WHAT IS CLAIMED IS:

1. A method for manufacturing an SOI substrate, comprising the steps of:

forming an SOI structure including a base substrate, a bonding layer including oxygen provided over the base substrate, and a single crystal semiconductor layer provided over the bonding layer including oxygen; and

melting a part of the single crystal semiconductor layer by irradiation with a laser beam while the base substrate is heated at a temperature of higher than or equal to 500 °C and lower than a melting point of the base substrate.

2. The method for manufacturing an SOI substrate according to claim 1, wherein an irradiation atmosphere of the laser beam is a reduced-pressure atmosphere.

3. The method for manufacturing an SOI substrate according to claim 1, wherein an irradiation atmosphere of the laser beam includes a reducing gas.

4. The method for manufacturing an SOI substrate according to claim 1, wherein an irradiation atmosphere of the laser beam includes a hydrogen fluoride gas.

5. The method for manufacturing an SOI substrate according to claim 4, wherein the SOI structure is exposed to an atmosphere including the hydrogen fluoride gas after formation of the SOI structure and before irradiation with the laser beam.

6. The method for manufacturing an SOI substrate according to claim 1, wherein the base substrate is heated by one of light irradiation and induction heating when the laser beam is emitted.

7. The method for manufacturing an SOI substrate according to claim 1, wherein the single crystal semiconductor layer is formed in such a manner that an embrittlement region is formed in a single crystal semiconductor substrate by an ion doping method in which mass separation is not performed and then the embrittlement region is subjected to heat treatment to separate a portion of the single crystal

semiconductor substrate.

8. The method for manufacturing a semiconductor device, wherein a semiconductor element is formed using the SOI substrate according to claim 1.

9. A method for manufacturing an SOI substrate, comprising the steps of:

forming an SOI structure including a base substrate, a bonding layer including oxygen provided over the base substrate, and a single crystal semiconductor layer provided over the bonding layer including oxygen; and

melting a part of the single crystal semiconductor layer by irradiation with a laser beam while the base substrate is heated at a temperature of higher than or equal to 500 °C and lower than a melting point of the base substrate,

wherein the part of the single crystal semiconductor layer is not in contact with the bonding layer.

10. The method for manufacturing an SOI substrate according to claim 9, wherein an irradiation atmosphere of the laser beam is a reduced-pressure atmosphere.

11. The method for manufacturing an SOI substrate according to claim 9, wherein an irradiation atmosphere of the laser beam includes a reducing gas.

12. The method for manufacturing an SOI substrate according to claim 9, wherein an irradiation atmosphere of the laser beam includes a hydrogen fluoride gas.

13. The method for manufacturing an SOI substrate according to claim 12, wherein the SOI structure is exposed to an atmosphere including the hydrogen fluoride gas after formation of the SOI structure and before irradiation with the laser beam.

14. The method for manufacturing an SOI substrate according to claim 9, wherein the base substrate is heated by one of light irradiation and induction heating when the laser beam is emitted.

15. The method for manufacturing an SOI substrate according to claim 9, wherein the single crystal semiconductor layer is formed in such a manner that an embrittlement region is formed in a single crystal semiconductor substrate by an ion doping method in which mass separation is not performed and then the embrittlement region is subjected to heat treatment to separate a portion of the single crystal semiconductor substrate.

16. The method for manufacturing a semiconductor device, wherein a semiconductor element is formed using the SOI substrate according to claim 9.

17. A method for manufacturing an SOI substrate, comprising the steps of:

forming an SOI structure including a base substrate, a bonding layer including oxygen provided over the base substrate, and a single crystal semiconductor layer provided over the bonding layer including oxygen;

etching back the single crystal semiconductor layer; and

melting a part of the single crystal semiconductor layer by irradiation with a laser beam while the base substrate is heated at a temperature of higher than or equal to 500 °C and lower than a melting point of the base substrate,

wherein after the etching back step and before the melting step, an average value of a thickness of the single crystal semiconductor layer is greater than or equal to 100 nm.

18. The method for manufacturing an SOI substrate according to claim 17, wherein an irradiation atmosphere of the laser beam is a reduced-pressure atmosphere.

19. The method for manufacturing an SOI substrate according to claim 17, wherein an irradiation atmosphere of the laser beam includes a reducing gas.

20. The method for manufacturing an SOI substrate according to claim 17, wherein an irradiation atmosphere of the laser beam includes a hydrogen fluoride gas.

21. The method for manufacturing an SOI substrate according to claim 20,

wherein the SOI structure is exposed to an atmosphere including the hydrogen fluoride gas after formation of the SOI structure and before irradiation with the laser beam.

22. The method for manufacturing an SOI substrate according to claim 17, wherein the base substrate is heated by one of light irradiation and induction heating when the laser beam is emitted.

23. The method for manufacturing an SOI substrate according to claim 17, wherein the single crystal semiconductor layer is formed in such a manner that an embrittlement region is formed in a single crystal semiconductor substrate by an ion doping method in which mass separation is not performed and then the embrittlement region is subjected to heat treatment to separate a portion of the single crystal semiconductor substrate.

