

CERTIFICATE OF TRANSLATION ACCURACY

I am a professional reviewer and coordinator specializing in translating Japanese, Korean, and Chinese to English and vice versa.

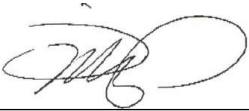
I served as Chief Examiner of the certified court interpreter test for the State of California and as a contract translator and interpreter for various federal agencies through the U.S. Department of State for more than a decade. I served as an instructor at the University of California at Berkeley and the Middlebury Institute of International Studies at Monterey (MIIS) Graduate Program in Translation.

I have more than 30 years of experience reviewing thousands of technical, legal, and business documents from Japanese to English submitted to, among others, Japanese judicial authorities, U.S. federal courts, the U.S. International Trade Commission (ITC), and the USPTO Patent Trial and Appeal Board (PTAB).

I certify that the following document translated from Japanese to English is a true, correct, and complete translation of the corresponding source text to the best of my knowledge and ability.

I certify under penalty of perjury that the foregoing is true and correct.

Executed this 14th day of April 2025 in Contra Costa County of the State of California.

By: 

Alex N. Jo
Member, ATA

(19) Japanese Patent
Office (JP)

(12) **Patent Application Gazette (A)**

(11) Published Application No.

H07-106619

(43) Appl. Published: Apr. 21, 1995

(51) Int. Cl ⁶	ID Number	JPO File Number	FI	Theme code (ref.)
H 01 L	31/042	H 01 F	31/04	R 7376-4M
				C 7376-4M

Request for Examination: Not Yet Requested Number of Claims: 2 OL Total pages: 5

(21) Filed Appl. No.: H05-251769	(71) Applicant:	000001889 SANYO ELECTRIC CO., LTD. 2-5-5 Keihanhondori, Moriguchi-shi, Osaka
(22) Filed: Oct. 7, 1993	(72) Inventor:	Masayoshi MAEHANE c/o Sanyo Electric Co., Ltd., 2-5-5 Keihan Hondori, Moriguchi-shi, Osaka
	(72) Inventor:	Yoshinobu TAKABATAKE c/o Sanyo Electric Co., Ltd., 2-5-5 Keihan Hondori, Moriguchi-shi, Osaka
	(72) Inventor:	Toshihiro NOMURA c/o Sanyo Electric Co., Ltd., 2-5-5 Keihan Hondori, Moriguchi-shi, Osaka
	(74) Agent or Attorney:	Takuji NISHINO, Patent Attorney

Continued on last page

(54) [TITLE OF THE INVENTION]
MANUFACTURING METHOD OF SOLAR CELL

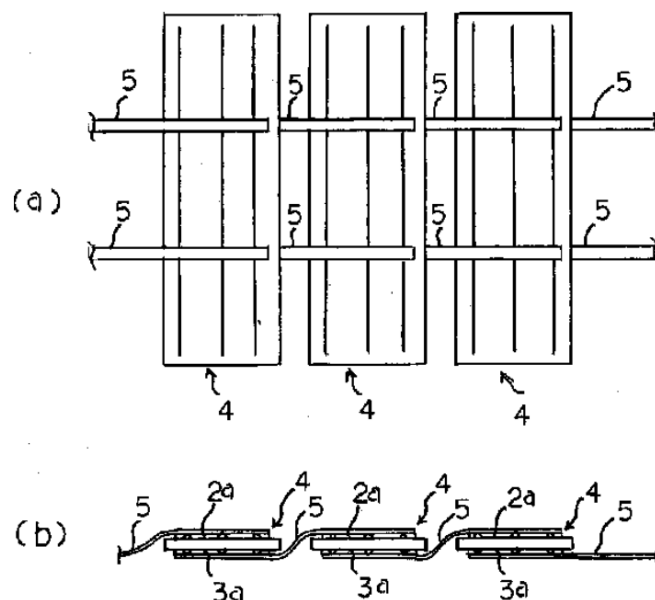
(57) ABSTRACT

PURPOSE

An object of the present invention is to provide a method for manufacturing solar cells that prevents short circuits when electrically connecting a front surface electrode of a divided solar cell element to a back surface electrode of an adjacent divided solar cell element using an electrical connecting member.

