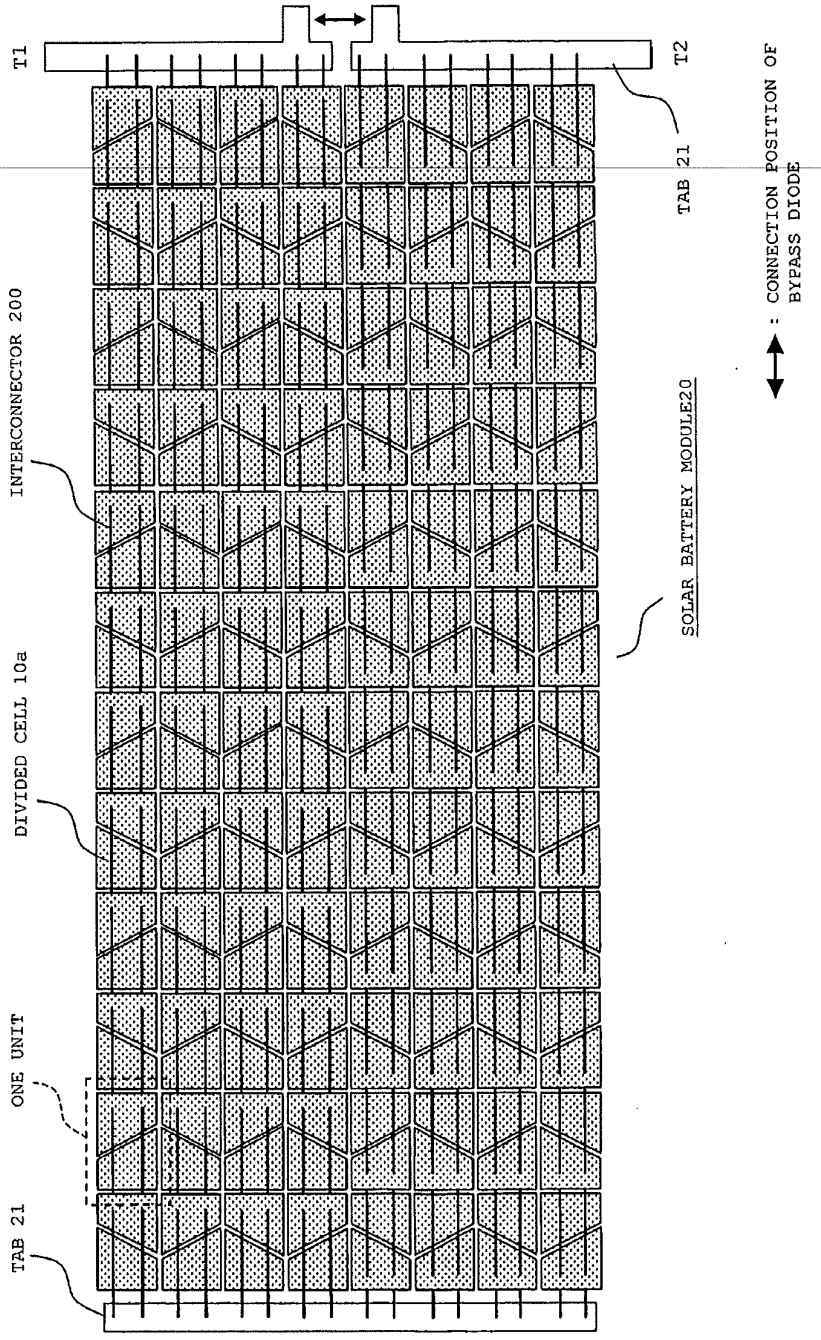


FIG. 6

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FIG. 7

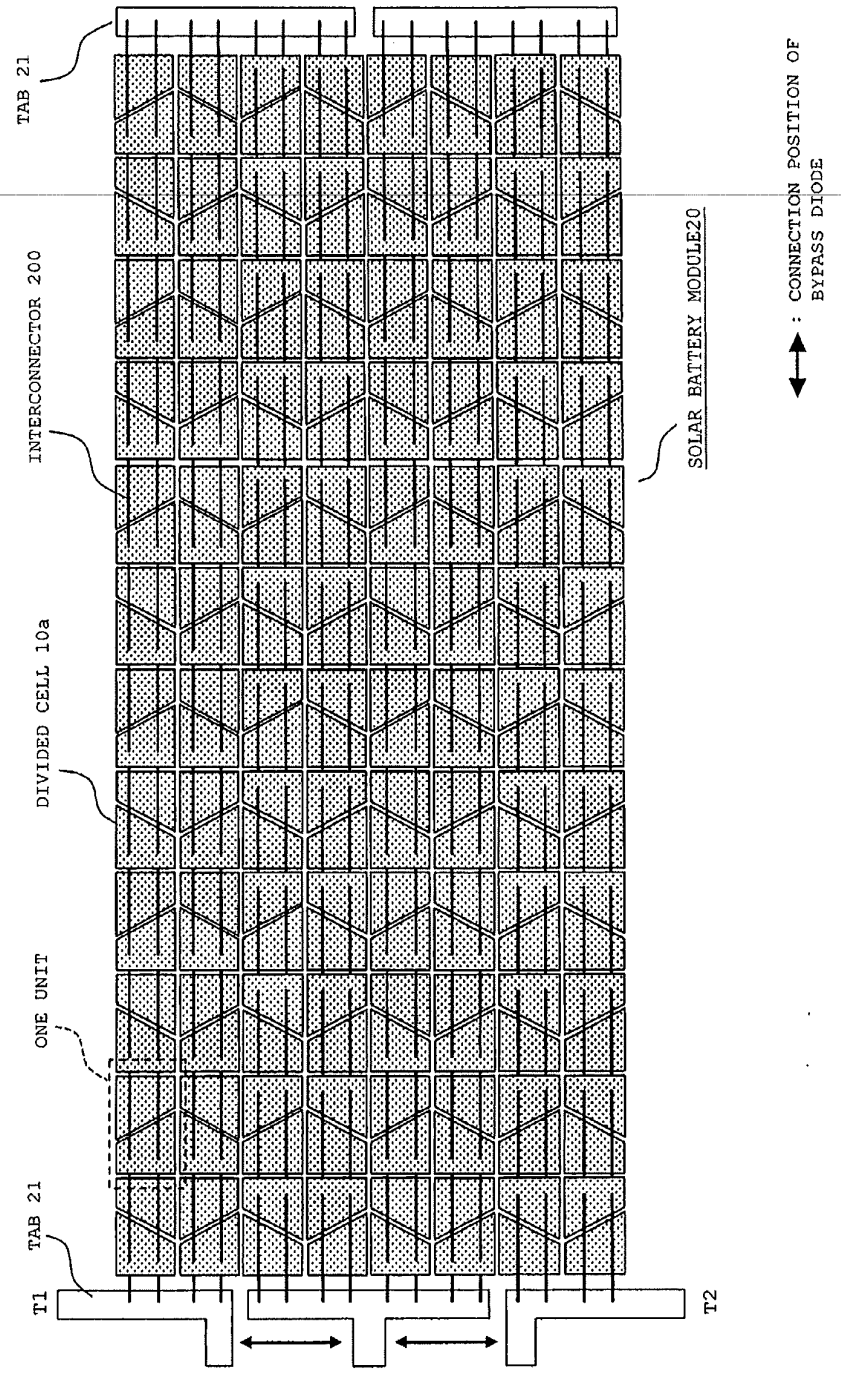
FOUR PARALLEL CONNECTION PATTERN



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FIG.8

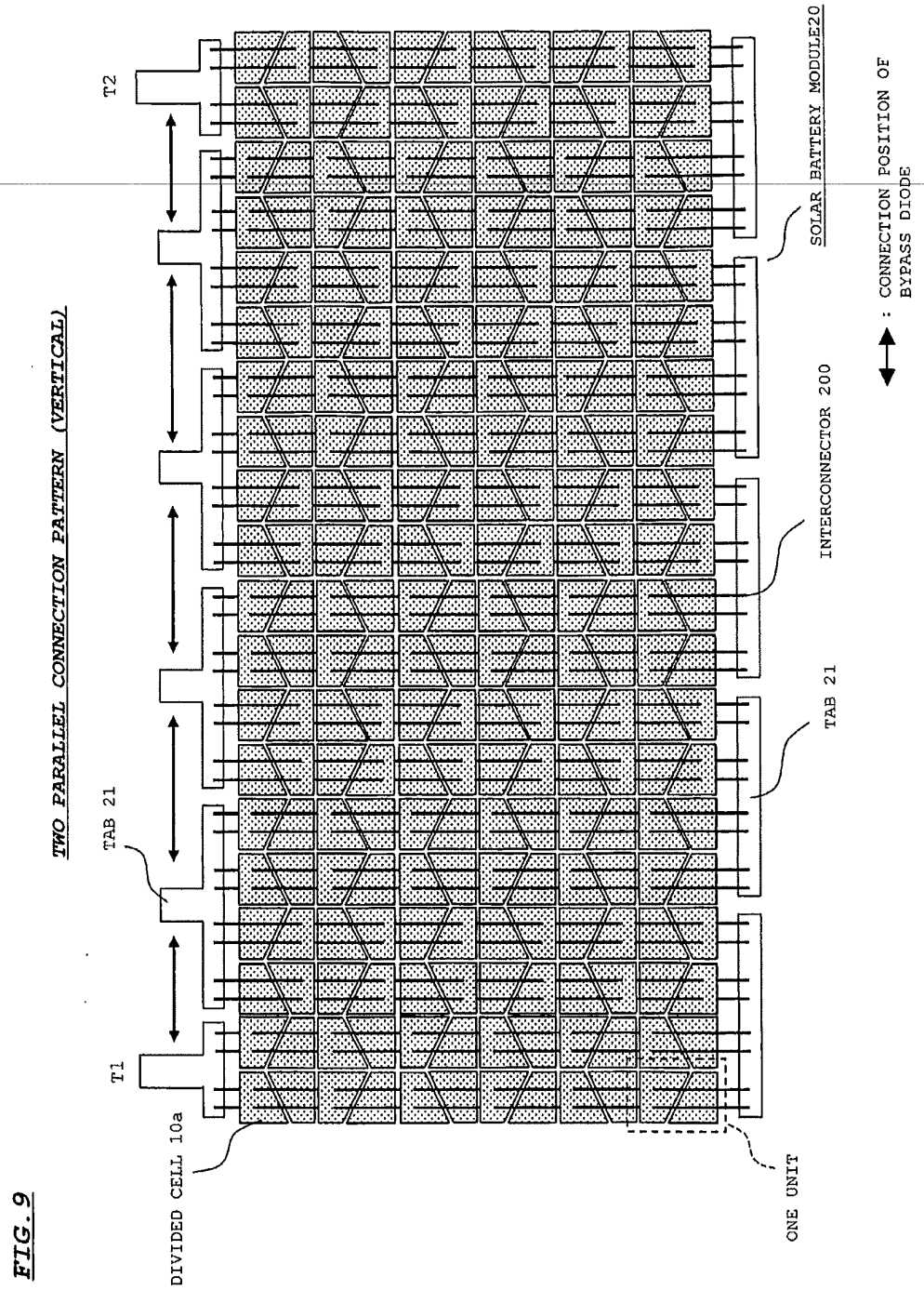
TWO PARALLEL CONNECTION PATTERN (LATERAL)



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FIG. 9

TWO PARALLEL CONNECTION PATTERN (VERTICAL)



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FIG.10A

MODIFICATION OF UNIT CONFIGURATION
(ONE UNIT = FOUR DIVIDED CELLS)

EXAMPLE OF CONNECTION BETWEEN UNITS

FIG.10B

SECTIONAL VIEW TAKEN ALONG LINE C-C'

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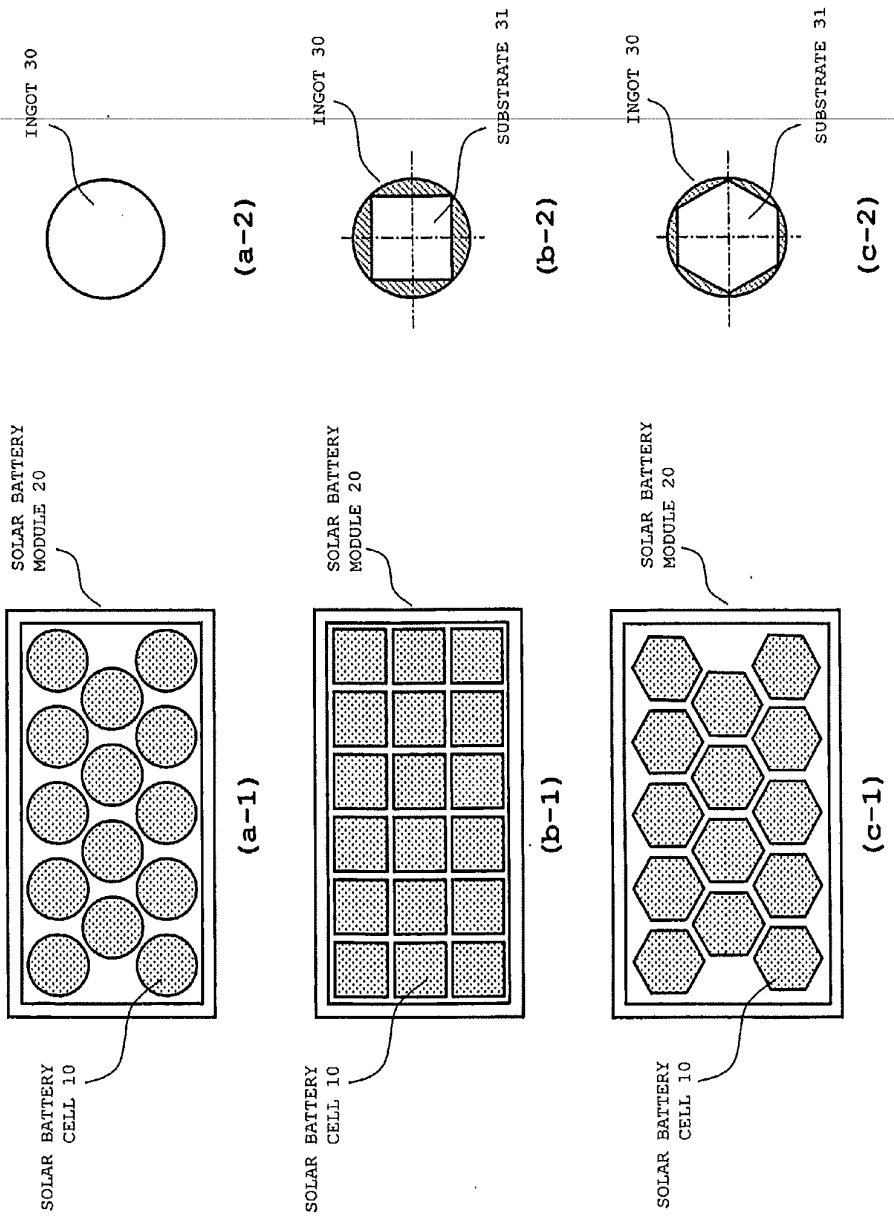


FIG. 11

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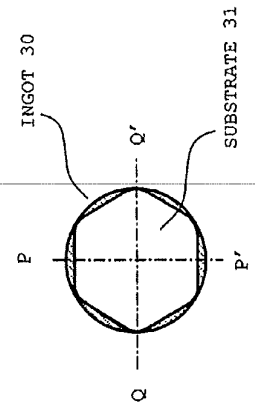


FIG. 12B

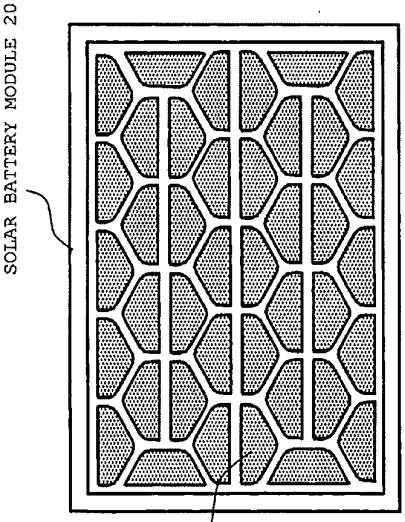


FIG. 12A

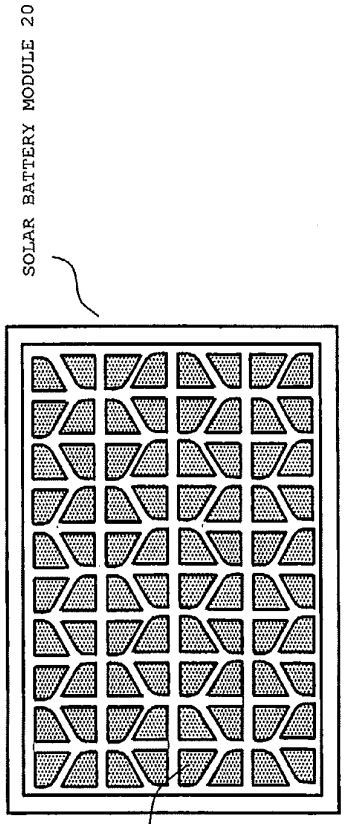


FIG. 12C

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FIG. 13A

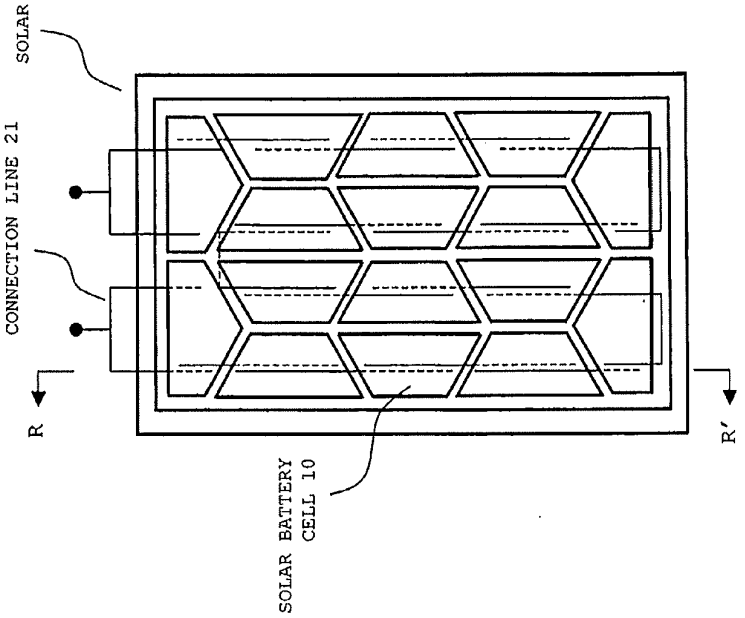
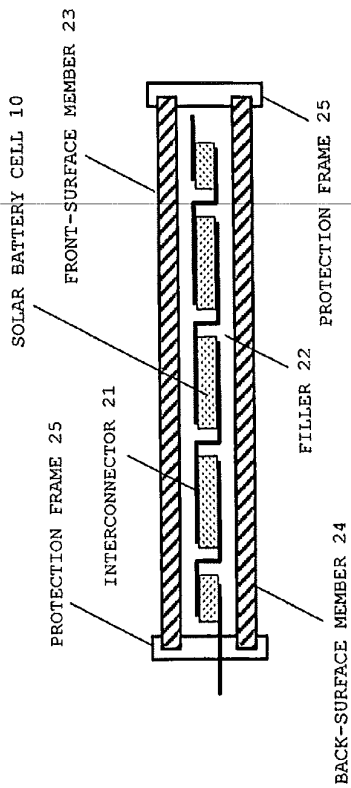


FIG. 13B



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REFERENCES CITED IN THE DESCRIPTION

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- JP 2001094127 A **[0008] [0013]**
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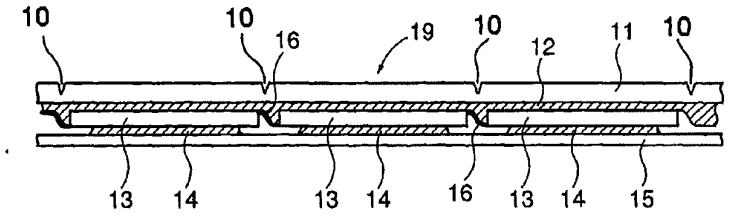
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(54) Solar cell module and solar cell panel

(57) A solar cell module includes a substrate (15), a plurality of solar cells (13) arranged in a plane on the substrate, a connection member (16) for electrically connecting the plurality of solar cells to each other to form a power generating circuit, and a single transparent cover sheet (11) for covering the plurality of solar cells and the connection member.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a solar cell module and a solar cell panel using the same, and particularly to a solar cell module including a plurality of cells covered with cover glass sheets and a solar cell panel using the solar cell module.

2. Description of Related Art

[0002] Referring to Fig. 15, a conventional solar cell module 9 for use in space is formed by bonding cover glass sheets 1 to a plurality of solar cells 3 with adhesive layers 2, connecting the cells 3 to each other in parallel and in series using interconnectors 6, and bonding the cells to a substrate 5 with adhesive layers 4. The solar cell module 9 includes a bus bar 8 through which the module 9 is electrically connected with another solar cell module. Consequently, the interconnectors 6 and the bus bar 8 mounted at an end of the module 9 are exposed to the environment in space (see Japanese Unexamined Patent Publication No. HEI 5(1993)-136441, for example).

[0003] The space environment is also an electromagnetic environment, where ionized electrons and ions exist in a plasmatic state. Therefore, the solar cell module 9, whose interconnectors 6 are exposed in such an environment, may electrically discharge via the interconnectors 6, which results in a decrease in generated electric power and destruction of the solar cells 3. For this reason, the interconnectors 6 themselves are covered with an insulating resin (see Japanese Unexamined Patent Publication No. HEI 61(1986)-202474, for example).

[0004] Also, in the conventional module, the adhesive layer 2 is forced out of the sides onto the top surface of the cover glass sheets 1 when the solar cells are bonded to the cover glass sheets 1, as shown in Fig. 16. If the forced out adhesive layer 2 is exposed to the space environment, it reduces its light transmittance and consequently decreases the output of the solar cells 3 thereunder. Therefore, the forced out adhesive layer needs to be removed. The removal thereof causes failures in production since the solar cells 3 and the cover glass sheets 1 are usually as thin as 50 μm to 200 μm and apt to break easily.

[0005] Further, in the conventional module, to bond each cover glass sheet 1 to each solar cell 3 takes a lot of time and labor. Besides, portions of the solar cells 3 which are not covered with the cover glass sheets 1 are deteriorated rapidly in the space environment, especially even due to low-energy protonic radiation. On the other hand, if the cover glass sheets 1 are larger than the solar cells 3, the ratio of the area of the solar cells 3 to the total area of the module decreases and accordingly the output of the solar cell module per unit area declines.

[0006] For this reason, it is not preferable to use larger cover glass sheets than the solar cells 3. Accordingly, at the boding of the glass sheets 1 to the solar cells 3, high accuracy in size is required so that each solar cells 3 is not projected from each cover glass sheet 1. This makes the bonding operation more time- and labor-consuming.

[0007] Furthermore, inexact positioning between the solar cells 3 and the cover glass sheets 1 results in an increased distance between adjacent solar cells and a consequent decline in power-generating efficiency per area.

SUMMARY OF THE INVENTION

[0008] The present invention provides a solar cell module including a substrate; a plurality of solar cells arranged in a plane on the substrate; a connection member for electrically connecting the plurality of solar cells to each other to form a power generating circuit; and a single transparent cover sheet for covering the plurality of solar cells and the connection member.

[0009] According to the present invention, because the single transparent cover sheet serves to cover the plurality of solar cells, accurate positioning of the solar cells is not required except in the periphery of the module, and there is little possibility of the adhesive layer being forced out onto the transparent cover sheet. Also because the electric connection member between the solar cells is covered with the transparent cover sheet, the connection member is less affected adversely by the electromagnetic environment in space.

[0010] These and other objects of the present application will become more readily apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Fig. 1 is a sectional view of a main part of a solar cell module in accordance with one embodiment of the present invention;

Fig. 2 is a plan view of the solar cell module shown in Fig. 1;

Fig. 3 is a side view of the solar cell module shown in Fig. 2;

Fig. 4 is an electric circuit diagram illustrating a circuit of the solar cell module shown in Fig. 2 and

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showing a way the solar cell module is used;

Fig. 5 is a plan view of an example of a panel in which solar cell modules as shown in Fig. 2 are incorporated;

Fig. 6 is a plan view of a solar cell module in accordance with another embodiment of the present invention;

Fig. 7 is an enlarged view of a main part illustrating a modification of the solar cell module of the present invention;

Fig. 8 is an enlarged view of a main part illustrating another modification of the solar cell module of the present invention;

Fig. 9 is a plan view of a solar cell module in accordance with another embodiment of the present invention;

Fig. 10 is a sectional view of a main part of a solar cell module in accordance with another embodiment of the present invention;

Fig. 11 is a sectional view of a main part of a solar cell module in accordance with another embodiment of the present invention;

Fig. 12 is a sectional view of a main part of a solar cell module in accordance with another embodiment of the present invention;

Fig. 13 is a sectional view of a main part of a solar cell module in accordance with another embodiment of the present invention;

Fig. 14 is an enlarged view of a main part of the solar cell module shown in Fig. 13;

Fig. 15 is a sectional view of a main part of a conventional solar cell module;

Fig. 16 is an enlarged sectional view of a main part of the conventional solar cell module;

Fig. 17 is a side view of a solar cell module in accordance with another embodiment of the present invention;

Fig. 18 is a plan view illustrating a way solar cell modules as shown in Fig. 17 are arranged;

Fig. 19 is a side view illustrating the way solar cell modules as shown in Fig. 17 are arranged.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] The substrate in the present invention preferably has flexibility to some extent in view of the possibility that the solar cell module may be mounted on a panel having a curvature. For this purpose, a film of a polyimide resin having a thickness of 0.1 to 0.2 mm or an FRP film may be used as the substrate. As solar cells, usable are conventionally known cells such as what are called silicon solar cells which are constructed, for example, by diffusing P-type impurities in a surface area of N-type silicon wafer. Such solar cells have, for example, a thickness of 50 μm to 200 μm and a size of 65mm × 105mm. The size of the solar cell is generally determined by a wafer size to be used.

[0013] The connection member for electrically connecting the solar cells to each other means a member generally referred to as an interconnector in the field of art which serves for connection between solar cells and a member generally referred to as a bus bar in the field of art which serves to take output current from a solar cell module. The interconnector preferably has a structure for absorbing an external stress, i.e., what is called stress relief structure. As materials for the bas bar, silver, gold-plated silver, silver-plated Koval (trademark for an iron-nickel-cobalt alloy), molybdenum, aluminum, copper and the like may be mentioned. The single transparent cover sheet may have a thickens of 50 μm to 200 μm and a size of 150mm × 200mm to 300mm × 400mm to covering 5-20 solar cells.

[0014] The transparent cover sheet, which is usually referred to as a cover glass sheet, is preferably made of a material which does not color when exposed to radiation from space, efficiently transmits light having wavelengths suiting the wavelength sensitivity of the solar cells (for example, light with wavelengths of 0.35 μm to 1.2 μm) can provide good protection for the solar cells against radiation from space and has a good mechanical strength and thermal resistance. For example, an inorganic glass sheet having a thickness of about 50 μm to 200 μm may be used. Especially a cerium-containing glass is preferred since it is not apt to color when exposed to cosmic rays and the like.

[0015] In the solar cell module of the present invention, a plurality of solar cells are connected in series and/or in parallel by the connection member to form a power generating circuit. Where a number of solar cell modules are combined to form a solar cell panel, a protecting element such as a diode or switching device is preferably connected to each power generating circuit in parallel so that, if any certain module or certain cell cannot receive solar light for an external cause, electric current may bypass the power generating circuit through the protecting element.

[0016] The protecting element may be connected to each solar cell in parallel. However, since such arrangement requires a large number of protecting elements, it is preferable that one protecting element is connected to each module, i.e., each power generating circuit.

[0017] Where a plurality of solar cell modules according to the present invention are combined to form a solar cell panel, the output of which is usually connected to a load and a battery, it is preferable to connect a protecting element such as an inverse voltage stop diode, i.e., a blocking diode, in series to each solar cell module for blocking inverse voltage from the battery when the solar cell modules cannot receive solar light.

[0018] The above-mentioned protecting elements such as bypass diodes or blocking diodes are placed between the substrate and the transparent cover sheet. In this case, at least one of the solar cells may be provided with a notch for accommodating the bypass diode or blocking diode in a space defined by the notch.

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[0019] Where there exist spaces between adjacent cells, such a diode may be put in the space. In such case, the bypass diode and blocking diode preferably have a shape (e.g., have a triangular or trapezoidal cross section) corresponding to the spaces in which they are accommodated.

[0020] The solar cell module of the present invention may further be provided with a connecting terminal for connecting the output of the electric circuit to outside. For ensuring a space for accommodating the connecting terminal, the solar cells may be provided with a notch.

[0021] Where the connecting terminals as described above are used for connection between solar cell modules, the transparent cover sheets of the modules may be provided with notches beforehand in correspondence to the connecting terminals. After the solar cell modules are connected to each other, the notches of the transparent cover sheets are covered with glass or ceramics in order that the connecting terminals are sheltered from radiation and from an electric-field environment in the space.

[0022] In one solar cell module, a plurality of independent power generating circuit may be formed. In such a case, the bypass diode is preferably connected in parallel to each power generating circuit.

[0023] A plurality of solar cell modules may be combined to form an electric power generating circuit.

[0024] Preferably, the solar cells are bonded to the transparent cover sheet with a resin layer and the resin layer is made of a silicone resin which emits little gas. In this case, since the silicone resin drastically changes its properties at a low temperature (about -100°C), an isolation member is preferably provided for dividing the resin layer in order to decrease stress generated when the properties change.

