

CLAIMS

What is claimed is:

1. A solar cell, 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.
2. The solar cell of claim 1, further comprising:
 - a P/N junction between the first polycrystalline silicon emitter region and the second polycrystalline silicon emitter region.
3. The solar cell of claim 1, wherein the impurity of the first conductivity type in the first polycrystalline silicon emitter region is an N-type impurity, and the impurity of the second conductivity type in the second polycrystalline silicon emitter region is a P-type impurity.
4. The solar cell of claim 3, wherein the N-type impurity is phosphorous and the total concentration of the impurity of the first conductivity type in the first polycrystalline silicon emitter region is $1\text{E}20\text{ atoms/cm}^3$, and wherein the P-type impurity is boron and the total concentration of the impurity of the second conductivity type in the second polycrystalline silicon emitter region is $1\text{E}18\text{ atoms/cm}^3$.
5. The solar cell of claim 1, wherein the first polycrystalline silicon emitter region further comprises the impurity of the second conductivity type.
6. The solar cell of claim 5, wherein the total concentration of the impurity of the first conductivity type in the first polycrystalline silicon emitter region is two orders of magnitude greater than the total concentration of the impurity of the second conductivity type in the second polycrystalline silicon emitter region and in the first polycrystalline silicon emitter region.

7. The solar cell of claim 1, further comprising:
 - a first conductive contact structure electrically connected to the first polycrystalline silicon emitter region; and
 - a second conductive contact structure electrically connected to the second polycrystalline silicon emitter region.

8. A method of fabricating a solar cell, the method 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.

9. 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,wherein a total concentration of phosphorous in the N-type polycrystalline silicon emitters is at least an order of magnitude greater than a total concentration of the boron in the P-type polycrystalline silicon emitters.

10. The method of claim 9, wherein forming the boron-containing silicon layer comprises forming a boron-containing amorphous silicon layer, and wherein the heating comprises crystallizing the boron-containing amorphous silicon layer.

11. The method of claim 9, wherein forming the boron-containing silicon layer comprises forming a boron-doped polycrystalline silicon layer, and wherein the heating comprises activating the phosphorous ions of the phosphorous-implanted regions to form phosphorous-doped regions.

12. The method of claim 11, wherein forming the boron-doped polycrystalline silicon layer comprises using a plasma-enhanced chemical vapor deposition (PECVD) process.

13. The method of claim 9, wherein implanting the boron-containing silicon layer with phosphorous ions comprises implanting through a shadow mask.

14. The method of claim 13, wherein implanting through the shadow mask comprises implanting through a graphite shadow mask positioned off of, but in close proximity to, the boron-containing silicon layer.

15. The method of claim 13, wherein implanting through the shadow mask comprises implanting through a silicon shadow mask positioned on the boron-containing silicon layer.

16. The method of claim 9, wherein the heating comprises forming a P/N junction between adjacent ones of the N-type polycrystalline silicon emitters and P-type polycrystalline silicon emitters.

17. The method of claim 9, wherein the heating provides the N-type polycrystalline silicon emitters comprising a total phosphorous dopant concentration of at least an order of magnitude greater than a total boron dopant concentration of the P-type polycrystalline silicon emitters.

18. The method of claim 9, wherein forming the boron-containing silicon layer comprises forming on a portion of a thin oxide layer formed on the substrate.