

CLAIMS

1. A method for treating a semiconductor layer comprising a semiconductor material, comprising:

(a) contacting at least a portion of the semiconductor material with a passivating agent, wherein the semiconductor material comprises a chalcogenide;

(b) forming a first region in the semiconductor layer by introducing a dopant into the semiconductor material;

(c) forming a chalcogen-rich region; and

(d) forming a second region in the semiconductor layer, the second region comprising a dopant;

wherein an average atomic concentration of the dopant in the second region is greater than an average atomic concentration of the dopant in the first region.

2. The method of claim 1, wherein two or more of the steps (a), (b), (c) and (d) are performed simultaneously.

3. The method of claim 1, wherein two or more of the steps (a), (b), (c) and (d) are performed sequentially.

4. The method of claim 1, wherein the step (b) comprises contacting at least a portion of the semiconductor material with a metal salt comprising the dopant.

5. The method of claim 1, wherein the dopant in the first region comprises copper, silver, gold, or combinations thereof.

6. The method of claim 1, wherein the step (c) comprises contacting at least a portion of the semiconductor material with a chemical agent.

7. The method of claim 6, wherein the chemical agent comprises an oxidant, an acid, a metal halide, or combinations thereof.

8. The method of claim 6, wherein the chemical agent comprises iodine, sulfuric acid, hydrochloric acid, manganese chloride, zinc chloride, ammonium chloride, or combinations thereof.

9. The method of claim 1, wherein the step (c) comprises forming a tellurium-rich region.

10. The method of claim 1, wherein the dopant in the second region comprises copper, silver, gold, or combinations thereof.

11. The method of claim 1, wherein the step (d) comprises contacting at least a portion of the semiconductor material with a contacting composition comprising the dopant at a concentration less than about 10 parts per million.

12. A method for treating a semiconductor layer comprising a semiconductor material, comprising:

(a) contacting at least a portion of the semiconductor material with cadmium chloride;

(b) forming a first region in the semiconductor layer by introducing copper into the semiconductor material;

(c) forming a tellurium-rich region by contacting at least a portion of the semiconductor material with a chemical agent, wherein the chemical agent comprises iodine; and

(d) forming a second region in the semiconductor layer, the second region comprising copper,

wherein an average atomic concentration of copper in the second region is greater than an average atomic concentration of copper in the first region.

13. A method for treating a semiconductor layer comprising a semiconductor material, comprising:

(a) contacting at least a portion of the semiconductor material with a passivating agent, the semiconductor material comprising a chalcogenide;
(b) introducing a dopant into the semiconductor material; and
(c) forming a chalcogen-rich region by contacting at least a portion of the semiconductor material with a chemical agent, wherein the chemical agent comprises iodine.

14. The method of claim 13, wherein the dopant comprises copper, silver, gold, or combinations thereof.

15. The method of claim 13, wherein the step (c) comprises forming a tellurium-rich region.

16. A method for treating a semiconductor layer comprising a semiconductor material, comprising:

(a) forming a chalcogen-rich region by contacting at least a portion of the semiconductor material with a chemical agent, wherein the chemical agent comprises iodine; and

(b) introducing a dopant into the chalcogen-rich region.

17. The method of claim 16, wherein the step (b) comprises contacting at least a portion of the semiconductor material with a contacting composition comprising the dopant at a concentration less than about 10 parts per million.

18. The method of claim 16, wherein the dopant comprises copper, silver, gold, or combinations thereof.

19. A method for treating a semiconductor layer comprising a semiconductor material, comprising:

(a) contacting at least a portion of the semiconductor material with a chemical agent, wherein the chemical agent comprises iodine; and

(b) contacting at least a portion of the semiconductor material with copper.

20. A method for treating a semiconductor layer comprising a semiconductor material, comprising:

- (a) contacting at least a portion of the semiconductor material with a chemical agent, wherein the chemical agent comprises a metal halide; and
- (b) contacting at least a portion of the semiconductor material with copper.

21. The method of claim 20, wherein the metal halide comprises manganese chloride, zinc chloride, ammonium chloride, or combinations thereof.

CLAIMS

1. A method for treating a semiconductor layer comprising a semiconductor material, comprising:
 - (a) contacting at least a portion of the semiconductor material with a passivating agent, wherein the semiconductor material comprises a chalcogenide;
 - (b) forming a first region in the semiconductor layer by introducing a dopant into the semiconductor material;
 - (c) forming a chalcogen-rich region; and
 - (d) forming a second region in the semiconductor layer, the second region comprising a dopant; wherein an average atomic concentration of the dopant in the second region is greater than an average atomic concentration of the dopant in the first region.
2. The method of claim 1, wherein two or more of the steps (a), (b), (c) and (d) are performed simultaneously.
3. The method of claim 1, wherein two or more of the steps (a), (b), (c) and (d) are performed sequentially.
4. The method of claim 1, wherein the step (b) comprises contacting at least a portion of the semiconductor material with a metal salt comprising the dopant.
5. The method of claim 1, wherein the dopant in the first region comprises copper, silver, gold, or combinations thereof.
6. The method of claim 1, wherein the steps (a) and (b) are performed simultaneously.
7. The method of claim 1, wherein the step (a) is performed after the step (b).
8. The method of claim 7, further comprising subjecting at least a portion of the semiconductor material to a heat treatment.
9. The method of claim 1, wherein the passivating agent comprises cadmium chloride.