[0025] The transparent cover sheet may be provided with projections for positioning the solar cells.

[0026] In order to absorb the distortion caused by the difference in thermal expansion coefficient between the solar cells and the transparent cover sheet, a member having a higher thermal expansion coefficient than the solar cells are preferably placed between adjacent solar cells.

[0027] Preferably, these members are less stiff than the solar cells so as to ease mechanical stress.

[0028] A member extending between adjacent solar cells whose tip abuts the transparent cover sheet may be mounted on the substrate. The tip may be adapted to reflect solar light and make it incident onto the solar cells.

[0029] The transparent cover sheet may be composed of a plurality of small glass sheets each having the same size as the solar cell which are flatly patched to be changed into a single transparent cover sheet using a bonding material having a lower thermal expansion coefficient than the small glass sheets.

[0030] Preferably, the transparent cover sheet is formed beforehand to include a cut or slit which allow the transparent cover sheet to break between adjacent solar cells when the cover sheet receives mechanical or thermal stress.

[0031] In another aspect, the present invention also provides a solar cell module including a plurality of solar cells electrically connected to each other and arranged planarly; and a single transparent cover sheet for covering the plurality of solar cells, wherein the plurality of solar cells are bonded to the transparent cover sheet.

[0032] According to this arrangement, because the solar cells with an electric connection member (an interconnector) for connecting the solar cells to each other are also covered with the transparent cover sheet, the solar cells and connection member are less affected by the electromagnetic environment in the space.

[0033] In this case, a plurality of solar cell modules can be placed in a plane on one substrate for use. Accordingly, workability in handling and installing the solar cells improves.

EXAMPLES

[0034] The invention is now detailed further with reference to the accompanying figures.

[0035] Fig. 1 is a sectional view of a main part of a solar cell module 19 in accordance with one embodiment of the present invention. As shown in the figure, the solar cell module 19 is provided with a substrate 15, a plurality of solar cells 13 arranged in a plane on the substrate 15 and bonded thereto with adhesive layers 14, connecting members, i.e., interconnectors 16, for electrically connecting the plurality of solar cells 13 to each other, and a single cover glass sheet 11 covering the solar cells 13 and the interconnectors 16. The cover glass sheet 11 is bonded to the solar cells 13 and interconnectors 16 with an adhesive layer 12.

[0036] The solar cell module 19 is constructed such that the plurality of solar cells 13 are covered with the single cover glass sheet 11. Thus, to place the solar cells 13 within the cover glass sheet 11, high accuracy of positioning the solar cells 13 is not required.

[0037] The adhesive layer 12 is not pushed out onto the upper face of the cover glass sheet 11 except the periphery.

[0038] Though not shown, if the interconnectors 16 are constructed to have a stress relief portion, stress is absorbed even if distortion is generated by a thermal environment in the space, so that detachment of the adhesive layer 12 and damage to the solar cells 13 and the cover glass sheet 11 can be reduced.

[0039] Preferably, as shown in Fig. 1 the cover glass sheet 11 is formed beforehand to have slit-like cuts 10 along boundary lines between the solar sells 13 on a surface thereof so that the slit-like cuts 10 allow the cover glass 11 to break between the adjacent solar cells 13 when the cover glass sheet 11 is subjected to an excessive stress. With this construction, more signifi-

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cant damage to the solar cells 13 can be avoided.

[0040] Fig. 2 is a plan view of the solar cell module 19 of this embodiment and Fig. 3 is a side view thereof. It is noted that Fig. 2 shows a state of the module 19 in which the substrate 15 is taken off for simplicity of drawing. In these figures, five solar cells 13 are bonded in each of the right and left columns to the cover glass sheet 11. Further, a bypass diode 17, a blocking diode 29 and bus bars 18 also are bonded to the cover glass sheet 11.

[0041] Thus, all necessary electric circuit components of the module, i.e., the solar cells 13, interconnectors 16, bus bars 18, bypass diode 17 and blocking diode 29 are covered with the cover glass sheet 11 and can be protected from the space environment. Fig. 4 is an electric circuit diagram illustrating an example of a circuit in this module.

[0042] Fig. 4 shows an electric circuit of a solar cell panel including four solar cell modules 19. In each solar cell module 19, two sets of series circuits each having five solar cells 13 connected in series by interconnectors 16 are further connected in series by another bus bar 18 to form a single power generating circuit. One end of the power generating circuit is taken out by a bus bar 18 and another end thereof is taken out via a blocking diode 29. This power generating circuit is connected to a bypass diode 17 in parallel.

[0043] The four solar cell modules 19 are connected to each other in series and parallel to supply power to a load L via a switch S. A supplementary battery B is inserted across the load L.

[0044] When the four solar cell modules 19 are irradiated with light, they supply power to the load L and charge the battery B. If one of the four solar cell modules 19 is not irradiated with light, current from the other solar cell modules 19 is supplied to the load L and battery B via the bypass diode 17 of the non-irradiated solar cell module 19. If the voltage generated by one of the solar cell modules 19 declines and inverse voltage is applied from the battery B to the solar module 19, the blocking diode 29 acts to stop the inverse voltage to protect the solar cell module 19.

[0045] Next, Fig. 5 is a plan view of a solar cell panel 22 in which ten solar cell modules 19 are electrically connected in series or in parallel and mounted on a base plate 25.

[0046] Fig. 6 illustrates another embodiment of the present invention, in which solar cells 13 are shaped to have notches in their both shoulders. Spaces defined by the notches are used for connection between adjacent solar cell modules 19. Cover glass sheet 11 also has a cut portion corresponding to the connection portion. Small cover glass sheet, not shown, is bonded there to cover the cut portion after the modules have been connected. The connection of the modules 19 is performed by soldering or welding.

[0047] Figs. 7 and 8 are enlarged views of main parts of modified examples of the solar cell modules 19. Figs. 7 and 8 show the blocking diodes 29 of different shapes, illustrating how two adjacent solar cell modules 19 are connected to each other through the blocking diode 29. Fig. 7 shows a case where the blocking diode 29 has a triangular-shape and Fig. 8 shows a case where the blocking diode 29 has a rectangular-shape with substantially the same width as a bus bar 18.

[0048] Fig. 9 is a plan view illustrating another embodiment of the present invention. In the figure, a solar cell panel 22 is composed of a combination of four solar cell modules 19a and four solar cell module 19b. The solar cell module 19a is provided with two sets of series circuits of five solar cells 13, a bypass diode 17 and a blocking diode 29. The solar cell module 19b is provided only with a set of a series circuit of ten solar cells 13.

[0049] By connecting the solar cell modules 19a and 19b as shown in Fig. 9, obtained is an electric circuit like the circuit of Fig. 4. This arrangement is effective in the case where the solar cell module is too long to be covered with a single cover glass sheet and provide good working and handling properties. All components of each of the solar cell modules 19a and 19b are covered with a cover glass sheet 11 as shown in Fig. 1.

[0050] Figs. 10 to 14 are sectional views of main parts illustrating modifications at the bonding portions of the solar cells 3. Fig. 10 shows an example in which the cover glass sheet 11 is provided with projections 34 for easy positioning and bonding of a plurality of solar cells 13. When the surface of the cover glass sheet 11 is shaped, the projections 34 are formed, for example, by a mechanical process or by an etching process with alkali or the like, or by attaching members of glass or ceramics to the surface.

[0051] When in thermal expansion coefficient the cover glass sheet 11 is larger than the materials of the solar cells 13 and the substrate 15 (Fig. 1), a thermal distortion may be generated by the thermal environment in space, which results in detachment of the adhesive layer 12 and damage to the solar cells 13 and the cover glass sheet 11. To prevent this, provided between the solar cells 13 are members 35 having a higher thermal expansion coefficient and a lower stiffness than the solar cells 13, as shown in Fig. 11. This construction can absorb the thermal distortion.

[0052] When a silicone adhesive is used for the adhesive layer 12, the silicon adhesive layer may break the solar cells 13 or the cover glass sheet 11 because the silicon adhesive radically changes its physical properties as it is cooled to a low temperature, e.g., -100°C. That is, its thermal expansion coefficient, elasticity modulus and the like change by several digits. Especially, a larger cover glass sheet 11 and an adhesive layer applied in a larger area will be more affected by changes in temperature.

[0053] For this reason, as shown in Fig. 12, separating members 36 are provided between solar cells for separating the adhesive layer 12 so as to prevent the

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adhesive layer 12 from forming a single continuous layer.

[0054] The above-mentioned members 35 and 36 may be made of a material such as a silicon resin, an epoxy resin, an acrylic resin or the like.

[0055] The cover glass sheet 11 may be formed by flatly patching a plurality of small glass sheets using a adhesive having a smaller thermal expansion coefficient than the small glass sheets. With this construction, the mechanical and thermal stress on the cover glass sheet 11 may be reduced and consequently the cover glass sheet 11 is less liable to break.

[0056] Fig. 13 shows an example in which members 37 are mounted on a substrate 15 for positioning the solar cells 13 or for separating the adhesive layer. As the members 37, may be used those having a sharp tip and high reflecting properties so as to reflect solar light 38 and render it incident on the solar cells 13, as shown in Fig. 14. This reflection by the members 37 increases the amount of solar light incident on the surface of the solar cells 13. Thus the power generated by the solar cell module increases. The tips of the members 37 may be coated with aluminum or silver by deposition for improvement of their reflectance.

[0057] Fig. 17 is a side view illustrating still another embodiment of the present invention.

[0058] As shown in the figure, in a solar cell module 19c, a plurality of solar cells 13 are arranged in a plane and electrically connected to each other using interconnectors 16. Then the solar cells 13 and the interconnectors 16 are covered with a single cover glass sheet 11. The solar cells 13 and the interconnectors 16 are fixed on a lower surface of the cover glass sheet 11 with an adhesive layer 12 such as a silicone adhesive layer. In other words, the solar cell module 19c of this embodiment is formed by excluding the substrate 15 from the solar cell module 19 shown in Fig. 1.

[0059] The cover glass sheet 11 shown in Fig. 17 may also include the projections 34 as shown Fig. 10 for positioning the solar cells 13.

[0060] Figs. 18 and 19 are a plan view and a side view illustrating a solar cell panel constructed by use of eight of the solar cell modules 19c. Here, the eight solar cell modules 19c are arranged in a plane on a single substrate 15a and electrically connected to each other in series and parallel to compose a single power generating circuit. Also in this embodiment, since the solar cells 13 and the interconnectors 16 are covered with the cover glass sheet 11 as shown in Fig. 17, effect by the electromagnetic environment in space is reduced. Further, since the solar cell modules 19c can be set on the single substrate 15a, the solar cell modules 19c can be easily handled or installed.

[0061] According to the present invention, since a plurality of solar cells are bonded to a single cover glass sheet, strict positioning of the cover glass sheet and the solar cells is not necessary any more. Also, an adhesive layer does not leak out onto the upper surface of the cover glass sheet, and therefore, the assembly of the solar cells is greatly simplified. In the case where the cover glass sheet and solar cells need to be positioned accurately, the cover glass sheet may be provided beforehand with projections for positioning the solar cells for simplifying the positioning operation.

[0062] Further, since the electrical connection members between the solar cells are also covered with the cover glass sheet, the electrical connection members less interacts with the electromagnetic environment in space.

[0063] Furthermore, the setting between the solar cells of the members which are less stiff and have a higher thermal expansion coefficient than the solar cells reduces thermal distortion caused by the thermal environment in space. As a result, the detachment of the adhesive and damage to the solar cells and cover glass sheet are reduced.

Claims

1. A solar cell module comprising:

   a substrate;
   a plurality of solar cells arranged in a plane on the substrate;
   a connection member for electrically connecting the plurality of solar cells to each other to form a power generating circuit; and
   a single transparent cover sheet for covering the plurality of solar cells and the connection member.

2. A solar cell module according to claim 1, wherein the single transparent cover sheet has a size of 150mm × 200mm to 300mm × 400mm to cover 5 to 20 solar cells.

3. A solar cell module according to claim 1, wherein the transparent cover sheet is made of a cerium-containing glass and is 50 μm to 200 μm in thickness.

4. A solar cell module according to claim 1, wherein the solar cells are 50 μm to 200 μm in thickness.

5. A solar cell module according to claim 1, wherein the solar cells are bonded to the transparent cover sheet.

6. A solar cell module according to claim 1, wherein the transparent cover sheet has projections for positioning the solar cells, the projections extending toward the solar cells.

7. A solar cell module according to claim 1, further comprising a dividing member, wherein the solar cells are bonded to the transparent cover sheet via

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an adhesive layer and the dividing member intervenes between adjacent solar cells to divide the adhesive layer for every solar cell.

8. A solar cell module according to claim 1, further comprising a reflection member which extends from the substrate and passes between solar cells and whose tip abuts the transparent cover sheet, the tip of the reflection member being so formed to reflect light incident from the transparent cover sheet toward the solar cells.

9. A solar cell module according to claim 1, further comprising a member for absorbing thermal expansion between the solar cells.

10. A solar cell module according to claim 9, wherein the member for absorbing thermal expansion is lower than the solar cells in rigidness.

11. A solar cell module according to claim 1, wherein the transparent cover sheet has a slit-like cut so that the transparent cover sheet is broken at the cut by mechanical or thermal stress.

12. A solar cell module according to claim 1, further comprising a protective electronic element added to the power generating circuit and provided between the substrate and the transparent cover sheet.

13. A solar cell module according to claim 12, wherein the protective electronic element is a bypass diode or a blocking diode.

14. A solar cell module according to claim 12, wherein at least one of the solar cells has a notch and the protective element is placed in the notch.

15. A solar cell module according to claim 14, wherein the protective electronic element has a shape corresponding to the shape of the notch.

16. A solar cell module according to claim 1, further comprising a connecting section for electrically connecting the power generating circuit to an external circuit, wherein at least one of the solar cells has a notch and the connecting section is placed in the notch.

17. A solar cell panel comprising a plurality of solar cell modules as set forth in claim 1.

18. A solar cell panel comprising a plurality of solar cell modules as set forth in claim 1 and a base plate for mounting the plurality of solar cell modules.

19. A solar cell module comprising:

a plurality of solar cells electrically connected to each other and arranged in a plane; and

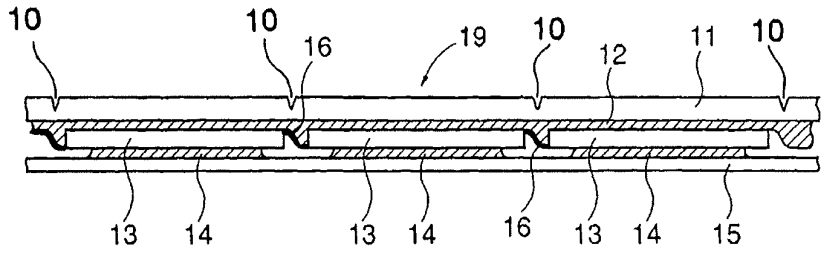
a single transparent cover sheet for covering the plurality of solar cells,

wherein the plurality of solar cells are bonded to the transparent cover sheet.

20. A solar cell panel comprising a plurality of solar cell modules as set forth in claim 19, the solar cell modules being arranged in a plane on a substrate.

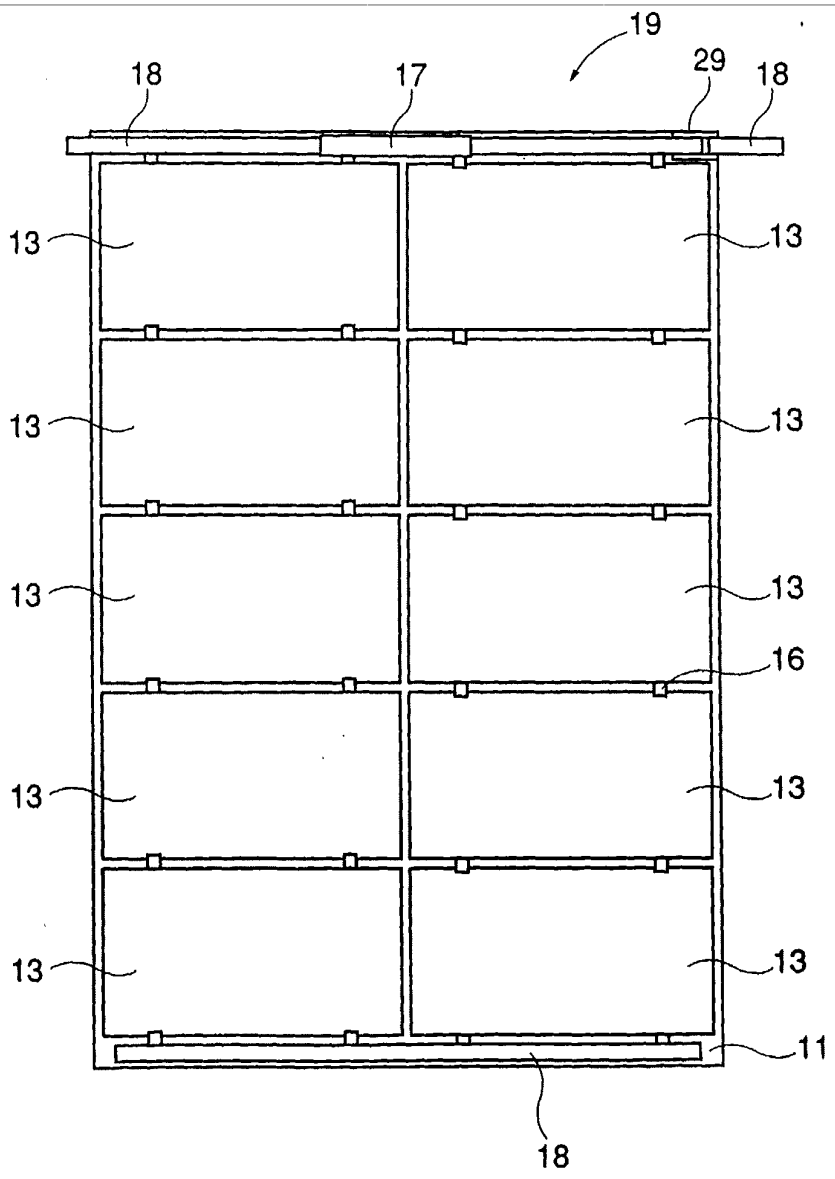
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FIG. 1



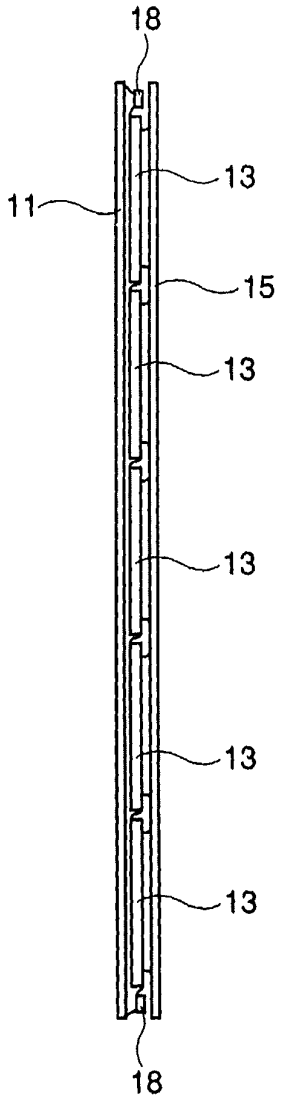
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FIG. 2



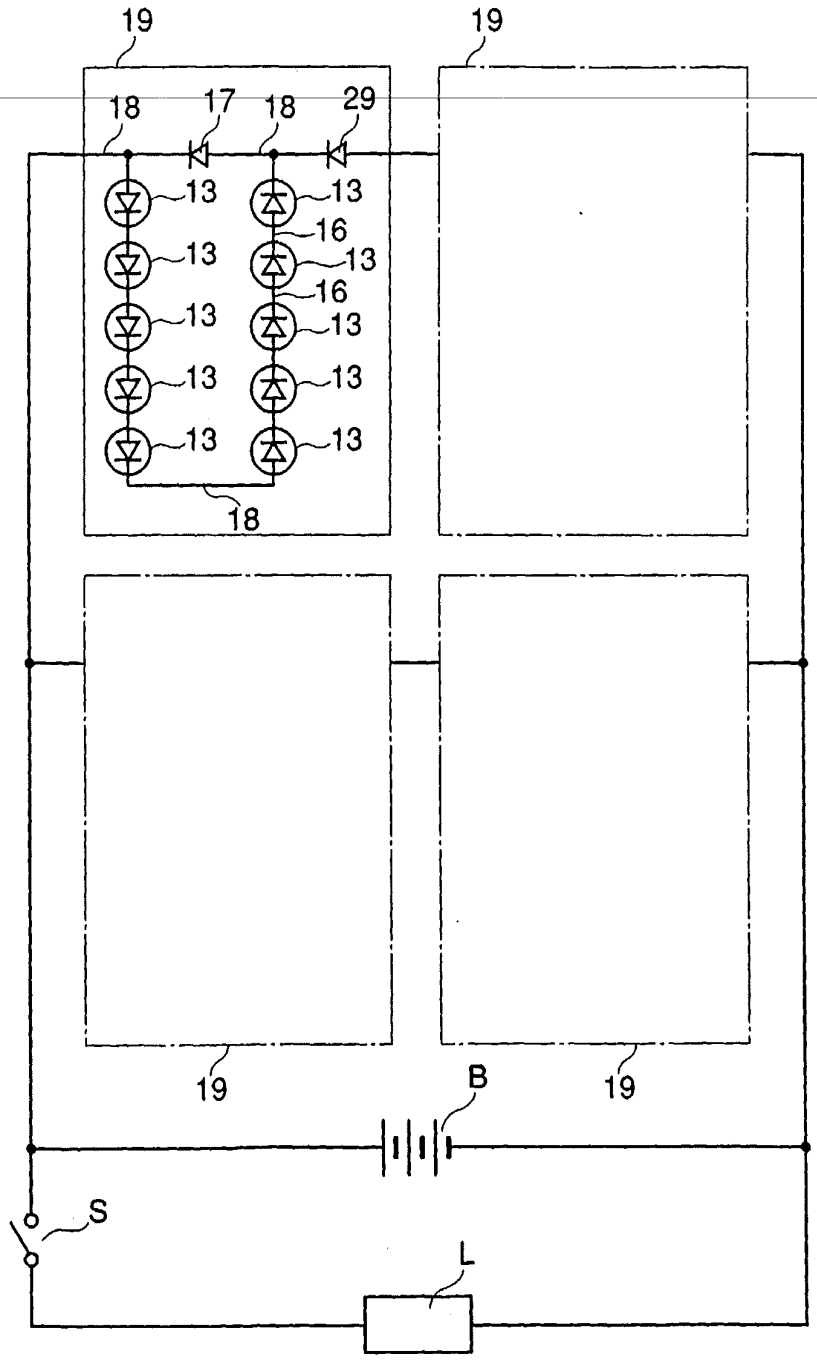
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FIG. 3



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FIG. 4



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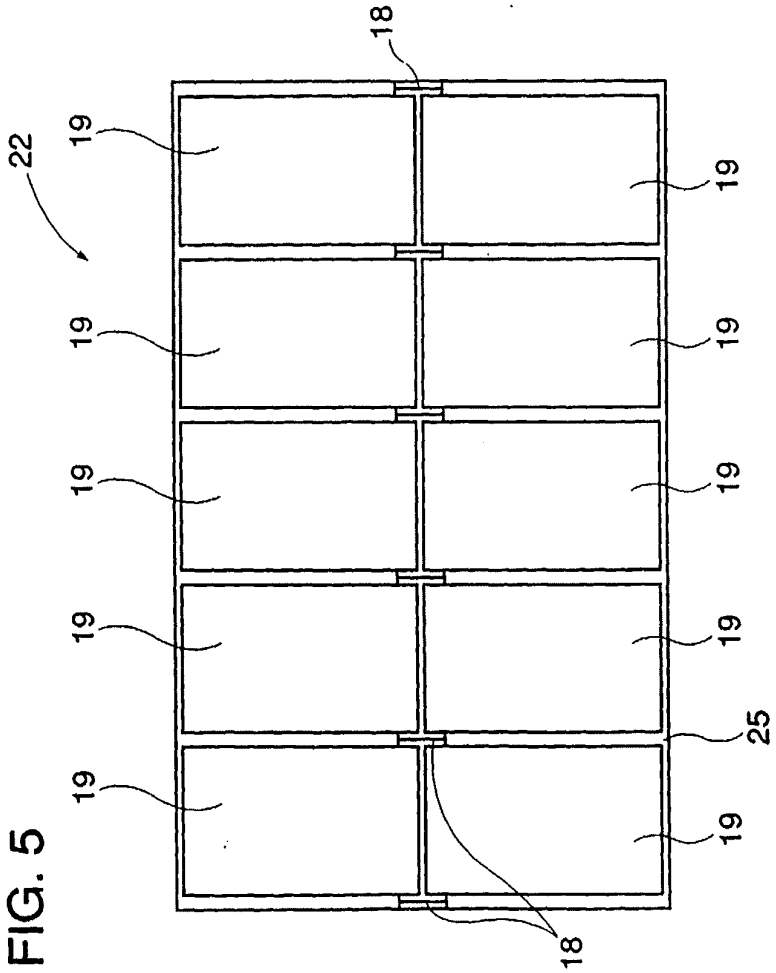
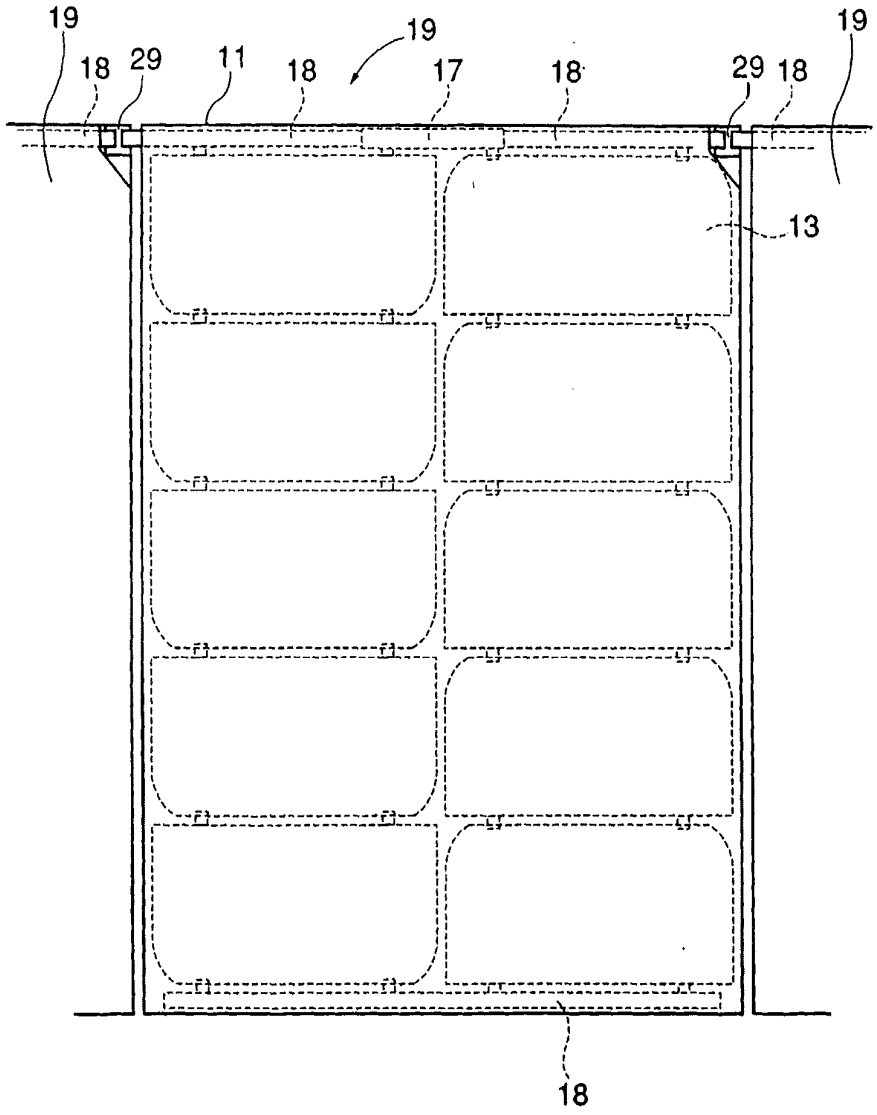


