CLAIMS

1. A method for manufacturing a semiconductor device, comprising:

forming a gate electrode layer over a substrate having an insulating surface;

forming a gate insulating layer over the gate electrode layer;

forming an oxide semiconductor layer over the gate insulating layer;

heating the oxide semiconductor layer in an oxygen atmosphere;

forming a source and drain electrode layers over the oxide semiconductor layer;

forming an oxide insulating layer which is in contact with part of the oxide semiconductor layer, over the gate insulating layer, the oxide semiconductor layer, and the source and drain electrode layers; and

performing a heat treatment in an oxygen atmosphere or an inert gas atmosphere.

2. A method for manufacturing a semiconductor device, comprising:

forming a gate electrode layer over a substrate having an insulating surface;

forming a gate insulating layer over the gate electrode layer;

forming an oxide semiconductor layer over the gate insulating layer;

heating the oxide semiconductor layer in an oxygen atmosphere, so that the oxide semiconductor layer is dehydrated or dehydrogenated;

forming a source and drain electrode layers over the oxide semiconductor layer;

forming an oxide insulating layer which is in contact with part of the oxide semiconductor layer, over the gate insulating layer, the oxide semiconductor layer, and the source and drain electrode layers; and

performing a heat treatment in an oxygen atmosphere or an inert gas atmosphere.

3. A method for manufacturing a semiconductor device, comprising:

forming an oxide semiconductor layer over an insulating layer;

heating the oxide semiconductor layer in an oxygen atmosphere;

forming a source and drain electrode layers over the oxide semiconductor layer;

forming an oxide insulating layer which is in contact with part of the oxide semiconductor layer, over the insulating layer, the oxide semiconductor layer, and the source and drain electrode layers; and

performing a heat treatment in an oxygen atmosphere or an inert gas atmosphere.

4. A method for manufacturing a semiconductor device, comprising:

forming an oxide semiconductor layer over an insulating layer;

heating the oxide semiconductor layer in an oxygen atmosphere, so that the oxide semiconductor layer is dehydrated or dehydrogenated;

forming a source and drain electrode layers over the oxide semiconductor layer;

forming an oxide insulating layer which is in contact with part of the oxide semiconductor layer, over the insulating layer, the oxide semiconductor layer, and the source and drain electrode layers; and

performing a heat treatment in an oxygen atmosphere or an inert gas atmosphere.

5. The method for manufacturing a semiconductor device according to any one of claims 1 to 4, wherein a temperature at which the oxide semiconductor layer is heated in the oxygen atmosphere is higher than or equal to 200 °C and lower than a strain point of the substrate.

6. The method for manufacturing a semiconductor device according to any one of claims 1 to 4, wherein after the oxide semiconductor layer is heated in the oxygen atmosphere, the oxide semiconductor layer is held in the oxygen atmosphere.

7. The method for manufacturing a semiconductor device according to any one of claims 1 to 4, wherein after the oxide semiconductor layer is heated in the oxygen

atmosphere, the oxide semiconductor layer is held in an inert gas atmosphere.

The invention claimed is:

1. A method for manufacturing a semiconductor device, comprising:

forming a gate electrode layer over a substrate having an insulating surface;

forming a gate insulating layer over the gate electrode layer;

forming an oxide semiconductor layer over the gate insulating layer;

heating the oxide semiconductor layer in an oxygen atmosphere after the step of forming the oxide semiconductor layer;

forming a source electrode layer over the oxide semiconductor layer;

forming a drain electrode layer over the oxide semiconductor layer;

forming an oxide insulating layer which is in contact with part of the oxide semiconductor layer, over the gate insulating layer, the oxide semiconductor layer, the source electrode layer, and the drain electrode layer; and

performing a heat treatment in an oxygen atmosphere or an inert gas atmosphere after the step of forming the oxide insulating layer.

2. A method for manufacturing a semiconductor device, comprising:

forming a gate electrode layer over a substrate having an insulating surface;

forming a gate insulating layer over the gate electrode layer;

forming an oxide semiconductor layer over the gate insulating layer;

heating the oxide semiconductor layer in an oxygen atmosphere, so that the oxide semiconductor layer is dehydrated or dehydrogenated after the step of forming the oxide semiconductor layer;

forming a source electrode layer over the oxide semiconductor layer;

forming a drain electrode layer over the oxide semiconductor layer;

forming an oxide insulating layer which is in contact with part of the oxide semiconductor layer, over the gate insulating layer, the oxide semiconductor layer, the source electrode layer, and the drain electrode layer; and

performing a heat treatment in an oxygen atmosphere or an inert gas atmosphere after the step of forming the oxide insulating layer.

