SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0007]

Embodiments of the invention seek to provide a solar cell and a solar cell module, featuring mitigated warpage of a solar cell substrate against high adhesive strength of distal portions of finger electrodes and possible electric conduction of a finger electrode to a bus bar electrode even if the electrodes are locally cut or broken, eventually having long-term reliability and high conversion efficiency, and maintaining high output.

SOLUTION TO PROBLEM

[0008]

Embodiments of the invention provide a solar cell and solar cell module as defined below.

~~[1]~~ According to a first aspect of the present invention, there is provided ~~A~~ a solar cell comprising a semiconductor substrate having at least a pn junction formed therein, a ~~multiplicity~~ plurality of finger electrodes which are formed in comb shape on at least one surface of the semiconductor substrate, and a plurality of bus bar electrodes which extend orthogonal to the longitudinal direction of the finger electrodes and are connected to the finger electrodes, wherein

each finger electrode of the plurality of finger electrodes projects from the bus bar electrode to which they are connected, in both directions orthogonal to the bus bar electrode, and a first group of finger electrodes of the plurality of finger electrodes which are connected to a first bus bar electrode of the plurality of bus bar electrodes are spaced apart from a second group of finger electrodes of the plurality of finger electrodes which are

connected to a second bus bar electrode of the plurality of bus bar electrodes extending parallel with the first bus bar electrode, and wherein all adjacent longitudinal ends ~~of adjacent two or more~~at each end of the finger electrodes of each group of the plurality of finger electrodes connected to ~~each~~ of the plurality of bus bar electrodes are ~~electrically~~ connected ~~together by~~via an auxiliary electrode, respectively and all adjacent longitudinal positions at each location along the length of the finger electrodes of each group of the plurality of finger electrodes connected to one of the plurality of bus bar electrodes, respectively, which is not an end of the finger electrodes between distal portions of the finger electrodes and the bus bar electrode are connected via 2 to 10 additional auxiliary electrodes, whereby any one finger electrode in each group of the plurality of finger electrodes is electrically connected to a common bus bar electrode of the plurality of bus bar electrodes via the auxiliary electrode or any one of the additional auxiliary electrodes and the other finger electrode in the same group of finger electrodes.

~~[2]~~ The solar cell ~~of [1]~~as disclosed, wherein longitudinal ends of adjacent two to four of the finger electrodes connected to each bus bar electrode are connected together by an auxiliary electrode.

~~[3] The solar cell of [1] wherein all adjacent longitudinal ends of the finger electrodes connected to each bus bar electrode are connected together by an auxiliary electrode.~~

~~[4] The solar cell of any one of [1] to [3] wherein the finger electrodes project from the bus bar electrode to which they are connected, in opposite directions orthogonal to the bus bar electrode, and at each of the opposite ends of the finger electrodes projecting from the bus bar electrode, longitudinal ends of adjacent finger electrodes are electrically connected together by an auxiliary electrode.~~

~~[5] The solar cell of any one of [1] to [4] wherein at a position other than the longitudinal end of the finger electrodes, adjacent finger electrodes connected to a common bus bar electrode are electrically connected by another auxiliary electrode extending orthogonal to the longitudinal direction of the finger electrodes.~~

~~[6] The solar cell of [5] wherein 1 to 10 auxiliary electrodes are provided at a position other than the longitudinal end of the finger electrodes.~~

~~[7]~~ The solar cell ~~of any one of [1] to [6]~~ as disclosed wherein the finger electrode has a width of 30 to 120 μm.

~~[8]~~ The solar cell as disclosed ~~of any one of [1] to [7]~~ wherein the auxiliary electrode has a width of 30 to 500 μm.

~~[9]~~ A solar cell module comprising a plurality of solar cells as disclosed ~~as set forth in any one of [1] to [8]~~ wherein their bus bar electrodes are connected in series.