CONFIGURATION

The method includes a step of forming a light receiving surface side surface electrode 2 having a connection region portion 2a that terminates immediately inside the outer periphery of each of a plurality of small power generation regions 1a to 1c of a semiconductor substrate 1 having a semiconductor junction, a step of forming a back surface electrode 3, a step of dividing the semiconductor substrate 1 into a plurality of small power generation regions 1a to 1c, and a step of electrically connecting the entire connection region portion 2a of the front surface electrode 2 of a solar cell element 4 containing the divided small power generation regions to the back surface electrode 3 of an adjacent solar cell element 4 by connecting with an electrical connecting member 5.



What is claimed is:

[Claim 1] A method of manufacturing a solar cell, comprising: a step of forming a light receiving surface side surface electrode having a connection region portion that terminates immediately inside the outer periphery of each of a plurality of small power generation regions of a semiconductor substrate having a semiconductor junction;

a step of forming a back surface electrode;

a step of dividing the semiconductor substrate into a plurality of small power generation regions; and

a step of electrically connecting an entire connection region portion of the front surface electrode of a solar cell element containing the divided small power generation regions to the back surface electrode of an adjacent solar cell element by connecting with an electrical connecting member.

[Claim 2] A method of manufacturing a solar cell, comprising: a step of forming a back surface electrode and a light receiving surface side front surface electrode having a connection region portion that terminates immediately inside the outer periphery of each of a plurality of small power generation regions of a semiconductor substrate having a semiconductor junction; and a step of electrically connecting a plurality of entire connection region portions of a solar cell element made of the semiconductor substrate to the back surface electrode of an adjacent solar cell element by the electrical connecting member.

DETAILED DESCRIPTION OF THE INVENTION

[0001]

FIELD OF INDUSTRIAL USE

The present invention relates to a method for manufacturing a solar cell.

[0002]

CONVENTIONAL TECHNOLOGY

A conventional method for manufacturing a solar cell will be described with reference to FIGS. 6 to 8.

[0003] First, a semiconductor substrate 10 made of polycrystalline silicon and shaped like a right-angled rectangle with a pn junction formed on the light receiving surface side has three small power generation regions 10a to 10c divided parallel to the vertical sides. A front surface electrode 12 is formed on the semiconductor substrate 10, spanning the three small power generation regions 10a to 10c, and including a pair of connection region portions 12a extending parallel to the horizontal sides and a plurality of branch portions 12b extending in a perpendicular direction from the connection region portions 12a. Furthermore, a back surface electrode 13 composed of a connection region portion 13a and a branch portion 13b having the aforementioned shape is also formed on the back surface of the semiconductor substrate 10. Furthermore, a solder layer is formed over the entire connection region portions 12a and 13a of the front surface electrode 12 and the back surface electrode 13.

[0004] Next, the semiconductor substrate 10 is divided into small power generation regions 10a to 10c to form solar cell elements 14a to 14c, each including a small power generation region 10a to 10c. FIG. 7 depicts one solar cell element 14b. Next, as depicted in FIG. 8, the plurality of divided solar cell elements 14a to 14c are arranged to be adjacent, and the connection region portion 12a of the front surface electrode 12 of one solar cell element 14b, 14c is electrically connected to the connection region portion 13a of the back surface electrode 13 of the other adjacent solar cell element 14a, 14b by an electrical connecting member 15, thereby completing a solar cell in which the solar cell elements 14a to 14b are connected in series. Moreover, the semiconductor substrate 10 can be used as a solar cell element made of a single semiconductor substrate 10 without dividing the semiconductor substrate.

[0005]

PROBLEMS TO BE SOLVED BY THE INVENTION

The aforementioned conventional method for manufacturing solar cells has the following problems. For example, the solar cell element 14b (see FIG. 7) is formed in a portion located in the middle of the semiconductor substrate 10, and therefore the connection region portion 12a extends to the vertical side that is the outer periphery. When an electrical connecting member 15 is connected to the connection region portion 12a, the solder on the connection region portion 12a is suspended down to the side of the solar cell element 14b as indicated by the symbol 16, and reaches the connection region portion 13a of the back surface electrode 13 located directly below, causing a short circuit (see FIG. 8(c)).