FIG. 5

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FIG. 6



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FIG. 7

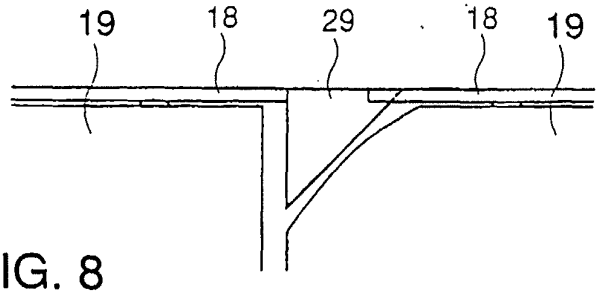
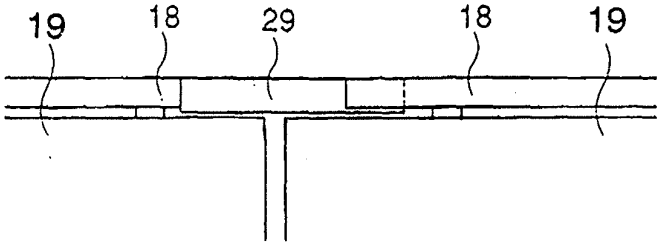
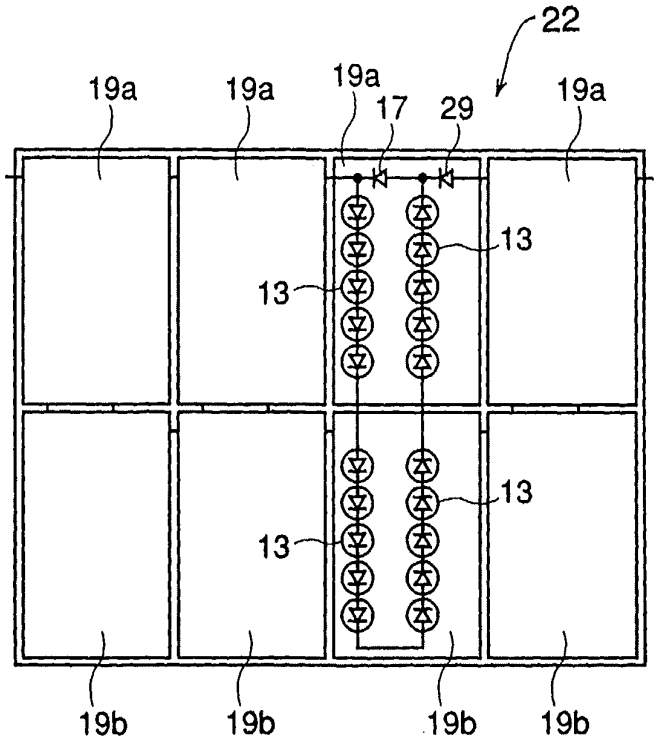


FIG. 8



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FIG. 9



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FIG. 10

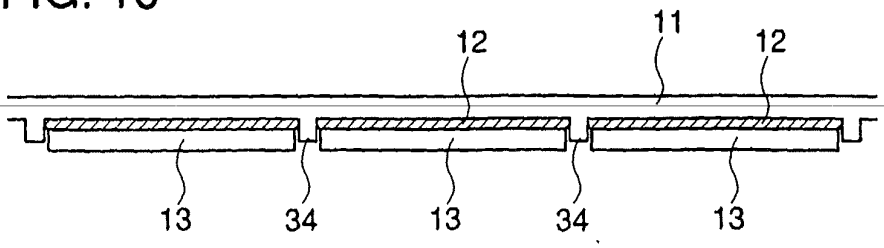


FIG. 11

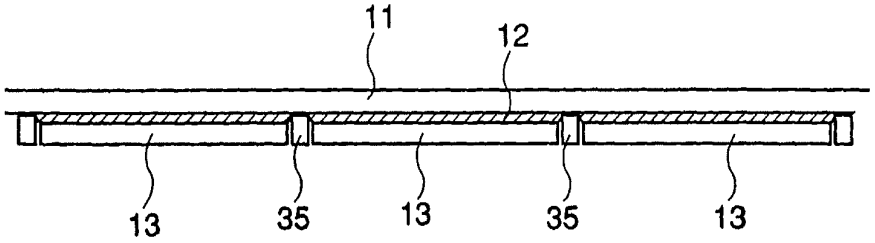
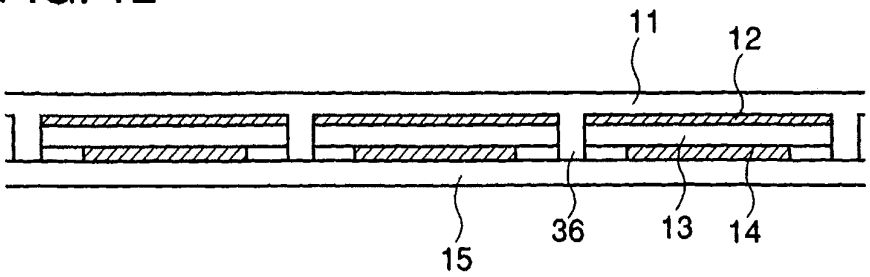


FIG. 12



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FIG. 13

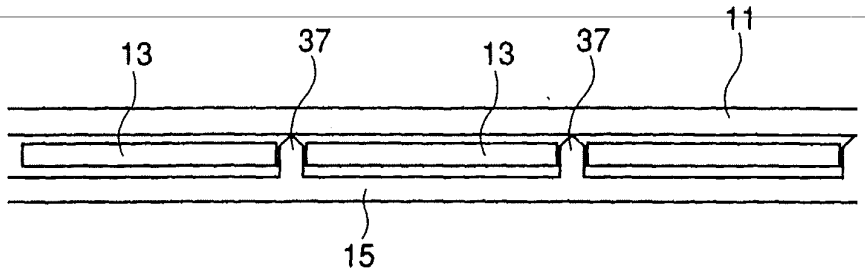
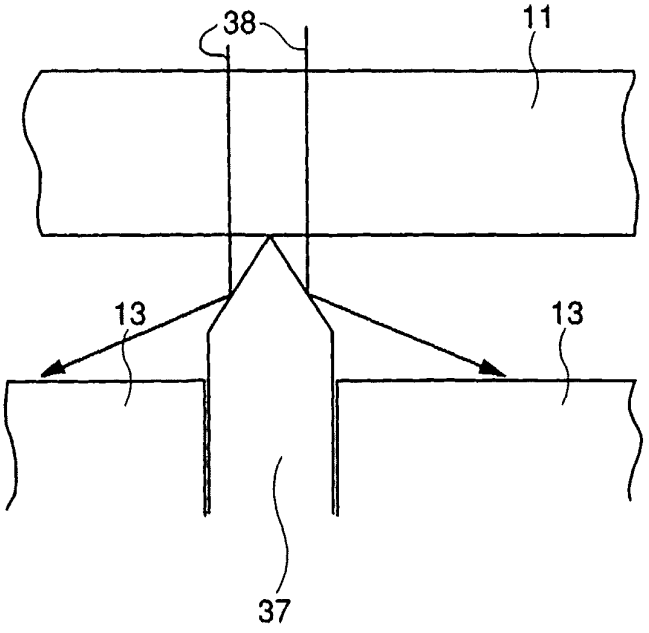


FIG. 14



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FIG. 15 PRIOR ART

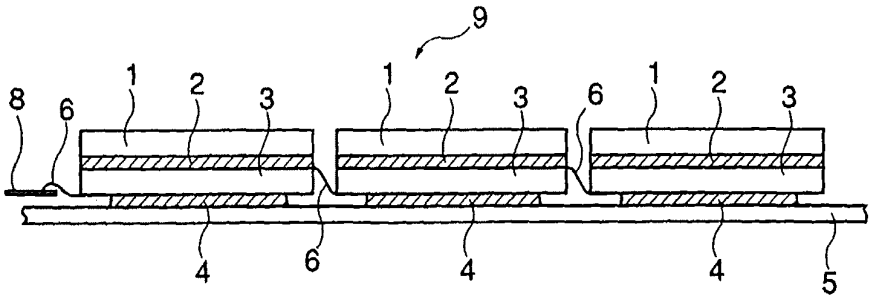
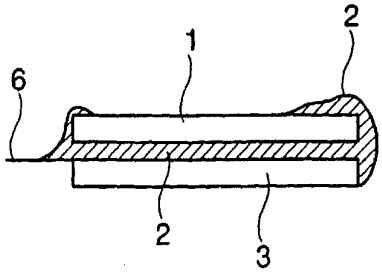


FIG. 16 PRIOR ART



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FIG. 17

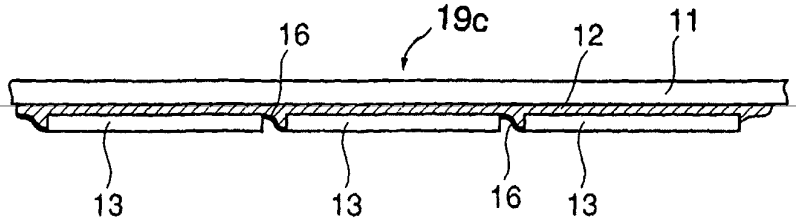


FIG. 18

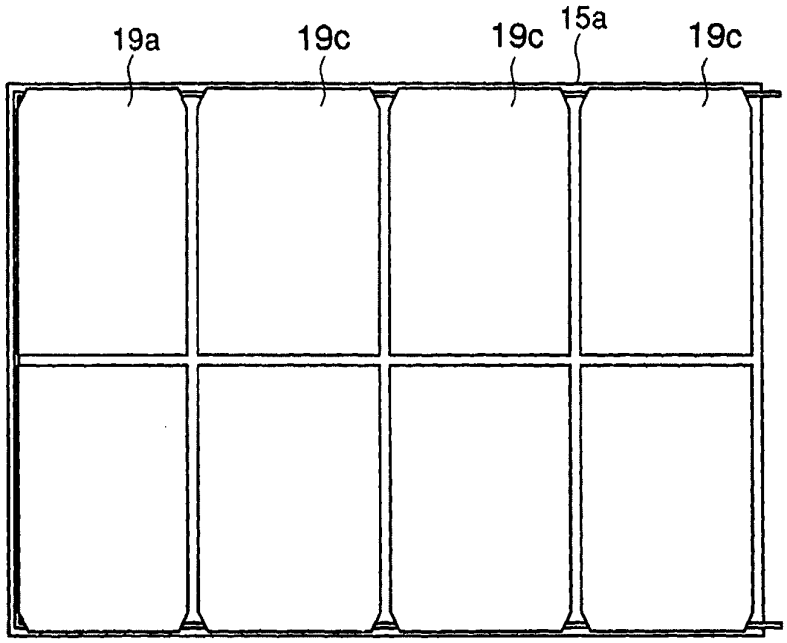
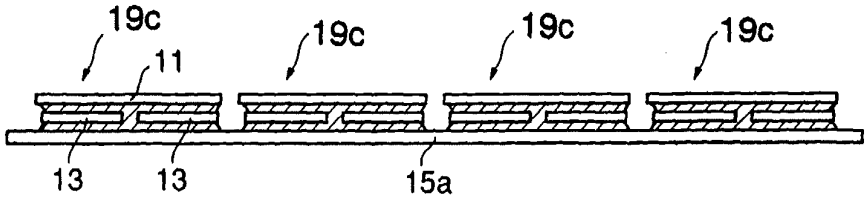


FIG. 19



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EUROPEAN SEARCH REPORT

Application Number
EP 00 10 3057

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	31 May 2000	Berthold, K

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X : particularly relevant if taken alone
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EUROPEAN SEARCH REPORT

Application Number
EP 00 10 3057

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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Place of search	Date of completion of the search	Examiner
MUNICH	31 May 2000	Berthold, K

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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Electronic Acknowledgement Receipt

EFS ID:	20403342
Application Number:	13806793
International Application Number:	
Confirmation Number:	2289
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Customer Number:	21839
Filer:	David Ray Kemeny/Michele Shockey
Filer Authorized By:	David Ray Kemeny
Attorney Docket Number:	1032404-000416
Receipt Date:	14-OCT-2014
Filing Date:	24-DEC-2012
Time Stamp:	09:28:13
Application Type:	U.S. National Stage under 35 USC 371

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/806,793	12/24/2012	Koji Shimasaki	1032404-000416	2289

21839 7590 11/20/2014

BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

EXAMINER
GONZALEZ RAMOS, MAYLA

ART UNIT	PAPER NUMBER
1758	

NOTIFICATION DATE	DELIVERY MODE
11/20/2014	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ADIPDOC1@BIPC.com

Office Action Summary	Application No. 13/806,793	Applicant(s) SHIMASAKI ET AL.	
	Examiner MAYLA GONZALEZ	Art Unit 1758	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *07/15/2014*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1 and 4-12* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1 and 4-12* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *12/24/2012* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *10/14/2014*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Status of Claims

1. **Claim(s)** 1 and 4-12 are currently pending.
2. **Claim(s)** 1, 5, 6, and 8 have been amended.
3. **Claim(s)** 2-3 have been canceled.
4. **Claim(s)** 9-12 have been added.

Claim Interpretation

Herein, the limitation “a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2)” is interpreted as the length of the long side of each solar cell being at least twice as long than the length of the short side of each solar cell.

Herein, the term “line symmetrical” is interpreted as the two halves of a cell being identical if they were to be folded/divided i.e., one half of the cell is a reflection of the other.

Claim Rejections - 35 USC § 103

5. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claims 1 and 4-10 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over JP 07-106619, Maehane et al in view of US 2010/0126550, Foss.

Regarding claim 1

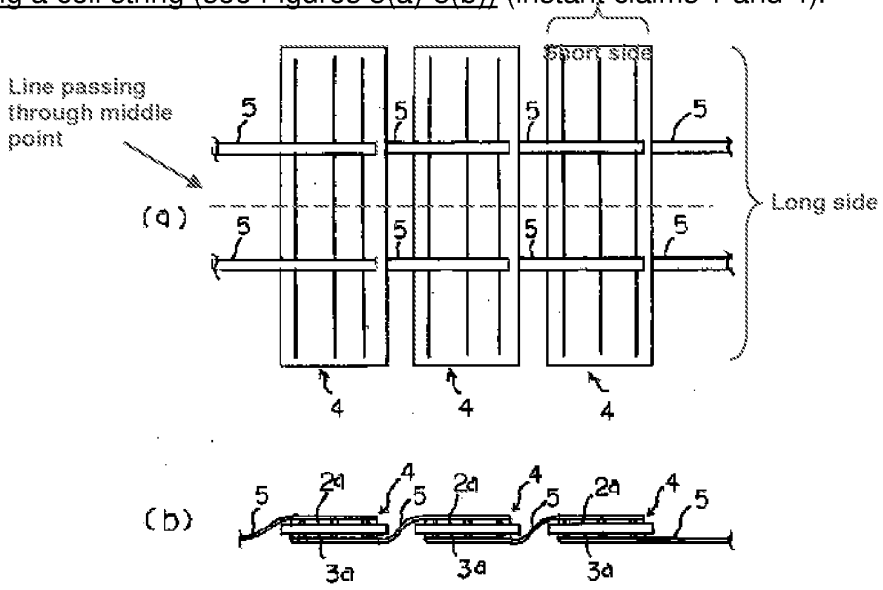
Maehane et al. teaches a solar battery module (see Figure 1-3 & [0015-0016]) comprising:

a plurality of solar battery cells (first, second and third solar battery elements, 4) (Figure 3(a) & [0016]),

a plain shape of each being a substantial rectangle (see Figure 3 wherein each solar cell element (4) is a substantial rectangle), and having a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2) since Figure 3(a) of Maehane demonstrates that the long side of each solar battery cells (4) is about three times as long as the short side of each cell (see Figure 3(a)), said plain shape including a plurality of light-receiving-surface bus electrodes (surface electrodes, 2a) parallel to the short side of the substantial rectangle on a light receiving surface (see Figure 3(b) & [0013-0016]), and including rear-surface bus electrodes (rear electrodes, 3a) each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes (see Figure 3(b) & [0013-0016]); and

an interconnector (electrical connection member, 5) that electrically connects the light-receiving-surface bus electrodes (surface electrodes, 2a) of a first one of the solar battery cells to the rear-surface bus electrodes (rear electrodes, 3a) of an adjacent second one of the solar battery cells (see Figure 3(b) & [0016]),

wherein a predetermined number of the solar battery cells (i.e., 3 solar battery element, 4) are serially connected to each other ([0016] & Figures 3a-3b), thereby configuring a cell string (see Figures 3(a)-3(b)) (instant claims 1 and 4).



Maehane et al. teaches one single column of cell strings instead of n column of cell strings.

However, the court has held that absent a showing of criticality or unexpected results the court has held that mere duplication of the essential working parts of a device involves only routine skill in the art [MPEP 2144.04]. Therefore, absent a showing of criticality or unexpected results it would have been obvious to one ordinarily skill in the art at the time of the invention to make duplicate columns of cell strings

thereby resulting in the claimed two/n-columns of cell string since the mere duplication of the essential working parts of a device involves only routine skill in the art [MPEP 2144.04].

Modified Maehane et al. is silent to the n/two-columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, and the n/two-column parallel-connected cell strings are further serially connected to another n-column parallel connected strings by a second string connector at an opposite end of the n-columns, thereby configuring an entire cell array (instant claims 1 and 4).

In the same field of endeavor of solar battery modules, Foss teaches a plurality PV cell strings connected in parallel by a first string connector (See e.g., bus 120) at one end of the n columns (see Figure 1A), said plurality of parallel-connected strings being further serially connected to another n-column parallel connected strings by a second string connector (see e.g., bus 125) at an opposite end of the n-columns (See Figure 1A), wherein such configuration results in an increase of output voltage and increased current (see Figures 1A and 3; see also paragraphs [0006] and [0029]).

Maehane et al. and Foss are analogous inventions in the field of solar battery modules. It would have been obvious to one ordinarily skilled in the art at the time of the invention to electrically connect the n-columns of the cell strings of Maehane et al. in parallel by a first string connector at one end of the n columns and in series to another n-column parallel connected string by a second string connector at an opposite end of the n-columns as taught by Foss thereby increasing the output voltage the generated current (see Figures 1A and 3; see also paragraphs [0006] and [0029]).

Regarding claim 5

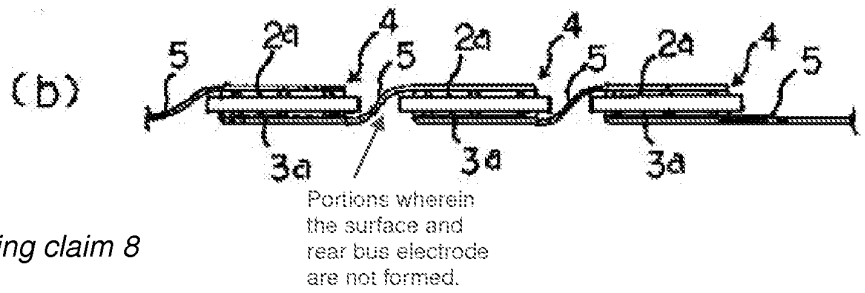
Modified Maehane et al. teaches the above solar battery module wherein the light-receiving-surface bus electrodes (surface electrodes, 2a) of the each solar battery cell (4) are formed at positions that are line-symmetrical (i.e., both halves of the cell look identical if it were to be folded) with respect to a line passing through a middle point of a side (i.e., long side of each cell (4) as shown in Figure 3(a) above) perpendicular to an extended line of the light-receiving-surface bus electrodes (surface electrode, 2a) and parallel to the light-receiving-surface bus electrodes (long side of the cell is parallel to the smaller side of the surface electrodes (2a) which are located beneath interconnector (5))) (see Figures 1(a) and 3(a)-3(b)).

Regarding claim 6

Modified Maehane et al. teaches the above solar battery module wherein the light-receiving-surface bus electrodes (surface electrodes, 2a) of the solar battery cell are formed at positions that are line-symmetrical (i.e., both halves of the cell look identical if it were to be folded) with respect to a line passing through a middle point of a side parallel (i.e., longer side of each cell is parallel to the short side of each light-receiving-surface bus electrodes (202) which are located underneath the interconnector (5)) to the light-receiving-surface bus electrodes (surface electrodes, 2a) and perpendicular to the light-receiving-surface bus electrodes (surface electrodes, 2a) since the longer side of each cell is also perpendicular to an extended line of the light-receiving-surface bus electrodes (surface electrodes, 2a) (see Figures 1(a) and 3(a)-3(b)).

Regarding claim 7

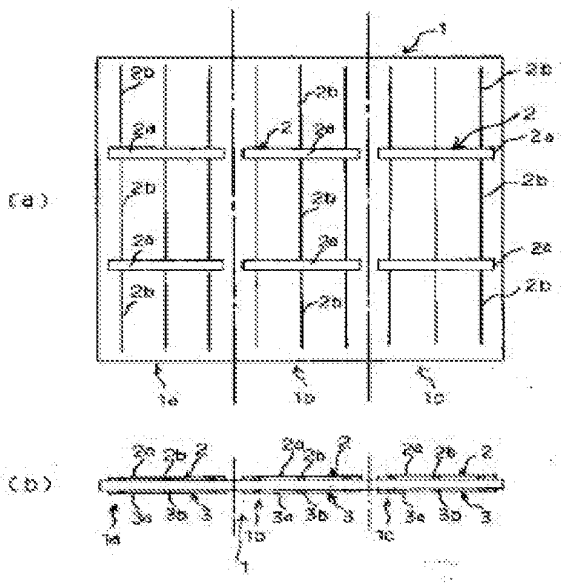
Modified Maehane et al. teaches the above solar battery module wherein each of the solar battery cells (first, second and third solar battery elements, 4) (see Figure 3(a)-3(b)) includes an area where the light-receiving-surface bus electrodes (surface electrodes, 2a) and the rear-surface bus electrodes (rear electrodes, 3a) are not formed within a predetermined dimension from an edge toward a central direction of the cell at an outer circumferential edge portion (outer boundary lines of the cells) thereof i.e., the bus electrodes are not formed at portions/areas where the cell has been divided (see figure 3(b) below and [0062-0063] of the present specification).



Regarding claim 8

Modified Maehane et al. teaches that the above solar battery module (see Figures 1-3) is obtained by dividing a basic solar battery cell with a plane shape thereof being a substantial square (see Figure 1 & [0015]), which includes n light-receiving-surface electrode areas (electricity generation regions 1a-1c) (Figures 1(a)-1(b) & [0013]) in each of which a plurality of light-receiving-surface bus electrodes (surface electrodes, 2a) parallel to a side of a substantial square (see Figure 1(a)) and a plurality of grid electrodes (branch parts, 2b) perpendicular to the light-receiving-surface bus electrodes (surface electrodes, 2a) are provided on a light-receiving surface side (see Figure 1(a) & [0013]) and includes rear-surface bus electrodes (rear electrodes, 3a)

each at a position on a non-light-receiving surface side (rear surface) corresponding to each of the light-receiving-surface bus electrodes (surface electrodes, 2a) into n respective boundaries (see Figure 1(b)) of the n light-receiving-surface electrode areas (electricity generation regions 1a-1c).



Although taught by the prior art, the limitation “which is obtained by dividing a basic solar battery cell with a plane shape thereof being a substantial square” is a product by process limitation and, therefore, does not impart any additional structure to the claimed product.

Even though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is

unpatentable even though the prior product was made by a different process. In re Thorpe, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985) [MPEP 2113]

Regarding claim 9

Modified Maehane et al. teaches the solar battery module as set forth above, wherein the second string connector (See, e.g., bus 125 in Figure 1A of Foss) extends continuously across the entire cell array (See Foss, Figure 1A).

Regarding claim 10

Modified Maehane et al. teaches the solar battery module as set forth above, wherein the interconnector (electrical connection member, 5) is joined to the light-receiving-surface bus electrode (surface electrodes, 2a) of a solar battery cell nearest to the second string connector of the n-column parallel-connected cell strings (see Maehane et al., Figure 1(a) and paragraph [0013] wherein the interconnector (5) is joined to the surface electrode/light-receiving bus electrode (2a) of each solar battery element (4) and therefore reads on the limitation "*joined to the light-receiving-surface bus electrode of a solar battery cell nearest to the second string connector of the n-column parallel-connected cell strings*"; see also Figure 1A of Foss), and is connected to the second string connector (see Foss, e.g., Bus 125 in Figure 1A), and the second string connector (see Foss, e.g., Bus 125 in Figure 1A) is connected to a rear surface lead at the rear-surface bus electrode (rear electrodes, 3a) of a head solar battery cell nearest the second string connector of the another n-column parallel- connected cell strings (see Maehane et al., Figure 1(a) and paragraph [0013]; see also Figure 1A of Foss).

It is noted that, as all the elements within the solar battery module of modified Maehane et al. are in electrical communication, the limitation “the second string connector is connected to a rear surface lead at the rear-surface bus electrode of a head solar battery cell nearest the second string connector of the another n-column parallel- connected cell strings) is met as the claims do not require said second string connector being *directly* connected to the rear surface lead at the rear-surface bus electrode of a head solar battery cell.

5. Claim 11 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over JP 07-106619, Maehane et al in view of US 2010/0126550, Foss as applied to claims 1 and 4-10 above, and further in view of US 2011/0214713, Hou et al.

Regarding claim 11

All the limitations of claim 1, from which claim 11 depends, have been set forth above.

Modified Maehane et al. teaches the solar battery module as set forth above, wherein long sides of the substantial rectangle include a first long side and a second long side (see Maehane et al., Figures 3(a)-3(b) above), and

Wherein the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other (See Maehane et al., Figures 3(a)-3(b) above and paragraph [0016]).

Modified Maehane et al. is silent to the substantial rectangle having chamfered corners on both ends of the first long side.

In the same field of endeavor of solar battery modules, Hou et al. teaches that chamfering the edges of such modules avoids damage caused to the panel/module as a result of the contact between said module and coupling members can be prevented (See Figure 2, paragraphs [0006], [0012], and [0020]).

It would have been obvious to one ordinarily skilled in the art at the time of the invention to modify the rectangle of Modified Maehane et al. to have chamfered edges as taught by Hou et al. thereby avoiding damage caused to the panel/module as a result of the contact between said module and coupling members can be prevented (See Hou et al., Figure 2, paragraphs [0006], [0012], and [0020]).

6. Claim 12 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over JP 07-106619, Maehane et al in view of US 2011/0214713, Hou et al.

Regarding claim 12

Maehane et al. teaches a solar battery module (see Figure 1-3 & [0015-0016]) comprising:

a plurality of solar battery cells (first, second and third solar battery elements, 4) (Figure 3(a) & [0016]),

a plain shape of each being a substantial rectangle (see Figure 3 wherein each solar cell element (4) is a substantial rectangle), and having a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2) since Figure 3(a) of Maehane demonstrates that the long side of each solar battery cells (4) is about three times as long as the short side of each cell (see Figure 3(a)), said plain shape including a plurality of light-receiving-surface bus

electrodes (surface electrodes, 2a) parallel to the short side of the substantial rectangle on a light receiving surface (see Figure 3(b) & [0013-0016]), and including rear-surface bus electrodes (rear electrodes, 3a) each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes (see Figure 3(b) & [0013-0016]); and

an interconnector (electrical connection member, 5) that electrically connects the light-receiving-surface bus electrodes (surface electrodes, 2a) of a first one of the solar battery cells to the rear-surface bus electrodes (rear electrodes, 3a) of an adjacent second one of the solar battery cells (see Figure 3(b) & [0016]),

wherein long sides of the substantial rectangle include a first long side and a second long side (see Figures 3(a)-3(b) above), and

Wherein the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other (See Figures 3(a)-3(b) above and paragraph [0016]).

Maehane et al. is silent to the substantial rectangle having chamfered corners on both ends of the first long side.

In the same field of endeavor of solar battery modules, Hou et al. teaches that chamfering the edges of such modules avoids damage caused to the panel/module as a result of the contact between said module and coupling members can be prevented (See Figure 2, paragraphs [0006], [0012], and [0020]).

It would have been obvious to one ordinarily skilled in the art at the time of the invention to modify the rectangle of Maehane et al. to have chamfered edges as taught by Hou et al. thereby avoiding damage caused to the panel/module as a result of the contact between said module and coupling members can be prevented (See Hou et al., Figure 2, paragraphs [0006], [0012], and [0020]).

Response to Arguments

7. Applicant's arguments, see Pages 7-9 of Remarks, filed 07/15/2014, with respect to the rejection of claim(s) 1 and 8 under 35 U.S.C. §112, second paragraph, have been fully considered and are persuasive. The rejection of claim(s) 1 and 8 under 35 U.S.C. §112, second paragraph, has been withdrawn.

8. Applicant's arguments, see Page 9-10 of Remarks Filed on 07/15/2014, with respect to the rejection of claim(s) 1 and 4-8 under 35 U.S.C. §103(a) have been considered but are moot because the arguments do not apply to the combination of references being used in the current rejection.