ADVANTAGEOUS EFFECTS OF INVENTION

[0009]

CLAIMS:

1. A solar cell comprising a semiconductor substrate having at least a pn junction formed therein, a ~~multiplicity~~ plurality of finger electrodes which are formed in comb shape on at least one surface of the semiconductor substrate, and a plurality of bus bar electrodes which extend orthogonal to the longitudinal direction of the finger electrodes and are connected to the finger electrodes, wherein

each finger electrode of the plurality of finger electrodes projects from the bus bar electrode to which they are connected, in both directions orthogonal to the bus bar electrode, and a first group of finger electrodes of the plurality of finger electrodes which are connected to a first bus bar electrode of the plurality of bus bar electrodes are spaced apart from second group of finger electrodes of the plurality of finger electrodes which are connected to a second bus bar electrode of the plurality of bus bar electrodes extending parallel with the first bus bar electrode, and

wherein all adjacent longitudinal ends ~~of adjacent two or more~~at each end of the finger electrodes of each group of the plurality of finger electrodes connected to ~~each~~ one of the plurality of bus bar electrodes are ~~electrically~~ connected ~~together by~~via an auxiliary electrode, respectively and all adjacent longitudinal positions at each location along the length of the finger electrodes of each group of the plurality of finger electrodes connected to one of the plurality of bus bar electrodes, respectively, which is not an end of the finger electrodes between distal portions of the finger electrodes and the bus bar electrode are connected via 2 to 10 additional auxiliary electrodes,

whereby any one finger electrode in each group of the plurality of finger electrodes is electrically connected to a common bus bar electrode of the plurality of bus bar electrodes via the auxiliary electrode or any one of the additional auxiliary electrodes and the other finger electrode in the same group of finger electrodes.

~~2. The solar cell of claim 1 wherein longitudinal ends of adjacent two to four of the finger electrodes connected to each bus bar electrode are connected together by an auxiliary electrode.~~

~~3. The solar cell of claim 1 wherein all adjacent longitudinal ends of the finger electrodes connected to each bus bar electrode are connected together by an auxiliary electrode.~~

~~4. The solar cell of any one of claims 1 to 3 wherein the finger electrodes project from the bus bar electrode to which they are connected, in opposite directions orthogonal to the bus bar electrode, and at each of the opposite ends of the finger electrodes projecting from the bus bar electrode,~~

~~longitudinal ends of adjacent finger electrodes are electrically connected together by an auxiliary electrode.~~

~~5. The solar cell of any one of claims 1 to 4 wherein at a position other than the longitudinal end of the finger electrodes, adjacent finger electrodes connected to a common bus bar electrode are electrically connected by another auxiliary electrode extending orthogonal to the longitudinal direction of the finger electrodes.~~

~~6. The solar cell of claim 5 wherein 1 to 10 auxiliary electrodes are provided at a position other than the longitudinal end of the finger electrodes.~~

2. The solar cell of claim 1, wherein the additional auxiliary electrodes are equally spaced between the distal portions of the finger electrodes of each group of the plurality of finger electrodes and the bus bar electrode to which the finger electrodes are connected, respectively.

3. The solar cell of claim 1, wherein the additional auxiliary electrodes are provided in a region that is deviated from an intermediate point between the distal portions of the finger electrodes of each group of the plurality of finger electrodes and the bus bar electrode to which the finger electrodes are connected toward the distal portions of the finger electrodes, respectively.

~~7~~4. The solar cell of any one of claims 1 to ~~6~~3 wherein each of the finger electrode of the plurality of finger electrodes has a width of 30 to 120 μm.

~~8~~5. The solar cell of any one of claims 1 to ~~7~~4 wherein the auxiliary electrode has a width of 30 to 500 μm.

~~9~~6. A solar cell module comprising a plurality of solar cells as set forth in any one of claims 1 to ~~8~~5 wherein their bus bar electrodes are connected in series.

7. A method for manufacturing a solar cell, comprising steps of:

screen printing a conductive paste containing silver powder, glass frit, organic vehicle and organic solvent on a semiconductor substrate at a time using screen printing plate having electrode pattern of a solar cell of any one of claims 1 to 5, and

firing to form bus bar electrodes, finger electrodes, auxiliary electrodes and additional auxiliary electrodes of any one of claims 1 to 5.