CLAIMS

1. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating an ion species into the semiconductor substrate, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature; and

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at the damaged region of the semiconductor substrate is formed over the base substrate with the bonding layer therebetween.

2. The method of manufacturing a semiconductor device according to claim 1, wherein the ion species is irradiated by an ion doping apparatus.

3. The method of manufacturing a semiconductor device according to claim 1, wherein any one of a hydrogen gas and a helium gas is used as a source gas of the ion species.

4. The method of manufacturing a semiconductor device according to claim 1, wherein the first temperature is lower than the second temperature, and wherein a furnace is used as the heating apparatus.

5. The method of manufacturing a semiconductor device according to claim 1, wherein the second temperature is 400 °C or higher and 700 °C or lower.

6. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating an ion species into the semiconductor substrate, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature;

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at the damaged region of the semiconductor substrate is formed over the base substrate with the bonding layer therebetween;

irradiating a Group 18 element into a portion of the semiconductor layer to form a gettering site; and

heating the semiconductor layer at a third temperature, wherein a metal element in the semiconductor layer is diffused into the gettering site.

7. The method of manufacturing a semiconductor device according to claim 6, wherein the ion species is irradiated by an ion doping apparatus.

8. The method of manufacturing a semiconductor device according to claim 6, wherein any one of a hydrogen gas and a helium gas is used as a source gas of the ion species.

9. The method of manufacturing a semiconductor device according to claim 6, wherein the first temperature is lower than the second temperature, and wherein a furnace is used as the heating apparatus.

10. The method of manufacturing a semiconductor device according to claim 6, wherein the second temperature is 400 °C or higher and 700 °C or lower.

11. The method of manufacturing a semiconductor device according to claim 6, wherein the third temperature is 500 °C or higher and 700 °C or lower.

12. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating an ion species into the semiconductor substrate, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature;

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at the damaged region of the semiconductor substrate is formed over the base substrate with the bonding layer therebetween;

etching a part of the semiconductor layer to form a semiconductor island;

forming an insulating film over the semiconductor island;

forming a gate electrode over the semiconductor island with the insulating film therebetween; and

forming a source electrode and a drain electrode over the insulating film, wherein the source electrode and the drain electrode is connected to a source portion and a drain portion of the semiconductor layer.

13. The method of manufacturing a semiconductor device according to claim 12, wherein the ion species is irradiated by an ion doping apparatus.

14. The method of manufacturing a semiconductor device according to claim 12, wherein any one of a hydrogen gas and a helium gas is used as a source gas of the ion species.

15. The method of manufacturing a semiconductor device according to claim 12, wherein the first temperature is lower than the second temperature, and wherein a furnace is used as the heating apparatus.

16. The method of manufacturing a semiconductor device according to claim 12, wherein the second temperature is 400°C or higher and 700 °C or lower.

17. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating an ion species into the semiconductor substrate, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature;

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at

the damaged region of the semiconductor substrate is formed over the base substrate with the bonding layer therebetween;

etching a part of the semiconductor layer to form a semiconductor island;

forming an insulating film over the semiconductor island;

forming a gate electrode over the semiconductor island with the insulating film therebetween;

irradiating a Group 18 element into a region of the semiconductor island to form a gettering site, wherein the region does not overlap with the gate electrode;

heating the semiconductor island at a third temperature, wherein a metal element in the semiconductor island is diffused into the gettering site; and

forming a source electrode and a drain electrode over the insulating film, wherein the source electrode and the drain electrode is connected to a source portion and a drain portion of the semiconductor layer.

18. The method of manufacturing a semiconductor device according to claim 17, wherein the ion species is irradiated by an ion doping apparatus.

19. The method of manufacturing a semiconductor device according to claim 17, wherein any one of a hydrogen gas and a helium gas is used as a source gas of the ion species.

20. The method of manufacturing a semiconductor device according to claim 17, wherein the first temperature is lower than the second temperature, and wherein a furnace is used as the heating apparatus.

21. The method of manufacturing a semiconductor device according to claim 17, wherein the second temperature is 400 °C or higher and 700 °C or lower.

22. The method of manufacturing a semiconductor device according to claim 17, wherein the third temperature is 500 °C or higher and 700 °C or lower.

23. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating an ion species into the semiconductor substrate, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature;

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at the damaged region of the semiconductor substrate is formed over the base substrate

with the bonding layer therebetween;

etching a part of the semiconductor layer to form a semiconductor island;

forming an insulating film over the semiconductor island;

forming a gate electrode over the semiconductor island with the insulating film therebetween;

irradiating an impurity element serving as a donor or an acceptor into a region of the semiconductor island, wherein the region does not overlap with the gate electrode;

irradiating a Group 18 element into the region to form a gettering site;

heating the semiconductor island at a third temperature, wherein a metal element in the semiconductor island is diffused into the gettering site; and

forming a source electrode and a drain electrode over the insulating film, wherein the source electrode and the drain electrode is connected to a source portion and a drain portion of the semiconductor layer.

24. The method of manufacturing a semiconductor device according to claim 23, wherein the ion species is irradiated by an ion doping apparatus.

25. The method of manufacturing a semiconductor device according to claim 23, wherein any one of a hydrogen gas and a helium gas is used as a source gas of the ion species.

26. The method of manufacturing a semiconductor device according to claim 23, wherein the first temperature is lower than the second temperature, and wherein a furnace is used as the heating apparatus.

27. The method of manufacturing a semiconductor device according to claim 23, wherein the second temperature is 400 °C or higher and 700 °C or lower.

28. The method of manufacturing a semiconductor device according to claim 23, wherein the third temperature is 500 °C or higher and 700 °C or lower.

29. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating an ion species into the semiconductor substrate, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature;

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at the damaged region of the semiconductor substrate is formed over the base substrate

with the bonding layer therebetween;

etching a part of the semiconductor layer to form a semiconductor island;

forming an insulating film over the semiconductor island;

forming a gate electrode over the semiconductor island with the insulating film therebetween;

irradiating a Group 18 element into a region of the semiconductor island to form a gettering site, wherein the region does not overlap with the gate electrode;

irradiating an impurity element serving as a donor or an acceptor into the region;

heating the semiconductor island at a third temperature, wherein a metal element in the semiconductor island is diffused into the gettering site; and

forming a source electrode and a drain electrode over the insulating film, wherein the source electrode and the drain electrode is connected to a source portion and a drain portion of the semiconductor layer.

30. The method of manufacturing a semiconductor device according to claim 29, wherein the ion species is irradiated by an ion doping apparatus.

31. The method of manufacturing a semiconductor device according to claim 29, wherein any one of a hydrogen gas and a helium gas is used as a source gas of the ion species.

32. The method of manufacturing a semiconductor device according to claim 29, wherein the first temperature is lower than the second temperature, and wherein a furnace is used as the heating apparatus.

33. The method of manufacturing a semiconductor device according to claim 29, wherein the second temperature is 400 °C or higher and 700 °C or lower.

34. The method of manufacturing a semiconductor device according to claim 29, wherein the third temperature is 500 °C or higher and 700 °C or lower.

35. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating an ion species into the semiconductor substrate, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature;

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at the damaged region of the semiconductor substrate is formed over the base substrate

with the bonding layer therebetween;

etching a part of the semiconductor layer to form a semiconductor island;

forming an insulating film over the semiconductor island;

forming a gate electrode over the semiconductor island with the insulating film therebetween;

irradiating an impurity element serving as a donor or an acceptor into a first region of the semiconductor island, wherein the first region does not overlap with the gate electrode;

irradiating a Group 18 element into a second region of the semiconductor island to form a gettering site, wherein the second region is a portion of the first region;

heating the semiconductor island at a third temperature, wherein a metal element in the semiconductor island is diffused into the gettering site; and

forming a source electrode and a drain electrode over the insulating film, wherein the source electrode and the drain electrode is connected to a source portion and a drain portion of the semiconductor layer.

36. The method of manufacturing a semiconductor device according to claim 35, wherein the ion species is irradiated by an ion doping apparatus.

37. The method of manufacturing a semiconductor device according to claim 35, wherein any one of a hydrogen gas and a helium gas is used as a source gas of the ion species.