3. A method for manufacturing a semiconductor device, comprising:

forming an oxide semiconductor layer over an insulating layer;

heating the oxide semiconductor layer in an oxygen atmosphere after the step of forming the oxide semiconductor layer;

forming a source electrode layer over the oxide semiconductor layer; forming a drain electrode layer over the oxide semiconductor layer;

forming an oxide insulating layer which is in contact with part of the oxide semiconductor layer, over the insulating layer, the oxide semiconductor layer, the source electrode layer, and the drain electrode layer; and

performing a heat treatment in an oxygen atmosphere or an inert gas atmosphere after the step of forming the oxide insulating layer.

4. A method for manufacturing a semiconductor device, comprising:

forming an oxide semiconductor layer over an insulating layer;

heating the oxide semiconductor layer in an oxygen atmosphere, so that the oxide semiconductor layer is dehydrated or dehydrogenated after the step of forming the oxide semiconductor layer;

forming a source electrode layer over the oxide semiconductor layer;

forming a drain electrode layer over the oxide semiconductor layer;

forming an oxide insulating layer which is in contact with part of the oxide semiconductor layer, over the insulating layer, the oxide semiconductor layer, the source electrode layer, and the drain electrode layer; and

performing a heat treatment in an oxygen atmosphere or an inert gas atmosphere after the step of forming the oxide insulating layer.

5. The method for manufacturing a semiconductor device according to claim 1 or claim 2, wherein a temperature at which the oxide semiconductor layer is heated in the oxygen atmosphere is higher than or equal to 200° C and lower than a strain point of the substrate.

6. The method for manufacturing a semiconductor device according to any one of claims 1 to 4, wherein after the oxide semiconductor layer is heated in the oxygen atmosphere, the oxide semiconductor layer is held in the oxygen atmosphere.

7. The method for manufacturing a semiconductor device according to any one of claims 1 to 4, wherein after the oxide semiconductor layer is heated in the oxygen atmosphere, the oxide semiconductor layer is held in an inert gas atmosphere.

8. The method for manufacturing a semiconductor device according to claim 1, wherein a temperature in the step of performing the heat treatment is higher than or equal to 150° C and lower than 350° C.

9. The method for manufacturing a semiconductor device according to claim 1, wherein the oxide insulating layer is formed by a sputtering method.

10. The method for manufacturing a semiconductor device according to claim 1,
wherein the oxygen atmosphere contains nitrogen, and
wherein an amount of oxygen is larger than an amount of nitrogen in the oxygen atmosphere.

11. The method for manufacturing a semiconductor device according to claim 2, wherein a temperature in the step of performing the heat treatment is higher than or equal to 150° C and lower than 350° C.

12. The method for manufacturing a semiconductor device according to claim 2, wherein the oxide insulating layer is formed by a sputtering method.

13. The method for manufacturing a semiconductor device according to claim 2,
wherein the oxygen atmosphere contains nitrogen, and
wherein an amount of oxygen is larger than an amount of nitrogen in the oxygen atmosphere.

14. The method for manufacturing a semiconductor device according to claim 3, wherein a temperature in the step of performing the heat treatment is higher than or equal to 150° C and lower than 350° C.

15. The method for manufacturing a semiconductor device according to claim 3, wherein the oxide insulating layer is formed by a sputtering method.

16. The method for manufacturing a semiconductor device according to claim 3,
wherein the oxygen atmosphere contains nitrogen, and
wherein an amount of oxygen is larger than an amount of nitrogen in the oxygen atmosphere.

17. The method for manufacturing a semiconductor device according to claim 4, wherein a temperature in the step of performing the heat treatment is higher than or equal to 150° C and lower than 350° C.

18. The method for manufacturing a semiconductor device according to claim 4, wherein the oxide insulating layer is formed by a sputtering method.

19. The method for manufacturing a semiconductor device according to claim 4,
wherein the oxygen atmosphere contains nitrogen, and
wherein an amount of oxygen is larger than an amount of nitrogen in the oxygen atmosphere.

