SUMMARY OF INVENTION

[0003a] According to ~~an~~ a first aspect of the present invention, there is provided a method ~~of fabricating a solar cell, the method comprising: forming, in a process tool having a controlled atmosphere, a thin dielectric layer on a surface of a semiconductor substrate of the solar cell, the semiconductor substrate having a bandgap; and, without removing the semiconductor substrate from the controlled atmosphere of the process tool, forming a semiconductor layer on the thin dielectric layer, the semiconductor layer having a bandgap at least approximately 0.2 electron Volts (eV) above the bandgap of the semiconductor substrate.~~

of fabricating a solar cell, the method comprising:

forming, in a process tool having a controlled atmosphere, a thin dielectric layer of aluminum oxide (Al2O3) on a surface of a single crystalline N-type silicon semiconductor substrate of the solar cell, the semiconductor substrate having a bandgap; and, without removing the semiconductor substrate from the controlled atmosphere of the process tool,

forming a semiconductor layer on the thin dielectric layer, the semiconductor layer being transparent in the visible spectrum and having a bandgap at least approximately 0.2 electron Volts (eV) above the bandgap of the semiconductor substrate and a bandgap of greater than 3 eV and comprising a material selected from the group consisting of: aluminum nitride (AIN), aluminum gallium nitride (AlxGa1-xN, where 0<x<1), and boron nitride (BN).

[0003b] According to ~~another~~ a second aspect of the present invention, there is provided a method of fabricating a solar cell, the method comprising: ~~forming a first emitter region on a surface of a semiconductor substrate of the solar cell, the first emitter region comprising a semiconductor material doped to a first conductivity type and formed on a first thin dielectric layer; and forming a second emitter region on the surface of the semiconductor substrate, the forming comprising: forming, in a process tool having a controlled atmosphere, a second thin dielectric layer on the surface of the semiconductor substrate, the semiconductor substrate having a bandgap; and, without removing the semiconductor substrate from the controlled atmosphere of the process tool, forming a wide bandgap semiconductor layer on the second thin dielectric layer, the wide bandgap semiconductor layer having a bandgap at least approximately 0.2 electron Volts (eV) above the bandgap of the semiconductor substrate; and doping the wide bandgap semiconductor layer with charge carrier dopant impurity atoms of a second, opposite,~~

~~conductivity type.~~ forming a first emitter region on a surface of a N-type silicon semiconductor substrate of the solar cell, the first emitter region comprising a semiconductor material doped to a first conductivity type and formed on a first thin dielectric layer; and

forming a second emitter region on the surface of the semiconductor substrate, the forming comprising:

forming, in a process tool having a controlled atmosphere, a thin dielectric layer of aluminum oxide (Al2O3) on a surface of a single crystalline N-type silicon semiconductor substrate of the solar cell, the semiconductor substrate having a bandgap; and, without removing the semiconductor substrate from the controlled atmosphere of the process tool,

forming a semiconductor layer on the thin dielectric layer, the semiconductor layer being transparent in the visible spectrum and having a bandgap at least approximately 0.2 electron Volts (eV) above the bandgap of the semiconductor substrate and a bandgap of greater than 3 eV and comprising a material selected from the group consisting of: aluminum nitride (AIN), aluminum gallium nitride (AlxGa1-xN, where 0 <x<1), and boron nitride (BN); and

doping the semiconductor layer with charge carrier dopant impurity ions of a second, opposite conductivity type.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Figure 1 illustrates a band diagram as a function of increasing energy (E) for a conventional heterojunction contact without an interfacial tunnel oxide.

CLAIMS

What is claimed is:

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

forming, in a process tool having a controlled atmosphere, a thin dielectric layer on a surface of a semiconductor substrate of the solar cell, the semiconductor substrate having a bandgap; and, without removing the semiconductor substrate from the controlled atmosphere of the process tool,

forming a semiconductor layer on the thin dielectric layer, the semiconductor layer having a bandgap at least approximately 0.2 electron Volts (eV) above the bandgap of the semiconductor substrate.

2. The method of claim 1, further comprising:

forming an emitter region for the solar cell from the semiconductor layer.