38. The method of manufacturing a semiconductor device according to claim 35, wherein the first temperature is lower than the second temperature, and

wherein a furnace is used as the heating apparatus.

39. The method of manufacturing a semiconductor device according to claim 35, wherein the second temperature is 400 °C or higher and 700 °C or lower.

40. The method of manufacturing a semiconductor device according to claim 35, wherein the third temperature is 500 °C or higher and 700 °C or lower.

41. A method of manufacturing a semiconductor device, comprising:

forming a damaged region in a semiconductor substrate by irradiating the semiconductor substrate with an ion species included in plasma which is generated by exciting a source gas using a doping apparatus;

forming a bonding layer over at least one of a base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

dividing the semiconductor substrate at the damaged region by heating the semiconductor substrate, thereby forming a first semiconductor layer separated from the semiconductor substrate, over the base substrate by a rapid thermal annealing apparatus;

etching a part of the first semiconductor layer to form a second semiconductor layer;

forming an insulating film over the second semiconductor layer;

forming a gate electrode over the second semiconductor layer with the insulating film interposed therebetween;

etching a portion of the insulating film that does not overlap with the gate electrode;

forming an impurity region imparting n-type or p-type conductivity, which includes an impurity element serving as a donor or an acceptor, in a region of the second semiconductor layer that does not overlap with the gate electrode and forming a gettering site region including a Group 18 element next to the impurity region; and

performing heat treatment, thereby gettering a metal element in the second semiconductor layer into the gettering site region.

42. The method of manufacturing a semiconductor device according to claim 41,

wherein the ion species is irradiated with a dosage in a range $1x10^{16}$ ions/cm^2 to $6x10^{16}$ ions/cm^2.

What is claimed is:

1. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating the semiconductor substrate with ions, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature; and

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at the damaged region of the semiconductor substrate is formed over the base substrate with the bonding layer therebetween,

wherein the ions include H^+ ions, H_2^+ ions, and H_3^+ ions, and

wherein the H_3^+ ions occupy 70% or more of the total amount of the H^+ ions, the $H_2^{\pm}$ ions, and the H_3^+ ions.

2. The method of manufacturing a semiconductor device according to claim 1, wherein the irradiating with the ions is performed by an ion doping apparatus.

3. The method of manufacturing a semiconductor device according to claim 1,

wherein the first temperature is lower than the second temperature, and

wherein a furnace is used as the heating apparatus.

4. The method of manufacturing a semiconductor device according to claim 1, wherein the second temperature is 400 °C or higher and 700 °C or lower.

5. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating the semiconductor substrate with ions, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature;

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at the damaged region of the semiconductor substrate is formed over the base substrate with the bonding layer therebetween;

irradiating a portion of the semiconductor layer with a Group 18 element to form a gettering site; and

heating the semiconductor layer at a third temperature, whereby a metal element in the semiconductor layer is diffused into the gettering site,

wherein the ions include H^+ ions, H_2^+ ions, and H_3^+ ions, and

wherein the H_3^+ ions occupy 70% or more of the total amount of the H^+ ions, the $H_2^{\pm}$ ions, and the H_3^+ ions.

6. The method of manufacturing a semiconductor device according to claim 5, wherein the irradiating with the ions is performed by an ion doping apparatus.

7. The method of manufacturing a semiconductor device according to claim 5,

wherein the first temperature is lower than the second temperature, and

wherein a furnace is used as the heating apparatus.

8. The method of manufacturing a semiconductor device according to claim 5, wherein the second temperature is 400 °C or higher and 700 °C or lower.

9. The method of manufacturing a semiconductor device according to claim 5, wherein the third temperature is 500 °C or higher and 700 °C or lower.

10. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating the semiconductor substrate with ions, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature;

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at the damaged region of the semiconductor substrate is formed over the base substrate with the bonding layer therebetween;

etching a part of the semiconductor layer to form a semiconductor island;

forming an insulating film over the semiconductor island;

forming a gate electrode over the semiconductor island with the insulating film therebetween; and

forming a source electrode and a drain electrode over the insulating film,

wherein the ions include H^+ ions, H_2^+ ions, and H_3^+ ions, and

wherein the H_3^+ ions occupy 70% or more of the total amount of the H^+ ions, the $H_2^{\pm}$ ions, and the H_3^+ ions.