[0006] In light of the foregoing problems, an object of the first aspect of the present invention is to provide a method for manufacturing solar cells that prevents short circuits when electrically connecting the front surface electrode of a divided solar cell element to the back surface electrode of an adjacent divided solar cell element using an electrical connecting member.

[0007] Furthermore, an object of the second aspect of the present invention is to provide a method for manufacturing a solar cell in which the same semiconductor substrate as in the first aspect is used, and solar cell elements made of a single semiconductor substrate are electrically connected.

[0008]

MEANS FOR SOLVING THE PROBLEM

The first aspect of the present invention includes: a step of forming a light receiving surface side surface electrode having a connection region portion that terminates immediately inside the outer periphery of each of a plurality of small power generation regions of a semiconductor substrate having a semiconductor junction; a step of forming a back surface electrode; a step of dividing the semiconductor substrate into a plurality of small power generation regions; and a step of electrically connecting an entire connection region portion of the front surface electrode of a solar cell element containing the divided small power generation regions to the back surface electrode of an adjacent solar cell element by connecting with an electrical connecting member.

[0009] Furthermore, the second aspect of the present invention includes: a step of forming a back surface electrode and a light receiving surface side front surface electrode having a connection region portion that terminates immediately inside the outer periphery of each of a plurality of small power generation regions of a semiconductor substrate having a semiconductor junction; and a step of electrically connecting a plurality of entire connection region portions of a solar cell element made of the semiconductor substrate to the back surface electrode of an adjacent solar cell element by the electrical connecting member.

[0010]

FUNCTION

Having the aforementioned configuration, the first aspect of the present invention provides that the entire connection region portion of the front surface electrode of a divided solar cell element is electrically connected to the back surface electrode of an adjacent solar cell element by an electrical connecting member. At this time, the connection region portion is located immediately inside the outer periphery of the solar cell element, so undesired short circuiting does not occur.

[0011] Furthermore, the second aspect can manufacture a solar cell using the same semiconductor substrate as the first aspect, and electrically connected solar cell elements made of a single semiconductor substrate without dividing the semiconductor substrate.

[0012]

EMBODIMENTS OF THE INVENTION

An embodiment of the first aspect of the present invention is described below in detail, with reference to FIGS. 1 to 4.

[0013] First, a semiconductor substrate 1 made of polycrystalline silicon and shaped like a right-angled rectangle with a pn junction formed on the light receiving surface side has three small power generation regions 1a to 1c divided parallel to the vertical sides. A surface electrode 2 made of silver paste is formed on the light receiving surface of this semiconductor substrate 1, for each of the three small power generation regions 1a to 1c. These front surface electrodes 2 have a pair of connection region portions 2a that are parallel to the horizontal sides of the semiconductor substrate 1 and have both ends terminating immediately inside the outer periphery of each small power generation region 1a to 1c, and a plurality of branch portions 2b extending in a perpendicular direction from the connection region portions 2a. Furthermore, a back surface electrode 3 composed of a connection region portion 3a and a branch portion 3b having the aforementioned shape is also formed on the back surface of the semiconductor substrate 1. Furthermore, a solder layer is formed over the entire connection region portions 2a and 3a of the front surface electrode 2 and the back surface electrode 3, using a dipping method or an ultrasonic soldering method.

[0014] Furthermore, the back surface electrode 3 may be made of a paste of aluminum, silver, or the like formed on the entire back surface of the semiconductor substrate 1. In this case, the solder layer on the back surface electrode 3 may be formed in the same shape as the connection region portion 3a or over the entire area of the back surface electrode 3.

[0015] Next, the semiconductor substrate 1 is divided into small power generation regions 1a to 1c from the light receiving surface side of the semiconductor substrate 1 using a dicing saw, thereby producing solar cell elements 4 (see FIG. 2).

[0016] Furthermore, as depicted in FIG. 3, the plurality of divided solar cell elements 4 are arranged to be adjacent, and the entire connection region portion 2a of the front surface electrode 2 of one solar cell element 4 and the entire connection region portion 3a of the back surface electrode 3 of an adjacent solar cell element 4 are connected with an electrical connecting member 5 made of a metal foil or the like, thereby electrically connecting the plurality of solar cell elements 4 in series and completing the solar cell.

