SOLAR CELL WITH TRENCH-FREE EMITTER REGIONS

TECHNICAL FIELD

[0001] Embodiments of the present disclosure are in the field of renewable energy and, in particular, methods of fabricating solar cells having trench-free emitter regions, and the resulting solar cells.

BACKGROUND

[0002] Photovoltaic cells, commonly known as solar cells, are well known devices for direct conversion of solar radiation into electrical energy. Generally, solar cells are fabricated on a semiconductor wafer or substrate using semiconductor processing techniques to form a p-n junction near a surface of the substrate. Solar radiation impinging on the surface of, and entering into, the substrate creates electron and hole pairs in the bulk of the substrate. The electron and hole pairs migrate to p-doped and n-doped regions in the substrate, thereby generating a voltage differential between the doped regions. The doped regions are connected to conductive regions on the solar cell to direct an electrical current from the cell to an external circuit coupled thereto.

[0003] Efficiency is an important characteristic of a solar cell as it is directly related to the capability of the solar cell to generate power. Likewise, efficiency in producing solar cells is directly related to the cost effectiveness of such solar cells. Accordingly, techniques for increasing the efficiency of solar cells, or techniques for increasing the efficiency in the manufacture of solar cells, are generally desirable. Some embodiments of the present disclosure allow for increased solar cell manufacture efficiency by providing novel processes for fabricating solar cell structures. Some embodiments of the present disclosure allow for increased solar cell efficiency by providing novel solar cell structures.

Summary

[0003a] According to the first aspect, a solar cell is provided comprising a substrate having a light-receiving surface and a back surface;

a thin dielectric layer disposed on a portion of the back surface of the substrate;

a first polycrystalline silicon emitter region disposed on a first portion of the thin dielectric layer and doped with an impurity of a first conductivity type; and

a second polycrystalline silicon emitter region disposed on a second portion of the thin dielectric layer proximate to the first polycrystalline silicon emitter region disposed on the first portion of the thin dielectric layer, the second polycrystalline silicon emitter region doped with an impurity of a second, opposite, conductivity type, wherein a total concentration of the impurity of the first conductivity type in the first polycrystalline silicon emitter region is at least an order of magnitude greater than a total concentration of the impurity of the second conductivity type in the second polycrystalline silicon emitter region.

[0003b] According to the second aspect, a method of fabricating a solar cell is provided, comprising:

forming a thin dielectric layer on a portion of a back surface of a substrate, the substrate having a light-receiving surface opposite the back surface;

forming a first polycrystalline silicon emitter region on a first portion of the thin dielectric layer and doped with an impurity of a first conductivity type; and

forming a second polycrystalline silicon emitter region on a second portion of the thin dielectric layer proximate to the first polycrystalline silicon emitter region, the second polycrystalline silicon emitter region doped with an impurity of a second, opposite, conductivity type, wherein a total concentration of the impurity of the first conductivity type in the first polycrystalline silicon emitter region is at least an order of magnitude greater than a total concentration of the impurity of the second conductivity type in the second polycrystalline silicon emitter region.

[0003c] According to a third aspect, a method of fabricating alternating N-type and P-type emitter regions of a solar cell, the method comprising:

forming a boron-containing silicon layer above a portion of a substrate by an in situ deposition process;

implanting first regions, but not second regions, of the boron-containing silicon layer with phosphorous ions to provide phosphorous-implanted regions of the boron-containing silicon layer;

heating to provide N-type polycrystalline silicon emitters in the first regions and to provide P-type polycrystalline silicon emitters in the second regions; and forming a plurality of conductive contact structures, each of the N-type polycrystalline silicon emitters and the P-type polycrystalline silicon emitters electrically connected to one of the plurality of conductive contact structures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Figures 1A-1E illustrate cross-sectional views of various stages in the fabrication of a solar cell, in accordance with an embodiment of the present disclosure, wherein:

[0005] Figure 1A illustrates a thin dielectric layer formed on a portion of a back surface of a substrate of a solar cell;

[0006] Figure 1B illustrates the structure of Figure 1A having a boron-containing silicon layer formed thereon;

[0007] Figure 1C illustrates the structure of Figure 1B having first regions, but not second regions, of the boron-containing silicon layer implanted with phosphorous ions;

[0008] Figure 1D illustrates the structure of Figure 1C heated to provide N-type polycrystalline silicon emitters and P-type polycrystalline silicon emitters; and