Conclusion

9. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAYLA GONZALEZ whose telephone number is (571)272-5054. The examiner can normally be reached on Monday through Thursday 9:00 to 5:00 EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer Michener can be reached on 571-272-1424. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MAYLA GONZALEZ/
Examiner, Art Unit 1758

/JAYNE MERSHON/
Primary Examiner, Art Unit 1758

Notice of References Cited	Application/Control No. 13/806,793	Applicant(s)/Patent Under Reexamination SHIMASAKI ET AL.	
	Examiner MAYLA GONZALEZ	Art Unit 1758	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2011/0214713	09-2011	Hou et al.	136/251
*	B	US-2010/0126550	05-2010	Foss, Andrew	136/244
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	13806793
Filing Date	2012-12-24
First Named Inventor	Koji SHIMASAKI et al.
Art Unit	1758
Examiner Name	Mayla Gonzales Ramos
Attorney Docket Number	1032404-000416

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	8049096	B2	2011-11-01	Yagiura et al.	corresp. to EP 1816684
	2	6262358	B1	2001-07-17	Kamimura et al.	corresp. to EP 1030376

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20120012152	A1	2012-01-19	Yagiura et al.	corresp. to EP 1816684
	2	20070175509	A1	2007-08-02	Yagiura et al.	corresp. to EP 1816684

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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	1816684	EP	A2	2007-08-08	Sanyo Electric Co., Ltd.	corresp. to US 2012/0012152, US 2007/0175509 and US 8029096	☐

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.G./

Receipt date: 10/14/2014	Application Number	13806793	13806793 - GAU: 1758
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2012-12-24	
(**Not for submission under 37 CFR 1.99**)	First Named Inventor	Koji SHIMASAKI et al.	
	Art Unit	1758	
	Examiner Name	Mayla Gonzales Ramos	
	Attorney Docket Number	1032404-000416	

	2	1030376	EP	A1	2000-08-23	Sharp Kabushiki Kaisha	corresp. to US 6262358	☐

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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Japanese Notice of Rejection dated August 12, 2014 issued in the corresponding Japanese Patent Application 2013-240845 and English language translation (3 pages).	☒
	2	German Office Action dated August 12, 2014 issued in the corresponding German Patent Application 112010005717.6 and English language translation (12 pages).	☒

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/Mayla Gonzalez Ramos/	Date Considered	11/03/2014

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.G./

Receipt date: 10/14/2014	Application Number	13806793 13806793 - GAU: 1758
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1758
	Examiner Name	Mayla Gonzales Ramos
	Attorney Docket Number	1032404-000416

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☒ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David R. Kemeny/	Date (YYYY-MM-DD)	3014-10-14
Name/Print	David R. Kemeny	Registration Number	57,241

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.G./

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.G./

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L16	3	"20100295377"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 08:52
L17	2	"13806793"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:15
L18	11733	(wafer substrate) with (corner edge) with (chamfer$3 round$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:15
L19	138	L18 and "136"/$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:16
L20	89	L19 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:16
L21	2928	cell with (corner edge) with (chamfer$3 round$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:17
L22	4754	(cell module) with (corner edge) with (chamfer$3 round$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:17

Jinko Ex. 1002 - 405/580

EAST Search History (Prior Art)

L23	140	L22 and "136"/$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:17
L24	80	L23 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:17
L25	32	cell with (corner edge) with chamfer$3 and "136"/$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:35
L26	17	L25 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:36

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13806793	SHIMASAKI ET AL.
	Examiner	**Art Unit**
	MAYLA GONZALEZ RAMOS	1758

CPC- SEARCHED		
Symbol	**Date**	**Examiner**

CPC COMBINATION SETS - SEARCHED		
Symbol	**Date**	**Examiner**

US CLASSIFICATION SEARCHED			
Class	**Subclass**	**Date**	**Examiner**
136	243-265	4/2014	Mayla Gonzalez

SEARCH NOTES		
Search Notes	**Date**	**Examiner**
Inventor serach	4/2014	Mayla Gonzalez
Assignee search	4/2014	Mayla Gonzalez
Class/Subclass search	4/2014	Mayla Gonzalez
Text search	4/2014	Mayla Gonzalez
Foreign Patent search	4/2014	Mayla Gonzalez
Consulted with Jayne Mershon	4/2014	Mayla Gonzalez
Updated search	11/2014	Mayla Gonzalez

INTERFERENCE SEARCH			
US Class/ CPC Symbol	**US Subclass / CPC Group**	**Date**	**Examiner**

/MAYLA GONZALEZ RAMOS/ Examiner.Art Unit 1758	

N THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)	**MAIL STOP AF**
Koji SHIMASAKI et al.	)	Group Art Unit: 1758
Application No.: 13/806,793	)	Examiner: Mayla Gonzales Ramos
Filed: December 24, 2012	)	Confirmation No.: 2289
For: SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF	)	

REQUEST FOR RECONSIDERATION AFTER FINAL

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In response to the Office Action dated November 20, 2014, reconsideration of the rejections are respectfully requested in view of the following remarks.

REMARKS

Favorable reconsideration of this application is respectfully requested in view of the following remarks.

Claims 1 and 4-12 are pending in this application. Claims 1 and 12 are the only independent claims.

The Office Action rejects Claims 1 and 4-10 under 35 U.S.C. §103(a) based on Japanese Patent Application Publication No. 07-106619 to Maehane et al. ("Maehane") in view of U.S. Patent Application Publication No. 2010/0126550 A1 to Foss. The rejection is respectfully traversed.

In the solar batter module defined in independent Claim 1, n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, and the n-column parallel-connected cell strings are further ***serially connected to*** another n-column parallel-connected cell strings by a second string connector at an opposite end of the n columns.

Having the n-column parallel-connected cell strings ***serially connected to*** another n-column parallel-connected cell strings as claimed is beneficial because, in a method of connecting to an inverter on a roof for example, the arrangement of modules (the number of serial/parallel connected modules) does not need to be changed significantly as discussed in paragraphs [0053] and [0054] of the published U.S. application, U.S. 2013/0098423 A1. Further, when a module formed by non-divided cells is broken in an existing solar power generation system, a module formed by the serially connected cells can be used as an alternative product because their characteristics are the same (see paragraph [0054] of the published U.S. application).

The Office Action acknowledges that Maehane fails to disclose n-column parallel-connected cell strings being serially connected to another n-column parallel-connected cell strings by a second string connector at an opposite end of the n columns, but asserts that these features are disclosed by Foss. Foss discloses that a string of solar cells PV is connected in parallel to other similar strings as shown in Fig. 1A of the reference:

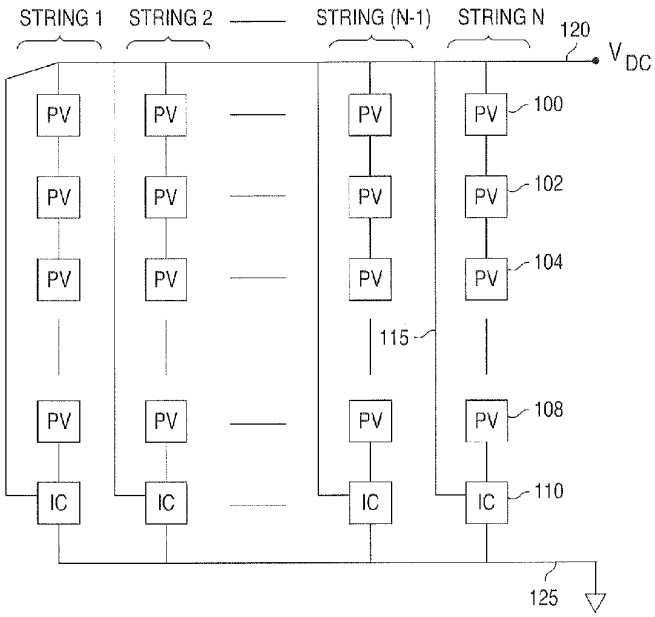


FIG. 1A

However, the parallel-connected cell strings are not ***serially connected*** to each other. This is evident from paragraph [0038] of Foss, which states that the strings of solar modules are labeled STRING 1, STRING 2, . . . , STRING (N-1), STRING N, and that *the strings are connected in parallel to form an array of solar modules*. Foss does not disclose that a parallel-connected cell string is ***serially connected*** to another parallel-connected cell string as claimed.

Accordingly, the combination of Maehane and Foss fails to disclose or suggest the combination of features recited in independent Claim 1, including that n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, and the n-column parallel-connected cell strings are further ***serially connected to*** another n-column parallel-connected cell strings by a second string connector at an opposite end of the n columns. Independent Claim 1 is thus patentable over Maehane and Foss for at least the above reasons.

Claims 4-10 are patentable over Maehane and Foss at least by virtue of their dependence from patentable independent Claim 1. Thus, a detailed discussion of the additional distinguishing features recited in these dependent claims is not set forth at this time. Withdrawal of the rejection is respectfully requested.

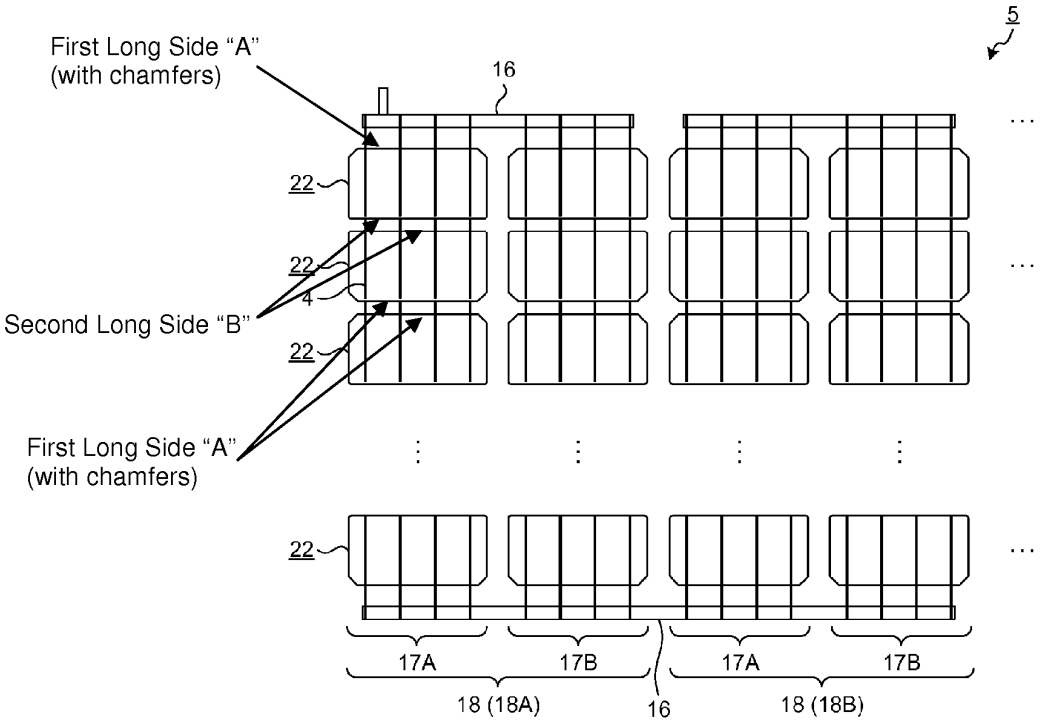
Claim 11 is rejected under 35 U.S.C. §103(a) based on Maehane in view of Foss, and further in view of U.S. Patent Application Publication No. 2011/0214713 A1 to Hou et al. ("Hou"). The rejection is respectfully traversed.

Claim 11 defines that long sides of the substantial rectangle include a first long side and a second long side, the substantial rectangle has chamfered corners on both ends of the first long side, and the first one of the solar battery cells and the second one of the solar battery cells are arranged in the cell array such that the first long side (with chamfered corners) and the second long side of the first one and the second one of the solar battery cells do not face each other.

To assist the Examiner's understanding of Claim 11 features, an annotated version of Fig. 15 of the present application is provided below. The claims, however, are not limited by this exemplary embodiment. The annotated figure shows that the

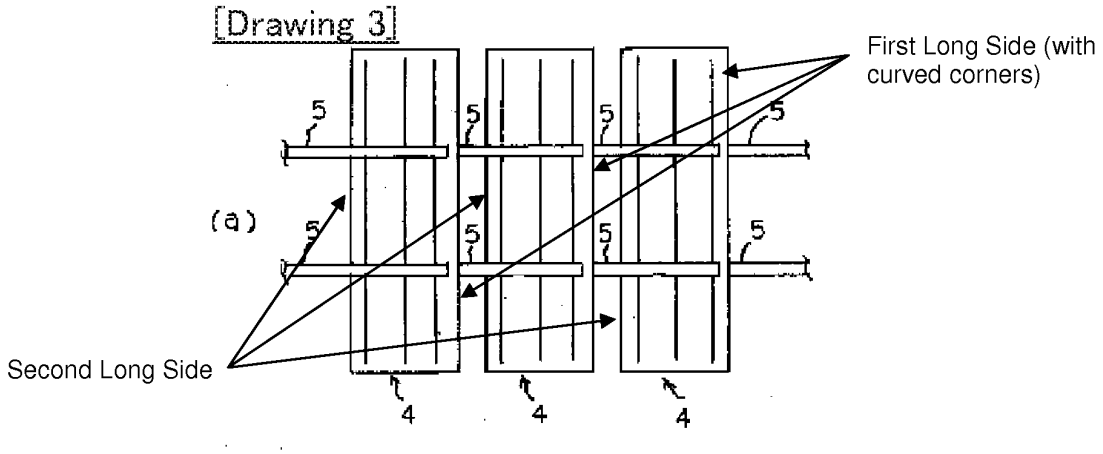
substantial rectangle has chamfered corners on both ends of the first long side "A". The first one of the solar battery cells 22 and the second one of the solar battery cells 22 are arranged in the cell array 5 such that the first long side "A" (with chamfered corners) and the second long side "B" of the first one and the second one of the solar battery cells 22 do not face each other:

FIG.15



The Office Action acknowledges that Maehane fails to disclose the claimed chamfered corners, but asserts that they would have been obvious in view of Hou. The Office Action takes the position that modifying Maehane's cells 4 to include the curved corners of Hou would have resulted in the claimed configuration. Applicant respectfully disagrees with the Office Action's position.

If Maehane's cells 4 were modified to include the curved corners of Hou on a first long side of each cell 4, the cells 4 would be arranged in the array such that the first long side (with curved corners) and the second long side of a first one and a second one of the cells 4 ***face each other*** as shown in Fig. 3a of the reference:



Such a result is contrary to Claim 11. Nowhere does Maehane or Hou disclose or suggest that the first one of the solar cells 4 and the second one of the solar cells 4 are arranged in a cell array such that the first long side (with curved corners) and the second long side of the first one and the second one of the solar cells 4 do not face each other, as defined in Claim 11 here.

Accordingly, Claim 11 is patentable over the applied references for at least the above reasons, as well as by virtue of its dependence from patentable independent Claim 1. Withdrawal of the rejection is respectfully requested.

The Office Action rejects independent Claim 12 under 35 U.S.C. §103(a) based on Maehane in view of Hou. The rejection is respectfully traversed.

Independent Claim 12 defines, among other things, features similar to those discussed above with respect to Claim 11. For the reasons discussed above, the

combination of Maehane and Hou fails to disclose or suggest that claimed configuration (i.e., long sides of the substantial rectangle include a first long side and a second long side, the substantial rectangle has chamfered corners on both ends of the first long side, and the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other) Thus, independent Claim 12 is patentable over Maehane and Hou at least for the reasons discussed above. Withdrawal of the rejection is respectfully requested.

Should any questions arise in connection with this application or should the Examiner believe that a telephone conference with the undersigned would be helpful in resolving any remaining issues pertaining to this application the undersigned respectfully requests that he be contacted at the number indicated below.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date: January 12, 2015 By: /David R. Kemeny/
David R. Kemeny
Registration No. 57241

Customer No. 21839
703 836 6620

Electronic Acknowledgement Receipt

EFS ID:	21181959
Application Number:	13806793
International Application Number:	
Confirmation Number:	2289
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Customer Number:	21839
Filer:	David Ray Kemeny/Michele Shockey
Filer Authorized By:	David Ray Kemeny
Attorney Docket Number:	1032404-000416
Receipt Date:	12-JAN-2015
Filing Date:	24-DEC-2012
Time Stamp:	14:05:02
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		REQ-RECONS-AF.pdf	182901 f191678e8cdcd1409fc3cd4ecf87d76ee07f03c5	yes	7

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Response After Final Action	1	1
	Applicant Arguments/Remarks Made in an Amendment	2	7
Warnings:			
Information:			
	Total Files Size (in bytes):	182901	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/806,793	12/24/2012	Koji Shimasaki	1032404-000416	2289

21839 7590 02/24/2015

BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

EXAMINER
GONZALEZ RAMOS, MAYLA

ART UNIT	PAPER NUMBER
1758	

NOTIFICATION DATE	DELIVERY MODE
02/24/2015	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ADIPDOC1@BIPC.com

Advisory Action Before the Filing of an Appeal Brief	**Application No.** 13/806,793	**Applicant(s)** SHIMASAKI ET AL.	
	Examiner MAYLA GONZALEZ	**Art Unit** 1758	**AIA (First Inventor to File) Status** No

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

THE REPLY FILED 12 January 2015 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

NO NOTICE OF APPEAL FILED

1. ☒ The reply was filed after a final rejection. No Notice of Appeal has been filed. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114 if this is a utility or plant application. Note that RCEs are not permitted in design applications. The reply must be filed within one of the following time periods:
   a) ☐ The period for reply expires _____months from the mailing date of the final rejection.
   b) ☒ The period for reply expires on: (1) the mailing date of this Advisory Action; or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.
   c) ☐ A prior Advisory Action was mailed more than 3 months after the mailing date of the final rejection in response to a first after-final reply filed within 2 months of the mailing date of the final rejection. The current period for reply expires months from the mailing date of *the prior Advisory Action* or SIX MONTHS from the mailing date of the final rejection, whichever is earlier.

   Examiner Note: If box 1 is checked, check either box (a), (b) or (c). ONLY CHECK BOX (b) WHEN THIS ADVISORY ACTION IS THE FIRST RESPONSE TO APPLICANT'S FIRST AFTER-FINAL REPLY WHICH WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. ONLY CHECK BOX (c) IN THE LIMITED SITUATION SET FORTH UNDER BOX (c). See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) or (c) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on _____. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37 CFR 41.37(a).

AMENDMENTS

3. ☐ The proposed amendments filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   a) ☐ They raise new issues that would require further consideration and/or search (see NOTE below);
   b) ☐ They raise the issue of new matter (see NOTE below);
   c) ☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   d) ☐ They present additional claims without canceling a corresponding number of finally rejected claims.

   NOTE: _____. (See 37 CFR 1.116 and 41.33(a)).

4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicant's reply has overcome the following rejection(s): _____.
6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☐ For purposes of appeal, the proposed amendment(s): (a) ☐ will not be entered, or (b) ☐ will be entered, and an explanation of how the new or amended claims would be rejected is provided below or appended.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
9. ☐ The affidavit or other evidence filed after final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
10. ☐ The affidavit or other evidence filed after the date of filing the Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing of good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
11. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

12. ☒ The request for reconsideration has been considered but does NOT place the application in condition for allowance because:

See Continuation Sheet.

13. ☐ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). _____
14. ☐ Other: _____.

STATUS OF CLAIMS

15. The status of the claim(s) is (or will be) as follows:

Claim(s) allowed: n/a.
Claim(s) objected to: n/a.
Claim(s) rejected: 1 and 4-12.
Claim(s) withdrawn from consideration: n/a.

/MAYLA GONZALEZ/ Examiner, Art Unit 1758	/JAYNE MERSHON/ Primary Examiner, Art Unit 1758

Continuation of 12. does NOT place the application in condition for allowance because: Applicant's arguments filed 01/12/2015 have been fully considered but they are not persuasive.

With regards to applicants arguments that the parallel-connected cell strings are not serially connected to each other and that Foss does not disclose that a parallel-connected cell string is serially connected to another parallel-connected cell string as claimed, Examiner respectfully disagrees.

A pieceamiel analysis of a specific paragraph in Foss is not persuasive as the reference is take for all that it teaches i.e., cells can be connected in series and in parallel. Therefore, it is obvious to combine these two electrical connections each of which is taught by the prior art to be useful for the same purpose. [T]he idea of combining them flows logically from their having been individually taught in the prior art." In re Kerkhoven, 626 F.2d 846, 850, 205 USPQ 1069, 1072 (CCPA 1980) [see MPEP §2144.06]

Furthermore, the claimed invention recites "n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, and the n-column parallel-connected cell strings are further serially connected to another n-column parallel-connected cell strings…" Paragraph [0038] of Foss teaches

Foss teaches the benefits of the combination of a series-parallel connection i.e., increased in output voltage and increased current (see Figures 1A and 3, paragraphs [0006] and [0029] wherein a series-connected string of solar cells is connected in parallel to other similar strings.)

The strings are connected in parallel to form an array of solar modules. An array may comprise any number of strings. Each string comprises a set of solar modules connected in series.

With regards to applicants arguments that [i]f Maehane's cells 4 were modified to include the curved corners of Hou on a first long side of each cell 4, the cells 4 would be arranged in the array such that the first long side (with curved corners) and the second long side of a first one and a second one of the cells 4 face each other, Examiner respectfully disagrees.

Applicants' interpretation of the prior art's Figure is overly narrow in scope. For instance, applicant interprets the left-most longer side of the cells as the second long side and the right-most longer side as the first long side. This is not necessarily true. Any one of the two long sides of the cell reads on both the first and second long side.

Additionally, chamfering the edges of a cell does not change or rearrange the position of the cell within the module. As the prior art teaches the benefits of chamfering the edges of such modules i.e., avoiding damage caused to the panel/module as a result of the contact between said module and coupling members can be prevented (See Hou, Figure 2, paragraphs [0006], [0012], and [0020]), the limitations of the claims are met.

Jinko Ex. 1002 - 419/580

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	13806793
	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1758
	Examiner Name	Mayla Gonzales Ramos
	Attorney Docket Number	1032404-000416

U.S.PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13806793
	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1758
	Examiner Name	Mayla Gonzales Ramos
	Attorney Docket Number	1032404-000416

	1	Chinese Notification of First Office Action dated December 2, 2014 issued in the corresponding Chinese Patent Application 201080067773.1 and English language translation (10 pages).	☒

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	13806793
	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1758
	Examiner Name	Mayla Gonzales Ramos
	Attorney Docket Number	1032404-000416

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☒ See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David R. Kemeny/	Date (YYYY-MM-DD)	2015-03-02
Name/Print	David R. Kemeny	Registration Number	57,241

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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Electronic Patent Application Fee Transmittal

Application Number:	13806793
Filing Date:	24-Dec-2012
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Filer:	David Ray Kemeny/Michele Shockey
Attorney Docket Number:	1032404-000416

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	21639462
Application Number:	13806793
International Application Number:	
Confirmation Number:	2289
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Customer Number:	21839
Filer:	David Ray Kemeny/Michele Shockey
Filer Authorized By:	David Ray Kemeny
Attorney Docket Number:	1032404-000416
Receipt Date:	02-MAR-2015
Filing Date:	24-DEC-2012
Time Stamp:	15:17:00
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$180
RAM confirmation Number	2053
Deposit Account	024800
Authorized User	KEMENY, DAVID R.

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDS-4.pdf	63833 b75440791061b1e7aaa76fae2e98513d2e66d8fd	no	4
Warnings:					
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2	Non Patent Literature	NPL1.pdf	452138 ddcb05adaff1c453f7761d3a5033575f1573f303	no	10
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New International Application Filed with the USPTO as a Receiving Office

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PTO/SB/30 (07-09)
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Request For Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	**13/806,793**
Filing Date	**December 24, 2012**
First Named Inventor	**Shimasaki, Koji**
Art Unit	**1758** Conf. No. **2289**
Examiner Name	**Gonzalez Ramos, Mayla**
Attorney Docket Number	**1032404-000416**

This is a Request for Continued Examination (RCE) under 37 C.F.R. § 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 C.F.R. 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).
   - a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
     - i ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
     - ii ☐ Other _____
   - b. ☒ Enclosed
     - i ☒ Amendment/Reply
     - ii ☐ Affidavit(s)/Declaration(s)
     - iii. ☐ Information Disclosure Statement (IDS)
     - iv. ☒ Other: Petition for Extension of Time

2. Miscellaneous
   - a. ☐ Suspension of action on the above-identified application is requested under 37 C.F.R. 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 C.F.R. 1.17(i) required)
   - b. ☐ Other _____

3. Fees The RCE fee under 37 C.F.R. 1.17 (e) is required by 37 C.F.R. 1.114 when RCE is filed.
   - a. ☒ The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any overpayments, to Deposit Account No. **02-4800**.
     - i ☐ RCE fee required under 37 C.F.R. 1.17 (e)
     - ii ☐ Extension of time fee (37 C.F.R. 1.136 and 1.17)
     - iii ☐ Other _____
   - b. ☐ Check in the amount of $ _____ enclosed
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SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	/**David R. Kemeny**/	Date	**March 19, 2015**
Name (Print/Type)	**David R. Kemeny**	Registration No.	**57,241**

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450 or facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.

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If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

N THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)	**MAIL STOP RCE**
Koji SHIMASAKI et al.	)	Group Art Unit: 1758
Application No.: 13/806,793	)	Examiner: Mayla Gonzales Ramos
Filed: December 24, 2012	)	Confirmation No.: 2289
For: SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF	)	

AMENDMENT FILED WITH RCE

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In response to the Office Action dated November 20, 2014 and the Advisory Action issued on February 24, 2015, the shortened statutory period for reply being extended by the attached Petition for Extension of Time, and upon entry of the attached Request for Continued Examination (RCE), please amend the above-identified patent application as follows:

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS:

1. (Currently Amended) A solar battery module comprising:

a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and

an interconnector that electrically connects the light-receiving-surface bus electrodes of a first one of the solar battery cells to the rear-surface bus electrodes of an adjacent second one of the solar battery cells, wherein a predetermined number of the solar battery cells are serially connected to each other, thereby configuring a cell string, n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, the n in the number of columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length, and the n-column parallel-connected cell strings are further serially connected to another n-column parallel-connected cell strings by a second string connector at an opposite end of the n columns, thereby configuring an entire cell array.

2-3. (Cancelled)

4. (Previously Presented) The solar battery module according to claim 1, wherein a predetermined number of the solar battery cells are serially connected, thereby configuring a cell string, two columns of the cell strings are connected in parallel, and the two-column parallel-connected cell strings are further serially connected, thereby configuring an entire cell array.

5. (Previously Presented) The solar battery module according to claim 1, wherein the light-receiving-surface bus electrodes of each solar battery cell are formed at positions that are line-symmetrical with respect to a line passing through a middle point of a side perpendicular to an extended line of the light-receiving-surface bus electrodes and parallel to the light-receiving-surface bus electrodes.

6. (Previously Presented) The solar battery module according to claim 1, wherein the light-receiving-surface bus electrodes of each solar battery cell are formed at positions that are line-symmetrical with respect to a line passing through a middle point of a side parallel to the light-receiving-surface bus electrodes and perpendicular to the light-receiving-surface bus electrodes.

7. (Original) The solar battery module according to claim 1, wherein each of the solar battery cells includes an area where the light-receiving-surface bus electrodes

and the rear-surface bus electrodes are not formed within a predetermined dimension from an edge toward a central direction of the cell at an outer circumferential edge portion thereof.

8. (Previously Presented) The solar battery module according to claim 1, which is obtained by dividing a basic solar battery cell with a plane shape thereof being a substantial square, which includes n light-receiving-surface electrode areas in each of which a plurality of light-receiving-surface bus electrodes parallel to a side of the substantial square and a plurality of grid electrodes perpendicular to the light-receiving-surface bus electrodes are provided on a light-receiving surface side and includes rear-surface bus electrodes each at a position on a non-light-receiving surface side corresponding to each of the light-receiving-surface bus electrodes into n respective boundaries of the n light-receiving-surface electrode areas.

9. (Previously Presented) The solar battery module according to claim 1, wherein the second string connector extends continuously across the entire cell array.

10. (Previously Presented) The solar battery module according to claim 1, wherein the interconnector is joined to the light-receiving-surface bus electrode of a solar battery cell nearest to the second string connector of the n-column parallel-connected cell strings, and is connected to the second string connector, and the second string connector is connected to a rear surface lead at the rear-surface bus electrode of

a head solar battery cell nearest the second string connector of the another n-column parallel-connected cell strings.

11. (Currently Amended) The solar battery module according to claim 1,

wherein long sides of the substantial rectangle include a first long side and a second long side,

the substantial rectangle has chamfered corners on both ends of only the first long side such that the second long side is without chamfered corners, and

wherein the first one of the solar battery cells and the second one of the solar battery cells are arranged in the cell array such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other.

12. (Currently Amended) A solar battery module comprising:

a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and

an interconnector that electrically connects the light-receiving-surface bus electrodes of a first one of the solar battery cells to the rear-surface bus electrodes of an adjacent second one of the solar battery cells, wherein

long sides of the substantial rectangle include a first long side and a second long side,

the substantial rectangle has chamfered corners on both ends of only the first long side such that the second long side is without chamfered corners, and

the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other.

REMARKS

Favorable reconsideration of this application is respectfully requested in view of the following remarks.

Claims 1 and 4-12 are pending in this application. Claims 1 and 12 are the only independent claims. By this Amendment, Claims 1, 11 and 12 are amended. Support for the amendment to Claim 1 can be found, for example, in paragraphs [0046] and [0054] of the published U.S. application, U.S. 2013/0098423 A1. Support for the amendment to Claims 11 and 12 can be found, for example, in Figs. 13 - 15 and paragraph [0060] of the published U.S. application. No new matter is added.

The Office Action rejects Claims 1 and 4-10 under 35 U.S.C. §103(a) based on Japanese Patent Application Publication No. 07-106619 to Maehane et al. ("Maehane") in view of U.S. Patent Application Publication No. 2010/0126550 A1 to Foss. The rejection is respectfully traversed.

The solar batter module defined in independent Claim 1 includes, *inter alia*, a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and ***a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1*** (n is an integer equal to or larger than 2), wherein a predetermined number of the solar battery cells are serially connected to each other, thereby configuring a cell string, n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, ***the n in the number of columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length***.

Accordingly, the integer "n" is the same for the number of columns of the cell strings connected in parallel and the ratio of the length of the short side to the long side of the solar battery cell. This configuration is beneficial because, in a method of connecting to an inverter on a roof for example, the electrical characteristics equivalent to those of a module having non-divided cells serially connected to each other can be obtained and the arrangement of modules (the number of serial/parallel connected modules) does not need to be changed significantly as discussed in paragraphs [0053] and [0054] of the published U.S. application.

The Office Action asserts that Maehane discloses the claimed ratio because Fig. 3(a) of the reference appears to show that the long side of each cell is about three times the length of the short side (see page 3 of the Office Action). The Office Action acknowledges that Maehane fails to disclose n-column parallel-connected cell strings being serially connected to another n-column parallel-connected cell strings by a second string connector at an opposite end of the n columns, but asserts that these features are disclosed by Foss. Foss discloses that a string of solar cells PV is connected to other similar strings as shown in Fig. 1A of the reference. However, the combination of Maehane and Foss does not disclose or suggest that the n in the number of columns of the cell strings connected in parallel is equal to the n in the ratio of the long side length to the short side length as defined in independent Claim 1 here. Moreover, there would have been no reason for such a limitation in Maehane's modified solar cell module.

Accordingly, the combination of Maehane and Foss fails to disclose or suggest the combination of features recited in independent Claim 1, including a plurality of solar

battery cells, a plain shape of each being a substantial rectangle, and *a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1* (n is an integer equal to or larger than 2), wherein a predetermined number of the solar battery cells are serially connected to each other, thereby configuring a cell string, n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, *the n in the number of columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length*. Independent Claim 1 is thus patentable over Maehane and Foss for at least the above reasons.