11. The method of manufacturing a semiconductor device according to claim 10, wherein the irradiating with the ions is performed by an ion doping apparatus.

12. The method of manufacturing a semiconductor device according to claim 10,

wherein the first temperature is lower than the second temperature, and

wherein a furnace is used as the heating apparatus.

13. The method of manufacturing a semiconductor device according to claim 10, wherein the second temperature is 400 °C or higher and 700 °C or lower.

14. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating the semiconductor substrate with ions, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature;

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at the damaged region of the semiconductor substrate is formed over the base substrate with the bonding layer therebetween;

etching a part of the semiconductor layer to form a semiconductor island;

forming an insulating film over the semiconductor island;

forming a gate electrode over the semiconductor island with the insulating film therebetween;

irradiating a region of the semiconductor island with a Group 18 element to form a gettering site, wherein the region does not overlap with the gate electrode;

heating the semiconductor island at a third temperature, whereby a metal element in the semiconductor island is diffused into the gettering site; and

forming a source electrode and a drain electrode over the insulating film,

wherein the ions include H^+ ions, H_2^+ ions, and H_3^+ ions, and

wherein the H_3^+ ions occupy 70% or more of the total amount of the H^+ ions, the H_2^+ ions, and the H_3^+ ions.

15. The method of manufacturing a semiconductor device according to claim 14, wherein the irradiating with the ions is performed by an ion doping apparatus.

16. The method of manufacturing a semiconductor device according to claim 14,

wherein the first temperature is lower than the second temperature, and

wherein a furnace is used as the heating apparatus.

17. The method of manufacturing a semiconductor device according to claim 14, wherein the second temperature is 400 °C or higher and 700 °C or lower.

18. The method of manufacturing a semiconductor device according to claim 14, wherein the third temperature is 500 °C or higher and 700 °C or lower.

19. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating the semiconductor substrate with ions, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature;

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at the damaged region of the semiconductor substrate is formed over the base substrate with the bonding layer therebetween;

etching a part of the semiconductor layer to form a semiconductor island;

forming an insulating film over the semiconductor island;

forming a gate electrode over the semiconductor island with the insulating film therebetween;

irradiating an impurity element serving as a donor or an acceptor into a region of the semiconductor island, wherein the region does not overlap with the gate electrode;

irradiating the region with a Group 18 element to form a gettering site;

heating the semiconductor island at a third temperature, whereby a metal element in the semiconductor island is diffused into the gettering site; and

forming a source electrode and a drain electrode over the insulating film,

wherein the ions include H^+ ions, H_2^+ ions, and H_3^+ ions, and

wherein the H_3^+ ions occupy 70% or more of the total amount of the H^+ ions, the $H_2^{\pm}$ ions, and the H_3^+ ions.

20. The method of manufacturing a semiconductor device according to claim 19, wherein the irradiating with the ions is performed by an ion doping apparatus.

21. The method of manufacturing a semiconductor device according to claim 19,

wherein the first temperature is lower than the second temperature, and

wherein a furnace is used as the heating apparatus.

22. The method of manufacturing a semiconductor device according to claim 19, wherein the second temperature is 400 °C or higher and 700 °C or lower.

23. The method of manufacturing a semiconductor device according to claim 19, wherein the third temperature is 500 °C or higher and 700 °C or lower.

24. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating the semiconductor substrate with ions, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature;

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at the damaged region of the semiconductor substrate is formed over the base substrate with the bonding layer therebetween;

etching a part of the semiconductor layer to form a semiconductor island;

forming an insulating film over the semiconductor island;

forming a gate electrode over the semiconductor island with the insulating film therebetween;

irradiating a region of the semiconductor island with a Group 18 element to form a gettering site, wherein the region does not overlap with the gate electrode;

irradiating an impurity element serving as a donor or an acceptor into the region;

heating the semiconductor island at a third temperature, whereby a metal element in the semiconductor island is diffused into the gettering site; and

forming a source electrode and a drain electrode over the insulating film,

wherein the ions include H^+ ions, H_2^+ ions, and H_3^+ ions, and

wherein the H_3^+ ions occupy 70% or more of the total amount of the H^+ ions, the $H_2^{\pm}$ ions, and the H_3^+ ions.