10. The method of claim 1, wherein the step (c) comprises contacting at least a portion of the semiconductor material with a chemical agent.

11. The method of claim 10, wherein the chemical agent comprises an oxidant, an acid, a metal halide, or combinations thereof.

12. The method of claim 10, wherein the chemical agent comprises iodine, sulfuric acid, hydrochloric acid, manganese chloride, zinc chloride, ammonium chloride, or combinations thereof.

13. The method of claim 1, wherein the step (c) comprises depositing a chalcogen-rich region on the semiconductor layer.

14. The method of claim 1, wherein the step (c) comprises forming a tellurium-rich region.

15. The method of claim 14, wherein an atomic ratio of tellurium to cadmium in the tellurium-rich region is greater than about 2.

16. The method of claim 14, wherein an atomic ratio of tellurium to cadmium in the tellurium-rich region is greater than about 10.

17. The method of claim 1, wherein the chalcogen-rich region has a thickness in a range from about 10 nanometers to about 1000 nanometers.

18. The method of claim 1, wherein the steps (c) and (d) are performed simultaneously.

19. The method of claim 1, wherein the steps (c) and (d) are performed sequentially.

20. The method of claim 1, wherein the steps (b), (c), and (d) are performed simultaneously.

21. The method of claim 1, wherein the dopant in the second region comprises copper, silver, gold, or combinations thereof.

22. The method of claim 1, wherein the step (d) comprises contacting at least a portion of the semiconductor material with a contacting composition comprising the dopant at a concentration less than about 10 parts per million.

23. The method of claim 1, wherein the step (d) comprises contacting at least a portion of the semiconductor material with a contacting composition comprising the dopant at a concentration in a range from about 10 parts per billion to about 1000 parts per billion.

24. The method of claim 1, wherein a ratio of the average atomic concentration of the dopant in the second region to the average atomic concentration of the dopant in the first region is greater than about 10.

25. The method of claim 1, wherein an average atomic concentration of the dopant in the second region is greater than about 5×10^{18} atoms/cm³.

26. The method of claim 1, wherein the semiconductor material comprises cadmium telluride, magnesium telluride, mercury telluride, lead telluride, zinc telluride, cadmium selenide, mercury selenide, lead selenide, zinc selenide, cadmium sulfide, mercury sulfide, zinc sulfide, lead sulfide, cadmium zinc telluride, cadmium sulfur telluride, cadmium manganese telluride, cadmium magnesium telluride, or combinations thereof.

27. A method for treating a semiconductor layer comprising a semiconductor material, comprising:

(a) contacting at least a portion of the semiconductor material with a passivating agent, wherein the semiconductor material comprises a chalcogenide;

(b) forming a first region in the semiconductor layer by introducing copper into the semiconductor material;

(c) forming a chalcogen-rich region; and

(d) forming a second region in the semiconductor layer, the second region comprising copper; wherein an average atomic concentration of copper in the second region is greater than an average atomic concentration of copper in the first region.

28. The method of claim 27, wherein two or more of the steps (a), (b), (c), and (d) are performed simultaneously.

29. The method of claim 27, wherein two or more of the steps (a), (b), (c), and (d) are performed sequentially.

30. The method of claim 27, wherein the step (a) is performed after step (b).

31. The method of claim 27, wherein the step (c) comprises contacting at least a portion of the semiconductor material with a chemical agent comprising an oxidant, an acid, a metal halide, or combinations thereof.

32. The method of claim 31, wherein the chemical agent comprises iodine, sulfuric acid, hydrochloric acid, manganese chloride, zinc chloride, ammonium chloride, or combinations thereof.

33. The method of claim 27, wherein the step (c) comprises forming a tellurium-rich region.

34. A method for treating a semiconductor layer comprising a semiconductor material, comprising:

(a) contacting at least a portion of the semiconductor material with a passivating agent, wherein the semiconductor material comprises a chalcogenide;

(b) forming a first region in the semiconductor layer by introducing a dopant into the semiconductor material;

(c) forming a chalcogen-rich region by contacting at least a portion of the semiconductor material with a chemical agent, wherein the chemical agent comprises iodine; and

(d) forming a second region in the semiconductor layer, the second region comprising a dopant; wherein an average atomic concentration of the dopant in the second region is greater than an average atomic concentration of the dopant in the first region.

35. The method of claim 34, wherein two or more of the steps (a), (b), (c), and (d) are performed simultaneously.

36. The method of claim 34, wherein two or more of the steps (a), (b), (c), and (d) are performed sequentially.

37. The method of claim 34, wherein the step (a) is performed after step (b).

38. The method of claim 34, wherein the dopant in the first region comprises copper, silver, gold, or combinations thereof.

39. The method of claim 34, wherein the step (c) comprises forming a tellurium-rich region.

40. The method of claim 34, wherein the dopant in the second region comprises copper, silver, gold, or combinations thereof.

41. A method for treating a semiconductor layer comprising a semiconductor material, comprising:

- (a) contacting at least a portion of the semiconductor material with cadmium chloride;
- (b) forming a first region in the semiconductor layer by introducing copper into the semiconductor material;
- (c) forming a tellurium-rich region by contacting at least a portion of the semiconductor material with a chemical agent, wherein the chemical agent comprises iodine; and
- (d) forming a second region in the semiconductor layer, the second region comprising copper, wherein an average atomic concentration of copper in the second region is greater than an average atomic concentration of copper in the first region.