WE CLAIM:

1. A silicon solar cell comprising:

a silicon substrate having a front surface and a rear surface;

at least one front dielectric layer directly on at least a portion of the front surface of the silicon substrate;

a plurality of fine grid lines on a portion of the front surface of the silicon substrate;

at least one front busbar layer in electrical contact with at least one of the plurality of fine grid lines;

an aluminum particle layer on at least a portion of the rear surface of the silicon substrate, the aluminum particle layer comprising aluminum particles; and

a rear tabbing layer on a portion of the rear surface of the silicon substrate, wherein the rear tabbing layer comprises:

a modified aluminum particle layer on a portion of the rear surface of the silicon substrate; and

a modified intercalation layer directly on at least a portion of the modified aluminum particle layer, the modified intercalation layer having a solderable surface;

wherein the modified aluminum particle layer comprises the aluminum particles and at least one material from the modified intercalation layer;
wherein the modified intercalation layer comprises a precious metal and a material selected from the group consisting of antimony, arsenic, barium, bismuth, boron, cadmium, calcium, cerium, cesium, chromium, cobalt, gallium, germanium, hafnium, indium, iron, lanthanum, lead, lithium, magnesium, manganese, molybdenum, niobium, phosphorous, potassium, rhenium, selenium, silicon, sodium, strontium, sulfur, tellurium, tin, vanadium, zinc, zirconium, combinations thereof, and alloys thereof, oxides thereof, composites thereof, and other combinations thereof;

an electrically conductive adhesive layer on at least a portion of the solderable surface of the modified intercalation layer.

2. The silicon solar cell of Claim 1, wherein the modified intercalation layer comprises two phases: a precious metal phase and an intercalation phase;

wherein more than 50% of the solderable surface comprises the precious metal phase;

wherein the modified aluminum particle layer comprises the aluminum particles and at least one material from the intercalation phase; and

wherein the intercalation phase comprises a material selected from the group consisting of antimony, arsenic, barium, bismuth, boron, cadmium, calcium, cerium, cesium, chromium, cobalt, gallium, germanium, hafnium, indium, iron, lanthanum, lead, lithium, magnesium, manganese, molybdenum, niobium, phosphorous, potassium, rhenium, selenium, silicon, sodium, strontium, sulfur, tellurium, tin, vanadium, zinc, zirconium, combinations thereof, and alloys thereof, oxides thereof, composites thereof, and other combinations thereof.

3. The silicon solar cell of Claim 1, wherein the modified intercalation layer comprises two sublayers:

an intercalation sublayer directly on at least a portion of the modified aluminum particle layer; and

a precious metal sublayer directly on at least a portion of the intercalation sublayer;

wherein the solderable surface comprises the precious metal sublayer;

wherein the modified aluminum particle layer comprises the aluminum particles and at least one material from the intercalation sublayer; and

wherein the intercalation sublayer comprises a material selected from the group consisting of antimony, arsenic, barium, bismuth, boron, cadmium, calcium, cerium, cesium, chromium, cobalt, gallium, germanium, hafnium, indium, iron, lanthanum, lead, lithium, magnesium, manganese, molybdenum, niobium, phosphorous, potassium, rhenium, selenium, silicon, sodium, strontium, sulfur, tellurium, tin, vanadium, zinc, zirconium, combinations thereof, and alloys thereof, oxides thereof, composites thereof, and other combinations thereof.

4. The silicon solar cell of Claim 1, wherein the modified intercalation layer comprises two sublayers:

a bismuth-rich sublayer directly on the modified aluminum particle layer; and

a silver-rich sublayer directly on the bismuth-rich sublayer;

wherein the modified aluminum particle layer further comprises at least one material selected from the group consisting of aluminum oxides, bismuth, and bismuth oxides; and the bismuth-rich sublayer has a thickness between 0.01 μιτι and 5μιτι.

5. The silicon solar cell of Claim 4, wherein the aluminum particle layer further comprises bismuth, and a weight ratio of bismuth to bismuth and aluminum (Bi:(Bi + Al)) is at least 20% higher in the modified aluminum particle layer than in the aluminum particle layer.

6. The silicon solar cell of Claim 1, wherein the precious metal comprises a material selected from the group consisting of silver, gold, platinum, palladium, rhodium, and alloys thereof, composites thereof, and other combinations thereof.

