HYBRID EMITTER ALL BACK CONTACT SOLAR CELL

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0001] The invention described herein was made with Governmental support under contract number DE-FC36-07GO17043 awarded by the United States Department of Energy. The Government may have certain rights in the invention.

TECHNICAL FIELD

[0002] Embodiments of the subject matter described herein relate generally to solar cells. More particularly, embodiments of the subject matter relate to solar cell fabrication processes and structures.

BACKGROUND

[0003] Solar cells are well known devices for converting solar radiation to electrical energy. A solar cell has a front side that faces the sun during normal operation to collect solar radiation and a backside opposite the front side. In an all back contact solar cell, all metal contacts and corresponding emitters are formed on the backside of the solar cell. An external electrical circuit, e.g., a load, may be connected to the metal contacts to be powered by the solar cell.

[0004] To remain a commercially-viable renewable energy source, solar cells need to be manufactured at low cost. Embodiments of the present invention pertain to a hybrid emitter design that simplifies the manufacture of solar cells while retaining efficiency.

BRIEF SUMMARY

[0004a] In a first aspect, the present disclosure provides an all back contact solar cell comprising: a single crystalline silicon substrate; a thin dielectric layer formed on a backside surface of the single crystalline silicon substrate; a first emitter of the solar cell, the first emitter of the solar cell being formed on the thin dielectric layer and comprising polycrystalline silicon doped to have a first polarity; a second emitter of the solar cell,

the second emitter of the solar cell being formed in the single crystalline silicon substrate and comprising single crystalline silicon doped to have a second polarity opposite the first polarity; a first metal contact connected to the first emitter on a backside of the solar cell, the backside being opposite a front side of the solar cell that faces the sun during normal operation; and a second metal contact connected to the second emitter on the backside of the solar cell, wherein the thin dielectric layer is only under the first emitter.

[0004b] In a second aspect, the present disclosure provides a method of manufacturing an all back contact solar cell, the method comprising: forming a thin dielectric layer on a backside surface of a single crystalline silicon substrate; forming a first emitter on the thin dielectric layer on a backside of the solar cell, the first emitter comprising polycrystalline silicon that is doped with dopants of a first polarity, the backside of the solar cell being opposite a front side of the solar cell that faces the sun during normal operation; removing all portions of the thin dielectric layer that are not under the first emitter; forming a second emitter in the single crystalline silicon substrate on the backside the solar cell, the second emitter comprising single crystalline silicon that is doped with dopants of a second polarity opposite to the first polarity; and forming a first metal contact connected to the first emitter and a second metal contact connected to the second emitter on the backside of the solar cell.

[0005] In one embodiment, an all back contact solar cell has a hybrid emitter design. The solar cell may have a thin dielectric layer formed on a backside surface of a single crystalline silicon substrate. The thin dielectric layer may comprise silicon dioxide that

CLAIMS

What is claimed is:

1. An all back contact solar cell comprising:

a single crystalline silicon substrate;

a thin dielectric layer formed on a backside surface of the single crystalline silicon substrate;

a first emitter of the solar cell, the first emitter of the solar cell being formed on the thin dielectric layer and comprising polycrystalline silicon doped to have a first polarity;

a second emitter of the solar cell, the second emitter of the solar cell being formed in the single crystalline silicon substrate and comprising single crystalline silicon doped to have a second polarity opposite the first polarity;

a first metal contact connected to the first emitter on a backside of the solar cell, the backside being opposite a front side of the solar cell that faces the sun during normal operation; and

a second metal contact connected to the second emitter on the backside of the solar cell, wherein the thin dielectric layer is only under the first emitter.

2. The solar cell of claim 1, wherein the thin dielectric layer comprises silicon dioxide formed directly on the backside surface of the single crystalline silicon substrate.

3. The solar cell of claim 1 or 2, further comprising:

a first layer of material formed on the first emitter and the backside surface of the single crystalline silicon substrate, and wherein the first metal contact connects to the first emitter through the first layer of material but not through the thin dielectric layer.

4. The solar cell of claim 3, further comprising a dopant source layer on the thin dielectric layer and on the single crystalline silicon substrate, wherein the dopant source layer comprises phosphorus-silicate glass (PSG).

5. The solar cell of claim 3, wherein the second metal contact connects to the second emitter through the first layer of material.

6. The solar cell of any one of claims 1 to 5, wherein the first emitter is a P-type doped emitter, the second emitter is an N-type doped emitter, and the single crystalline silicon substrate is doped with an N-type dopant.

7. The solar cell of any one of claims 1 to 6, wherein a total area of the first emitter and other emitters of the solar cell comprising polycrystalline silicon covers at least 80% of a total area of the backside surface of the single crystalline silicon wafer.

8. A method of manufacturing an all back contact solar cell, the method comprising:

forming a thin dielectric layer on a backside surface of a single crystalline silicon substrate;

forming a first emitter on the thin dielectric layer on a backside of the solar cell, the first emitter comprising polycrystalline silicon that is doped with dopants of a first polarity, the backside of the solar cell being opposite a front side of the solar cell that faces the sun during normal operation;

removing all portions of the thin dielectric layer that are not under the first emitter;

forming a second emitter in the single crystalline silicon substrate on the backside the solar cell, the second emitter comprising single crystalline silicon that is doped with dopants of a second polarity opposite to the first polarity; and

forming a first metal contact connected to the first emitter and a second metal contact connected to the second emitter on the backside of the solar cell.

9. The method of claim 8, wherein the single crystalline silicon substrate is doped with N-type dopants, the polycrystalline silicon of the first emitter is doped with P-type dopants, and the single crystalline silicon of the second emitter is doped with N-type dopants.

10. The method of claim 8 or 9, further comprising:

forming a first layer of material on the thin dielectric layer and the first emitter;

forming a contact hole through the first layer of material but not through the thin dielectric layer to expose the first emitter; and

forming another contact hole through the first layer of material to expose the second emitter.

11. The method of any one of claims 8 to 10, wherein forming the first emitter comprises:

depositing a polycrystalline silicon layer on the thin dielectric layer; and

patterning the polycrystalline silicon layer to form the first emitter.

12. The method of any one of claims 8 to 10, wherein forming the first emitter comprises:

printing silicon nanoparticles on the thin dielectric layer; and

thermally processing the silicon nanoparticles to form polycrystalline silicon first emitter.

13. The method of any one of claims 8 to 12, wherein the thin dielectric layer comprises silicon dioxide that is thermally grown directly on the backside surface of the single crystalline silicon substrate.

14. The method of any one of claims 8 to 13, wherein forming the second emitter comprises:

forming a dopant source layer on the single crystalline silicon substrate; and

diffusing dopants from the dopant source layer into the single crystalline silicon substrate.

15. The method of claim 14, wherein the dopant source layer comprises phosphorus-silicate glass (PSG).