What is claimed is:

1. A method for manufacturing a multijunction solar cell comprising:

forming a first subcell comprising $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$, wherein,

the content levels are selected to achieve a bandgap from 0.9 eV to 1.1 eV;

the content values for x, y, and z are within composition ranges as follows: $0.07 \leq x \leq 0.18$, $0.025 \leq y \leq 0.04$ and $0.001 \leq z \leq 0.03$;

the first subcell is characterized by a short circuit current Jsc greater than 13 mA/cm^2 and an open circuit voltage Voc greater than 0.3 V when illuminated with a filtered 1 sun AM1.5D spectrum in which all light having an energy greater than the bandgap of GaAs is blocked; and

forming at least one second subcell overlying the first subcell to form the multijunction solar cell.

2. The method of claim 1, wherein the first subcell is substantially lattice matched to the at least one second subcell.

3. The method of claim 1, wherein the at least one second subcell is selected from a $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell, a GaInNAs(Sb) subcell, a (Al)(In)GaP subcell, an (In)(Al)GaAs subcell, an (Al)InGaP subcell, and an (In)GaAs subcell.

4. The method of claim 1, wherein forming the second subcell comprises growing pseudomorphically.

5. The method of claim 1, wherein the first subcell is characterized by a lattice constant that is within 0.5% of the lattice constant of the at least one second subcell when fully relaxed.

6. The method of claim 1, wherein the first subcell is not a current-limiting subcell upon illumination of the multijunction solar cell using the AM1.5D spectrum.

7. The method of claim 1, wherein,

forming a first subcell comprises substantially lattice matching the first subcell to a substrate; and

the substrate is selected from Ge and GaAs.

8. The method of claim 1, wherein $0.001 \leq z < 0.02$.

9. The method of claim 1, wherein the first subcell is characterized by a thickness from 1 μm to 2 μm.

10. The method of claim 1, wherein the first subcell is characterized by a thickness greater than 1 μm.

11. The method of claim 1, wherein a base of the first subcell comprises p-type $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$.

12. A method for manufacturing a multijunction solar cell comprising:

forming a first subcell comprising $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$, wherein,

the content levels are selected to achieve a bandgap from 0.9 eV to 1.1 eV;

the content values for x, y, and z are within composition ranges as follows: $0.07 \leq x \leq 0.18$, $0.025 \leq y \leq 0.04$ and $0.001 \leq z \leq 0.03$;

the first subcell is characterized by a short circuit current Jsc greater than 13 mA/cm2 and an open circuit voltage Voc greater than 0.3 V when illuminated with a filtered 1 sun AM1.5D spectrum in which all light having an energy greater than the bandgap of GaAs is blocked;

the first subcell is characterized by a thickness greater than 1 μm; and

a base of the first subcell comprises p-type $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$; and

forming at least one second subcell overlying the first subcell to form the multijunction solar cell;

forming the first subcell comprises substantially lattice matching the first subcell to a substrate; and

the substrate is selected from Ge and GaAs.

13. The method of claim 12, wherein forming the at least one second subcell comprises epitaxially growing.

14. The method of claim 12, wherein forming the at least one second subcell comprises joining.

15. A multijunction solar cell comprising:

at least one subcell comprising $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$, the at least one subcell having a low antimony (Sb) content and enhanced indium (In) content and enhanced nitrogen (N) content, wherein the content levels are selected to achieve a bandgap of at least 0.9 eV, wherein the content values for x, y, and z are within compositions ranges as follows: $0.14 \leq x \leq 0.18$, $0.025 \leq y \leq 0.04$ and $0.001 \leq z \leq 0.03$, wherein low corresponds to the content value for z and enhanced corresponds to the content value for x.

16. The multijunction solar cell according to claim 15, wherein the at least one $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell is substantially lattice matched to a substrate.

17. The multijunction solar cell according to claim 16, further comprising at least one additional subcell that is substantially lattice matched to the at least one $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell.

18. The multijunction solar cell according to claim 16, wherein the at least one $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell has a lattice constant that is within 0.5% of the lattice constant of the substrate.

19. The multijunction solar cell according to claim 15, wherein the at least one $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell is capable of producing an open circuit voltage of at least 0.3 V under illumination of the multijunction solar cell at an intensity of 1,000 W/m^2 using the AM1.5D spectrum.

20. The multijunction solar cell according to claim 15, wherein the at least one $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell is not a current-limiting subcell upon illumination of the multijunction solar cell using the AM1.5D spectrum.

21. A multijunction solar cell comprising:

a first subcell comprising $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$, wherein,

the content levels are selected to achieve a bandgap from 0.9 eV to 1.1 eV;

the content values for x, y, and z are within composition ranges as follows: $0.07 \leq x \leq 0.18$, $0.025 \leq y \leq 0.04$ and $0.001 \leq z \leq 0.03$;

the first subcell is characterized by a short circuit current Jsc greater than 13 mA/cm^2 and an open circuit voltage Voc greater than 0.3 V when illuminated with a filtered 1 sun AM1.5D spectrum in which all light having an energy greater than the bandgap of GaAs is blocked; and

at least one second subcell overlying the first subcell to form the multijunction solar cell.