[0017] At this time, the connection region portion 2a is located immediately inside the outer periphery of the solar cell element 4, so the solder does not reach the outer periphery and side surfaces of the solar cell element 4 from the light receiving surface side. Furthermore, when the back surface electrode 3 is formed over the entire back surface of the solar cell element 4, the solder will not come into contact with the connection region portion 2a located immediately inside the outer periphery of the solar cell element 4, even if the solder reaches the side surface of the solar cell element 4 from the back surface side. Therefore, the solar cell element is not short-circuited.

[0018] Furthermore, the connection region portion 2a of the front surface electrode 2 terminates immediately inside the outer periphery of the solar cell element 4, so when the interval between adjacent solar cell elements 4 becomes narrow, as depicted in FIG. 4, the electrical connecting member 5 connected to the connection region portion 2a of the solar cell element 4 on the right side will not be undesirably short-circuited with the connection region portion 2a of the solar cell element 4 on the left side, or the electrical connecting member 5 connected thereto. Furthermore, when the back surface electrode 3 has a

connection region portion 3a that terminates immediately inside the outer periphery of the solar cell element 4, as depicted in the figure, the front surface electrode 2 and the back surface electrode 3 of the same solar cell element 4 are not short-circuited by the electrical connecting member 5 between adjacent solar cell elements.

[0019] Next, the second aspect of the present invention will be described. The semiconductor substrate 1 depicted in FIG. 1 is fabricated by the same steps as in the aforementioned first aspect. Thereafter, as depicted in FIG. 5, a plurality of solar cell elements 6 made of the semiconductor substrate 1 are arranged adjacently without dividing the semiconductor substrate 1. Furthermore, the connection region portions 2a, 2a, 2a of the front surface electrode 2 of one of the solar cell elements 6 are electrically connected using one end of the electrical connecting member 5 made of metal foil or the like, and the connection region portions 3a, 3a, 3a of the back surface electrode 3 of the adjacent solar cell element 6 are electrically connected using the other end of the electrical connecting member 5. Thus, the solar cell elements 6 are electrically connected in series to complete the solar cell.

[0020] Herein, spaces 7, 7 are formed directly below the electrical connecting member 5 between connection region portions 2a, 2a, 2a in the lateral direction. These spaces 7, 7 allow incident light from an oblique direction to be deflected, or the incident light is reflected from the light receiving surface of the solar cell element 6 and then reflected by the back surface of the electrical connecting member 5 in the space 7 and re-enters the solar cell element 6, thereby improving properties.

[0021]

EFFECT OF THE INVENTION

Having the aforementioned configuration, the first aspect of the present invention provides that the entire connection region portion of the front surface electrode of a divided solar cell element is electrically connected to the back surface electrode of an adjacent solar cell element by an electrical connecting member. At this time, the connection region portion of the front surface electrode is located immediately inside the outer periphery of the solar cell element, so undesired short circuiting does not occur.

[0022] In addition, the front surface electrodes of all divided solar cell elements have connection region portions immediately inside the outer periphery, thereby increasing the effective area contributing to power generation as compared to a conventional solar cell element where the connection region portion extends to the outer periphery.

[0023] Furthermore, the electrical connecting member is soldered to the entire connection region portion of the front surface electrode, so the connection strength is high, and the electrical connecting member functions as a collector electrode together with the connection region portion.

[0024] In the second aspect of the present invention, the semiconductor substrate of the first aspect is utilized, and the entire connection region portion of the front surface electrode is electrically connected by an electrical connecting member without dividing the semiconductor substrate. In other words, the same semiconductor substrate as the first aspect can be used.

[0025] In addition, the electrical connecting members are connected to the entire region of the plurality of connection region portions on one semiconductor substrate, so the connection strength is high and the electrical connecting member functions as collector electrodes together with the connection region portions.

