BUILT-IN BYPASS DIODE

BACKGROUND

[0001] 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.

SUMMARY

[0001a] According to the first aspect, a method of fabricating a bypass diode for a solar cell is provided, the method comprising:

forming a first conductive region of a first conductivity type on a first dielectric layer on a substrate of the solar cell;

forming a second dielectric layer on the first conductive region;

removing a portion of the second dielectric layer;

forming a second conductive region of a second conductivity type above a portion of the first conductive region exposed by the removed portion of the second dielectric layer;

coupling metal of the second conductivity type to the first conductive region and metal of the first conductivity type to the first portion of the second conductive region

[0001b] According to the second aspect, a method of fabricating a bypass diode for a solar cell is provided, the method comprising:

forming an opening in a dielectric layer on a first conductive region;

forming a second conductive region above the first conductive region through the opening in the dielectric layer;

isolating a first portion of the second conductive region from a second portion of the second conductive region; and

forming a conductive connection between the first conductive region of a first conductivity type and a metal of a second conductivity type, and between the second portion of the second conductivity region of the second conductivity type and a metal of the first conductivity type.

[0001c] According to a third aspect, a bypass diode for a solar cell is provided, the bypass diode comprising:

a first conductive region of a first conductivity type disposed on a first dielectric layer on a substrate of the solar cell;

a second dielectric layer disposed above the first conductive region, a portion of the second dielectric layer being removed;

a second conductive region of a second conductivity type disposed above a portion of the first conductive region exposed by the removed portion of the second dielectric layer; a portion of the second conductive region being removed to separate the second conductive region into first and second portions of the second conductive region;

a metal of the second conductivity type is coupled to the first conductive region and a metal of the first conductivity type is coupled to the first portion of the second conductive region; and

a thin dielectric region disposed directly between the first and second conductive regions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Figure 1 illustrates a top-down plan view of a bypass diode for a solar cell, according to some embodiments.

[0003] Figure 2 illustrates a top-down plan view of a bypass diode including P-type and N-type regions, according to some embodiments.

[0004] Figure 3 illustrates a cross-section view of a bypass diode, according to some embodiments.

[0005] Figure 4 is a flowchart illustrating an example method of forming a bypass diode, according to some embodiments.

[0006] Figures 5-14 illustrate cross-sectional views of example sequences of forming a bypass diode, according to some embodiments.

DETAILED DESCRIPTION

[0007] The following detailed description is merely illustrative in nature and is not intended to limit the embodiments of the subject matter of the application or uses of such embodiments. As used herein, the word "exemplary" means "serving as an example, instance, or illustration." Any implementation described herein as exemplary is not necessarily to be construed as preferred or

advantageous over other implementations. Furthermore, there is no intention to be bound by any expressed or implied theory presented in the preceding technical field, background, brief summary or the following detailed description.

CLAIMS

What is claimed is:

1. A method of fabricating a bypass diode for a solar cell, the method comprising:

forming a first conductive region of a first conductivity type on a first dielectric layer on a substrate of the solar cell;

forming a second dielectric layer on the first conductive region;

removing a portion of the second dielectric layer;

forming a second conductive region of a second conductivity type above a portion of the first conductive region exposed by the removed portion of the second dielectric layer;

removing a portion of the second conductive region to separate the second conductive region into first and second portions of the second conductive region; and

coupling metal of the second conductivity type to the first conductive region and metal of the first conductivity type to the first portion of the second conductive region.

2. The method of claim 1, wherein said forming the first conductive region includes forming a p-type conductive region, and wherein said forming the second conductive region includes forming an n-type conductive region, wherein said coupling includes coupling n-metal to the p-type conductive region and p-metal to the first portion of the n-type conductive region.

3. The method of claim 1, wherein said removing the portion of the second conductive region includes laser ablating the portion of the second conductive region.

4. The method of claim 1, further comprising prior to said forming the second conductive region, forming a third dielectric layer, wherein the third dielectric layer provides separation between the first and second conductive regions.

5. The method of claim 1, wherein said removing the portion of the second dielectric layer includes laser ablating the portion of the second dielectric layer without removing a portion of the first conductive region below the ablated portion.

6. A method of fabricating a bypass diode for a solar cell, the method comprising:

forming an opening in a dielectric layer on a first conductive region;

forming a second conductive region above the first conductive region through the opening in the dielectric layer;

isolating a first portion of the second conductive region from a second portion of the second conductive region; and

forming a conductive connection between the first conductive region of a first conductivity type and a metal of a second conductivity type, and between the second portion of the second conductive region of the second conductivity type and a metal of the first conductivity type .

7. The method of claim 6, wherein said forming the opening in the dielectric layer is performed by laser ablation.

8. The method of claim 6, wherein said isolating the first from the second portion of the second conductive region includes laser ablating the second conductive region.

9. The method of claim 6, wherein said forming the conductive connection includes forming a conductive connection between an n-type conductive region and p-type metal and between a p-type conductive region and n-type metal.

10. The method of claim 6, wherein said forming the opening in the dielectric layer includes forming the opening in a silicon dioxide layer on the first conductive region, wherein the first conductive region is a p-type conductive region.

11. The method of claim 6, further comprising forming another dielectric layer before said forming the second conductive region wherein the other dielectric layer provides separation between the first and second conductive regions.

12. The method of claim 11, wherein forming the other dielectric layer provides a lateral separation between the first and second conductive regions.

13. The method of claim 11, wherein forming the other dielectric layer provides lateral and vertical separation between the first and second conductive regions.

14. The method of claim 6, wherein said forming the second conductive region includes forming amorphous silicon above the first conductive region through the opening in the dielectric layer.

15. The method of claim 6, wherein said forming the second conductive region includes forming n-type polysilicon on the first conductive region.

16. A bypass diode for a solar cell, the bypass diode comprising:

a first conductive region of a first conductivity type disposed on a first dielectric layer on a substrate of the solar cell;

a second dielectric layer disposed above the first conductive region, a portion of the second dielectric layer being removed;

a second conductive region of a second conductivity type disposed above a portion of the first conductive region exposed by the removed portion of the second dielectric layer; a portion of the second conductive region being removed to separate the second conductive region into first and second portions of the second conductive region;

a metal of the second conductivity type is coupled to the first conductive region and a metal of the first conductivity type is coupled to the first portion of the second conductive region; and

a thin dielectric region disposed directly between the first and second conductive regions.

17. The bypass diode of claim 16, wherein the thin dielectric region is disposed laterally directly between the first and second conductive regions without an isolation trench disposed in the substrate between the first and second conductive regions.

18. The bypass diode of claim 16, wherein the thin dielectric region is disposed directly above the first conductive region and wherein the second conductive region is disposed directly above the thin dielectric region.

19. The bypass diode of claim 16, wherein the thin dielectric region is a tunnel oxide.

20. The bypass diode of claim 16, further comprising:

a thin dielectric layer disposed on the substrate, wherein the first conductive region is disposed on the thin dielectric layer.