22. The multijunction solar cell of claim 21, comprising a substrate underlying the first subcell, wherein,

the substrate is selected from GaAs and Ge, and

the first subcell is substantially lattice matched to the substrate.

23. The multijunction solar cell of claim 21, wherein the at least one second subcell is selected from a $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell, a GaInNAs(Sb) subcell, a (Al)(In)GaP subcell, an (In)(Al)GaAs subcell, an (Al)InGaP subcell, and an (In)GaAs subcell.

24. The multijunction solar cell of claim 21, wherein the first subcell is characterized by a lattice constant that is within 0.5% of the lattice constant of the at least one second subcell when fully relaxed.

25. The multijunction solar cell of claim 21, wherein the first subcell is not a current-limiting subcell upon illumination of the multijunction solar cell using the AM1.5D spectrum.

26. The multijunction solar cell of claim 21, wherein $0.001 \leq z < 0.02$.

27. The multijunction solar cell of claim 21, wherein the first subcell is characterized by a thickness from 1 μm to 2 μm.

28. The multijunction solar cell of claim 21, wherein the first subcell is characterized by a thickness greater than 1 μm.

29. The multijunction solar cell of claim 21, wherein a base of the first subcell comprises p-type $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$.

30. A multijunction solar cell comprising:

a substrate selected from Ge and GaAs;

a first subcell overlying the substrate, wherein the first subcell comprises a base comprising $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$, wherein,

the content levels are selected to achieve a bandgap from 0.9 eV to 1.1 eV;

the content values for x, y, and z are within composition ranges as follows: $0.07 \leq x \leq 0.18$, $0.025 \leq y \leq 0.04$ and $0.001 \leq z \leq 0.03$;

the first subcell is characterized by a short circuit current Jsc greater than 13 mA/cm^2 and an open circuit voltage Voc greater than 0.3 V when illuminated with a filtered 1 sun AM1.5D spectrum in which all light having an energy greater than the bandgap of GaAs is blocked;

the first subcell is substantially lattice matched to the substrate;

the first subcell is characterized by a thickness greater than 1 μm; and

at least one second subcell overlying the first subcell.

Claims

1. A semiconductor alloy composition, wherein the semiconductor alloy composition is $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$, wherein,
the content values for x, y, and z are within composition ranges as follows: $0.07 \leq x \leq 0.18$, $0.025 \leq y \leq 0.04$ and $0.001 \leq z \leq 0.03$;
the content levels are selected such that the semiconductor alloy composition exhibits a bandgap from 0.9 eV to 1.1 eV; and a short circuit current density Jsc greater than 13 mA/cm^2 and an open circuit voltage Voc greater than 0.3 V when illuminated with a filtered 1 sun AM1.5D spectrum in which all light having an energy greater than the bandgap of GaAs is blocked.

2. The semiconductor alloy composition of claim 1, wherein the semiconductor alloy composition is characterized by a thickness from 1 μm to 2 μm.

3. The semiconductor alloy composition of claim 1, wherein the semiconductor alloy composition is characterized by a thickness greater than 1 μm.

4. The semiconductor alloy composition of claim 1, wherein the semiconductor alloy composition is substantially lattice matched to GaAs.

5. The semiconductor alloy composition of claim 1, wherein the semiconductor alloy composition is substantially lattice matched to Ge.

6. The semiconductor alloy composition of claim 1, wherein the semiconductor alloy composition is n-doped.

7. The semiconductor alloy composition of claim 1, wherein the semiconductor alloy composition is p-doped.

8. The semiconductor alloy composition of claim 1, wherein the semiconductor alloy composition is in the form of a layer of semiconductor material.

9. The semiconductor alloy composition of claim 1, wherein the content values are selected such that the semiconductor alloy composition is lattice matched to GaAs or Ge.

10. A multijunction solar cell comprising:
a first subcell comprising the semiconductor alloy composition according to claim 1; and

at least one second subcell overlying the first subcell to form the multijunction solar cell.

11. The multijunction solar cell of claim 10, comprising a substrate underlying the first subcell, wherein,
the substrate is selected from GaAs and Ge, and
the first subcell is substantially lattice matched to the substrate.

12. The multijunction solar cell of claim 10, wherein the at least one second subcell is selected from a $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell, a GaInNAs(Sb) subcell, a (Al)(In)GaP subcell, an (In)(Al)GaAs subcell, an (Al)InGaP subcell, and an (In)GaAs subcell.

13. The multijunction solar cell of claim 10, wherein the first subcell is characterized by a lattice constant that is within 0.5% of the lattice constant of the at least one second subcell when fully relaxed.

14. The multijunction solar cell of claim 10, wherein the first subcell is not a current-limiting subcell upon illumination of the multijunction solar cell using the AM1.5D spectrum.

15. The multijunction solar cell of claim 10, wherein $0.001 \leq z < 0.02$.

16. The multijunction solar cell of claim 10, wherein the first subcell is characterized by a thickness from 1 μm to 2 μm.