3. The method of claim 1, further comprising:

doping the semiconductor layer with charge carrier dopant impurity atoms having a concentration approximately in the range of 1×10^{17} – 1×10^{21} atoms/cm^3.

4. The method of claim 3, wherein the doping is performed *in situ* during the forming of the semiconductor layer.

5. The method of claim 3, wherein the doping is performed subsequent to the forming of the semiconductor layer.

6. The method of claim 1, wherein forming the semiconductor layer comprises forming a layer substantially transparent in the visible spectrum.

7. The method of claim 6, wherein forming the layer substantially transparent in the visible spectrum comprises forming a semiconductor layer having a bandgap greater than approximately 3 eV and comprising a material selected from the group consisting of aluminum nitride (AlN), aluminum gallium nitride ($Al_xGa_{1-x}N$, where $0 < x < 1$), boron nitride (BN), 4H-phase silicon carbide (SiC), and 6H-phase silicon carbide (SiC).

~~8. The method of claim 1, wherein the semiconductor substrate comprises single-crystalline N-type silicon, and wherein forming the semiconductor layer comprises forming a semiconductor layer having a bandgap greater than approximately 1.5 eV and comprising a material selected from the group consisting of amorphous silicon (a-Si), silicon carbide, aluminum nitride (AlN), aluminum gallium nitride ($Al_xGa_{1-x}N$, where $0 < x < 1$), and boron nitride (BN).~~

~~9. The method of claim 1, wherein forming the thin dielectric layer on the surface of the semiconductor substrate comprises consuming a portion of the semiconductor substrate by thermal oxidation.~~

~~10. The method of claim 9, wherein consuming the portion of the semiconductor substrate comprises thermally oxidizing a portion of a single-crystalline N-type silicon substrate to form a silicon dioxide (SiO_2) layer having a thickness of approximately 3 nanometers or less.~~

~~11. The method of claim 1, wherein forming the thin dielectric layer on the surface of the semiconductor substrate comprises depositing a dielectric material layer on the surface of the semiconductor substrate.~~

~~12. The method of claim 11, wherein depositing the dielectric material layer on the surface of the semiconductor substrate comprises forming an aluminum oxide (Al_2O_3) layer on the surface of a single-crystalline N-type silicon substrate.~~

~~13. The method of claim 1, wherein forming the thin dielectric layer and the semiconductor layer in the process tool comprises using a low pressure chemical vapor deposition (LPCVD) chamber, a rapid thermal anneal (RTA) chamber, a rapid thermal processing (RTP) chamber, an atmospheric pressure chemical vapor deposition (APCVD) chamber, a hydride vapor phase epitaxy (HVPE) chamber, or both of an RTP chamber and a plasma enhanced chemical vapor deposition (PECVD) chamber.~~

~~14. The method of claim 1, further comprising:~~

texturizing the surface of the semiconductor substrate prior to forming the thin dielectric layer.

15. The method of claim 1, wherein forming the thin dielectric layer and the semiconductor layer on the surface of the semiconductor substrate comprises forming on a back-contact surface of the semiconductor substrate, the forming further comprising forming the thin dielectric layer and the semiconductor layer on a light-receiving surface of the semiconductor substrate.

16. A method of fabricating a solar cell, the method comprising:

forming a first emitter region on a surface of a semiconductor substrate of the solar cell, the first emitter region comprising a semiconductor material doped to a first conductivity type and formed on a first thin dielectric layer deposited on the surface of the semiconductor substrate; and

forming a second emitter region on the surface of the semiconductor substrate, the forming comprising:

forming, in a process tool having a controlled atmosphere, a second thin dielectric layer on the surface of the semiconductor substrate, the semiconductor substrate having a bandgap; and, without removing the semiconductor substrate from the controlled atmosphere of the process tool,

forming a wide bandgap semiconductor layer on the second thin dielectric layer, the wide bandgap semiconductor layer having a bandgap at least approximately 0.2 electron Volts (eV) above the bandgap of the semiconductor substrate; and

doping the wide bandgap semiconductor layer with charge carrier dopant impurity atoms of a second, opposite, conductivity type.