20. A method for manufacturing a semiconductor device, comprising:
forming a first gate electrode over a substrate having an insulating surface;
forming a gate insulating layer over the first gate electrode;
forming an oxide semiconductor layer over the gate insulating layer;
heating the oxide semiconductor layer in an oxygen atmosphere after the step of forming the oxide semiconductor layer;
forming a source electrode layer and a drain electrode layer, wherein each of the source electrode layer and the drain electrode layer is in electrical contact with the oxide semiconductor layer;
forming an oxide insulating layer over the source electrode layer and the drain electrode layer, wherein the oxide insulating layer is in contact with a portion of the oxide semiconductor layer between the source electrode layer and the drain electrode layer;
performing a heat treatment in an oxygen atmosphere after the step of forming the oxide insulating layer; and
forming a second gate electrode over the oxide insulating layer, wherein the second gate electrode overlaps with the first gate electrode and the oxide semiconductor layer.

21. The method for manufacturing a semiconductor device according to claim 20, wherein the first gate electrode is configured to have a same potential as the second gate electrode.

22. The method for manufacturing a semiconductor device according to claim 20, wherein a temperature at which the oxide semiconductor layer is heated in the oxygen atmosphere is higher than or equal to 200° C and lower than a strain point of the substrate.

23. The method for manufacturing a semiconductor device according to claim 20, wherein after the oxide semiconductor layer is heated in the oxygen atmosphere, the oxide semiconductor layer is held in the oxygen atmosphere.

24. The method for manufacturing a semiconductor device according to claim 20, wherein after the oxide semiconductor layer is heated in the oxygen atmosphere, the oxide semiconductor layer is held in an inert gas atmosphere.

25. The method for manufacturing a semiconductor device according to claim 20, wherein a temperature in the step of performing the heat treatment is higher than or equal to 150° C and lower than 350° C.

26. The method for manufacturing a semiconductor device according to claim 20, wherein the oxide insulating layer is formed by a sputtering method.

27. The method for manufacturing a semiconductor device according to claim 20,
wherein the oxygen atmosphere contains nitrogen, and
wherein an amount of oxygen is larger than an amount of nitrogen in the oxygen atmosphere.

28. The method for manufacturing a semiconductor device according to claim 20, wherein the semiconductor device is formed in a pixel portion over the substrate.

29. A method for manufacturing a semiconductor device, comprising:
forming a first gate electrode over a substrate having an insulating surface;
forming a gate insulating layer over the first gate electrode;
forming an oxide semiconductor layer over the gate insulating layer;
heating the oxide semiconductor layer in an oxygen atmosphere after the step of forming the oxide semiconductor layer;
forming an oxide insulating layer over the oxide semiconductor layer,

forming a source electrode layer and a drain electrode layer over the oxide insulating layer, wherein each of the source electrode layer and the drain electrode layer is in electrical contact with the oxide semiconductor layer;

forming an insulating layer over and in contact with the oxide insulating layer, the source electrode layer, and the drain electrode layer;

performing a heat treatment in an oxygen atmosphere after the step of forming the oxide insulating layer; and

forming a second gate electrode over the insulating layer, wherein the second gate electrode overlaps with the first gate electrode and the oxide semiconductor layer.

30. The method for manufacturing a semiconductor device according to claim 29, wherein the first gate electrode is configured to have a same potential as the second gate electrode.

31. The method for manufacturing a semiconductor device according to claim 29, wherein a temperature at which the oxide semiconductor layer is heated in the oxygen atmosphere is higher than or equal to 200° C and lower than a strain point of the substrate.

32. The method for manufacturing a semiconductor device according to claim 29, wherein after the oxide semiconductor layer is heated in the oxygen atmosphere, the oxide semiconductor layer is held in the oxygen atmosphere.

33. The method for manufacturing a semiconductor device according to claim 29, wherein after the oxide semiconductor layer is heated in the oxygen atmosphere, the oxide semiconductor layer is held in an inert gas atmosphere.

34. The method for manufacturing a semiconductor device according to claim 29, wherein a temperature in the step of performing the heat treatment is higher than or equal to 150° C and lower than 350° C.

35. The method for manufacturing a semiconductor device according to claim 29, wherein the oxide insulating layer is formed by a sputtering method.

36. The method for manufacturing a semiconductor device according to claim 29, wherein the oxygen atmosphere contains nitrogen, and

wherein an amount of oxygen is larger than an amount of nitrogen in the oxygen atmosphere.

37. The method for manufacturing a semiconductor device according to claim 29, wherein the semiconductor device is formed in a pixel portion over the substrate.

38. The method for manufacturing a semiconductor device according to claim 29, wherein the oxide insulating layer comprises silicon oxide, silicon oxynitride, or silicon nitride oxide.