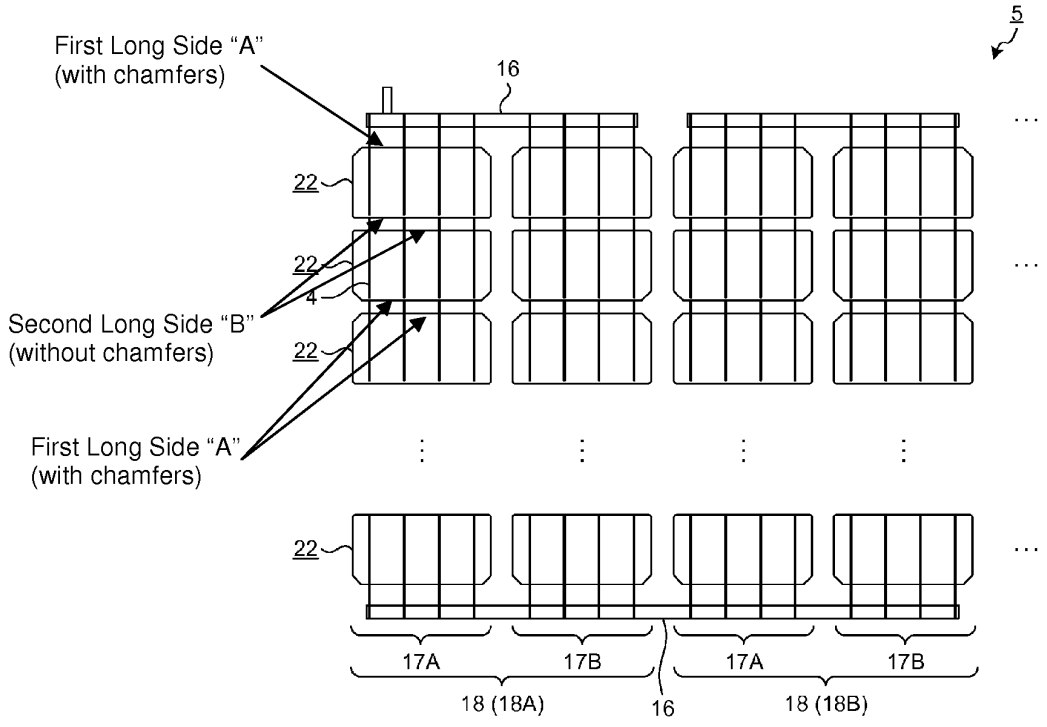
Claims 4-10 are patentable over Maehane and Foss at least by virtue of their dependence from patentable independent Claim 1. Thus, a detailed discussion of the additional distinguishing features recited in these dependent claims is not set forth at this time. Withdrawal of the rejection is respectfully requested.

Claim 11 is rejected under 35 U.S.C. §103(a) based on Maehane in view of Foss, and further in view of U.S. Patent Application Publication No. 2011/0214713 A1 to Hou et al. ("Hou"). The rejection is respectfully traversed.

Claim 11 defines that long sides of the substantial rectangle include a first long side and a second long side, *the substantial rectangle has chamfered corners on both ends of* ***only the first long side*** such that ***the second long side is without chamfered corners***, and the first one of the solar battery cells and the second one of the solar battery cells are arranged in the cell array such that the first long side (with chamfered corners) and the second long side of the first one and the second one of the solar battery cells do not face each other.

To assist the Examiner's understanding of Claim 11 features, an annotated version of Fig. 15 of the present application is provided below. The claims, however, are not limited by this exemplary embodiment. The annotated figure shows that the substantial rectangle has chamfered corners on both ends of *only* the first long side "A" *such that the second long side "B" is without chamfered corners*. The first one of the solar battery cells 22 and the second one of the solar battery cells 22 are arranged in the cell array 5 such that the first long side "A" (with chamfered corners) and the second long side "B" (without chamfered corners) of the first one and the second one of the solar battery cells 22 do not face each other:

FIG.15



The Office Action acknowledges that Maehane fails to disclose the claimed chamfered corners, but asserts that they would have been obvious in view of Hou. The

Office Action takes the position that modifying Maehane's cells 4 to include the curved corners of Hou would have resulted in the claimed configuration. However, Hou teaches that *all* four corners of the solar battery module frame member 2 are chamfered (see paragraph [0020] of the reference) so that the corners cannot hurt a person during assembly of the coupling members 22 and the frame strips 21, and so that damage caused to the panel 3 as a result of contact between the panel 3 and the coupling members 22 can be prevented (see paragraph [0012] of the reference). Thus, if Maehane's cells 4 were modified to include the curved corners as taught by Hou (which Applicant does not concede would have been obvious), *both* the first long side *and* the second long side of each cell 4 would be chamfered. The cells 4 would not be arranged such that the first long side (with curved corners) and the second long side (*without* curved corners) of a first one and a second one of the cells 4 *face each other* as defined in Claim 11 here.

Accordingly, Claim 11 is patentable over the applied references for at least the above reasons, as well as by virtue of its dependence from patentable independent Claim 1. Withdrawal of the rejection is respectfully requested.

The Office Action rejects independent Claim 12 under 35 U.S.C. §103(a) based on Maehane in view of Hou. The rejection is respectfully traversed.

Independent Claim 12 defines, among other things, features similar to those discussed above with respect to Claim 11. For the reasons discussed above, the combination of Maehane and Hou fails to disclose or suggest that claimed configuration (i.e., long sides of the substantial rectangle include a first long side and a second long side, the substantial rectangle has chamfered corners on both ends of *only* the first long

side *such that the second long side is without chamfered corners*, and the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other). Thus, independent Claim 12 is patentable over Maehane and Hou at least for the reasons discussed above. Withdrawal of the rejection is respectfully requested.

Should any questions arise in connection with this application or should the Examiner believe that a telephone conference with the undersigned would be helpful in resolving any remaining issues pertaining to this application the undersigned respectfully requests that he be contacted at the number indicated below.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date: March 19, 2015 By: /David R. Kemeny/
David R. Kemeny
Registration No. 57241

Customer No. 21839
703 836 6620

Electronic Patent Application Fee Transmittal

Application Number:	13806793
Filing Date:	24-Dec-2012
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Filer:	David Ray Kemeny/Michele Shockey
Attorney Docket Number:	1032404-000416

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 1 month with $0 paid	1251	1	200	200
Miscellaneous:				
Request for Continued Examination	1801	1	1200	1200
		Total in USD ($)		**1400**

Electronic Acknowledgement Receipt

EFS ID:	21816571
Application Number:	13806793
International Application Number:	
Confirmation Number:	2289
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Customer Number:	21839
Filer:	David Ray Kemeny/Michele Shockey
Filer Authorized By:	David Ray Kemeny
Attorney Docket Number:	1032404-000416
Receipt Date:	19-MAR-2015
Filing Date:	24-DEC-2012
Time Stamp:	10:52:22
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$1400
RAM confirmation Number	10695
Deposit Account	024800
Authorized User	KEMENY, DAVID R.
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. 1.492 (National application filing, search, and examination fees) Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)	

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Extension of Time	EOT.pdf	21042 2e710e4f4b38cbddeaace3b5ca2284cc0ad54954	no	1
Warnings:					
Information:					
2	Request for Continued Examination (RCE)	RCE.pdf	29974 188dadc483ef597f6d3147164eccfbf7d6ddc13e	no	1
Warnings:					
This is not a USPTO supplied RCE SB30 form.					
Information:					
3		AMD.pdf	133233 afe5e8d6daccf24d654d1b13836f95fa4a7ec93d	yes	12

Multipart Description/PDF files in .zip description

Document Description	Start	End
Amendment Submitted/Entered with Filing of CPA/RCE	1	1
Claims	2	6
Applicant Arguments/Remarks Made in an Amendment	7	12

Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	32856 26d10701a4d4cbebea150cd4752c181cc62dc789	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	217105	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/22 (03-132)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)	Docket Number (Optional) **1032404-000416**
Application Number **13/806,793**	Filed **December 24, 2012**
For **Solar Battery Module and Manufacturing Method Thereof**	
Art Unit **1758** Confirmation No. **2289**	Examiner **GONZALEZ RAMOS, MAYLA**

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Large Fee	Small Fee	Micro Fee	
☒ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$ **200**
☐ Two month (37 CFR 1.17(a)(2))	$600	$300	$150	$
☐ Three month (37 CFR 1.17(a)(3))	$1,400	$700	$350	$
☐ Four month (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐ Five month (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☒ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number **02-4800**.

☒ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☒ attorney or agent of record. Registration number **57,241.**

☐ attorney or agent acting under 37 CFR 1.34. Registration number **57,241.**

/David R. Kemeny/	March 19, 2015
Signature	Date
David R. Kemeny	703-836-6620
Type or printed name	Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required. See below*.

☐ Total of ___ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/806,793	Filing Date 12/24/2012	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)		
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

		(Column 1)		(Column 2)	(Column 3)		
AMENDMENT	03/19/2015	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 10	Minus	** 20	= 0	X $80 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	X $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	**0**

		(Column 1)		(Column 2)	(Column 3)		
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/YOLANDA A. MIDDLETON/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/806,793	12/24/2012	Koji Shimasaki	1032404-000416	2289

21839 7590 07/02/2015

BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

EXAMINER
GONZALEZ RAMOS, MAYLA

ART UNIT	PAPER NUMBER
1758	

NOTIFICATION DATE	DELIVERY MODE
07/02/2015	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ADIPDOC1@BIPC.com

Office Action Summary	Application No. 13/806,793	Applicant(s) SHIMASAKI ET AL.	
	Examiner MAYLA GONZALEZ	Art Unit 1758	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *03/19/2015*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1 and 4-12* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1 and 4-12* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *12/24/2012* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *03/02/2015*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application is being examined under the pre-AIA first to invent provisions.

Continued Examination Under 37 CFR 1.114

2. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 03/19/2015 has been entered.

Status of Claims

3. This action is in response to Applicant's Request for Reconsideration dated 03/19/2015.

4. **Claim(s)** 1 and 4-12 are currently pending.

5. **Claim(s)** 1, 11 and 12 have been amended.

6. **Claim(s)** 2 and 3 have been canceled.

Claim Interpretation

7. Herein, the limitation "a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2)" is interpreted as the length of the long side of each solar cell being at least twice as long than the length of the short side of each solar cell.

8. Herein, the term "line symmetrical" is interpreted as the two halves of a cell being identical if they were to be folded/divided i.e., one half of the cell is a reflection of the other.

Claim Rejections - 35 USC § 103

9. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

10. Claims 1 and 4-10 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over JP 07-106619, Maehane et al in view of US 2007/0175509, Yagiura et al.

Regarding claims 1 and 4

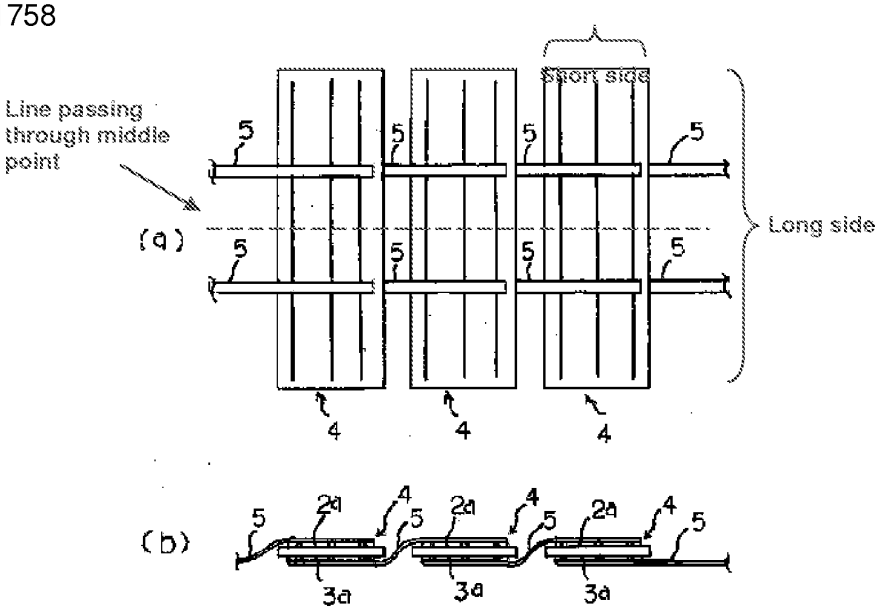
Maehane et al. teaches a solar battery module (see Figure 1-3 & [0015-0016]) comprising:

a plurality of solar battery cells (first, second and third solar battery elements, 4) (Figure 3(a) & [0016]),

a plain shape of each being a substantial rectangle (see Figure 3 wherein each solar cell element (4) is a substantial rectangle), and having a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2) since Figure 3(a) of Maehane demonstrates that the long side of each solar battery cells (4) is about three times as long as the short side of each cell (see Figure 3(a)), said plain shape including a plurality of light-receiving-surface bus electrodes (surface electrodes, 2a) parallel to the short side of the substantial rectangle on a light receiving surface (see Figure 3(b) & [0013-0016]), and including rear-surface bus electrodes (rear electrodes, 3a) each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes (see Figure 3(b) & [0013-0016]); and

an interconnector (electrical connection member, 5) that electrically connects the light-receiving-surface bus electrodes (surface electrodes, 2a) of a first one of the solar battery cells to the rear-surface bus electrodes (rear electrodes, 3a) of an adjacent second one of the solar battery cells (see Figure 3(b) & [0016]),

wherein a predetermined number of the solar battery cells (i.e., 3 solar battery element, 4) are serially connected to each other ([0016] & Figures 3a-3b), thereby configuring a cell string (see Figures 3(a)-3(b)) (instant claims 1 and 4).



Maehane et al. teaches one single column of cell strings instead of n column of cell strings.

However, the court has held that absent a showing of criticality or unexpected results the court has held that mere duplication of the essential working parts of a device involves only routine skill in the art [MPEP 2144.04]. Therefore, absent a showing of criticality or unexpected results it would have been obvious to one ordinarily skill in the art at the time of the invention to make duplicate columns of cell strings thereby resulting in the claimed two/n-columns of cell string since the mere duplication of the essential working parts of a device involves only routine skill in the art [MPEP 2144.04].

Modified Maehane et al. is silent to the n/two-columns of the cell strings being connected in parallel by a first string connector at one end of the n columns, and the n/two-column parallel-connected cell strings being further serially connected to another

n-column parallel connected strings by a second string connector at an opposite end of the n-columns, thereby configuring an entire cell array (instant claims 1 and 4).

Yagiura et al., similar to modified Maehane et al., teaches a solar battery module wherein 12 solar battery cells are serially connected to form a cell string (8 total strings), any two of the cell strings of solar battery cells being connected in parallel (4 total columns) by a first string connector (tab, 21) (see Fig. 8), wherein the 4-column parallel-connected cells are further serially connected by a second string connector (tab, 21) to form an entire cell array (see Figure 8 and paragraphs [0066-0068]). Specifically, such configuration is merely one of a finite number of electrical connection patterns e.g., series, parallel, and combinations thereof, available to one skilled in the art (See e.g., Figs. 5-9). Further, one skilled in the art would have found obvious to electrically connect the solar battery cells such that they have a predetermined output power.

Maehane et al. and Yagiura et al. are analogous inventions in the field of solar battery modules. It would have been obvious to one ordinarily skilled in the art at the time of the invention to modify the electrical configuration of the PV cell strings in modified Maehane et al. to be connected in parallel by a first string connector at one end of the n columns, and to be further serially connected to another n-column parallel connected strings by a second string connector as taught by Yagiura et al. in order to achieve a predetermined power output.

Furthermore, because Yagiura et al. teaches choosing from a finite number of identified, predictable electrical connection patterns, one of ordinary skill in the art would have found obvious to pursue the known options with reasonable expectation of

success [see MPEP 2143]. Since Yagiura et al. teaches that the claimed configuration leads to the anticipated success, said connection pattern is not of innovation but of ordinary skill and common sense [see MPEP 2143].

With regards to the limitation "the n in the number pf columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length", such feature is necessarily present in the above combination since "n" is defined by applicants as being equal two or greater than two, and the above combination teaches at least two parallel connected strings.

Regarding claim 5

Modified Maehane et al. teaches the solar battery module as set forth above, wherein the light-receiving-surface bus electrodes (surface electrodes, 2a) of the each solar battery cell (4) are formed at positions that are line-symmetrical (i.e., both halves of the cell look identical if it were to be folded) with respect to a line passing through a middle point of a side (i.e., long side of each cell (4) as shown in Figure 3(a) above) perpendicular to an extended line of the light-receiving-surface bus electrodes (surface electrode, 2a) and parallel to the light-receiving-surface bus electrodes (long side of the cell is parallel to the smaller side of the surface electrodes (2a) which are located beneath interconnector (5))) (see Maehane et al., Figures 1(a) and 3(a)-3(b)).

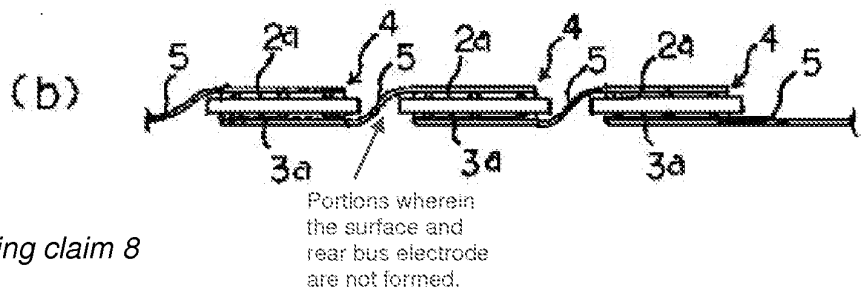
Regarding claim 6

Modified Maehane et al. teaches the solar battery module as set forth above, wherein the light-receiving-surface bus electrodes (surface electrodes, 2a) of the solar battery cell are formed at positions that are line-symmetrical (i.e., both halves of the cell

look identical if it were to be folded) with respect to a line passing through a middle point of a side parallel (i.e., longer side of each cell is parallel to the short side of each light-receiving-surface bus electrodes (202) which are located underneath the interconnector (5)) to the light-receiving-surface bus electrodes (surface electrodes, 2a) and perpendicular to the light-receiving-surface bus electrodes (surface electrodes, 2a) since the longer side of each cell is also perpendicular to an extended line of the light-receiving-surface bus electrodes (surface electrodes, 2a) (see Maehane et al., Figures 1(a) and 3(a)-3(b)).

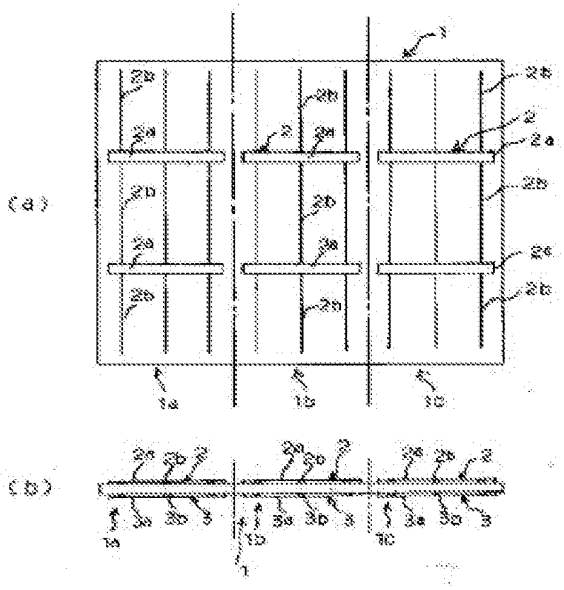
Regarding claim 7

Modified Maehane et al. teaches the solar battery module as set forth above, wherein each of the solar battery cells (first, second and third solar battery elements, 4) (see Maehane et al., Figure 3(a)-3(b)) includes an area where the light-receiving-surface bus electrodes (surface electrodes, 2a) and the rear-surface bus electrodes (rear electrodes, 3a) are not formed within a predetermined dimension from an edge toward a central direction of the cell at an outer circumferential edge portion (outer boundary lines of the cells) thereof i.e., the bus electrodes are not formed at portions/areas where the cell has been divided (see figure 3(b) below; see also paragraphs [0062-0063] of applicants' instant specification).



Regarding claim 8

Modified Maehane et al. teaches the solar battery module as set forth above, which is obtained by dividing a basic solar battery cell with a plane shape thereof being a substantial square (see Figure 1 & [0015]), which includes n light-receiving-surface electrode areas (electricity generation regions 1a-1c) (Figures 1(a)-1(b) & [0013]) in each of which a plurality of light-receiving-surface bus electrodes (surface electrodes, 2a) parallel to a side of a substantial square (see Figure 1(a)) and a plurality of grid electrodes (branch parts, 2b) perpendicular to the light-receiving-surface bus electrodes (surface electrodes, 2a) are provided on a light-receiving surface side (see Figure 1(a) & [0013]) and includes rear-surface bus electrodes (rear electrodes, 3a) each at a position on a non-light-receiving surface side (rear surface) corresponding to each of the light-receiving-surface bus electrodes (surface electrodes, 2a) into n respective boundaries (see Figure 1(b)) of the n light-receiving-surface electrode areas (electricity generation regions 1a-1c).



Although taught by the prior art, the limitation “which is obtained by dividing a basic solar battery cell with a plane shape thereof being a substantial square” is a product by process limitation and, therefore, does not impart any additional structure to the claimed product.

Even though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process. In re Thorpe, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985) [MPEP 2113]

Regarding claim 9

Modified Maehane et al. teaches the solar battery module as set forth above, wherein the second string connector (See, e.g., bus 125 in Figure 1A of Foss) extends continuously across the entire cell array (See Foss, Figure 1A).

Regarding claim 10

Modified Maehane et al. teaches the solar battery module as set forth above, wherein the interconnector (electrical connection member, 5) is joined to the light-receiving-surface bus electrode (surface electrodes, 2a) of a solar battery cell nearest to the second string connector of the n-column parallel-connected cell strings (see Maehane et al., Figure 1(a) and paragraph [0013] wherein the interconnector (5) is joined to the surface electrode/light-receiving bus electrode (2a) of each solar battery element (4) and therefore reads on the limitation "*joined to the light-receiving-surface*

bus electrode of a solar battery cell nearest to the second string connector of the n-column parallel-connected cell strings"; see also Figure 1A of Foss), and is connected to the second string connector (see Foss, e.g., Bus 125 in Figure 1A), and the second string connector (see Foss, e.g., Bus 125 in Figure 1A) is connected to a rear surface lead at the rear-surface bus electrode (rear electrodes, 3a) of a head solar battery cell nearest the second string connector of the another n-column parallel- connected cell strings (see Maehane et al., Figure 1(a) and paragraph [0013]; see also Figure 1A of Foss).

It is noted that, as all the elements within the solar battery module of modified Maehane et al. are in electrical communication, the limitation "the second string connector is connected to a rear surface lead at the rear-surface bus electrode of a head solar battery cell nearest the second string connector of the another n-column parallel- connected cell strings) is met as the claims do not require said second string connector being *directly* connected to the rear surface lead at the rear-surface bus electrode of a head solar battery cell.

11. Claim 11 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over JP 07-106619, Maehane et al in view of US 2007/0175509, Yagiura et al., as applied to claims 1 and 4-10 above, and further in view of US 6,262,358, Kamimura et al.

Regarding claim 11

All the limitations of claim 1, from which claim 11 depends, have been set forth above.

Modified Maehane et al. teaches the solar battery module as set forth above, wherein long sides of the substantial rectangle include a first long side and a second long side (see Maehane et al., Figures 3(a)-3(b) above), and

Wherein the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other (See Maehane et al., Figures 3(a)-3(b) above and paragraph [0016]).

Modified Maehane et al. is silent to the substantial rectangle having chamfered corners on both ends of only the first long side such that the second long side is without chamfered corners.

In the same field of endeavor of solar battery modules, Kamimura et al. teaches providing notches, thereby forming chamfered corners, on both ends of only the first long side such that the second long side is without chamfered corners in order to provide a space that shelters the connecting terminals from radiation and from an electric-field environment (see Fig. 6, Column 4, lines 30-38 and Column 6, lines 33-420.

It would have been obvious to one ordinarily skilled in the art at the time of the invention to modify the substantial rectangle of Modified Maehane et al. to have chamfered edges/corners on both ends of only the first long side such that the second long side is without chamfered corners as taught by Kamimura et al. in order to provide a space that shelters the connecting terminals from radiation and from an electric-field environment (see Fig. 6, Column 4, lines 30-38 and Column 6, lines 33-420.

12. Claim 12 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over JP 07-106619, Maehane et al in view of US 6,262,358, Kamimura et al.

Regarding claim 12

Maehane et al. teaches a solar battery module (see Figure 1-3 & [0015-0016]) comprising:

a plurality of solar battery cells (first, second and third solar battery elements, 4) (Figure 3(a) & [0016]),

a plain shape of each being a substantial rectangle (see Figure 3 wherein each solar cell element (4) is a substantial rectangle), and having a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2) since Figure 3(a) of Maehane demonstrates that the long side of each solar battery cells (4) is about three times as long as the short side of each cell (see Figure 3(a)), said plain shape including a plurality of light-receiving-surface bus electrodes (surface electrodes, 2a) parallel to the short side of the substantial rectangle on a light receiving surface (see Figure 3(b) & [0013-0016]), and including rear-surface bus electrodes (rear electrodes, 3a) each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes (see Figure 3(b) & [0013-0016]); and

an interconnector (electrical connection member, 5) that electrically connects the light-receiving-surface bus electrodes (surface electrodes, 2a) of a first one of the solar battery cells to the rear-surface bus electrodes (rear electrodes, 3a) of an adjacent second one of the solar battery cells (see Figure 3(b) & [0016]),

wherein long sides of the substantial rectangle include a first long side and a second long side (see Figures 3(a)-3(b) above), and

Wherein the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other (See Figures 3(a)-3(b) above and paragraph [0016]).

Modified Maehane et al. is silent to the substantial rectangle having chamfered corners on both ends of only the first long side such that the second long side is without chamfered corners.

In the same field of endeavor of solar battery modules, Kamimura et al. teaches providing notches, thereby forming chamfered corners, on both ends of only the first long side such that the second long side is without chamfered corners in order to provide a space that shelters the connecting terminals from radiation and from an electric-field environment (see Fig. 6, Column 4, lines 30-38 and Column 6, lines 33-420.

It would have been obvious to one ordinarily skilled in the art at the time of the invention to modify the substantial rectangle of Modified Maehane et al. to have chamfered edges/corners on both ends of only the first long side such that the second long side is without chamfered corners as taught by Kamimura et al. in order to provide a space that shelters the connecting terminals from radiation and from an electric-field environment (see Fig. 6, Column 4, lines 30-38 and Column 6, lines 33-420.