24. The method for manufacturing a semiconductor device, wherein a semiconductor element is formed using the SOI substrate according to claim 17.

WHAT IS CLAIMED IS:

1. A method for manufacturing an SOI substrate, comprising the steps of:

forming an SOI structure including a base substrate, a bonding layer including oxygen over the base substrate, and a single crystal semiconductor layer over the bonding layer including oxygen; and

melting a part of the single crystal semiconductor layer by irradiation with a laser beam while the base substrate is heated at a temperature of higher than or equal to 500 °C and lower than a melting point of the base substrate,

wherein an irradiation atmosphere of the laser beam includes a reducing gas.

2. The method for manufacturing an SOI substrate according to claim 1, wherein an irradiation atmosphere of the laser beam is a reduced-pressure atmosphere.

3. The method for manufacturing an SOI substrate according to claim 1, wherein an irradiation atmosphere of the laser beam includes a hydrogen fluoride gas.

4. The method for manufacturing an SOI substrate according to claim 3, wherein the SOI structure is exposed to an atmosphere including the hydrogen fluoride gas after formation of the SOI structure and before irradiation with the laser beam.

5. The method for manufacturing an SOI substrate according to claim 1, wherein the base substrate is heated by one of light irradiation and induction heating when the laser beam is emitted.

6. The method for manufacturing an SOI substrate according to claim 1, wherein the single crystal semiconductor layer is formed in such a manner that an embrittlement region is formed in a single crystal semiconductor substrate by an ion doping method in which mass separation is not performed and then the embrittlement region is subjected to heat treatment to separate a portion of the single crystal semiconductor substrate.

7. The method for manufacturing a semiconductor device, wherein a semiconductor element is formed using the SOI substrate according to claim 1.

8. A method for manufacturing an SOI substrate, comprising the steps of:

forming an SOI structure including a base substrate, a bonding layer including oxygen over the base substrate, and a single crystal semiconductor layer over the bonding layer including oxygen; and

melting a part of the single crystal semiconductor layer by irradiation with a laser beam while the base substrate is heated at a temperature of higher than or equal to 500 °C and lower than a melting point of the base substrate,

wherein an irradiation atmosphere of the laser beam includes a reducing gas,

wherein the part of the single crystal semiconductor layer is not in contact with the bonding layer.

9. The method for manufacturing an SOI substrate according to claim 8, wherein an irradiation atmosphere of the laser beam is a reduced-pressure atmosphere.

10. The method for manufacturing an SOI substrate according to claim 8, wherein an irradiation atmosphere of the laser beam includes a hydrogen fluoride gas.

11. The method for manufacturing an SOI substrate according to claim 10, wherein the SOI structure is exposed to an atmosphere including the hydrogen fluoride gas after formation of the SOI structure and before irradiation with the laser beam.

12. The method for manufacturing an SOI substrate according to claim 8, wherein the base substrate is heated by one of light irradiation and induction heating when the laser beam is emitted.

13. The method for manufacturing an SOI substrate according to claim 8, wherein the single crystal semiconductor layer is formed in such a manner that an embrittlement region is formed in a single crystal semiconductor substrate by an ion doping method in which mass separation is not performed and then the embrittlement region is

subjected to heat treatment to separate a portion of the single crystal semiconductor substrate.

14. The method for manufacturing a semiconductor device, wherein a semiconductor element is formed using the SOI substrate according to claim 8.

15. A method for manufacturing an SOI substrate, comprising the steps of:

forming an SOI structure including a base substrate, a bonding layer including oxygen over the base substrate, and a single crystal semiconductor layer over the bonding layer including oxygen;

etching back the single crystal semiconductor layer; and

melting a part of the single crystal semiconductor layer by irradiation with a laser beam while the base substrate is heated at a temperature of higher than or equal to 500 °C and lower than a melting point of the base substrate,

wherein after the etching back step and before the melting step, an average value of a thickness of the single crystal semiconductor layer is greater than or equal to 100 nm.

16. The method for manufacturing an SOI substrate according to claim 15, wherein an irradiation atmosphere of the laser beam is a reduced-pressure atmosphere.

17. The method for manufacturing an SOI substrate according to claim 15, wherein an irradiation atmosphere of the laser beam includes a reducing gas.

18. The method for manufacturing an SOI substrate according to claim 15, wherein an irradiation atmosphere of the laser beam includes a hydrogen fluoride gas.

19. The method for manufacturing an SOI substrate according to claim 18, wherein the SOI structure is exposed to an atmosphere including the hydrogen fluoride gas after formation of the SOI structure and before irradiation with the laser beam.

20. The method for manufacturing an SOI substrate according to claim 15, wherein the base substrate is heated by one of light irradiation and induction heating when

the laser beam is emitted.

21. The method for manufacturing an SOI substrate according to claim 15, wherein the single crystal semiconductor layer is formed in such a manner that an embrittlement region is formed in a single crystal semiconductor substrate by an ion doping method in which mass separation is not performed and then the embrittlement region is subjected to heat treatment to separate a portion of the single crystal semiconductor substrate.

22. The method for manufacturing a semiconductor device, wherein a semiconductor element is formed using the SOI substrate according to claim 15.