Claims

[Claim 1] 1. A method for manufacturing a semiconductor device, comprising the steps of:
forming an oxide semiconductor stack including a first oxide semiconductor layer and a second oxide semiconductor layer with an energy gap different from an energy gap of the first oxide semiconductor layer;
forming a source electrode layer and a drain electrode layer over the oxide semiconductor stack;
forming a gate insulating film over the source electrode layer and the drain electrode layer;
introducing oxygen into the oxide semiconductor stack with use of the source electrode layer and the drain electrode layer as a mask; and
forming a gate electrode layer overlapping the oxide semiconductor stack with the gate insulating film interposed therebetween.

[Claim 2] 2. The method for manufacturing a semiconductor device according to claim 1, further comprising a step of introducing dopant into the oxide semiconductor stack with use of the gate electrode layer as a mask.

[Claim 3] 3. The method for manufacturing a semiconductor device according to claim 1, further comprising steps of:
forming an interlayer insulating film over the gate electrode layer;
forming a contact hole in the interlayer insulating film so as to reach at least one of the source electrode layer and the drain electrode layer; and
forming a wiring layer over the interlayer insulating film, wherein the wiring layer is connected to the at least one of the source electrode layer and the drain electrode layer through the contact hole.

[Claim 4] 4. A method for manufacturing a semiconductor device, comprising the steps of:
forming an oxide semiconductor stack including a first oxide semiconductor layer, a second oxide semiconductor layer over the first oxide semiconductor layer, and a third oxide semiconductor layer over the second oxide semiconductor layer, wherein the second oxide semiconductor layer has a smaller energy gap than the first oxide semiconductor layer, and the third oxide semiconductor layer has a larger energy gap than the second oxide semiconductor layer;
forming a source electrode layer and a drain electrode layer over the oxide semiconductor stack;
forming a gate insulating film over the source electrode layer and the

drain electrode layer;
introducing oxygen into the oxide semiconductor stack with use of the source electrode layer and the drain electrode layer as a mask; and
forming a gate electrode layer overlapping the oxide semiconductor stack with the gate insulating film interposed therebetween.

[Claim 5] 5. The method for manufacturing a semiconductor device according to claim 4,
wherein the third oxide semiconductor layer covers a side surface of the first oxide semiconductor layer and a side surface of the second oxide semiconductor layer.

[Claim 6] 6. The method for manufacturing a semiconductor device according to claim 4, further comprising a step of introducing dopant into the oxide semiconductor stack with use of the gate electrode layer as a mask.

[Claim 7] 7. The method for manufacturing a semiconductor device according to claim 4, further comprising steps of:
forming an interlayer insulating film over the gate electrode layer;
forming a contact hole in the interlayer insulating film so as to reach at least one of the source electrode layer and the drain electrode layer; and
forming a wiring layer over the interlayer insulating film, wherein the wiring layer is connected to the at least one of the source electrode layer and the drain electrode layer through the contact hole.

[Claim 8] 8. A semiconductor device comprising:
an oxide semiconductor stack including a first oxide semiconductor layer and a second oxide semiconductor layer with an energy gap different from an energy gap of the first oxide semiconductor layer;
a source electrode layer and a drain electrode layer adjacent to the oxide semiconductor stack;
a gate insulating film adjacent to the oxide semiconductor stack; and
a gate electrode layer adjacent to the oxide semiconductor stack with the gate insulating film interposed therebetween.

[Claim 9] 9. The semiconductor device according to claim 8, wherein, in the oxide semiconductor stack, a region which does not overlap the source electrode layer nor the drain electrode layer has a higher oxygen concentration than a region which overlaps the source electrode layer or the drain electrode layer.

[Claim 10] 10. The semiconductor device according to claim 8, wherein a region which is in the oxide semiconductor stack and does not overlap with the gate electrode layer contains dopant.

[Claim 11] 11. The semiconductor device according to claim 8, further comprising:
an interlayer insulating film over the gate electrode layer, wherein the interlayer insulating film has a contact hole reaching at least one of the source electrode layer and the drain electrode layer; and
a wiring layer over the interlayer insulating film, wherein the wiring layer is connected to the at least one of the source electrode layer and the drain electrode layer through the contact hole.

[Claim 12] 12. The semiconductor device according to claim 8, wherein the semiconductor device is one selected from the group consisting of a table having a display portion, a television set, a computer, and a mobile phone.

[Claim 13] 13. A semiconductor device comprising:
an oxide semiconductor stack including a first oxide semiconductor layer, a second oxide semiconductor layer in contact with the first oxide semiconductor layer, and a third oxide semiconductor layer in contact with the second oxide semiconductor layer, wherein the second oxide semiconductor layer has a smaller energy gap than the first oxide semiconductor layer, and the third oxide semiconductor layer has a larger energy gap than the second oxide semiconductor layer;
a source electrode layer and a drain electrode layer adjacent to the oxide semiconductor stack;
a gate insulating film adjacent to the oxide semiconductor stack; and
a gate electrode layer adjacent to the oxide semiconductor stack with the gate insulating film interposed therebetween.

