SOLAR CELLS WITH TUNNEL DIELECTRICS

BACKGROUND

[0001] Photovoltaic (PV) cells, commonly known as solar cells, are well known devices for conversion of solar radiation into electrical energy. Generally, solar radiation impinging on the surface of, and entering into, the substrate of a solar cell 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 creating a voltage differential between the doped regions. The doped regions are connected to the conductive regions on the solar cell to direct an electrical current from the cell to an external circuit.

[0002] Efficiency is an important characteristic of a solar cell as it is directly related to the solar cell's capability to generate power. Accordingly, techniques for improving the fabrication process, reducing the cost of manufacturing and increasing the efficiency of solar cells are generally desirable. Such techniques can include forming improved contact regions of solar cells to increase electrical conduction and solar cell efficiency.

SUMMARY

[002a] According to an aspect, a solar cell is provided, comprising a first dielectric formed over a P-type doped region of a silicon substrate; a second dielectric formed over an N-type doped region of the silicon substrate, wherein the first dielectric is a different type of dielectric than the second dielectric; a doped semiconductor formed over the first and second dielectric; a positive-type metal contact formed over the doped semiconductor and the first dielectric; and a negative-type metal contact formed over the doped semiconductor and over the second dielectric.

[0002b] According to another aspect, a solar cell is provided, comprising a first dielectric formed over a P-type region of a silicon substrate; a second dielectric formed over an N-type doped region of the silicon substrate, wherein the first dielectric is a different type of dielectric than the second dielectric; a first doped polysilicon formed over the first dielectric; a second doped polysilicon formed over the second dielectric; a positive-type metal contact formed over the first doped polysilicon; and a negative-type metal contact formed over the second doped polysilicon.

In an embodiment, the first portion of the silicon substrate 210 can be in the same location 212 as the first doped region. In an embodiment, the second portion of the silicon substrate 210 can be in the same location 214 as the second doped region.

[0040] A first doped semiconductor 230 can be formed over the first dielectric 220. A second doped semiconductor 232 can be formed over the second dielectric 222. In an embodiment, the doped semiconductor can include doped polysilicon or a doped amorphous silicon. In some embodiments, the doped semiconductor can be a wide band gap doped semiconductor such as doped amorphous silicon. In an embodiment, the first and second doped semiconductors 230, 232 can be a first and second doped polysilicon, respectively. In an embodiment, a first doped polysilicon (e.g., 230) can be a P-type doped polysilicon. In an embodiment, a second doped polysilicon (e.g., 232) can be an N-type doped polysilicon. In an embodiment, the dopant concentration ratio between the first doped polysilicon (e.g., regions 230) and the first doped region 212 of the silicon substrate 210 can be at least 10. In an embodiment, the dopant concentration ratio between the second doped polysilicon (e.g., regions 232) and the second doped region 214 of the silicon substrate 210 can be at least 10.

[0041] In an embodiment, a third dielectric layer 224 can be formed over the first and second doped semiconductors 230, 232. The solar cell 200 can include contact openings through the third dielectric 224. In an embodiment, the contact openings can be formed by any number of lithography processes including wet-etching and ablation techniques (e.g., laser ablation, etc.). In an embodiment, the third dielectric 224 can be an anti-reflective coating (ARC) or a back anti-reflective coating (BARC) formed on either a front or back side of a solar cell. In an embodiment, the third dielectric 224 can be silicon nitride.

[0042] First and second metal contacts 240, 242 can be formed over the first and second doped semiconductors 230, 232 and through contact openings in the third dielectric 224. In an embodiment, the first metal contact 240 can be a positive-type metal contact and the second metal contact 242 can be a negative-type metal contact. In an embodiment, the first and second metal contacts 240, 242 can be, but not limited to one or more of copper, tin, aluminum, silver, gold, chromium, iron, nickel, zinc, ruthenium, palladium, and/or platinum.

[0043] As described herein, the solar cell 200 can include a first and second doped semiconductor 230, 232 such as a first and second doped polysilicon respectively. In an embodiment, the first and second doped polysilicon can be grown by a thermal process. In some embodiments, the first and second doped polysilicon can be formed by depositing dopants in the silicon substrate 210 by a conventional doping process. The first and second doped polysilicon regions and first and second doped regions 212, 214 of the silicon substrate 210 can each include

CLAIMS

What is claimed is:

1. A solar cell, comprising:

a first dielectric formed over a P-type doped region of a silicon substrate;

a second dielectric formed over an N-type doped region of the silicon substrate, wherein the first dielectric is a different type of dielectric than the second dielectric;

a doped semiconductor formed over the first and second dielectric;

a positive-type metal contact formed over the doped semiconductor and the first dielectric; and

a negative-type metal contact formed over the doped semiconductor and over the second dielectric.

2. The solar cell of claim 1, wherein the first dielectric comprises at least an oxide monolayer in contact with the silicon substrate.

3. The solar cell of claim 1, wherein the second dielectric comprises a plurality of oxide monolayers.

4. The solar cell of claim 1, wherein the first dielectric comprises silicon nitride.

5. The solar cell of claim 1, wherein the second dielectric comprises silicon dioxide.

6. The solar cell of claim 1, wherein the doped semiconductor comprises doped polysilicon.

7. The solar cell of claim 1, wherein the doped semiconductor comprises a P-type doped polysilicon and an N-type doped polysilicon.

8. The solar cell of claim 7, wherein the P-type doped polysilicon is formed over the first dielectric and the N-type doped polysilicon is formed over the second dielectric.

9. The solar cell of claim 8, wherein the silicon substrate comprises a first doped region under the first dielectric and a second doped region under the second dielectric.

10. The solar cell of claim 9, wherein a dopant concentration ratio between the P-type doped polysilicon and the first doped region is at least 10.

11. The solar cell of claim 1, wherein the doped semiconductor comprises doped amorphous silicon.

12. A solar cell, comprising:

a first dielectric formed over a P-type doped region of a silicon substrate;

a second dielectric formed over an N-type doped region of the silicon substrate, wherein the first dielectric is a different type of dielectric than the second dielectric;

a first doped polysilicon formed over the first dielectric;

a second doped polysilicon formed over the second dielectric;

a positive-type metal contact formed over the first doped polysilicon; and

a negative-type metal contact formed over the second doped polysilicon.

13. The solar cell of claim 12, wherein the first dielectric comprises at least an oxide monolayer in contact with the silicon substrate.

14. The solar cell of claim 12, wherein the second dielectric comprises a plurality of oxide monolayers.

15. The solar cell of claim 12, wherein the first dielectric comprises silicon nitride.

16. The solar cell of claim 12, wherein the second dielectric comprises silicon dioxide.

17. The solar cell of claim 12, wherein a dopant concentration ratio between the first doped polysilicon and the first doped region is at least 10.

18. A solar cell, comprising:

silicon nitride formed over a P-type doped region of a silicon substrate;

silicon dioxide formed over an N-type doped region of the silicon substrate;

P-type doped polysilicon formed on the silicon nitride;

N-type doped polysilicon formed on the silicon dioxide;

a positive-type metal contact formed on the P-type doped polysilicon region; and

a negative-type metal contact formed on the N-type doped polysilicon region.

19. The solar cell of claim 18, wherein a dopant concentration ratio between the P-type doped polysilicon and the P-type doped region is at least 10.

20. The solar cell of claim 18, wherein the silicon nitride comprises at least an oxide monolayer in contact with the silicon substrate.