[0026] Furthermore, the properties can be improved by allowing incident light to be deflected and re-enter the space formed immediately below the electrical connecting member between a plurality of connection region portions.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 depicts a semiconductor substrate according to an embodiment of the present invention, in which (a) is a plan view, and (b) is a side view;

FIG. 2 depicts a solar cell element according to the first aspect of the present invention, where (a) is a plan view and (b) is a side view;

FIG. 3 depicts a solar cell in which solar cell elements according to the first aspect of the present invention are connected in series, where (a) is a plan view and (b) is a side view;

FIG. 4 is a side view of a solar cell in which the solar cell elements are connected in series with a narrower interval according to the first aspect of the present invention;

FIG. 5 depicts a solar cell in which solar cell elements according to a second aspect of the present invention are connected in series, where (a) is a plan view and (b) is a side view;

FIG. 6 is a plan view of a conventional semiconductor substrate; FIG. 7 depicts a conventional solar cell element, where (a) is a plan view and (b) is a side view; and

FIG. 8 depicts a solar cell in which conventional solar cell elements are connected in series, where (a) is a plan view, (b) is a side view, and (c) is an expanded view of part A.

DESCRIPTION OF REFERENTIAL NUMERALS

1. Semiconductor substrate

1a, 1b, 1c. Small power generation region

2. Front surface electrode, 2a. Connection region portion, 2b. Branch portion

3. Back surface electrode, 3a. Connection region portion, 3b. Branch portion

4. Solar cell element

5. Electrical connecting member

6. Solar cell element

7. Space

FIG. 1

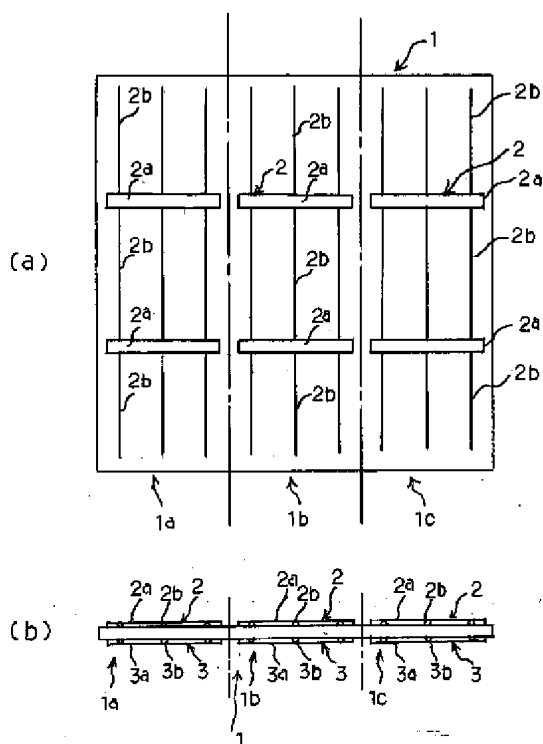


FIG. 2

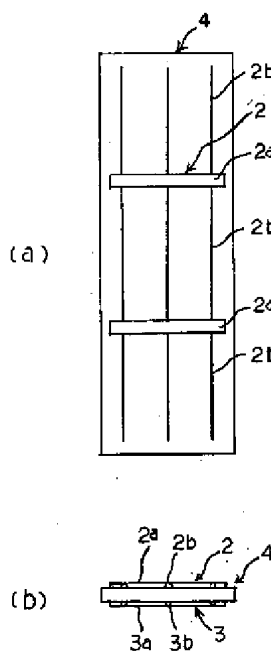


FIG. 4

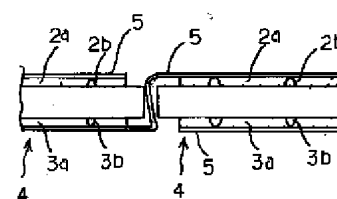


FIG. 6

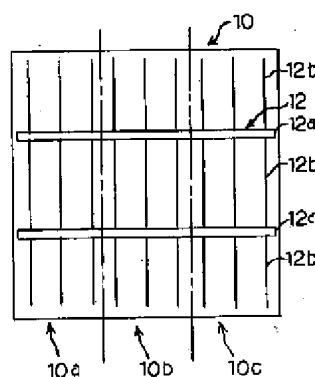


FIG. 7

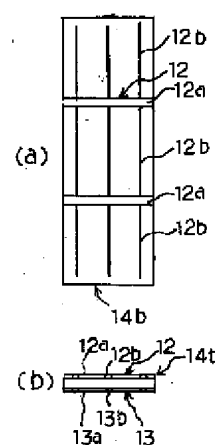


FIG. 3

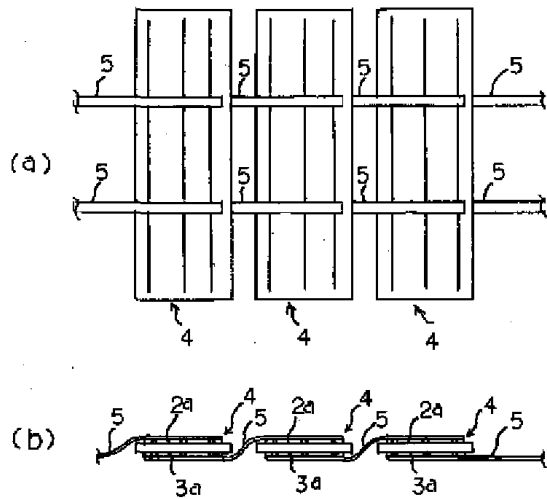


FIG. 5

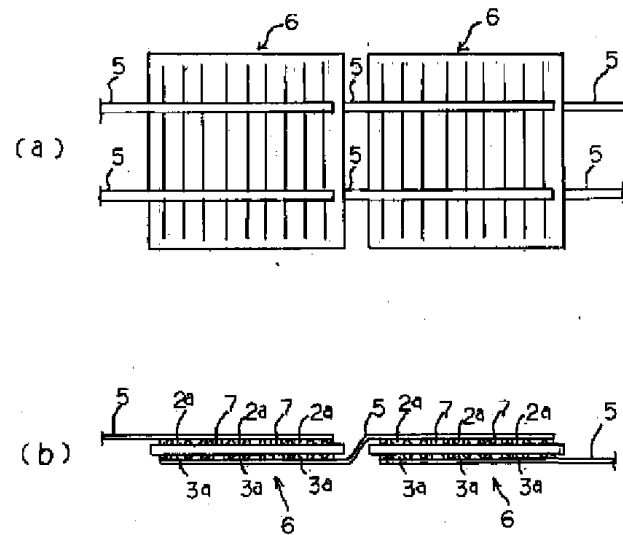
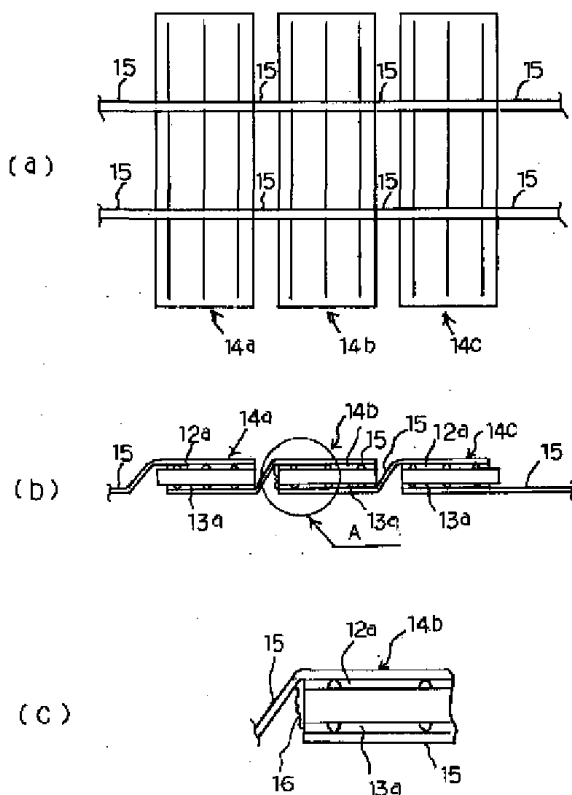


FIG. 8



Continued from front page

(72) Inventor: Yasuharu Matsukawa
 c/o SANYO Electric Co., Ltd.
 2-5-5 Keihanhondori, Moriguchi-shi,
 Osaka, Japan