Response to Arguments

13. Applicant's arguments, see Remarks Filed on 03/19/2015, with respect to the rejection of claim(s) 1 and 4-12 under 35 U.S.C. §103(a) have been considered but are moot because the arguments do not apply to the combination of references being used in the current rejection in view of applicants' newly submitted amendments.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAYLA GONZALEZ whose telephone number is (571)272-5054. The examiner can normally be reached on Monday through Thursday 9:00 to 5:00 EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer Michener can be reached on 571-272-1424. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MAYLA GONZALEZ/
Examiner, Art Unit 1758

/JAYNE MERSHON/
Primary Examiner, Art Unit 1758

Notice of References Cited	Application/Control No. 13/806,793	Applicant(s)/Patent Under Reexamination SHIMASAKI ET AL.	
	Examiner MAYLA GONZALEZ	Art Unit 1758	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,262,358	07-2001	Kamimura et al.	136/244
*	B	US-2007/0175509	08-2007	Yagiura et al.	136/256
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
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FOREIGN PATENT DOCUMENTS

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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13806793
Filing Date	2012-12-24
First Named Inventor	Koji SHIMASAKI et al.
Art Unit	1758
Examiner Name	Mayla Gonzales Ramos
Attorney Docket Number	1032404-000416

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Receipt date: 03/02/2015	Application Number	13806793	13806793 - GAU: 1758
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	2012-12-24	
	First Named Inventor	Koji SHIMASAKI et al.	
	Art Unit	1758	
	Examiner Name	Mayla Gonzales Ramos	
	Attorney Docket Number	1032404-000416	

	1	Chinese Notification of First Office Action dated December 2, 2014 issued in the corresponding Chinese Patent Application 201080067773.1 and English language translation (10 pages).	☒

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EXAMINER SIGNATURE

Examiner Signature	/Mayla Gonzalez Ramos/	Date Considered	06/27/2015

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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Receipt date: 03/02/2015	Application Number	13806793 13806793 - GAU: 1758
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1758
	Examiner Name	Mayla Gonzales Ramos
	Attorney Docket Number	1032404-000416

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☒ See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David R. Kemeny/	Date (YYYY-MM-DD)	2015-03-02
Name/Print	David R. Kemeny	Registration Number	57,241

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L3	3	"20070175509"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/26 16:49
L5	2	"13806793"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/26 16:56
L8	2	"6262358".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/26 17:00
L9	2	L3 and series and parallel	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 00:22
L18	107316	(cell element photovoltaic "pv" string) with (series serial$2) with parallel	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:00
L19	28193	(cell element photovoltaic "pv" string) with (series serial$2) with parallel same output	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:00
L20	52687	L18 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:00

Jinko Ex. 1002 - 470/580

EAST Search History (Prior Art)

L21	13988	L19 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:00
L22	1988	20 AND ((H01L31/048 OR H01L31/02008 OR H01L31/0508 OR H01L31/02013 OR H01L31/022425 OR H01L31/042 OR H01L31/0504 OR H01L31/18 OR H02M2007/4835 OR H02M7/003 OR Y02E10/50 OR H02S40/34).CPC. OR (136/244).CCLS.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:02
L23	628	21 AND ((H01L31/048 OR H01L31/02008 OR H01L31/0508 OR H01L31/02013 OR H01L31/022425 OR H01L31/042 OR H01L31/0504 OR H01L31/18 OR H02M2007/4835 OR H02M7/003 OR Y02E10/50 OR H02S40/34).CPC. OR (136/244).CCLS.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:02
L24	20	(wafer substrate) with (corner edge) with (chamfer$3 round$3) and L22	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:03
L25	8	(wafer substrate) with (corner edge) with (chamfer$3 round$3) and L23	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:03
L26	11149	(cell module element device panel assembl$3 array) with (solar photovoltaic "pv" string) with (series serial$2) with parallel	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:07
L27	4496	L26 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:07

Jinko Ex. 1002 - 471/580

EAST Search History (Prior Art)

L28	1686	27 AND ((H01L31/048 OR H01L31/02008 OR H01L31/0508 OR H01L31/02013 OR H01L31/022425 OR H01L31/042 OR H01L31/0504 OR H01L31/18 OR H02M2007/4835 OR H02M7/003 OR Y02E10/50 OR H02S40/34).CPC. OR (136/244).CCLS.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:07
L29	534	L28 and (bus busbar (bus adj bar))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:08
L30	270	L29 and grid	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:08

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13806793	SHIMASAKI ET AL.
	Examiner	**Art Unit**
	MAYLA GONZALEZ RAMOS	1758

CPC- SEARCHED		
Symbol	**Date**	**Examiner**
H01L31/048, 02008, 0508, 02013, 022425, 042, 0504, 18	06/2015	Mayla Gonzalez
H02M2007/4835, 003	06/2015	Mayla Gonzalez
Y02E10/50	06/2015	Mayla Gonzalez
H02S40/34	06/2015	Mayla Gonzalez

CPC COMBINATION SETS - SEARCHED		
Symbol	**Date**	**Examiner**

US CLASSIFICATION SEARCHED			
Class	**Subclass**	**Date**	**Examiner**
136	243-265	4/2014	Mayla Gonzalez
136	244	06/2015	Mayla Gonzalez

SEARCH NOTES		
Search Notes	**Date**	**Examiner**
Inventor serach	4/2014	Mayla Gonzalez
Assignee search	4/2014	Mayla Gonzalez
Class/Subclass search	4/2014	Mayla Gonzalez
Text search	4/2014	Mayla Gonzalez
Foreign Patent search	4/2014	Mayla Gonzalez
Consulted with Jayne Mershon	4/2014	Mayla Gonzalez
Updated search	11/2014	Mayla Gonzalez
Updated search	06/2015	Mayla Gonzalez
Consulted with Jayne Mershon	06/2015	Mayla Gonzalez

/MAYLA GONZALEZ RAMOS/ Examiner.Art Unit 1758	

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/MAYLA GONZALEZ RAMOS/ Examiner.Art Unit 1758	

N THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	**MAIL STOP AMENDMENT**
Koji SHIMASAKI et al.	Group Art Unit: 1758
Application No.: 13/806,793	Examiner: Mayla Gonzales Ramos
Filed: December 24, 2012	Confirmation No.: 2289
For: SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF	

AMENDMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In response to the Office Action dated July 2, 2015, please amend the above-identified patent application as follows:

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS:

1. (Previously Presented) A solar battery module comprising:

a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and

an interconnector that electrically connects the light-receiving-surface bus electrodes of a first one of the solar battery cells to the rear-surface bus electrodes of an adjacent second one of the solar battery cells, wherein a predetermined number of the solar battery cells are serially connected to each other, thereby configuring a cell string, n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, the n in the number of columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length, and the n-column parallel-connected cell strings are further serially connected to another n-column parallel-connected cell strings by a second string connector at an opposite end of the n columns, thereby configuring an entire cell array.

2-3. (Cancelled)

4. (Previously Presented) The solar battery module according to claim 1, wherein a predetermined number of the solar battery cells are serially connected, thereby configuring a cell string, two columns of the cell strings are connected in parallel, and the two-column parallel-connected cell strings are further serially connected, thereby configuring an entire cell array.

5. (Previously Presented) The solar battery module according to claim 1, wherein the light-receiving-surface bus electrodes of each solar battery cell are formed at positions that are line-symmetrical with respect to a line passing through a middle point of a side perpendicular to an extended line of the light-receiving-surface bus electrodes and parallel to the light-receiving-surface bus electrodes.

6. (Previously Presented) The solar battery module according to claim 1, wherein the light-receiving-surface bus electrodes of each solar battery cell are formed at positions that are line-symmetrical with respect to a line passing through a middle point of a side parallel to the light-receiving-surface bus electrodes and perpendicular to the light-receiving-surface bus electrodes.

7. (Original) The solar battery module according to claim 1, wherein each of the solar battery cells includes an area where the light-receiving-surface bus electrodes

and the rear-surface bus electrodes are not formed within a predetermined dimension from an edge toward a central direction of the cell at an outer circumferential edge portion thereof.

8. (Previously Presented) The solar battery module according to claim 1, which is obtained by dividing a basic solar battery cell with a plane shape thereof being a substantial square, which includes n light-receiving-surface electrode areas in each of which a plurality of light-receiving-surface bus electrodes parallel to a side of the substantial square and a plurality of grid electrodes perpendicular to the light-receiving-surface bus electrodes are provided on a light-receiving surface side and includes rear-surface bus electrodes each at a position on a non-light-receiving surface side corresponding to each of the light-receiving-surface bus electrodes into n respective boundaries of the n light-receiving-surface electrode areas.

9. (Previously Presented) The solar battery module according to claim 1, wherein the second string connector extends continuously across the entire cell array.

10. (Previously Presented) The solar battery module according to claim 1, wherein the interconnector is joined to the light-receiving-surface bus electrode of a solar battery cell nearest to the second string connector of the n-column parallel-connected cell strings, and is connected to the second string connector, and the second string connector is connected to a rear surface lead at the rear-surface bus electrode of

a head solar battery cell nearest the second string connector of the another n-column parallel-connected cell strings.

11. (Previously Presented) The solar battery module according to claim 1,

wherein long sides of the substantial rectangle include a first long side and a second long side,

the substantial rectangle has chamfered corners on both ends of only the first long side such that the second long side is without chamfered corners, and

wherein the first one of the solar battery cells and the second one of the solar battery cells are arranged in the cell array such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other.

12. (Previously Presented) A solar battery module comprising:

a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2), includes a plurality of light-receiving-surface bus electrodes parallel to the short side of the substantial rectangle on a light receiving surface, and includes rear-surface bus electrodes each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes; and

an interconnector that electrically connects the light-receiving-surface bus electrodes of a first one of the solar battery cells to the rear-surface bus electrodes of an adjacent second one of the solar battery cells, wherein

long sides of the substantial rectangle include a first long side and a second long side,

the substantial rectangle has chamfered corners on both ends of only the first long side such that the second long side is without chamfered corners, and

the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other.

13. (New) The solar battery module according to claim 1, wherein the solar battery cells in the cell array are arranged so that the short side lengths are parallel to the extension of the n-column parallel-connected cell strings.

REMARKS

Favorable reconsideration of this application is respectfully requested in view of the following remarks.

By this Amendment, Claim 13 is added. Thus, Claims 1 and 4-13 are pending in this application. Claims 1 and 12 are the only independent claims. Support for Claim 13 can be found, for example, in Figs. 11 and 12 of the application. No new matter is added.

Claims 1 and 4-10 are rejected under 35 U.S.C. §103(a) based on Japanese Patent Application Publication No. 07-106619 to Maehane et al. ("Maehane") in view of U.S. Patent Application Publication No. 2007/0175509 A1 to Yagiura et al. ("Yagiura"). The rejection is respectfully traversed.

Independent Claim 1 defines that the solar batter module includes, *inter alia*, a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and ***a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1*** (n is an integer equal to or larger than 2), wherein a predetermined number of the solar battery cells are serially connected to each other, thereby configuring a cell string, n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, ***the n in the number of columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length***.

According to the claimed configuration, the integer "n" for the number of columns of the cell strings connected in parallel *is the same* as the "n" in the ratio of the length of the short side to the long side of the solar battery cell. For example, if the integer "n" for

the number of columns of the cell strings connected in parallel is “3”, the “n” in the ratio of the length of the short side to the long side of the solar battery cell also is “3”. This configuration is beneficial because, in a method of connecting to an inverter on a roof for example, the electrical characteristics equivalent to those of a module having non-divided cells serially connected to each other can be obtained and the arrangement of modules (the number of serial/parallel connected modules) does not need to be changed significantly as discussed in paragraphs [0053] and [0054] of the published U.S. application.

The Office Action asserts that Maehane discloses the claimed ratio because Fig. 3(a) of the reference appears to show that the long side of each cell is about three times the length of the short side (see page 3 of the Office Action). The Office Action acknowledges that Maehane fails to disclose n-column parallel-connected cell strings being serially connected to another n-column parallel-connected cell strings by a second string connector at an opposite end of the n columns, but asserts that these features are disclosed by Yagiura.

Yagiura discloses strings of solar cells that are connected to each other as shown in Fig. 8 of the reference. The Office Action says Fig. 8 of Yagiura shows four 2-column cell strings connected in parallel. The Office Action goes on to say that Yagiura necessarily discloses the n in the number of columns of the cell strings connected in parallel as shown in Fig. 8 is equal to the n in the ratio of the long side length to the short side length of each solar cell because the number of columns of the cell strings connected in parallel in Yagiura is 2 (see page 7 of the Office Action). However, there is no teaching in Yagiura that ties the number of columns of the cell

strings connected in parallel to the ratio of the long side length to the short side length of each solar cell. For instance, Yagiura does not disclose that the size of each solar cell in Fig. 8 of the reference has a ratio of a short side length and a long side length being 1/n:1 where n is equal to 2, so as to be the same as the number (i.e., 2) of the columns of the cell strings that are connected in parallel. Moreover, there would have been no reason for such a limitation in Yagiura's or Maehane's solar cell module.

Accordingly, the combination of Maehane and Yagiura fails to disclose or suggest the claimed combination of features, including a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and *a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1* (n is an integer equal to or larger than 2), wherein a predetermined number of the solar battery cells are serially connected to each other, thereby configuring a cell string, n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, *the n in the number of columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length*, as recited in independent Claim 1. Claim 1 is thus patentable over Maehane and Yagiura for at least the above reasons.

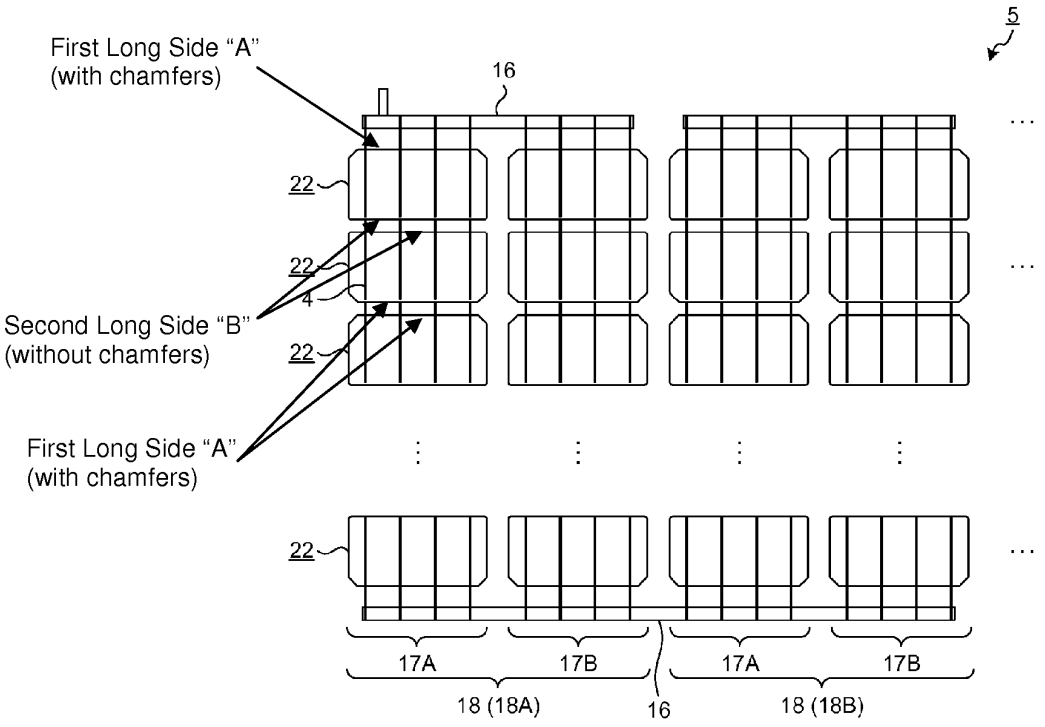
Claims 4-10 are patentable over Maehane and Yagiura at least by virtue of their dependence from patentable independent Claim 1. Thus, a detailed discussion of the additional distinguishing features recited in these dependent claims is not set forth at this time. Withdrawal of the rejection is respectfully requested.

The Office Action rejects Claim 11 under 35 U.S.C. §103(a) based on Maehane in view of Yagiura, and further in view of U.S. Patent No. 6,262,358 to Kamimura et al. ("Kamimura"). The rejection is respectfully traversed.

Claim 11 defines that long sides of the substantial rectangle include a first long side and a second long side, *the substantial rectangle has chamfered corners on both ends of* ***only the first long side*** such that ***the second long side is without chamfered corners***, and the first one of the solar battery cells and the second one of the solar battery cells are arranged in the cell array such that the first long side (with chamfered corners) and the second long side of the first one and the second one of the solar battery cells do not face each other.

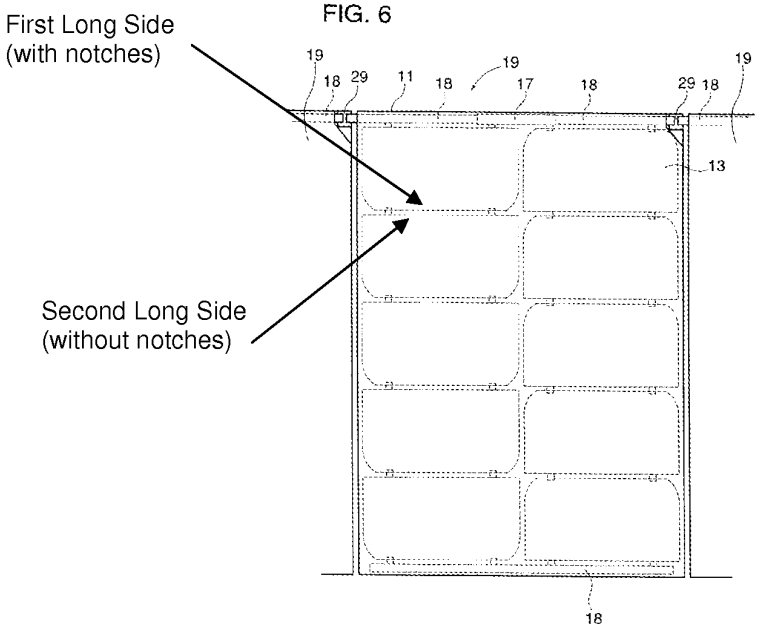
To assist the Examiner's understanding of these features, an annotated version of Fig. 15 of the present application is provided below. The claims, however, are not limited by this exemplary embodiment. The annotated figure shows that the substantial rectangle has chamfered corners on both ends of *only* the first long side "A" *such that the second long side "B" is without chamfered corners*. The first one of the solar battery cells 22 and the second one of the solar battery cells 22 are arranged in the cell array 5 such that the first long side "A" (with chamfered corners) and the second long side "B" (without chamfered corners) of the first one and the second one of the solar battery cells 22 do not face each other:

FIG.15



The Office Action acknowledges that Maehane fails to disclose the claimed configuration, but asserts that it is shown by Kamimura in Fig. 6 of that reference. Here, however, Kamimura discloses that the solar cells 13 are arranged such that the first long side (with notches) of a first solar cell 13 and the second long side of a second solar cell 13 (without notches) ***face each other***:

FIG. 6



The solar cells 13 are not arranged such that the first long side (with notches) and the second long side (*without* notches) of a first one and a second one of the cells 4 do ***not*** face each other as defined in Claim 11 here.

Accordingly, Claim 11 is patentable over the applied references for at least the above reasons, as well as by virtue of its dependence from patentable independent Claim 1. Withdrawal of the rejection is respectfully requested.

The Office Action rejects independent Claim 12 under 35 U.S.C. §103(a) based on Maehane in view of Kamimura. The rejection is respectfully traversed.

Independent Claim 12 defines features similar to those discussed above with respect to Claim 11. For the reasons discussed above, the combination of Maehane and Kamimura fails to disclose or suggest that claimed configuration (i.e., long sides of the substantial rectangle include a first long side and a second long side, the substantial rectangle has chamfered corners on both ends of *only* the first long side *such that the*

second long side is without chamfered corners, and the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other). Thus, independent Claim 12 is patentable over Maehane and Kamimura at least for the reasons discussed above. Withdrawal of the rejection is respectfully requested.

Claim 13 is presented for consideration and defines that the solar battery cells in the cell array are arranged so that the short side lengths are parallel to the extension of the n-column parallel-connected cell strings.

In Yagiura on the other hand, the solar battery cells in the cell array are arranged so that the short side lengths are *perpendicular* to the extension of the n-column parallel-connected cell strings (see Fig. 8 of Yagiura).

Should any questions arise in connection with this application or should the Examiner believe that a telephone conference with the undersigned would be helpful in resolving any remaining issues pertaining to this application the undersigned respectfully requests that he be contacted at the number indicated below.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date: September 4, 2015 By: /David R. Kemeny/
David R. Kemeny
Registration No. 57241

Customer No. 21839
703 836 6620

Electronic Acknowledgement Receipt

EFS ID:	23407373
Application Number:	13806793
International Application Number:	
Confirmation Number:	2289
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Customer Number:	21839
Filer:	David Ray Kemeny/Michele Shockey
Filer Authorized By:	David Ray Kemeny
Attorney Docket Number:	1032404-000416
Receipt Date:	04-SEP-2015
Filing Date:	24-DEC-2012
Time Stamp:	12:19:47
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		AMD.pdf	169088 5f8941070d9b93c9a5260645271854f536b2e05a	yes	13

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	6
	Applicant Arguments/Remarks Made in an Amendment	7	13
Warnings:			
Information:			
	Total Files Size (in bytes):	169088	

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/806,793	Filing Date 12/24/2012	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)		
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

		(Column 1)		(Column 2)	(Column 3)		
	09/04/2015	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	Total (37 CFR 1.16(i))	* 11	Minus	** 20	= 0	X $80 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	X $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	**0**

		(Column 1)		(Column 2)	(Column 3)		
		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/MINNIE JACKSON/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	13806793
	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1758
	Examiner Name	Mayla Gonzales Ramos
	Attorney Docket Number	1032404-000416

U.S.PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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U.S.PATENT APPLICATION PUBLICATIONS						
Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐
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NON-PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	13806793
	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1758
	Examiner Name	Mayla Gonzales Ramos
	Attorney Docket Number	1032404-000416

	1	Chinese Notification of the Second Office Action dated July 22, 2015 issued in the corresponding Chinese Patent Application 201080067773.1 and English language translation (7 pages).	☒

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	13806793
	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1758
	Examiner Name	Mayla Gonzales Ramos
	Attorney Docket Number	1032404-000416

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☒ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David R. Kemeny	Date (YYYY-MM-DD)	2015-09-18
Name/Print	David R. Kemeny	Registration Number	57,241

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	23536354
Application Number:	13806793
International Application Number:	
Confirmation Number:	2289
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Customer Number:	21839
Filer:	David Ray Kemeny/Michele Shockey
Filer Authorized By:	David Ray Kemeny
Attorney Docket Number:	1032404-000416
Receipt Date:	18-SEP-2015
Filing Date:	24-DEC-2012
Time Stamp:	14:04:35
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDS-5.pdf	63796 d6e88d52be2c66a6a2b0304e02df1da8a6fa9773	no	4

Warnings:	
Information:	

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2	Non Patent Literature	NPL1-CN-OA.pdf	361720 26967dab6a7b6a9afe9ae7f27cc3c56c10ac5873	no	7
Warnings:					
Information:					
			Total Files Size (in bytes):	425516	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/806,793	12/24/2012	Koji Shimasaki	1032404-000416	2289

21839 7590 12/17/2015

BUCHANAN, INGERSOLL & ROONEY PC
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EXAMINER
GONZALEZ RAMOS, MAYLA

ART UNIT	PAPER NUMBER
1758	

NOTIFICATION DATE	DELIVERY MODE
12/17/2015	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ADIPDOC1@BIPC.com

Office Action Summary	Application No. 13/806,793	Applicant(s) SHIMASAKI ET AL.	
	Examiner MAYLA GONZALEZ	Art Unit 1758	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *09/04/2015*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1 and 4-13* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1 and 4-13* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *12/24/2012* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *09/18/2015*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application is being examined under the pre-AIA first to invent provisions.

Status of Claims

2. This action is in response to Applicant's Request for Reconsideration dated 09/04/2015.

3. **Claim(s)** 1 and 4-13 are currently pending.

4. **Claim(s)** 2 and 3 have been canceled.

5. **Claim(s)** 13 has been added.

Claim Interpretation

6. Herein, the limitation "a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2)" is interpreted as the length of the long side of each solar cell being at least twice as long than the length of the short side of each solar cell.

7. Herein, the term "line symmetrical" is interpreted as the two halves of a cell being identical if they were to be folded/divided i.e., one half of the cell is a reflection of the other.

Claim Rejections - 35 USC § 103

8. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

9. Claims 1 and 4-10 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over JP 07-106619, Maehane et al in view of US 2007/0175509, Yagiura et al.

Regarding claims 1 and 4

Maehane et al. teaches a solar battery module (see Figure 1-3 & [0015-0016]) comprising:

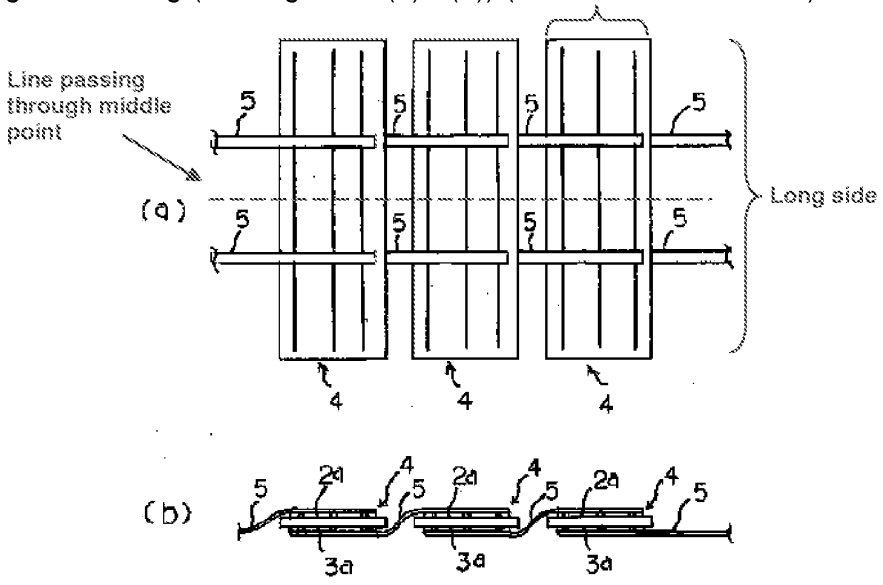
a plurality of solar battery cells (first, second and third solar battery elements, 4) (Figure 3(a) & [0016]),

a plain shape of each being a substantial rectangle (see Figure 3 wherein each solar cell element (4) is a substantial rectangle), and having a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2) (see Figs. 1 and 3(a), paragraph [0003-0004] and [0013-0020] wherein the solar battery cell is square shaped and is divided into three rectangular solar battery cells resulting in a ratio of a short side length and a long side length of the substantial rectangle being 1/3:1 i.e., n=3), said plain shape including a plurality of light-receiving-

surface bus electrodes (surface electrodes, 2a) parallel to the short side of the substantial rectangle on a light receiving surface (see Figure 3(b) & [0013-0016]), and including rear-surface bus electrodes (rear electrodes, 3a) each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes (see Figure 3(b) & [0013-0016]); and

an interconnector (electrical connection member, 5) that electrically connects the light-receiving-surface bus electrodes (surface electrodes, 2a) of a first one of the solar battery cells to the rear-surface bus electrodes (rear electrodes, 3a) of an adjacent second one of the solar battery cells (see Figure 3(b) & [0016]),

wherein a predetermined number of the solar battery cells (i.e., 3 solar battery element, 4) are serially connected to each other ([0016] & Figures 3a-3b), thereby configuring a cell string (see Figures 3(a)-3(b)) (instant claims 1 and 4).



Modified Maehane et al. is silent to n-columns of the cell strings being connected in parallel by a first string connector at one end of the n columns, the n in the number of

columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length, and the n-column parallel-connected cell strings being further serially connected to another n-column parallel connected strings by a second string connector at an opposite end of the n-columns, thereby configuring an entire cell array (instant claims 1 and 4).

Yagiura et al., similar to modified Maehane et al., teaches a solar battery module wherein 12 solar battery cells are serially connected to form a cell string (8 total strings), any two of the cell strings of solar battery cells being connected in parallel (4 total columns) by a first string connector (tab, 21) (see Fig. 8), wherein the 4-column parallel-connected cells are further serially connected by a second string connector (tab, 21) to form an entire cell array (see Figure 8 and paragraphs [0066-0068]). Specifically, such configuration is merely one of a finite number of electrical connection patterns e.g., series, parallel, and combinations thereof, available to one skilled in the art (See e.g., Figs. 5-9). Further, one skilled in the art would have found obvious to electrically connect the solar battery cells such that they have a predetermined output power.

Maehane et al. and Yagiura et al. are analogous inventions in the field of solar battery modules. It would have been obvious to one ordinarily skilled in the art at the time of the invention to modify the electrical configuration of the PV cell strings in modified Maehane et al. to be connected in parallel by a first string connector at one end of the n columns, and to be further serially connected to another n-column parallel connected strings by a second string connector as taught by Yagiura et al. in order to achieve a predetermined power output.

Furthermore, because Yagiura et al. teaches choosing from a finite number of identified, predictable electrical connection patterns, one of ordinary skill in the art would have found obvious to pursue the known options with reasonable expectation of success [see MPEP 2143]. Since Yagiura et al. teaches that the claimed configuration leads to the anticipated success, said connection pattern is not of innovation but of ordinary skill and common sense [see MPEP 2143].

With regards to the limitation “the n in the number of columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length", such feature is taught by the prior art since Yagiura teaches that the ration of a long side length to a short side length is approximately 2, and further teaches that connecting any two of the strings of divided solar battery cells being connected in parallel.

Regarding claim 5

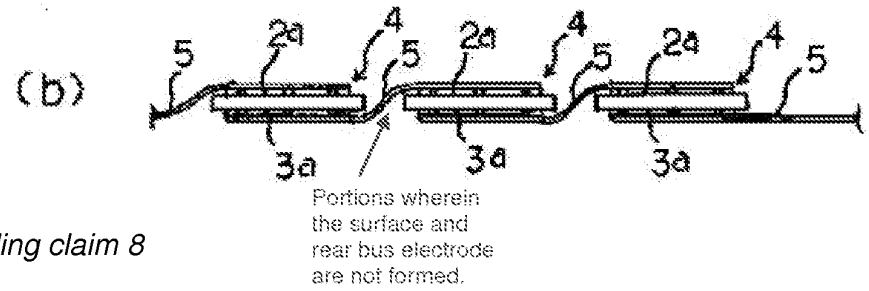
Modified Maehane et al. teaches the solar battery module as set forth above, wherein the light-receiving-surface bus electrodes (surface electrodes, 2a) of the each solar battery cell (4) are formed at positions that are line-symmetrical (i.e., both halves of the cell look identical if it were to be folded) with respect to a line passing through a middle point of a side (i.e., long side of each cell (4) as shown in Figure 3(a) above) perpendicular to an extended line of the light-receiving-surface bus electrodes (surface electrode, 2a) and parallel to the light-receiving-surface bus electrodes (long side of the cell is parallel to the smaller side of the surface electrodes (2a) which are located beneath interconnector (5))) (see Maehane et al., Figures 1(a) and 3(a)-3(b)).

Regarding claim 6

Modified Maehane et al. teaches the solar battery module as set forth above, wherein the light-receiving-surface bus electrodes (surface electrodes, 2a) of the solar battery cell are formed at positions that are line-symmetrical (i.e., both halves of the cell look identical if it were to be folded) with respect to a line passing through a middle point of a side parallel (i.e., longer side of each cell is parallel to the short side of each light-receiving-surface bus electrodes (202) which are located underneath the interconnector (5)) to the light-receiving-surface bus electrodes (surface electrodes, 2a) and perpendicular to the light-receiving-surface bus electrodes (surface electrodes, 2a) since the longer side of each cell is also perpendicular to an extended line of the light-receiving-surface bus electrodes (surface electrodes, 2a) (see Maehane et al., Figures 1(a) and 3(a)-3(b)).

