Claims

[Claim 1] 1. A method for manufacturing an oxide semiconductor film, comprising the steps of:
forming an oxide semiconductor film containing an oxide of at least one of indium and zinc, so as to be in contact with an insulating metal oxide film; and
heating the oxide semiconductor film by irradiation with an energy beam, so that the oxide semiconductor film includes a crystalline region.

[Claim 2] 2. The method for manufacturing an oxide semiconductor film, according to claim 1, wherein the insulating metal oxide film has a melting point higher than a melting point of the oxide of at least one of indium and zinc.

[Claim 3] 3. The method for manufacturing an oxide semiconductor film, according to claim 1, wherein the crystalline region exists in a region of 2 nm or less from an interface between the insulating metal oxide film and the oxide semiconductor film.

[Claim 4] 4. The method for manufacturing an oxide semiconductor film, according to claim 1, wherein an aluminum oxide film is formed as the insulating metal oxide film.

[Claim 5] 5. The method for manufacturing an oxide semiconductor film, according to claim 1, wherein an yttria-stabilized zirconia film is formed as the insulating metal oxide film.

[Claim 6] 6. The method for manufacturing an oxide semiconductor film, according to claim 1, wherein the energy beam is a laser beam having energy higher than a band gap of the oxide semiconductor film.

[Claim 7] 7. The method for manufacturing an oxide semiconductor film, according to claim 1, wherein the crystalline region is a crystalline region with c-axis alignment.

[Claim 8] 8. The method for manufacturing an oxide semiconductor film, according to claim 1, wherein the oxide semiconductor film contains indium, zinc and an element selected from gallium, zirconium, tin, gadolinium, and cerium.

[Claim 9] 9. A method for manufacturing a semiconductor device, comprising the steps of:
forming an insulating metal oxide film;
forming an oxide semiconductor film containing an oxide of at least

one of indium and zinc, so as to be in contact with the insulating metal oxide film;
irradiating the oxide semiconductor film with an energy beam, so that the oxide semiconductor film includes a crystalline region; and
forming a transistor in which the crystalline region is used as a channel formation region.

[Claim 10] 10. The method for manufacturing a semiconductor device, according to claim 9, wherein the insulating metal oxide film has a melting point higher than a melting point of the oxide of at least one of indium and zinc.

[Claim 11] 11. The method for manufacturing a semiconductor device, according to claim 9, wherein the crystalline region exists in a region of 2 nm or less from an interface between the insulating metal oxide film and the oxide semiconductor film.

[Claim 12] 12. The method for manufacturing a semiconductor device, according to claim 9, wherein an aluminum oxide film is formed as the insulating metal oxide film.

[Claim 13] 13. The method for manufacturing a semiconductor device, according to claim 9, wherein an yttria-stabilized zirconia film is formed as the insulating metal oxide film.

[Claim 14] 14. The method for manufacturing a semiconductor device, according to claim 9, wherein the energy beam is a laser beam having energy higher than a band gap of the oxide semiconductor film.

[Claim 15] 15. The method for manufacturing a semiconductor device, according to claim 9, wherein the crystalline region is a crystalline region with c-axis alignment.

[Claim 16] 16. The method for manufacturing a semiconductor device, according to claim 9, further comprising the step of: forming a gate electrode before forming the insulating metal oxide film.

[Claim 17] 17. The method for manufacturing a semiconductor device, according to claim 9, further comprising the steps of:
forming a gate insulating film over the oxide semiconductor film including the crystalline region; and
forming a gate electrode over the gate insulating film.

[Claim 18] 18. The method for manufacturing a semiconductor device, according to claim 9, wherein the oxide semiconductor film contains indium, zinc and an element selected from gallium, zirconium, tin, gadolinium, and cerium.

[Claim 19] 19. A semiconductor device comprising:
an insulating metal oxide film; and
an oxide semiconductor film which is in contact with the insulating metal oxide film, contains an oxide of at least one of indium and zinc, and includes a crystalline region with c-axis alignment,
wherein the crystalline region in the oxide semiconductor film also exists in a vicinity of an interface with the insulating metal oxide film.

