CLAIMS

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

forming an oxide film on a single crystal semiconductor substrate;

introducing accelerated ions into the single crystal semiconductor substrate through the oxide film to form an embrittled region in the single crystal semiconductor substrate;

bonding a supporting substrate such that the supporting substrate and the single crystal semiconductor substrate face each other with the oxide film interposed therebetween;

forming a single crystal semiconductor layer bonded to the supporting substrate by heating the single crystal semiconductor substrate and performing separation at the embrittled region:

performing first etching on a surface of the single crystal semiconductor layer bonded to the supporting substrate;

after performing the first etching, irradiating the single crystal semiconductor layer with a laser beam and melting and solidifying at least part of the surface of the single crystal semiconductor layer; and

after irradiating the single crystal semiconductor layer, performing second etching on the surface of the single crystal semiconductor layer with no substrate bias applied.

2. The method for manufacturing an SOI substrate according to Claim 1, wherein the first etching is performed using a chlorine-based gas.

3. The method for manufacturing an SOI substrate according to Claim 1, wherein the second etching is performed using a fluorine-based gas.

4. The method for manufacturing an SOI substrate according to Claim 1, wherein the first etching and the second etching are performed using a fluorine-based gas.

5. The method for manufacturing an SOI substrate according to Claim 1, wherein the supporting substrate is a glass substrate.

6. A method for manufacturing a semiconductor device using an SOI substrate manufactured by the method for manufacturing an SOI substrate according to Claim 1, the method comprising the step of:

forming a semiconductor element comprising the single crystal semiconductor layer over the supporting substrate,

wherein the single crystal semiconductor layer is etched by performing the second etching.

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

forming an oxide film on a single crystal semiconductor substrate;

introducing accelerated ions into the single crystal semiconductor substrate through the oxide film to form an embrittled region in the single crystal semiconductor substrate;

bonding a supporting substrate such that the supporting substrate and the single crystal semiconductor substrate face each other with the oxide film interposed therebetween;

forming a single crystal semiconductor layer bonded to the supporting substrate by heating the single crystal semiconductor substrate and performing separation at the embrittled region:

performing first etching on a surface of the single crystal semiconductor layer bonded to the supporting substrate with no substrate bias applied;

after performing the first etching, irradiating the single crystal semiconductor layer with a laser beam and melting and solidifying at least part of the surface of the single crystal semiconductor layer; and

after irradiating the single crystal semiconductor layer, performing second etching on the surface of the single crystal semiconductor layer with no substrate bias applied.

8. The method for manufacturing an SOI substrate according to Claim 7, wherein the first etching is performed using a chlorine-based gas.

9. The method for manufacturing an SOI substrate according to Claim 7, wherein the second etching is performed using a fluorine-based gas.

10. The method for manufacturing an SOI substrate according to Claim 7, wherein the first etching and the second etching are performed using a fluorine-based gas.

11. The method for manufacturing an SOI substrate according to Claim 7, wherein the supporting substrate is a glass substrate.

12. A method for manufacturing a semiconductor device using an SOI substrate manufactured by the method for manufacturing an SOI substrate according to Claim 7, the method comprising the step of:

forming a semiconductor element comprising the single crystal semiconductor layer over the supporting substrate,

wherein the single crystal semiconductor layer is etched by performing the second etching.

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

forming an oxide film on a single crystal semiconductor substrate;

introducing accelerated ions into the single crystal semiconductor substrate through the oxide film to form an embrittled region in the single crystal semiconductor substrate;

forming an insulating layer over a supporting substrate;

bonding the supporting substrate such that the supporting substrate and the single crystal semiconductor substrate face each other with the oxide film interposed therebetween;

forming a single crystal semiconductor layer bonded to the supporting substrate by heating the single crystal semiconductor substrate and performing separation at the embrittled region:

performing first etching on a surface of the single crystal semiconductor layer bonded to the supporting substrate with no substrate bias applied;

after performing the first etching, irradiating the single crystal semiconductor layer with a laser beam and melting and solidifying at least part of the surface of the single crystal semiconductor layer; and

after irradiating the single crystal semiconductor layer, performing second etching on the surface of the single crystal semiconductor layer with no substrate bias applied.

14. The method for manufacturing an SOI substrate according to Claim 13, wherein the first etching is performed using a chlorine-based gas.

15. The method for manufacturing an SOI substrate according to Claim 13, wherein the second etching is performed using a fluorine-based gas.

16. The method for manufacturing an SOI substrate according to Claim 13, wherein the first etching and the second etching are performed using a fluorine-based gas.

17. The method for manufacturing an SOI substrate according to Claim 13, wherein the supporting substrate is a glass substrate.

18. A method for manufacturing a semiconductor device using an SOI substrate manufactured by the method for manufacturing an SOI substrate according to Claim 13, the method comprising the step of:

forming a semiconductor element comprising the single crystal semiconductor layer over the supporting substrate,

wherein the single crystal semiconductor layer is etched by performing the second etching.

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after performing the first etching, irradiating the single crystal semiconductor layer with a laser beam and melting and solidifying at least part of the surface of the single crystal semiconductor layer; and

after irradiating the single crystal semiconductor layer, performing second etching on the surface of the single crystal semiconductor layer using a plasma with no substrate bias applied.

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