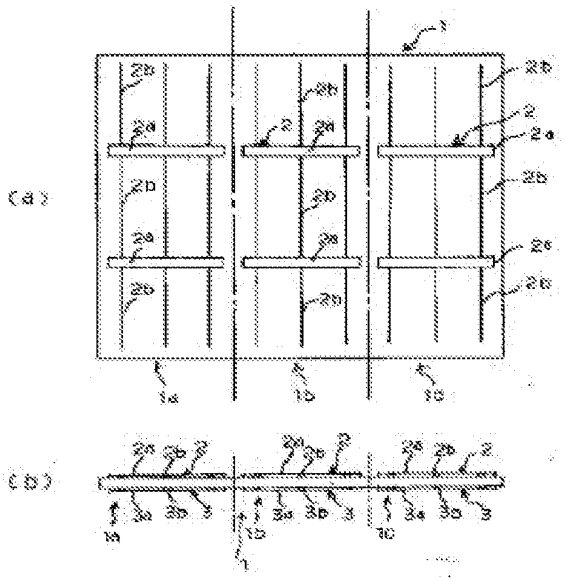
Regarding claim 7

Modified Maehane et al. teaches the solar battery module as set forth above, wherein each of the solar battery cells (first, second and third solar battery elements, 4) (see Maehane et al., Figure 3(a)-3(b)) includes an area where the light-receiving-surface bus electrodes (surface electrodes, 2a) and the rear-surface bus electrodes (rear electrodes, 3a) are not formed within a predetermined dimension from an edge toward a central direction of the cell at an outer circumferential edge portion (outer boundary lines of the cells) thereof i.e., the bus electrodes are not formed at portions/areas where the cell has been divided (see figure 3(b) below; see also paragraphs [0062-0063] of applicants' instant specification).



Regarding claim 8

Modified Maehane et al. teaches the solar battery module as set forth above, which is obtained by dividing a basic solar battery cell with a plane shape thereof being a substantial square (see Figure 1 & [0015]), which includes n light-receiving-surface electrode areas (electricity generation regions 1a-1c) (Figures 1(a)-1(b) & [0013]) in each of which a plurality of light-receiving-surface bus electrodes (surface electrodes, 2a) parallel to a side of a substantial square (see Figure 1(a)) and a plurality of grid electrodes (branch parts, 2b) perpendicular to the light-receiving-surface bus electrodes (surface electrodes, 2a) are provided on a light-receiving surface side (see Figure 1(a) & [0013]) and includes rear-surface bus electrodes (rear electrodes, 3a) each at a position on a non-light-receiving surface side (rear surface) corresponding to each of the light-receiving-surface bus electrodes (surface electrodes, 2a) into n respective boundaries (see Figure 1(b)) of the n light-receiving-surface electrode areas (electricity generation regions 1a-1c).



Although taught by the prior art, the limitation “which is obtained by dividing a basic solar battery cell with a plane shape thereof being a substantial square” is a product by process limitation and, therefore, does not impart any additional structure to the claimed product.

Even though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process. In re Thorpe, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985) [MPEP 2113]

Regarding claim 9

Modified Maehane et al. teaches the solar battery module as set forth above, wherein the second string connector (See, e.g., bus 125 in Figure 1A of Foss) extends continuously across the entire cell array (See Foss, Figure 1A).

Regarding claim 10

Modified Maehane et al. teaches the solar battery module as set forth above, wherein the interconnector (electrical connection member, 5) is joined to the light-receiving-surface bus electrode (surface electrodes, 2a) of a solar battery cell nearest to the second string connector of the n-column parallel-connected cell strings (see Maehane et al., Figure 1(a) and paragraph [0013] wherein the interconnector (5) is joined to the surface electrode/light-receiving bus electrode (2a) of each solar battery element (4) and therefore reads on the limitation "*joined to the light-receiving-surface bus electrode of a solar battery cell nearest to the second string connector of the n-column parallel-connected cell strings*"; see also Figure 1A of Foss), and is connected to the second string connector (see Foss, e.g., Bus 125 in Figure 1A), and the second string connector (see Foss, e.g., Bus 125 in Figure 1A) is connected to a rear surface lead at the rear-surface bus electrode (rear electrodes, 3a) of a head solar battery cell nearest the second string connector of the another n-column parallel- connected cell strings (see Maehane et al., Figure 1(a) and paragraph [0013]; see also Figure 1A of Foss).

It is noted that, as all the elements within the solar battery module of modified Maehane et al. are in electrical communication, the limitation “the second string connector is connected to a rear surface lead at the rear-surface bus electrode of a

head solar battery cell nearest the second string connector of the another n-column parallel- connected cell strings) is met as the claims do not require said second string connector being *directly* connected to the rear surface lead at the rear-surface bus electrode of a head solar battery cell.

Regarding claim 13

Modified Maehane et al. teaches the solar battery module as set forth above, wherein the solar battery cells (first, second and third solar battery elements, 4) are arranged so that the short side lengths are parallel to the extension of the n-column of parallel connected strings (see Maehane, Figure 3(a) & [0016]; see also Yagiura, Fig. 8).

10. Claim 11 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over JP 07-106619, Maehane et al in view of US 2007/0175509, Yagiura et al., as applied to claims 1, 4-10 and 13 above, and further in view of US 6,262,358, Kamimura et al.

Regarding claim 11

All the limitations of claim 1, from which claim 11 depends, have been set forth above.

Modified Maehane et al. teaches the solar battery module as set forth above, wherein long sides of the substantial rectangle include a first long side and a second long side (see Maehane et al., Figures 3(a)-3(b) above), and

Wherein the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second

long side of the first one and the second one of the solar battery cells do not face each other (See Maehane et al., Figures 3(a)-3(b) above and paragraph [0016]).

Modified Maehane et al. is silent to the substantial rectangle having chamfered corners on both ends of only the first long side such that the second long side is without chamfered corners.

In the same field of endeavor of solar battery modules, Kamimura et al. teaches providing notches, thereby forming chamfered corners, on both ends of only the first long side such that the second long side is without chamfered corners in order to provide a space that shelters the connecting terminals from radiation and from an electric-field environment (see Fig. 6, Column 4, lines 30-38 and Column 6, lines 33-420.

It would have been obvious to one ordinarily skilled in the art at the time of the invention to modify the substantial rectangle of Modified Maehane et al. to have chamfered edges/corners on both ends of only the first long side such that the second long side is without chamfered corners as taught by Kamimura et al. in order to provide a space that shelters the connecting terminals from radiation and from an electric-field environment (see Fig. 6, Column 4, lines 30-38 and Column 6, lines 33-420.

11. Claim 12 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over JP 07-106619, Maehane et al in view of US 6,262,358, Kamimura et al.

Regarding claim 12

Maehane et al. teaches a solar battery module (see Figure 1-3 & [0015-0016]) comprising:

a plurality of solar battery cells (first, second and third solar battery elements, 4) (Figure 3(a) & [0016]),

a plain shape of each being a substantial rectangle (see Figure 3 wherein each solar cell element (4) is a substantial rectangle), and having a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1 (n is an integer equal to or larger than 2) (see Figs. 1 and 3(a), paragraph [0003-0004] and [0013-0020] wherein the solar battery cell is square shaped and is divided into three rectangular solar battery cells resulting in a ratio of a short side length and a long side length of the substantial rectangle being 1/3 i.e., n=3), said plain shape including a plurality of light-receiving-surface bus electrodes (surface electrodes, 2a) parallel to the short side of the substantial rectangle on a light receiving surface (see Figure 3(b) & [0013-0016]), and including rear-surface bus electrodes (rear electrodes, 3a) each at a position on a non-light-receiving surface corresponding to each of the light-receiving-surface bus electrodes (see Figure 3(b) & [0013-0016]); and

an interconnector (electrical connection member, 5) that electrically connects the light-receiving-surface bus electrodes (surface electrodes, 2a) of a first one of the solar battery cells to the rear-surface bus electrodes (rear electrodes, 3a) of an adjacent second one of the solar battery cells (see Figure 3(b) & [0016]),

wherein long sides of the substantial rectangle include a first long side and a second long side (see Figures 3(a)-3(b) above), and

Wherein the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second

long side of the first one and the second one of the solar battery cells do not face each other (See Figures 3(a)-3(b) above and paragraph [0016]).

Modified Maehane et al. is silent to the substantial rectangle having chamfered corners on both ends of only the first long side such that the second long side is without chamfered corners.

In the same field of endeavor of solar battery modules, Kamimura et al. teaches providing notches, thereby forming chamfered corners, on both ends of only the first long side such that the second long side is without chamfered corners in order to provide a space that shelters the connecting terminals from radiation and from an electric-field environment (see Fig. 6, Column 4, lines 30-38 and Column 6, lines 33-420.

It would have been obvious to one ordinarily skilled in the art at the time of the invention to modify the substantial rectangle of Modified Maehane et al. to have chamfered edges/corners on both ends of only the first long side such that the second long side is without chamfered corners as taught by Kamimura et al. in order to provide a space that shelters the connecting terminals from radiation and from an electric-field environment (see Fig. 6, Column 4, lines 30-38 and Column 6, lines 33-420.

Response to Arguments

12. Applicant's arguments filed 09/04/2015 have been fully considered but they are not persuasive.

Applicant argues that there is no teaching in Yagiura that ties the number of columns of the cell strings connected in parallel to the ratio of the long side length to the short side length of each solar cell. For instance, Yagiura does not disclose that the size of each solar cell in Fig. 8 of the reference has a ratio of a short side length and a long side length being 1/n:1 where n is equal to 2, so as to be the same as the number (i.e., 2) of the columns of the cell strings that are connected in parallel.

Examiner respectfully disagrees. One cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

Examiner notes that Maehane specifically teaches a solar cell substrate (1), which is square in shape, divided into three solar cell parts i.e., n=3 (see Figs. 1-3 and paragraphs [0003-0004]). Therefore, the ratio of the long side length to the short side length of the solar cell is 1/3:1. As seen from Fig. 8 of Yagiura, the ratio of a long side length to a short side length of each solar battery cell is about 2 (cells are divided in 2). Further, Yagiura teaches that the number n of the n columns of the cell strings connected in parallel is 2. Therefore, the combination of the divided cells of Maehane and the electrical connection shown in Fig. 8 of Yagiura teaches that the number of n columns of cell strings connected in parallel is equal to the n in the ratio of the long side length to a short side length.

Applicant argues that the solar cells 13 are not arranged such that the first long side (with notches) and the second long side (without notches) of a first one and a second one of the cells 4 do not face each other as defined in Claim 11 here.

Examiner respectfully disagrees. The second column (not annotated by applicant) of Fig. 6 of Kamimura shows a first long side of a first solar battery cell (10) not facing the second long side of a second solar battery cell (13).

Applicant argues that in Yagiura the solar battery cells in the cell array are arranged so that the short side lengths are perpendicular to the extension of the n-column parallel-connected cell strings (see Fig. 8 of Yagiura).

Examiner respectfully disagrees. Applicant has not defined what the extension is. Further, applicant has not defined in which direction said columns extend. Examiner cannot fully appreciate the scope of applicant's argument because of said ambiguity.

Additionally, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See In re Keller, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); In re Merck & Co., 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Specifically, the solar cell of the primary reference (Maehane) is divided into three sections. Therefore, the short side lengths are parallel to the extension of the n-column parallel-connected cell strings.

Conclusion

13. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAYLA GONZALEZ whose telephone number is (571)272-5054. The examiner can normally be reached on Monday through Thursday 9:00 to 5:00 EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer Michener can be reached on 571-272-1424. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MAYLA GONZALEZ/
Examiner, Art Unit 1758

/JAYNE MERSHON/
Primary Examiner, Art Unit 1758

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13806793	SHIMASAKI ET AL.
	Examiner	**Art Unit**
	MAYLA GONZALEZ RAMOS	1758

CPC- SEARCHED		
Symbol	**Date**	**Examiner**
H01L31/048, 02008, 0508, 02013, 022425, 042, 0504, 18	06/2015	Mayla Gonzalez
H02M2007/4835, 003	06/2015	Mayla Gonzalez
Y02E10/50	06/2015	Mayla Gonzalez
H02S40/34	06/2015	Mayla Gonzalez
H01L31/02, 02008, 042, 0504	12/2015	Mayla Gonzalez
Y02E10/50	12/2015	Mayla Gonzalez

CPC COMBINATION SETS - SEARCHED		
Symbol	**Date**	**Examiner**

US CLASSIFICATION SEARCHED			
Class	**Subclass**	**Date**	**Examiner**
136	243-265	4/2014	Mayla Gonzalez
136	244	06/2015	Mayla Gonzalez

SEARCH NOTES		
Search Notes	**Date**	**Examiner**
Inventor serach	4/2014	Mayla Gonzalez
Assignee search	4/2014	Mayla Gonzalez
Class/Subclass search	4/2014	Mayla Gonzalez
Text search	4/2014	Mayla Gonzalez
Foreign Patent search	4/2014	Mayla Gonzalez
Consulted with Jayne Mershon	4/2014	Mayla Gonzalez

/MAYLA GONZALEZ RAMOS/ Examiner.Art Unit 1758	

SEARCH NOTES		
Search Notes	**Date**	**Examiner**
Updated search	11/2014	Mayla Gonzalez
Updated search	06/2015	Mayla Gonzalez
Consulted with Jayne Mershon	06/2015	Mayla Gonzalez
Updated search	12/2015	Mayla Gonzalez

INTERFERENCE SEARCH			
US Class/ CPC Symbol	**US Subclass / CPC Group**	**Date**	**Examiner**

/MAYLA GONZALEZ RAMOS/ Examiner.Art Unit 1758	

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	450	(string same column same parallel same series)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/13 02:39
L2	229	L1 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/13 02:40
L3	22	2 AND ((H01L31/02 OR H01L31/02008 OR H01L31/042 OR H01L31/0504 OR Y02E10/50).CPC.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/13 02:43
S1	2	"13806793"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:06
S2	1361	shimasaki-koji.in. suzuki-masayoshi.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:07
S3	408896	(mitsubishi adj electric).as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:07
S4	11	S2 and ((solar photovoltaic pv) near2 module)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:07

EAST Search History (Prior Art)

S6	582	S3 and ((solar photovoltaic pv) near2 module)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:07
S7	53	S6 and (bus busbar busses buses (bus adj bar))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:08
S8	11	S7 and (parallel with (series serial$2))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:11
S10	132	"136"/$.ccls. and (cell with (series serial$2)) and (string with parallel with (series serial$2)) and (bus busbar busses buses (bus adj bar))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:15
S11	80	S10 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:16
S12	307	"136"/$.ccls. and (cell with (series serial$2)) and (string with parallel with (series serial$2))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 12:11
S13	224	S12 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 12:11

EAST Search History (Prior Art)

S15	9	"07106619"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:47
S16	219	"136"/$.ccls. and (cell with (series serial$2)) and (string near4 parallel near6 (series serial$2))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:53
S17	165	S16 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:53
S18	43	"136"/$.ccls. and (cell with (series serial$2)) and (string with parallel with (series serial$2) with system)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:54
S19	36	S18 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:54
S20	623	"136"/$.ccls. and (cell with (series serial$2)) and (string near4 (series serially))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:56
S21	433	S20 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:57

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EAST Search History (Prior Art)

S22	242	S21 and (string with parallel)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:57
S24	6	"7812247".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:59
S25	307	"136"/$.ccls. and (cell with (series serial$2)) and (string with parallel with (series serial$2))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 14:07
S26	224	S25 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 14:07
S27	4	"20090133739"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 14:21
S29	5	"4795500".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 14:22

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EAST Search History (Prior Art)

S38	142	("20070059493"|"20080178928"|"5807440"|"6753065"|"5882774"|"20080006323"|"5953877"|"6232544"|"6268558"|"6574045"|"6590707"|"5807440"|"5990414"|"6538192"|"20090000221"|"20090000222"|"5662977"|"6451414"|"6565982"|"5203941"|"5284693"|"5506031"|"6180228"|"6355132"|"6467235"|"6679308"|"7118794"|"20030178058"|"6455140"|"20060266406"|"20070153354"|"20080102270"|"20080271773"|"6049035"|"6296732"|"6521038"|"7227078"|"20070054129"|"20070146624"|"5421909"|"5468532"|"6237288"|"6590705"|"6609795"|"4235643"|"20070056625"|"6538192"|"7138173"|"6459514"|"20040031518"|"5273608"|"5303525"|"5680734"|"6523316"|"6715252"|"6329046"|"5575861").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 14:32
S47	0	"14226443"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 15:34
S48	4	"20090133739"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 15:42
S49	1	"13616933"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 16:05
S50	2	"20100229926"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 17:17
S60	6	"7812247".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:06

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EAST Search History (Prior Art)

S61	8	"20040035460"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:08
S62	307	((solar photovoltaic) near2 (cell module battery)) and (string near2 parallel near4 series)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:09
S63	179	S62 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:09
S64	93	((solar photovoltaic) near2 (cell module battery)) and (string near2 parallel near4 series with array)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:10
S65	56	S64 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:10
S66	56	S65 and (array with series with parallel)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:17
S67	88	S63 and (array with series with parallel)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:18

EAST Search History (Prior Art)

S68	2	"12814361"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 15:06
S69	2	"6440769".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 15:06
S75	3	"20100295377"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 08:52
S76	2	"13806793"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:15
S77	11733	(wafer substrate) with (corner edge) with (chamfer$3 round$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:15
S78	138	S77 and "136"/$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:16
S79	89	S78 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:16

EAST Search History (Prior Art)

S80	2928	cell with (corner edge) with (chamfer$3 round$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:17
S81	4754	(cell module) with (corner edge) with (chamfer$3 round$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:17
S82	140	S81 and "136"/$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:17
S83	80	S82 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:17
S84	32	cell with (corner edge) with chamfer$3 and "136"/$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:35
S85	17	S84 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:36
S86	2	"20110277834"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 10:22

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EAST Search History (Prior Art)

S89	3	"20070175509"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/26 16:49
S91	2	"13806793"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/26 16:56
S94	2	"6262358".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/26 17:00
S95	2	S89 and series and parallel	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 00:22
S96	107316	(cell element photovoltaic "pv" string) with (series serial$2) with parallel	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:00
S97	28193	(cell element photovoltaic "pv" string) with (series serial$2) with parallel same output	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:00
S98	52687	S96 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:00

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EAST Search History (Prior Art)

S99	13988	S97 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:00
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S101	628	S99 AND ((H01L31/048 OR H01L31/02008 OR H01L31/0508 OR H01L31/02013 OR H01L31/022425 OR H01L31/042 OR H01L31/0504 OR H01L31/18 OR H02M2007/4835 OR H02M7/003 OR Y02E10/50 OR H02S40/34).CPC. OR (136/244).CCLS.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:02
S102	20	(wafer substrate) with (corner edge) with (chamfer$3 round$3) and S100	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:03
S103	8	(wafer substrate) with (corner edge) with (chamfer$3 round$3) and S101	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:03
S104	11149	(cell module element device panel assembl$3 array) with (solar photovoltaic "pv" string) with (series serial$2) with parallel	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:07
S105	4496	S104 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:07

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EAST Search History (Prior Art)

S106	1686	S105 AND ((H01L31/048 OR H01L31/02008 OR H01L31/0508 OR H01L31/02013 OR H01L31/022425 OR H01L31/042 OR H01L31/0504 OR H01L31/18 OR H02M2007/4835 OR H02M7/003 OR Y02E10/50 OR H02S40/34).CPC. OR (136/244).CCLS.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:07
S107	534	S106 and (bus busbar (bus adj bar))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:08

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13806793
Filing Date	2012-12-24
First Named Inventor	Koji SHIMASAKI et al.
Art Unit	1758
Examiner Name	Mayla Gonzales Ramos
Attorney Docket Number	1032404-000416

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
		ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.G./	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13806793
	Filing Date	2012-12-24
	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1758
	Examiner Name	Mayla Gonzales Ramos
	Attorney Docket Number	1032404-000416

	1	Chinese Notification of the Second Office Action dated July 22, 2015 issued in the corresponding Chinese Patent Application 201080067773.1 and English language translation (7 pages).	☒

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EXAMINER SIGNATURE

Examiner Signature	/Mayla Gonzalez Ramos/	Date Considered	12/13/2015

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13806793
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	First Named Inventor	Koji SHIMASAKI et al.
	Art Unit	1758
	Examiner Name	Mayla Gonzales Ramos
	Attorney Docket Number	1032404-000416

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☒ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David R. Kemeny	Date (YYYY-MM-DD)	2015-09-18
Name/Print	David R. Kemeny	Registration Number	57,241

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /MJG/

N THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	**MAIL STOP AMENDMENT**
Koji SHIMASAKI et al.	Group Art Unit: 1758
Application No.: 13/806,793	Examiner: Mayla Gonzales Ramos
Filed: December 24, 2012	Confirmation No.: 2289
For: SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF	

PRE-APPEAL BRIEF REQUEST FOR REVIEW

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Appellants respectfully request review of the Final Rejection mailed on December 17, 2015 in the above-identified application. Claims 1 and 4-13 are pending in this application, with Claims 1 and 12 being the only independent claims.

Claims 1, 4-10 and 13 are rejected under 35 U.S.C. §103(a) as allegedly being obvious based on Japanese Patent Application Publication No. 07-106619 to Maehane et al. ("Maehane") in view of U.S. Patent Application Publication No. 2007/0175509 A1 to Yagiura et al. ("Yagiura"). Claim 11 is rejected under 35 U.S.C. §103(a) based on Maehane in view of Yagiura, and further in view of U.S. Patent No. 6,262,358 to Kamimura et al. ("Kamimura"). Claim 12 is rejected under 35 U.S.C. §103(a) based on Maehane in view of Kamimura. The rejections are based on clear legal and factual deficiencies, and therefore must be withdrawn.

To establish a *prima facie* case of obviousness, there must be **sufficient evidence** supported by clear **articulated reasoning** and **rational underpinning** that the claimed invention would have been obvious (*KSR International Co. v. Teleflex Inc.*, 82 USPQ2d 1385 (2007); MPEP §2142 and §2143). In the present case, there is no factual evidence supported by clear articulated reasoning and rational underpinning that the features recited in Claims 1, 11 and 12 would have been obvious in view of the cited references. The Examiner has thus failed to establish a *prima facie* case of obviousness.

Claim 1 defines that the solar batter module includes, among other things, a plurality of solar battery cells, a plain shape of each being a substantial rectangle, and ***a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1*** (n is an integer equal to or larger

than 2), wherein a predetermined number of the solar battery cells are serially connected to each other, thereby configuring a cell string, n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, ***the n in the number of columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length***.

According to the claimed configuration, the integer "n" for the number of columns of the cell strings connected in parallel *is the same* as the "n" in the ratio of the length of the short side to the long side of the solar battery cell. For example, if the integer "n" for the number of columns of the cell strings connected in parallel is "3", the "n" in the ratio of the length of the short side to the long side of the solar battery cell also is "3". This configuration is beneficial because, in a method of connecting to an inverter on a roof for example, the electrical characteristics equivalent to those of a module having non-divided cells serially connected to each other can be obtained and the arrangement of modules (the number of serial/parallel connected modules) does not need to be changed significantly as discussed in paragraphs [0053] and [0054] of the published U.S. application (U.S. 2103/0098423 A1).

The Examiner asserts that Maehane discloses the claimed ratio of the short side length to the long side length because Fig. 3(a) of the reference appears to show that the long side of each cell 4 is about three times the length of the short side (see page 3 of the Final Rejection). The Examiner admits that Maehane fails to disclose that the cells 4 are arranged in n columns of cell strings serially connected in parallel as claimed, but asserts that these features are disclosed by Yagiura.

Yagiura discloses strings of solar cells 10a that are connected to each other as shown in Fig. 8 of the reference. That figure shows four 2-column cell strings connected in parallel. The Examiner asserts that each solar cell 10a in the cell strings has a long side that is twice as large as the short side, i.e., n = 2, such that the ratio of the long side length to the short side length of each solar cell 10a is ½:2 (see page 15 of the Final Rejection). The Examiner goes on to say that because the number of columns of Yagiura's cell strings connected in parallel is 2 in Fig. 8, the n in the number of columns of Yagiura's cell strings connected in parallel ***is equal to the n in the ratio of the long side length to the short side length*** of each solar cell 10a as claimed.

There is no factual evidence to support the Examiner's position. Nowhere does Yagiura actually disclose that the ratio of the long side length of the solar cells 10a to the short side length is ½:2. The Examiner's position seems based simply on the apparent lengths of the long and short sides of the solar cells as shown in Fig. 8. However, Yagiura does not disclose that Fig. 8 is drawn to scale, and the disclosure is silent as to the length dimensions of the solar cells 10a. According to MPEP §2125, "When the reference does not disclose that the drawings are to scale and is silent as

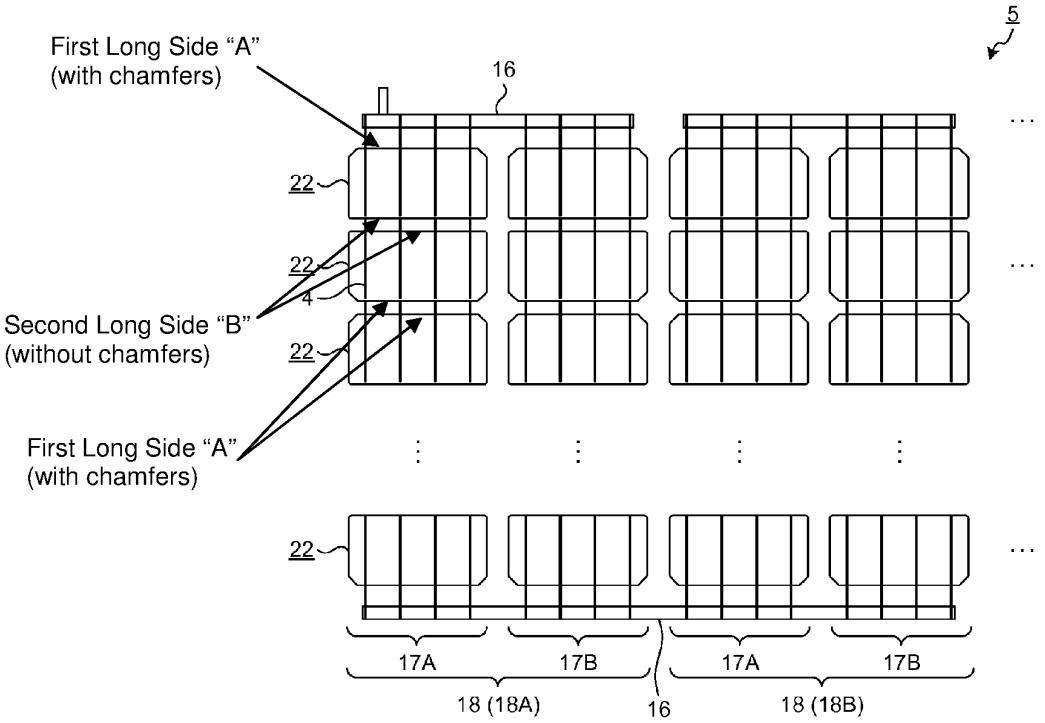
to dimensions, arguments based on measurement of the drawing features are of little value" (see *Hockerson-Halberstadt, Inc. v. Avia Group Int'l,* 222 F.3d 951, 956 (Fed. Cir. 2000)). Even if a ruler was used to measure the sides of the solar cells 10a as drawn in Fig. 8, the short side length of the solar cells is 9 mm and the long side length is 13 mm. That is not a ½:2 ratio. Note that Claim 1 defines *that n is an integer*, and so n must be a whole number. Accordingly, there is no factual evidence to support the Examiner's belief that the ratio of the long side length to the short side length of each of Yagiura's solar cells 10a is ½:2. The Examiner has thus not met her burden of showing that the size of each solar cell 10a in Fig. 8 of the reference has a ratio of a short side length and a long side length being 1/n:1 where n is equal to 2, ***so as to be equal to*** the number (i.e., 2) of the columns of the cell strings that are connected in parallel as defined in Claim 1 at issue here. Moreover, there would have been no reason for such a limitation in Yagiura's or Maehane's solar cell module.

In view of the foregoing, there is no factual evidence supported by clear articulated reasoning and rational underpinning to support the Examiner's conclusion that the combination of Maehane and Yagiura discloses the claimed configuration, including that *a ratio of a short side length and a long side length of the substantial rectangle being 1/n:1* (n is an integer equal to or larger than 2), wherein a predetermined number of the solar battery cells are serially connected to each other, thereby configuring a cell string, n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, *the n in the number of columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length*. The rejection of Claim 1 is thus improper and must be withdrawn for at least the above reasons.

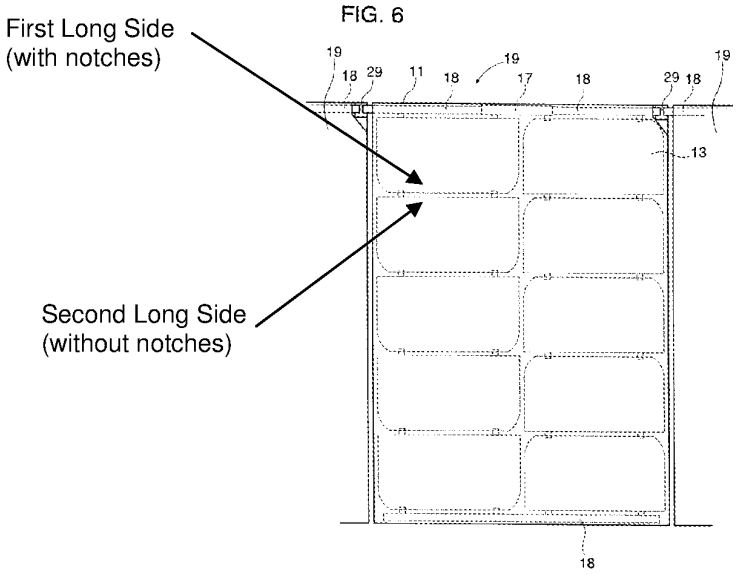
Independent Claim 12 defines that long sides of the substantial rectangle include a first long side and a second long side, *the substantial rectangle has chamfered corners on both ends of* ***only the first long side*** such that the ***second long side is without chamfered corners***, and the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other.