25. The method of manufacturing a semiconductor device according to claim 24, wherein the irradiating with the ions is performed by an ion doping apparatus.

26. The method of manufacturing a semiconductor device according to claim 24,

wherein the first temperature is lower than the second temperature, and

wherein a furnace is used as the heating apparatus.

27. The method of manufacturing a semiconductor device according to claim 24, wherein the second temperature is 400 °C or higher and 700 °C or lower.

28. The method of manufacturing a semiconductor device according to claim 24, wherein the third temperature is 500 °C or higher and 700 °C or lower.

29. A method of manufacturing a semiconductor device:

preparing a base substrate and a semiconductor substrate;

irradiating the semiconductor substrate with ions, whereby a damaged region is formed in the semiconductor substrate;

forming a bonding layer over at least one of the base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

heating the semiconductor substrate and the base substrate by a heating apparatus at a first temperature;

heating the semiconductor substrate and the base substrate by a rapid thermal annealing apparatus at a second temperature, so that a semiconductor layer separated at the damaged region of the semiconductor substrate is formed over the base substrate with the bonding layer therebetween;

etching a part of the semiconductor layer to form a semiconductor island;

forming an insulating film over the semiconductor island;

forming a gate electrode over the semiconductor island with the insulating film therebetween;

irradiating an impurity element serving as a donor or an acceptor into a first region of the semiconductor island, wherein the first region does not overlap with the gate electrode;

irradiating a second region of the semiconductor island with a Group 18 element to form a gettering site, wherein the second region is a portion of the first region;

heating the semiconductor island at a third temperature, wherein a metal element in the semiconductor island is diffused into the gettering site; and

forming a source electrode and a drain electrode over the insulating film,

wherein the ions include H^+ ions, H_2^+ ions, and H_3^+ ions, and

wherein the H_3^+ ions occupy 70% or more of the total amount of the H^+ ions, the $H_2^{\pm}$ ions, and the H_3^+ ions.

30. The method of manufacturing a semiconductor device according to claim 29, wherein the irradiating with the ions is performed by an ion doping apparatus.

31. The method of manufacturing a semiconductor device according to claim 29,

wherein the first temperature is lower than the second temperature, and

wherein a furnace is used as the heating apparatus.

32. The method of manufacturing a semiconductor device according to claim 29, wherein the second temperature is 400 °C or higher and 700 °C or lower.

33. The method of manufacturing a semiconductor device according to claim 29, wherein the third temperature is 500 °C or higher and 700 °C or lower.

34. A method of manufacturing a semiconductor device, comprising:

forming a damaged region in a semiconductor substrate by irradiating the semiconductor substrate with ions included in plasma which is generated by exciting a source gas using a doping apparatus;

forming a bonding layer over at least one of a base substrate and the semiconductor substrate;

attaching the base substrate and the semiconductor substrate to each other with the bonding layer interposed therebetween;

dividing the semiconductor substrate at the damaged region by heating the semiconductor substrate, thereby forming a first semiconductor layer separated from the semiconductor substrate, over the base substrate by a rapid thermal annealing apparatus;

etching a part of the first semiconductor layer to form a second semiconductor layer;

forming an insulating film over the second semiconductor layer;

forming a gate electrode over the second semiconductor layer with the insulating film interposed therebetween;

etching a portion of the insulating film that does not overlap with the gate electrode;

forming an impurity region imparting n-type or p-type conductivity, which includes an impurity element serving as a donor or an acceptor, in a region of the second semiconductor layer that does not overlap with the gate electrode and forming a gettering site region including a Group 18 element next to the impurity region; and

performing heat treatment, thereby gettering a metal element in the second semiconductor layer into the gettering site region,

wherein the ions include H^+ ions, H_2^+ ions, and H_3^+ ions, and

wherein the H_3^+ ions occupy 70% or more of the total amount of the H^+ ions, the $H_2^{\pm}$ ions, and the H_3^+ ions.

35. The method of manufacturing a semiconductor device according to claim 34, wherein the ions are irradiated with a dosage in a range 1×10^{16} ions/cm^2 to 6×10^{16} ions/cm^2.