

CLAIMS

1. A method for manufacturing a semiconductor device, comprising the steps of:
forming a first transistor including a single crystal semiconductor as a channel;
forming a first insulating film over the first transistor;
forming an oxide semiconductor film over the first insulating film;
forming a first conductive film over the oxide semiconductor film;
forming an inorganic film over the first conductive film;
forming a first mask over the inorganic film;
forming a second mask including the inorganic film by processing the inorganic film using the first mask as a mask;
forming an opening in the first conductive film, the oxide semiconductor film, and the first insulating film using the second mask as a mask; and
forming a second conductive film which penetrates the first conductive film, the oxide semiconductor film, and the first insulating film in the opening,
wherein the first mask is a resist mask,
wherein the oxide semiconductor film and the first conductive film are included in a second transistor, and
wherein the second conductive film is electrically connected to the first transistor and the second transistor.
2. The method for manufacturing a semiconductor device according to claim 1, further comprising the step of:
polishing the second conductive film.
3. The method for manufacturing a semiconductor device according to claim 1, wherein a width of a bottom surface of the second conductive film is 5 nm or less.
4. The method for manufacturing a semiconductor device according to claim 1, wherein the first conductive film is in contact with a source region or a drain region of the first transistor.
5. The method for manufacturing a semiconductor device according to claim 1, wherein, assuming that a center of a top surface of a gate electrode of the first transistor is at an apex of an inverted square pyramid with a square and first to fourth isosceles triangles each having a vertex angle of 120° or less, a bottom surface of the oxide semiconductor film fits inside the square.

6. The method for manufacturing a semiconductor device according to claim 5,
 wherein the center of the top surface of the gate electrode of the first transistor and a
 center of a top surface of a gate electrode of the second transistor overlap with each other, and
 wherein the center of the top surface of the gate electrode of the first transistor and a
 center of a top surface of the oxide semiconductor film overlap with each other.

7. The method for manufacturing a semiconductor device according to claim 1, further
 comprising a capacitor between the first transistor and the second transistor.

8. A method for manufacturing a semiconductor device, comprising the steps of:
 forming a first transistor including a single crystal semiconductor as a channel;
 forming a first insulating film over the first transistor;
 forming an oxide semiconductor film over the first insulating film;
 forming a first conductive film over the oxide semiconductor film;
 forming an inorganic film over the first conductive film;
 forming a first mask over the inorganic film with an organic resin film therebetween;
 forming a second mask including the inorganic film by processing the inorganic film
 using the first mask as a mask;
 forming an opening in the first conductive film, the oxide semiconductor film, and the
 first insulating film using the second mask as a mask; and
 forming a second conductive film which penetrates the first conductive film, the oxide
 semiconductor film, and the first insulating film in the opening,
 wherein the first mask is a resist mask,
 wherein the oxide semiconductor film and the first conductive film are included in a
 second transistor, and
 wherein the second conductive film is electrically connected to the first transistor and
 the second transistor.

9. The method for manufacturing a semiconductor device according to claim 8, further
 comprising the step of: polishing the second conductive film.

10. The method for manufacturing a semiconductor device according to claim 8,
 wherein a width of a bottom surface of the second conductive film is 5 nm or less.

11. The method for manufacturing a semiconductor device according to claim 8,
 wherein the first conductive film is in contact with a source region or a drain region of the first
 transistor.

12. The method for manufacturing a semiconductor device according to claim 8, wherein, assuming that a center of a top surface of a gate electrode of the first transistor is at an apex of an inverted square pyramid with a square and first to fourth isosceles triangles each having a vertex angle of 120° or less, a bottom surface of the oxide semiconductor film fits inside the square.

13. The method for manufacturing a semiconductor device according to claim 12, wherein the center of the top surface of the gate electrode of the first transistor and a center of a top surface of a gate electrode of the second transistor overlap with each other, and wherein the center of the top surface of the gate electrode of the first transistor and a center of a top surface of the oxide semiconductor film overlap with each other.

14. The semiconductor device according to claim 8, further comprising a capacitor between the first transistor and the second transistor.

15. A method for manufacturing a semiconductor device, comprising the steps of:
forming a first transistor including a single crystal semiconductor as a channel;
forming a first insulating film over the first transistor;
forming an oxide semiconductor film over the first insulating film;
forming a first conductive film over the oxide semiconductor film;
forming an inorganic film over the first conductive film;
forming a first mask over the inorganic film;
forming a second mask including the inorganic film by processing the inorganic film using the first mask as a mask;
forming a third mask including the inorganic film and the first conductive film by processing the first conductive film using the second as a mask;
forming an opening in the oxide semiconductor film, and the first insulating film using the third mask as a mask; and
forming a second conductive film which penetrates the first conductive film, the oxide semiconductor film, and the first insulating film in the opening,
wherein the first mask is a resist mask,
wherein the oxide semiconductor film and the first conductive film are included in a second transistor, and
wherein the second conductive film is electrically connected to the first transistor and the second transistor.

16. The method for manufacturing a semiconductor device according to claim 15, wherein the first mask is formed over the inorganic film with an organic resin film.

17. The method for manufacturing a semiconductor device according to claim 15, further comprising the step of:
polishing the second conductive film.

18. The method for manufacturing a semiconductor device according to claim 15, wherein a width of a bottom surface of the second conductive film is 5 nm or less.

19. The method for manufacturing a semiconductor device according to claim 15, wherein the first conductive film is in contact with a source region or a drain region of the first transistor.

20. The method for manufacturing a semiconductor device according to claim 15, wherein, assuming that a center of a top surface of a gate electrode of the first transistor is at an apex of an inverted square pyramid with a square and first to fourth isosceles triangles each having a vertex angle of 120° or less, a bottom surface of the oxide semiconductor film fits inside the square.

21. The method for manufacturing a semiconductor device according to claim 20,
wherein the center of the top surface of the gate electrode of the first transistor and a center of a top surface of a gate electrode of the second transistor overlap with each other, and
wherein the center of the top surface of the gate electrode of the first transistor and a center of a top surface of the oxide semiconductor film overlap with each other.