17. The method of claim 16, wherein the semiconductor substrate comprises single-crystalline N-type silicon, and wherein forming the wide bandgap semiconductor layer comprises forming a semiconductor layer having a bandgap greater than approximately 1.5 eV and comprising a material selected from the group consisting of

~~amorphous silicon (a-Si), silicon carbide, aluminum nitride (AlN), aluminum gallium nitride ($Al_xGa_{1-x}N$, where $0 < x < 1$), and boron nitride (BN).~~

~~18. The method of claim 16, further comprising:~~

~~texturizing the surface of the semiconductor substrate prior to forming the second thin dielectric layer.~~

What is claimed is:

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

forming, in a process tool having a controlled atmosphere, a thin dielectric layer of aluminum oxide (Al2O3) on a surface of a single crystalline N-type silicon semiconductor substrate of the solar cell, the semiconductor substrate having a bandgap; and, without removing the semiconductor substrate from the controlled atmosphere of the process tool,

forming a semiconductor layer on the thin dielectric layer, the semiconductor layer being transparent in the visible spectrum and having a bandgap at least approximately 0.2 electron Volts (eV) above the bandgap of the semiconductor substrate and a bandgap of greater than 3 eV and comprising a material selected from the group consisting of: aluminum nitride (AIN), aluminum gallium nitride (AlxGa1-xN, where $0<x<1$), and boron nitride (BN).

2. A method of fabricating a solar cell, the method comprising:

forming a first emitter region on a surface of a N-type silicon semiconductor substrate of the solar cell, the first emitter region comprising a semiconductor material doped to a first conductivity type and formed on a first thin dielectric layer; and

forming a second emitter region on the surface of the semiconductor substrate, the forming comprising:

forming, in a process tool having a controlled atmosphere, a thin dielectric layer of aluminum oxide (Al2O3) on a surface of a single crystalline N-type silicon semiconductor substrate of the solar cell, the semiconductor substrate having a bandgap; and, without removing the semiconductor substrate from the controlled atmosphere of the process tool,

forming a semiconductor layer on the thin dielectric layer, the semiconductor layer being transparent in the visible spectrum and having a bandgap at least approximately 0.2 electron Volts (eV) above the bandgap of the semiconductor substrate and a bandgap of greater than 3 eV and comprising a material selected from the group consisting of: aluminum nitride (AIN), aluminum gallium nitride (AlxGa1-xN, where $0<x<1$), and boron nitride (BN); and

doping the semiconductor layer with charge carrier dopant impurity ions of a second, opposite conductivity type.

3. The method of claim 1, further comprising:
forming an emitter region for the solar cell from the semiconductor layer.

4. The method of claim 1, further comprising:
doping the semiconductor layer with charge carrier dopant impurity atoms having a concentration approximately in the range of 1×10^{17}-1×10^{21} atoms/cm^3.

5. The method of claim 4, wherein the doping is performed in situ during the

forming of the semiconductor layer.

6. The method of claim 4, wherein the doping is performed subsequent to the forming of the semiconductor layer.

7. The method of claim 1, wherein forming the thin dielectric layer on the surface of the semiconductor substrate comprises consuming a portion of the semiconductor substrate by thermal oxidation.

8. The method of claim 1, wherein forming the thin dielectric layer and the semiconductor layer in the process tool comprises using a low pressure chemical vapor deposition (LPCVD) chamber, a rapid thermal anneal (RTA) chamber, a rapid thermal processing (RTP) chamber, an atmospheric pressure chemical vapor deposition (APCVD) chamber, a hydride vapor phase epitaxy (HVPE) chamber, or both of an RTP chamber and a plasma enhanced chemical vapor deposition (PECVD) chamber.

9. The method of claim 1, further comprising:
texturizing the surface of the semiconductor substrate prior to forming the thin dielectric layer.

10. The method of claim 1, wherein forming the thin dielectric layer and the semiconductor layer on the surface of the semiconductor substrate comprises forming on a back-contact surface of the semiconductor substrate, the forming further comprising forming the thin dielectric layer and the semiconductor layer on a light-receiving surface of the semiconductor substrate.

11. The method of claim 2, further comprising:
texturizing the surface of the semiconductor substrate prior to forming the second thin dielectric layer.