To assist the Panel's understanding of these features, a non-limiting annotated version of Fig. 15 of the present application is provided below. This figure shows that the substantial rectangle has chamfered corners on both ends of *only* the first long side "A" *such that the second long side "B" is without chamfered corners*. The first one of the solar battery cells 22 and the second one of the solar battery cells 22 are arranged in the cell array 5 such that the first long side "A" (with chamfered corners) and the second long side "B" (without chamfered corners) of the first one and the second one of the solar battery cells 22 do not face each other:

FIG.15



The Examiner admits that Maehane fails to disclose the claimed configuration, but asserts that it is shown in Fig. 6 of Kamimura. Here, however, Kamimura discloses that the solar cells 13 are arranged such that the first long side (with notches) of a first solar cell 13 and the second long side of a second solar cell 13 (without notches) ***face each other***:



The solar cells 13 are not arranged such that the first long side (with notches) and the second long side (*without* notches) of a first one and a second one of the cells 4 do ***not*** face each other as defined in independent Claim 12 here. There is thus no factual evidence to support the Examiner's position that Kamimura discloses the claimed arrangement.

The Examiner comments that the second column (the right-hand side column) of Fig. 6 of Kamimura "shows a first long side of a first solar battery cell (10) not facing the second long side of a second solar batter cell (13)" (see page 16 of the Final Rejection). First of all, reference numeral 10 in Kamimura refers to a slit-like cut along boundary lines between solar cells (see col. 5, lines 54-56 of the reference) rather than to a solar cell, and so the Examiner's comparison between "a first solar battery cell (10)" and a second solar battery cell 13 is not understood.

The Examiner may be comparing the top solar battery cell in the left-hand column of Fig. 6 of Kamimura with the top solar battery cell 13 in the right-hand column of the figure. It is noted, however, that the first one of the solar battery cells and the second one of the solar battery cells defined in Claim 12 are *connected by an interconnector that electrically connects the light-receiving-surface bus electrodes of the first one of the solar battery cells to the rear-surface bus electrodes of the adjacent second one of the solar battery cells*. On the other hand, the top solar battery cell in the left-hand column of Fig. 6 of Kamimura and the top solar battery cell 13 in the right-hand column of the figure are not connected by the interconnector 16 (see Fig. 1 of Kamimura) as claimed. Accordingly, the top solar battery cell in the left-hand column of Fig. 6 of Kamimura and the top solar battery cell 13 in the right-hand column of the figure do not correspond to the claimed first and second ones of the solar battery cells defined in independent Claim 12. The rejection of independent Claim 12 is thus improper and must be withdrawn for at least these reasons.

Claim 11, which depends from Claim 1, defines features similar to those discussed above with respect to Claim 12 and so the rejection of this claim also is improper for the reasons discussed above. Dependent Claims 4-10 and 13 incorporate the features of Claim 1, and so the rejection of these claims is improper and must be withdrawn for at least this reason.

It is respectfully submitted that the rejections are in error and that the claims are in condition for allowance. Appellants respectfully request the panel of Examiners to review the December 17, 2015 Final Rejection prior to Appeal and to withdraw the rejections therein.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date: February 19, 2016

By: /David R. Kemeny/
David R. Kemeny
Registration No. 57241

Customer No. 21839
703 836 6620

Electronic Patent Application Fee Transmittal

Application Number:	13806793
Filing Date:	24-Dec-2012
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Filer:	David Ray Kemeny/Michele Shockey
Attorney Docket Number:	1032404-000416

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Notice of Appeal	1401	1	800	800
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**800**

Electronic Acknowledgement Receipt

EFS ID:	24962414
Application Number:	13806793
International Application Number:	
Confirmation Number:	2289
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Customer Number:	21839
Filer:	David Ray Kemeny/Michele Shockey
Filer Authorized By:	David Ray Kemeny
Attorney Docket Number:	1032404-000416
Receipt Date:	19-FEB-2016
Filing Date:	24-DEC-2012
Time Stamp:	12:31:52
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$800
RAM confirmation Number	9840
Deposit Account	024800
Authorized User	KEMENY, DAVID R.

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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Warnings:					
Information:					
2	Pre-Brief Conference request	Pre-Appeal-Brief.pdf	153929 37fe029b244f09e40373719d6396ee235d05395c	no	5
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30746 5ebf2bdd07a059cfe38146d6faf95c60196b1796	no	2
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New International Application Filed with the USPTO as a Receiving Office

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PTO/AIA/31 (07-12)
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NOTICE OF APPEAL FROM THE EXAMINER TO THE BOARD OF PATENT APPEALS AND INTERFERENCES

Docket Number (Optional)

1032404-000416

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on _____

Signature _____

Typed or printed name _____

In re Application of

Shimasaki, Koji

Application Number	Filed
13/806,793	**December 24, 2012**

For **Solar Battery Module and Manufacturing Method Thereof**

Art Unit **1758**	Examiner
Conf. No. **2289**	**GONZALEZ RAMOS, MAYLA**

Applicant hereby **appeals** to the Board of Patent Appeals and Interferences from the last decision of the examiner.

The fee for this Notice of Appeal is (37 CFR 41.20(b)(1)) $ **800**

☐ Applicant claims small entity status. See 37 CFR 1.27. Therefore, the fee shown above is reduced by half, and the resulting fee is: $ _____

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☒ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **02-4800**.

☒ Payment made via EFS-Web.

☐ A petition for an extension of time under 37 CFR 1.136(a) (PTO/AIA/22) is enclosed.

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I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest.
See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

☒ attorney or agent of record.
Registration number **57,241.**

☐ attorney or agent acting under 37 CFR 1.34.
Registration number if acting under 37 CFR 1.34. _____

/David R. Kemeny/
Signature

David R. Kemeny
Typed or printed name

703-836-6620
Telephone number

February 19, 2016
Date

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☐ *Total of_____ forms are submitted.

This collection of information is required by 37 CFR 41.31. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11, 1.14 and 41.6. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/806,793	12/24/2012	Koji Shimasaki	1032404-000416	2289

21839 7590 04/13/2016

BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

EXAMINER
GONZALEZ RAMOS, MAYLA

ART UNIT	PAPER NUMBER
1758	

MAIL DATE	DELIVERY MODE
04/13/2016	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of Panel Decision from Pre-Appeal Brief Review	Application No. 13/806,793	Applicant(s) SHIMASAKI ET AL.
	Examiner MAYLA GONZALEZ	Art Unit 1758

This is in response to the Pre-Appeal Brief Request for Review filed 19 February, 2016.

1. ☐ **Improper Request** – The Request is improper and a conference will not be held for the following reason(s):

☐ The Notice of Appeal has not been filed concurrent with the Pre-Appeal Brief Request.
☐ The request does not include reasons why a review is appropriate.
☐ A proposed amendment is included with the Pre-Appeal Brief request.
☐ Other: .

The time period for filing a response continues to run from the receipt date of the Notice of Appeal or from the mail date of the last Office communication, if no Notice of Appeal has been received.

2. ☐ **Proceed to Board of Patent Appeals and Interferences** – A Pre-Appeal Brief conference has been held. The application remains under appeal because there is at least one actual issue for appeal. Applicant is required to submit an appeal brief in accordance with 37 CFR 41.37. The time period for filing an appeal brief will be reset to be one month from mailing this decision, or the balance of the two-month time period running from the receipt of the notice of appeal, whichever is greater. Further, the time period for filing of the appeal brief is extendible under 37 CFR 1.136 based upon the mail date of this decision or the receipt date of the notice of appeal, as applicable.

☐ The panel has determined the status of the claim(s) is as follows:
Claim(s) allowed: _____.
Claim(s) objected to: _____.
Claim(s) rejected: _____.
Claim(s) withdrawn from consideration: _____.

3. ☐ **Allowable application** – A conference has been held. The rejection is withdrawn and a Notice of Allowance will be mailed. Prosecution on the merits remains closed. No further action is required by applicant at this time.

4. ☒ **Reopen Prosecution** – A conference has been held. The rejection is withdrawn and a new Office action will be mailed. No further action is required by applicant at this time.

All participants:

(1) *MAYLA GONZALEZ*.	(3) *Robert Hill*.
(2) *Jennifer Michener*.	(4)_____.

/MAYLA GONZALEZ/ Examiner, Art Unit 1758	/Robert J Hill Jr/ Primary Examiner, TC 1700	/JENNIFER MICHENER/ Supervisory Patent Examiner, Art Unit 1758

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

21839 7590 08/29/2016
BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

EXAMINER	
GONZALEZ RAMOS, MAYLA	
ART UNIT	PAPER NUMBER
1758	

DATE MAILED: 08/29/2016

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/806,793	12/24/2012	Koji Shimasaki	1032404-000416	2289

TITLE OF INVENTION: SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	11/29/2016

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

Jinko Ex. 1002 - 545/580

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

21839 7590 08/29/2016
BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/806,793	12/24/2012	Koji Shimasaki	1032404-000416	2289

TITLE OF INVENTION: SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	11/29/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
GONZALEZ RAMOS, MAYLA	1758	136-244000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Jinko Ex. 1002 - 546/580

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/806,793	12/24/2012	Koji Shimasaki	1032404-000416	2289

21839 7590 08/29/2016

BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

EXAMINER	
GONZALEZ RAMOS, MAYLA	
ART UNIT	PAPER NUMBER
1758	

DATE MAILED: 08/29/2016

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Jinko Ex. 1002 - 547/580

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 13/806,793	Applicant(s) SHIMASAKI ET AL.	
	Examiner MAYLA GONZALEZ	Art Unit 1758	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *02/19/2016*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1 and 4-13*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/MAYLA GONZALEZ/
Examiner, Art Unit 1758

Jinko Ex. 1002 - 549/580

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application is being examined under the pre-AIA first to invent provisions.

Status of Claims

2. This action is in response to Applicant's Request for Reconsideration dated 02/19/2016.

3. **Claim(s)** 1 and 4-13 are currently pending.

4. **Claim(s)** 2-3 have been canceled.

5. **Claim(s)** 13 have been added.

Allowable Subject Matter

6. Claims 1 and 4-13 are allowed.

Reasons for Allowance

7. The following is an examiner's statement of reasons for allowance:

Regarding claim 1

The prior art of record, whether alone or in combination, fails to teach or fairly suggest the limitation "the n in the number of columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length" in the context of other limitations in the claim.

Maehane (JP H07-106619) teaches a plurality of solar battery cells (4) with a substantial rectangular shape (Figure 3(a) & [0016]), wherein the ratio of a short side length and a long side length of the substantial rectangle is 1/n:1 (n is an integer equal to or larger than 2) (see Figs. 1 and 3(a), paragraph [0003-0004] and [0013-0020] wherein the solar battery cell is square shaped and is divided into three rectangular solar battery cells resulting in n being at least 2). Maehane further teaches that a predetermined number (e.g. 3) of solar battery cells (4) are serially connected to each other in order to form a cell string (Fig. 3(a) and paragraph [0016]).

Maehane does not teach "n columns of the cell strings are connected in parallel by a first string connector at one end of the n columns, the n in the number of columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length, and the n-column parallel-connected cell strings are further serially connected to another n-column parallel-connected cell strings by a second string connector at an opposite end of the n columns, thereby configuring an entire cell array."

Yagiura (US 2007/0175509) teaches serially connected cells (12) forming a string wherein any two strings are also connected in parallel by a first string connector (21), and further serially connected by a second string connector (tab, 21) to form an entire cell array (see Figure 8 and paragraphs [0066-0068]). Such configuration is merely one of a finite number of electrical connection patterns e.g., series, parallel, and combinations thereof, available to one skilled in the art (See e.g., Figs. 5-9). Further,

one skilled in the art would have found obvious to electrically connect the solar battery cells such that they have a predetermined output power.

However, Yagiura does not teach that “the n in the number of columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length” in the context of other limitations of the claims.

The prior art of record, whether alone or in combination, fails to teach or fairly suggest the limitation “the n in the number of columns of the cell strings connected in parallel being equal to the n in the ratio of the long side length to the short side length” in the context of other limitations in the claim.

Regarding claim 12

The prior art of record, whether alone or in combination, fails to teach of fairly suggest the limitation “the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other.”

Maehane (JP H07-106619) teaches a plurality of solar battery cells (4) with a substantial rectangular shape (Figure 3(a) & [0016]). However, nowhere in Maehane is there a disclosure that supports that ""the substantial rectangle has chamfered corners on both ends of only the first long side such that the second long side is without chamfered corners, and the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the

second long side of the first one and the second one of the solar battery cells do not face each other."

Kamimura (US 6,262,358) teaches providing notches, thereby forming chamfered corners, on both ends of a first long side of a cell such that a second long side is without chamfered corners in order to provide a space that shelters the connecting terminals from radiation and from an electric-field environment (see Fig. 6, Column 4, lines 30-38 and Column 6, lines 33- 420.

Kamimura does not teach that “the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other”. In Kamimura the solar cells 13 are arranged such that the first long side (with notches) of a first solar cell 13 and the second long side of a second solar cell 13 (without notches) face each other:

The prior art of record, whether alone or in combination, fails to teach of fairly suggest the limitation “the first one of the solar battery cells and the second one of the solar battery cells are arranged in the module such that the first long side and the second long side of the first one and the second one of the solar battery cells do not face each other” in the context of other limitations in the claim.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled “Comments on Statement of Reasons for Allowance.”

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAYLA GONZALEZ whose telephone number is (571)272-5054. The examiner can normally be reached on Monday through Thursday 9:00 to 5:00 EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer Michener can be reached on 571-272-1424. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MAYLA GONZALEZ/
Examiner, Art Unit 1758

/JAYNE MERSHON/
Primary Examiner, Art Unit 1758

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13806793	SHIMASAKI ET AL.
	Examiner	**Art Unit**
	MAYLA GONZALEZ RAMOS	1758

CPC- SEARCHED		
Symbol	**Date**	**Examiner**
H01L31/048, 02008, 0508, 02013, 022425, 042, 0504, 18	06/2015	Mayla Gonzalez
H02M2007/4835, 003	06/2015	Mayla Gonzalez
Y02E10/50	06/2015	Mayla Gonzalez
H02S40/34	06/2015	Mayla Gonzalez
H01L31/02, 02008, 042, 0504	12/2015	Mayla Gonzalez
Y02E10/50	12/2015	Mayla Gonzalez
H01L31/0201, 042, 05, 0504	08/2016	Mayla Gonzalez
Y02E10/50	08/2016	Mayla Gonzalez

CPC COMBINATION SETS - SEARCHED		
Symbol	**Date**	**Examiner**

US CLASSIFICATION SEARCHED			
Class	**Subclass**	**Date**	**Examiner**
136	243-265	4/2014	Mayla Gonzalez
136	244	06/2015	Mayla Gonzalez

SEARCH NOTES		
Search Notes	**Date**	**Examiner**
Inventor serach	4/2014	Mayla Gonzalez
Assignee search	4/2014	Mayla Gonzalez

/MAYLA GONZALEZ RAMOS/ Examiner.Art Unit 1758	

SEARCH NOTES		
Search Notes	**Date**	**Examiner**
Class/Subclass search	4/2014	Mayla Gonzalez
Text search	4/2014	Mayla Gonzalez
Foreign Patent search	4/2014	Mayla Gonzalez
Consulted with Jayne Mershon	4/2014	Mayla Gonzalez
Updated search	11/2014	Mayla Gonzalez
Updated search	06/2015	Mayla Gonzalez
Consulted with Jayne Mershon	06/2015	Mayla Gonzalez
Updated search	12/2015	Mayla Gonzalez
Updated search	07/2016	Mayla Gonzalez
Consulted with Jennifer Michener and Robert Hill	04/2016	Mayla Gonzalez
Updated search	08/2016	Mayla Gonzalez

INTERFERENCE SEARCH			
US Class/ CPC Symbol	**US Subclass / CPC Group**	**Date**	**Examiner**
See attached		08/2016	Mayla Gonzalez

/MAYLA GONZALEZ RAMOS/ Examiner.Art Unit 1758	

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	2	"13806793"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/08/22 08:46
L2	479	(string same column same parallel same series)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/08/22 08:47
L3	231	L2 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/08/22 08:47
L4	22	L3 AND ((H01L31/05 OR H01L31/0201 OR H01L31/042 OR H01L31/0504 OR Y02E10/50).CPC.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/08/22 08:47
S1	2	"13806793"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:06
S2	1361	shimasaki-koji.in. suzuki-masayoshi.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:07
S3	408896	(mitsubishi adj electric).as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:07

EAST Search History (Prior Art)

S4	11	S2 and ((solar photovoltaic pv) near2 module)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:07
S6	582	S3 and ((solar photovoltaic pv) near2 module)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:07
S7	53	S6 and (bus busbar busses buses (bus adj bar))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:08
S8	11	S7 and (parallel with (series serial$2))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:11
S10	132	"136"/$.ccls. and (cell with (series serial$2)) and (string with parallel with (series serial$2)) and (bus busbar busses buses (bus adj bar))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:15
S11	80	S10 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/03/12 14:16
S12	307	"136"/$.ccls. and (cell with (series serial$2)) and (string with parallel with (series serial$2))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 12:11

EAST Search History (Prior Art)

S13	224	S12 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 12:11
S15	9	"07106619"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:47
S16	219	"136"/$.ccls. and (cell with (series serial$2)) and (string near4 parallel near6 (series serial$2))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:53
S17	165	S16 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:53
S18	43	"136"/$.ccls. and (cell with (series serial$2)) and (string with parallel with (series serial$2) with system)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:54
S19	36	S18 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:54
S20	623	"136"/$.ccls. and (cell with (series serial$2)) and (string near4 (series serially))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:56

EAST Search History (Prior Art)

S21	433	S20 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:57
S22	242	S21 and (string with parallel)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:57
S24	6	"7812247".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 13:59
S25	307	"136"/$.ccls. and (cell with (series serial$2)) and (string with parallel with (series serial$2))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 14:07
S26	224	S25 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 14:07
S27	4	"20090133739"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 14:21
S29	5	"4795500".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 14:22

EAST Search History (Prior Art)

S38	142	("20070059493"|"20080178928"|"5807440"|"6753065"|"5882774"|"20080006323"|"5953877"|"6232544"|"6268558"|"6574045"|"6590707"|"5807440"|"5990414"|"6538192"|"20090000221"|"20090000222"|"5662977"|"6451414"|"6565982"|"5203941"|"5284693"|"5506031"|"6180228"|"6355132"|"6467235"|"6679308"|"7118794"|"20030178058"|"6455140"|"20060266406"|"20070153354"|"20080102270"|"20080271773"|"6049035"|"6296732"|"6521038"|"7227078"|"20070054129"|"20070146624"|"5421909"|"5468532"|"6237288"|"6590705"|"6609795"|"4235643"|"20070056625"|"6538192"|"7138173"|"6459514"|"20040031518"|"5273608"|"5303525"|"5680734"|"6523316"|"6715252"|"6329046"|"5575861").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 14:32
S47	0	"14226443"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 15:34
S48	4	"20090133739"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 15:42
S49	1	"13616933"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 16:05
S50	2	"20100229926"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/24 17:17
S60	6	"7812247".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:06

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EAST Search History (Prior Art)

S61	8	"20040035460"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:08
S62	307	((solar photovoltaic) near2 (cell module battery)) and (string near2 parallel near4 series)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:09
S63	179	S62 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:09
S64	93	((solar photovoltaic) near2 (cell module battery)) and (string near2 parallel near4 series with array)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:10
S65	56	S64 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:10
S66	56	S65 and (array with series with parallel)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:17
S67	88	S63 and (array with series with parallel)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 13:18

EAST Search History (Prior Art)

S68	2	"12814361"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 15:06
S69	2	"6440769".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/28 15:06
S75	3	"20100295377"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 08:52
S76	2	"13806793"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:15
S77	11733	(wafer substrate) with (corner edge) with (chamfer$3 round$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:15
S78	138	S77 and "136"/$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:16
S79	89	S78 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:16

EAST Search History (Prior Art)

S80	2928	cell with (corner edge) with (chamfer$3 round$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:17
S81	4754	(cell module) with (corner edge) with (chamfer$3 round$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:17
S82	140	S81 and "136"/$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:17
S83	80	S82 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:17
S84	32	cell with (corner edge) with chamfer$3 and "136"/$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:35
S85	17	S84 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 09:36
S86	2	"20110277834"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/11/03 10:22

EAST Search History (Prior Art)

S89	3	"20070175509"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/26 16:49
S91	2	"13806793"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/26 16:56
S94	2	"6262358".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/26 17:00
S95	2	S89 and series and parallel	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 00:22
S96	107316	(cell element photovoltaic "pv" string) with (series serial$2) with parallel	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:00
S97	28193	(cell element photovoltaic "pv" string) with (series serial$2) with parallel same output	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:00
S98	52687	S96 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:00

EAST Search History (Prior Art)

S99	13988	S97 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:00
S100	1988	S98 AND ((H01L31/048 OR H01L31/02008 OR H01L31/0508 OR H01L31/02013 OR H01L31/022425 OR H01L31/042 OR H01L31/0504 OR H01L31/18 OR H02M2007/4835 OR H02M7/003 OR Y02E10/50 OR H02S40/34).CPC. OR (136/244).CCLS.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:02
S101	628	S99 AND ((H01L31/048 OR H01L31/02008 OR H01L31/0508 OR H01L31/02013 OR H01L31/022425 OR H01L31/042 OR H01L31/0504 OR H01L31/18 OR H02M2007/4835 OR H02M7/003 OR Y02E10/50 OR H02S40/34).CPC. OR (136/244).CCLS.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:02
S102	20	(wafer substrate) with (corner edge) with (chamfer$3 round$3) and S100	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:03
S103	8	(wafer substrate) with (corner edge) with (chamfer$3 round$3) and S101	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:03
S104	11149	(cell module element device panel assembl$3 array) with (solar photovoltaic "pv" string) with (series serial$2) with parallel	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:07
S105	4496	S104 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:07

EAST Search History (Prior Art)

S106	1686	S105 AND ((H01L31/048 OR H01L31/02008 OR H01L31/0508 OR H01L31/02013 OR H01L31/022425 OR H01L31/042 OR H01L31/0504 OR H01L31/18 OR H02M2007/4835 OR H02M7/003 OR Y02E10/50 OR H02S40/34).CPC. OR (136/244).CCLS.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:07
S107	534	S106 and (bus busbar (bus adj bar))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/27 01:08
S130	450	(string same column same parallel same series)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/13 02:39
S131	229	S130 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/13 02:40
S132	22	S131 AND ((H01L31/02 OR H01L31/02008 OR H01L31/042 OR H01L31/0504 OR Y02E10/50).CPC.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/13 02:43
S133	63011	(solar cell battery substrate) with (cut$4 divid$3) with side	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/07/11 10:48
S134	30	"1816684"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/07/11 10:52

EAST Search History (Prior Art)

S135	3	"20070175509"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/07/11 10:57
S136	673654	(solar cell battery substrate) with (cut$4 divid$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/07/11 11:23
S137	17370	S136 and (square quadrangle) with (cut$4 divid$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/07/11 11:25
S138	11798	S137 and @ad<"20100702"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/07/11 11:25
S139	172	S138 and ratio with side same (cut$4 divid$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/07/11 11:25
S140	9	S139 and (solar photovoltaic) adj (cell device module battery)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/07/11 11:26
S141	711	(solar cell battery substrate) with length with width and S138	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/07/11 11:28

EAST Search History (Prior Art)

S142	37	(solar cell battery substrate) with length with width with ratio and S138	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/07/11 11:28
S143	13	("2008/0223429").URPN.	USPAT	OR	ON	2016/08/07 01:08
S144	22	("4361950"|"5316788"|"20090308430"|"5647915"|"20040074531"|"4494580"|"5178685"|"6524351"|"6380477"|"3819417"|"6364089"|"3459391"|"5567248"|"20050133081"|"4542258"|"4877460"|"5617990"|"6178152"|"20020148499"|"4067319"|"20050045224"|"3993505"|"4164808"|"5148961"|"3411952"|"20020185173"|"20050272225"|"4180414"|"3450568").PN.	USPAT	OR	ON	2016/08/07 01:14

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L5	0	(ratio and short and long and length and cell and rectangle and bus and electrode and interconnector and series and parallel).clm.	US-PGPUB; USPAT	OR	ON	2016/08/22 08:54
L6	0	(ratio and short and long and length and cell and rectangle and bus and series and parallel).clm.	US-PGPUB; USPAT	OR	ON	2016/08/22 08:54
L7	11	(ratio and short and long and length and cell and rectangle).clm.	US-PGPUB; USPAT	OR	ON	2016/08/22 08:55
L8	0	(short and long and length and cell and rectangle and bus and connector and series and parallel).clm.	US-PGPUB; USPAT	OR	ON	2016/08/22 08:55
L9	0	(short and long and length and cell and rectangle and bus and series and parallel).clm.	US-PGPUB; USPAT	OR	ON	2016/08/22 08:55
L10	0	(ratio and short and long and length and cell and rectangle and bus and chamfered and face).clm.	US-PGPUB; USPAT	OR	ON	2016/08/22 08:56
L11	0	(ratio and short and long and length and cell and rectangle and bus and chamfered).clm.	US-PGPUB; USPAT	OR	ON	2016/08/22 08:56

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BIB DATA SHEET

CONFIRMATION NO. 2289

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/806,793	12/24/2012	136	1758	1032404-000416

APPLICANTS

INVENTORS

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Masayoshi Suzuki, Chiyoda-ku, JAPAN;

**** CONTINUING DATA ***************************

This application is a 371 of PCT/JP2010/061334 07/02/2010

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

01/07/2013

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☐ No Verified and Acknowledged /MAYLA GONZALEZ RAMOS/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		JAPAN	10	11 ~~6~~	2 ~~1~~

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UNITED STATES

TITLE

SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF

FILING FEE RECEIVED		
1140	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

Jinko Ex. 1002 - 571/580

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13806793	SHIMASAKI ET AL.
	Examiner	**Art Unit**
	MAYLA GONZALEZ RAMOS	1758

CPC						
Symbol					**Type**	**Version**
H01L		31	/	05	F	2013-01-01
H01L		31	/	0504	I	2013-01-01
Y02E		10	/	50	A	2013-01-01
H01L		31	/	0201	I	2013-01-01
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CPC Combination Sets						
Symbol				**Type**	**Set**	**Ranking**	**Version**
			/				
			/				

/MAYLA GONZALEZ RAMOS/ Examiner.Art Unit 1758	08/22/2016	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	11	
(Primary Examiner)	(Date)	O.G. Print Claim(s) 1	O.G. Print Figure 2

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13806793	SHIMASAKI ET AL.
	Examiner	**Art Unit**
	MAYLA GONZALEZ RAMOS	1758

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
		H	0	1	L	31 / 02 (2006.01.01)						
CROSS REFERENCE(S)		H	0	1	L	31 / 05 (2014.01.01)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)											

/MAYLA GONZALEZ RAMOS/ Examiner.Art Unit 1758	08/22/2016	**Total Claims Allowed:** 11	
(Assistant Examiner)	(Date)		
(Primary Examiner)	(Date)	O.G. Print Claim(s) 1	O.G. Print Figure 2

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13806793	SHIMASAKI ET AL.
	Examiner	**Art Unit**
	MAYLA GONZALEZ RAMOS	1758

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1														
2	4														
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8	10														
9	11														
10	12														
11	13														

/MAYLA GONZALEZ RAMOS/ Examiner.Art Unit 1758	08/22/2016	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	11	
		O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
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INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

21839 7590 08/29/2016
BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

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I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/806,793	12/24/2012	Koji Shimasaki	1032404-000416	2289

TITLE OF INVENTION: SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	11/29/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
GONZALEZ RAMOS, MAYLA	1758	136-244000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 **BUCHANAN INGERSOLL & ROONEY PC**
2
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3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: **MITSUBISHI ELECTRIC CORPORATION**

(B) RESIDENCE: (CITY and STATE OR COUNTRY): **CHIYODA-KU, TOKYO, JAPAN**

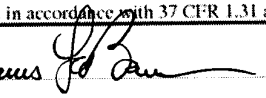
Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
☒ Issue Fee
☐ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
☐ A check is enclosed.
☒ Payment by credit card.
☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number **02-4800** (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
☐ Applicant certifying micro entity status. See 37 CFR 1.29
NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
☐ Applicant asserting small entity status. See 37 CFR 1.27
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
☐ Applicant changing to regular undiscounted fee status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature  Date **October 25, 2016**

Typed or printed name **James A. LaBarre** Registration No. **28,632**

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Jinko Ex. 1002 - 575/580

Electronic Patent Application Fee Transmittal

Application Number:	13806793
Filing Date:	24-Dec-2012
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Filer:	James A. LaBarre/Kevin Chanthakhoune
Attorney Docket Number:	1032404-000416

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**960**

Electronic Acknowledgement Receipt

EFS ID:	27309710
Application Number:	13806793
International Application Number:	
Confirmation Number:	2289
Title of Invention:	SOLAR BATTERY MODULE AND MANUFACTURING METHOD THEREOF
First Named Inventor/Applicant Name:	Koji Shimasaki
Customer Number:	21839
Filer:	James A. LaBarre/Kevin Chanthakhoune
Filer Authorized By:	James A. LaBarre
Attorney Docket Number:	1032404-000416
Receipt Date:	25-OCT-2016
Filing Date:	24-DEC-2012
Time Stamp:	10:20:09
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$960
RAM confirmation Number	102516INTEFSW10214200
Deposit Account	024800
Authorized User	Kevin Chanthakhoune

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

37 CFR 1.492 (National application filing, search, and examination fees)

37 CFR 1.492(a) (Basic national fee only)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	Fee_Transmittal.pdf	271814 abcd711b4e9c642427e81e631f02fb5bf0866584	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30987 55df713323dda6dd7a63c3d1696013d17098b9e4	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	302801		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/806,793	12/06/2016	9515214	1032404-000416	2289

21839 7590 11/16/2016

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ALEXANDRIA, VA 22313-1404

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Koji Shimasaki, Chiyoda-kku, JAPAN;
Masayoshi Suzuki, Chiyoda-ku, JAPAN;

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