[Claim 14] 14. The semiconductor device according to claim 13, wherein, in the oxide semiconductor stack, a region which does not overlap the source electrode layer nor the drain electrode layer has a higher oxygen concentration than a region which overlaps the source electrode layer or the drain electrode layer.

[Claim 15] 15. The semiconductor device according to claim 13, wherein an electron affinity of the second oxide semiconductor layer is higher than electron affinities of the first oxide semiconductor layer and the third oxide semiconductor layer.

[Claim 16] 16. The semiconductor device according to claim 13, wherein a region which is in the oxide semiconductor stack and does not overlap with the gate electrode layer contains dopant.

[Claim 17] 17. The semiconductor device according to claim 13, further comprising:

an interlayer insulating film over the gate electrode layer, wherein the interlayer insulating film has a contact hole reaching at least one of the source electrode layer and the drain electrode layer; and

a wiring layer over the interlayer insulating film, wherein the wiring layer is connected to the at least one of the source electrode layer and the drain electrode layer through the contact hole.

[Claim 18] 18. The semiconductor device according to claim 13, wherein the semiconductor device is one selected from the group consisting of a table having a display portion, a television set, a computer, and a mobile phone.

CLAIMS

1. A semiconductor device comprising:

an oxide semiconductor stack including a first oxide semiconductor layer, a second oxide semiconductor layer in contact with a top surface of the first oxide semiconductor layer, and a third oxide semiconductor layer in contact with a top surface and a side surface of the second oxide semiconductor layer and in contact with a side surface of the first oxide semiconductor layer, wherein the second oxide semiconductor layer has a smaller energy gap than the first oxide semiconductor layer, and the third oxide semiconductor layer has a larger energy gap than the second oxide semiconductor layer;

a source electrode layer and a drain electrode layer adjacent to the oxide semiconductor stack;

a gate insulating film adjacent to the oxide semiconductor stack; and

a gate electrode layer adjacent to the oxide semiconductor stack with the gate insulating film interposed therebetween,

wherein, in the oxide semiconductor stack, a region which does not overlap the source electrode layer nor the drain electrode layer has a higher oxygen concentration than a region which overlaps the source electrode layer or the drain electrode layer.

2. The semiconductor device according to claim 1, wherein an electron affinity of the second oxide semiconductor layer is higher than electron affinities of the first oxide semiconductor layer and the third oxide semiconductor layer.

3. The semiconductor device according to claim 1, wherein a region which is in the oxide semiconductor stack and does not overlap with the gate electrode layer contains dopant.

4. The semiconductor device according to claim 1, further comprising:

an interlayer insulating film over the gate electrode layer, wherein the interlayer insulating film has a contact hole reaching at least one of the source electrode layer and the drain electrode layer; and

a wiring layer over the interlayer insulating film, wherein the wiring layer is connected to the at least one of the source electrode layer and the drain electrode layer through the contact hole.

5. The semiconductor device according to claim 1, wherein the semiconductor device is one selected from the group consisting of a table having a display portion, a television set, a computer, and a mobile phone.

6. A semiconductor device comprising:

an oxide semiconductor stack including a first oxide semiconductor layer, a second oxide semiconductor layer in contact with a top surface of the first oxide semiconductor layer, and a third oxide semiconductor layer in contact with a top surface and a side surface of the second oxide semiconductor layer and in contact with a side surface of the first oxide semiconductor layer, wherein the second oxide semiconductor layer has a smaller energy gap than the first oxide semiconductor layer, and the third oxide semiconductor layer has a larger energy gap than the second oxide semiconductor layer;

a source electrode layer and a drain electrode layer adjacent to the oxide semiconductor stack;

a gate insulating film over the oxide semiconductor stack; and

a gate electrode layer over the oxide semiconductor stack with the gate insulating film interposed therebetween,

wherein, in the oxide semiconductor stack, a region which does not overlap the source electrode layer nor the drain electrode layer has a higher oxygen concentration than a region which overlaps the source electrode layer or the drain electrode layer.

7. The semiconductor device according to claim 6, wherein an electron affinity of the second oxide semiconductor layer is higher than electron affinities of the first oxide semiconductor layer and the third oxide semiconductor layer.

8. The semiconductor device according to claim 6, wherein a region which is in the oxide semiconductor stack and does not overlap with the gate electrode layer contains dopant.

9. The semiconductor device according to claim 6, further comprising:

an interlayer insulating film over the gate electrode layer, wherein the interlayer insulating film has a contact hole reaching at least one of the source electrode layer and the drain electrode layer; and

a wiring layer over the interlayer insulating film, wherein the wiring layer is connected to the at least one of the source electrode layer and the drain electrode layer through the contact hole.

10. The semiconductor device according to claim 6, wherein the semiconductor device is one selected from the group consisting of a table having a display portion, a television set, a computer, and a mobile phone.