17. The multijunction solar cell of claim 10, wherein the first subcell is characterized by a thickness greater than 1 μm.

18. The multijunction solar cell of claim 10, wherein a base of the first subcell comprises p-type $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$.

19. A multijunction solar cell comprising:
a substrate selected from Ge and GaAs;
a first subcell overlying the substrate, wherein the first subcell comprises a base comprising the semiconductor alloy composition according to claim 1;
the first subcell is substantially lattice matched to the substrate;
the first subcell is characterized by a thickness greater than 1 μm; and
at least one second subcell overlying the first subcell.

20. A multijunction solar cell comprising:
at least one subcell comprising $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$, the at least one subcell having a low antimony (Sb) content and enhanced indium (In) content and enhanced nitrogen (N) content, wherein the content levels are selected to achieve a bandgap from 0.9 eV to 1.1 eV, wherein the content values for x, y, and z are within compositions ranges as follows: $0.14 \leq x \leq 0.18$, $0.025 \leq y \leq 0.04$ and $0.001 \leq z \leq 0.03$, wherein low corresponds to the content value for z and enhanced corresponds to the content value for x.

21. The multijunction solar cell according to claim 20, wherein the at least one $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell is substantially lattice matched to a substrate.

22. The multijunction solar cell according to claim 21, further comprising at least one additional subcell that is substantially lattice matched to the at least one $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell.

23. The multijunction solar cell according to claim 21, wherein the at least one $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell has a lattice constant that is within 0.5% of the lattice constant of the substrate.

24. The multijunction solar cell according to claim 20, wherein the at least one $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell is capable of producing an open circuit voltage of at least 0.3 V under illumination of the multijunction solar cell at an intensity of 1,000 W/m^2 using the AM1.5D spectrum.

25. The multijunction solar cell according to claim 20, wherein the at least one $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell is not a current-limiting subcell upon illumination of the multijunction solar cell using the AM1.5D spectrum.

26. A method for manufacturing a multijunction solar cell comprising:
forming a first subcell comprising $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$, wherein,
the content levels are selected to achieve a bandgap from 0.9 eV to 1.1 eV;
the content values for x, y, and z are within composition ranges as follows: $0.07 \leq x \leq 0.18$, $0.025 \leq y \leq 0.04$ and $0.001 \leq z \leq 0.03$;
the first subcell is characterized by a short circuit current Jsc greater than 13 mA/cm^2 and an open circuit voltage Voc greater than 0.3 V when illuminated with a filtered 1 sun AM1.5D spectrum in which all light having an energy greater than the bandgap of GaAs is blocked; and
forming at least one second subcell overlying the first subcell to form the multijunction solar cell.

27. The method of claim 26, wherein the first subcell is substantially lattice matched to the at least one second subcell.

28. The method of claim 26, wherein the at least one second subcell is selected from a $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$ subcell, a GaInNAs(Sb) subcell, a (Al)(In)GaP subcell, an (In)(Al)GaAs subcell, an (Al)InGaP subcell, and an (In)GaAs subcell.

29. The method of claim 26, wherein forming the second subcell comprises growing pseudomorphically.

30. The method of claim 26, wherein the first subcell is characterized by a lattice constant that is within 0.5% of the lattice constant of the at least one second subcell when fully relaxed.

31. The method of claim 26, wherein the first subcell is not a current-limiting subcell upon illumination of the multijunction solar cell using the AM1.5D spectrum.

32. The method of claim 26, wherein,
forming a first subcell comprises substantially lattice matching the first subcell to a substrate; and
the substrate is selected from Ge and GaAs.

33. The method of claim 26, wherein $0.001 \leq z < 0.02$.

34. The method of claim 26, wherein the first subcell is characterized by a thickness from 1 μm to 2 μm.

35. The method of claim 26, wherein the first subcell is characterized by a thickness greater than 1 μm.

36. The method of claim 26, wherein a base of the first subcell comprises p-type $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$.

37. A method for manufacturing a multijunction solar cell comprising:
forming a first subcell comprising $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$, wherein,
the content levels are selected to achieve a bandgap from 0.9 eV to 1.1 eV;
the content values for x, y, and z are within composition ranges as follows: $0.07 \leq x \leq 0.18$, $0.025 \leq y \leq 0.04$ and $0.001 \leq z \leq 0.03$;

the first subcell is characterized by a short circuit current Jsc greater than 13 mA/cm^2 and an open circuit voltage Voc greater than 0.3 V when illuminated with a filtered 1 sun AM1.5D spectrum in which all light having an energy greater than the bandgap of GaAs is blocked;
the first subcell is characterized by a thickness greater than 1 μm; and
a base of the first subcell comprises p-type $Ga_{1-x}In_xN_yAs_{1-y-z}Sb_z$; and
forming at least one second subcell overlying the first subcell to form the multijunction solar cell;
forming the first subcell comprises substantially lattice matching the first subcell to a substrate; and
the substrate is selected from Ge and GaAs.

38. The method of claim 37, wherein forming the at least one second subcell comprises epitaxially growing.

39. The method of claim 37, wherein forming the at least one second subcell comprises joining.