7. The silicon solar cell of Claim 1 further comprising at least one rear dielectric layer directly on at least a portion of the rear surface of the silicon substrate, wherein the rear dielectric layer comprises at least one material selected from the group consisting of silicon, aluminum, germanium, hafnium, gallium, and oxides thereof, nitrides thereof, composites thereof, and combinations thereof.

8. The silicon solar cell of Claim 1 further comprising a first rear dielectric layer comprising aluminum oxide directly on at least a portion of the rear surface of the silicon substrate and a second rear dielectric layer comprising silicon nitride directly on the first rear dielectric layer.

9. The silicon solar cell of Claim 1 further comprising a solid aluminum-silicon eutectic layer directly on the silicon substrate.

10. The silicon solar cell of Claim 1 wherein the silicon solar cell is a first silicon solar cell and the first silicon solar cell has a rear tabbing layer, wherein the rear tabbing layer is connected to a front busbar of a second silicon solar cell through the electrically conductive adhesive.

11. The silicon solar cell of Claim 1, wherein the solderable surface comprises at least 70 wt% silver.

12. The silicon solar cell of Claim 1, wherein the modified aluminum particle layer has variable thickness.

13. A shingled silicon solar cell array comprising:

a plurality of silicon solar cells arranged in line with end portions of adjacent silicon solar cells overlapping and conductively bonded to each other so that the silicon solar cells are electrically connected to one another in series;

wherein each silicon solar cell comprises the silicon solar cell of Claim 1 ;

wherein within any pair of adjacent silicon solar cells, a portion of a first silicon solar cell overlaps a portion of a second silicon solar cell so that the front busbar layer of the second silicon solar cell is below the rear tabbing layer of the first solar cell; and

wherein an electronically conductive adhesive is conductively bonded to both the front busbar layer of the second silicon solar cell, and the rear tabbing layer of the first silicon solar cell to electrically connect the first silicon solar cell and the second silicon solar cell.

14. The shingled silicon solar cell array of Claim 13, wherein the modified intercalation layer comprises the modified intercalation layer of Claim 2.

15. The shingled silicon solar cell array of Claim 13, wherein the modified intercalation layer comprises the two sublayers of Claim 3.

16. The shingled silicon solar cell array of Claim 13, wherein the modified intercalation layer comprises the two sublayers of Claim 4.

17. The shingled silicon solar cell array of Claim 13, wherein the front dielectric layer comprises at least one material selected from the group consisting of silicon,

aluminum, germanium, hafnium, gallium, and oxides thereof, nitrides thereof, composites thereof, and combinations thereof.

18. The shingled silicon solar cell array of Claim 13, wherein each silicon solar cell further comprises at least one rear dielectric layer directly on the rear surface of the silicon substrate, wherein rear dielectric layer comprises at least one material selected from the group consisting of silicon, aluminum, germanium, hafnium, gallium, oxides thereof, nitrides thereof, composites thereof, and combinations thereof.

19. The shingled silicon solar cell array of Claim 13, wherein each silicon solar cell further comprises a first rear dielectric layer comprising aluminum oxide directly on at least a portion of the rear surface of the silicon substrate and a second rear dielectric layer comprising silicon nitride directly on the first rear dielectric layer.

20. The shingled silicon solar cell array of Claim 13, wherein each silicon solar cell further comprises a solid aluminum silicon eutectic layer directly on the rear surface of the silicon substrate.

21. The shingled silicon solar cell array of Claim 13, wherein a portion of the rear tabbing layer has variable thickness.

22. A silicon solar cell module comprising:

a front sheet having a front surface and a rear surface;

a front encapsulant layer on the rear surface of the front sheet;

a plurality of shingled silicon solar cell arrays according to Claim 13 on the front encapsulant layer, the shingled silicon solar cell arrays electrically connected to one another;

a plurality of flexible, conductive interconnects, wherein each flexible, conductive interconnect is conductively connected to adj acent silicon shingled solar cell arrays;

a rear sheet having a front surface and a rear surface, the rear surface of the rear sheet exposed to an outside environment; and

a rear encapsulant layer on the front surface of the rear sheet, wherein a first portion of the rear encapsulant layer is on the plurality of shingled silicon solar cell arrays, and a second portion of the rear encapsulant layer is on the front encapsulant layer.

23. The silicon solar cell module of Claim 22, wherein the flexible, conductive interconnect further comprises a junction box in contact with the rear sheet.

24. The silicon solar cell module of Claim 22, further comprising a bus ribbon connected to a portion of the shingled silicon solar cell array and electrically connected to a bypass diode and a junction box.