[Claim 20] 20. The semiconductor device according to claim 19,
wherein the insulating metal oxide film has a melting point higher than a melting point of the oxide of at least one of indium and zinc.

[Claim 21] 21. The semiconductor device according to claim 19, wherein the crystalline region exists in a region of 2 nm or less from the interface between the insulating metal oxide film and the oxide semiconductor film.

[Claim 22] 22. The semiconductor device according to claim 19, wherein the insulating metal oxide film is an aluminum oxide film.

[Claim 23] 23. The semiconductor device according to claim 19, wherein the insulating metal oxide film is an yttria-stabilized zirconia film.

[Claim 24] 24. The semiconductor device according to claim 19, wherein the oxide semiconductor film contains indium, zinc, and an element selected from gallium, zirconium, tin, gadolinium, and cerium.

[Claim 25] 25. The semiconductor device according to claim 19, further comprising: a gate electrode under the insulating metal oxide film.

[Claim 26] 26. The semiconductor device according to claim 19, further comprising:
a gate insulating film over the oxide semiconductor film; and
a gate electrode over the gate insulating film.

CLAIMS

1. A method for manufacturing an oxide semiconductor film, comprising the steps of:

forming a gallium oxide film;

forming a first oxide semiconductor film on and in contact with the gallium oxide film; and

heating the first oxide semiconductor film by irradiation with a laser beam, so that crystallinity of a region of the first oxide semiconductor film at an interface between the gallium oxide film and the oxide semiconductor film is increased,

wherein the first oxide semiconductor film comprises gallium, indium and zinc, and

wherein the region of the first oxide semiconductor film is a crystalline region with c-axis alignment.

2. The method for manufacturing an oxide semiconductor film, according to claim 1, wherein the region of the first oxide semiconductor film is in a region of 2 nm or less from the interface between the gallium oxide film and the oxide semiconductor film.

3. The method for manufacturing an oxide semiconductor film, according to claim 1, wherein the laser beam has energy higher than a band gap of the oxide semiconductor film.

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

forming a gallium oxide film;

forming an oxide semiconductor film on and in contact with the gallium oxide film;

irradiating the oxide semiconductor film with a laser beam, so that crystallinity of a region of the oxide semiconductor film at an interface between the gallium oxide film and the oxide semiconductor film is increased;

forming a gate insulating film over the oxide semiconductor film; and

forming a gate electrode over the gate insulating film,

wherein the oxide semiconductor film contains gallium, indium and zinc, and

wherein the region of the oxide semiconductor film is a crystalline region with c-axis alignment.

5. The method for manufacturing a semiconductor device, according to claim 4, wherein the region of the oxide semiconductor film is in a region of 2 nm or less from an interface between the gallium oxide film and the oxide semiconductor film.

6. The method for manufacturing a semiconductor device, according to claim 4, wherein the laser beam has energy higher than a band gap of the oxide semiconductor film.

7. A method for manufacturing an oxide semiconductor film, comprising the steps of:

forming a gallium oxide film;

forming a first oxide semiconductor film on and in contact with a surface of the gallium oxide film, an average surface roughness of the surface of the gallium oxide film is 1 nm or less; and

heating the first oxide semiconductor film by irradiation with a laser beam, so that crystallinity of a region of the first oxide semiconductor film at an interface between the gallium oxide film and the oxide semiconductor film is increased,

wherein the first oxide semiconductor film comprises gallium, indium and zinc, and

wherein the region of the first oxide semiconductor film is a crystalline region with c-axis alignment.

8. The method for manufacturing an oxide semiconductor film, according to claim 7, wherein the region of the first oxide semiconductor film is in a region of 2 nm or less from the interface between the gallium oxide film and the oxide semiconductor film.

9. The method for manufacturing an oxide semiconductor film, according to claim 7, wherein the laser beam has energy higher than a band gap of the oxide semiconductor film.

10. The method for manufacturing an oxide semiconductor film, according to claim 7, further comprising a step of polishing an upper surface of the gallium oxide film to form the surface having the average surface roughness 1 nm or less.