WHAT IS CLAIMED IS:

1. A reprocessing method of a semiconductor substrate, comprising the steps of:

subjecting a semiconductor substrate in which a projection comprising a damaged semiconductor region and an insulating layer is provided in a peripheral portion to a first etching treatment for removing the insulating layer; and

subjecting the semiconductor substrate to a second etching treatment for removing selectively the damaged semiconductor region with a non-damaged semiconductor region left,

wherein the second etching treatment uses a mixed solution comprising:

nitric acid;

a substance dissolving a semiconductor material included in the semiconductor substrate and oxidized by the nitric acid;

a substance controlling a speed of oxidation of the semiconductor material and a speed of dissolution of the oxidized semiconductor material; and

nitrous acid, and

wherein a concentration of the nitrous acid is higher than or equal to 10 mg/l and lower than or equal to 1000 mg/l.

2. The reprocessing method of a semiconductor substrate according to claim 1,

wherein hydrofluoric acid is used as the substance dissolving the semiconductor material included in the semiconductor substrate and oxidized by the nitric acid, and

wherein acetic acid is used as the substance controlling the speed of oxidation and the speed of dissolution of the semiconductor material.

3. A manufacturing method of a reprocessed semiconductor substrate,

wherein a reprocessed semiconductor substrate is manufactured from the semiconductor substrate using the method according to claim 1.

4. A manufacturing method of an SOI substrate, comprising steps of:

forming an embrittlement region by adding ions to a reprocessed semiconductor substrate manufactured by the method according to claim 3;

bonding the reprocessed semiconductor substrate and a base substrate with an insulating layer provided therebetween; and

forming a semiconductor layer over the base substrate by separating the reprocessed semiconductor substrate by heat treatment.

5. The reprocessing method of a semiconductor substrate according to claim 1,

wherein the concentration of the nitrous acid is higher than or equal to 50 mg/l and lower than or equal to 300 mg/l.

6. The reprocessing method of a semiconductor substrate according to claim 1,

wherein the projection further comprising a first region corresponding to the edge roll off region and a second region corresponding to a chamfer portion,

wherein the first region is located at a distance longer than or equal to 0.2 mm and shorter than or equal to 0.9 mm from the end of the semiconductor substrate, and

wherein the second region is located at a distance shorter than 0.2 mm from the end of the semiconductor substrate.

7. The reprocessing method of a semiconductor substrate according to claim 1,

wherein a temperature of the mixed solution is 10 °C to 40 °C.

8. The reprocessing method of a semiconductor substrate according to claim 2,

wherein a concentration of the hydrofluoric acid is 50 weight%,

wherein a concentration of the nitric acid is 70 weight%,

wherein a concentration of the acetic acid is 97.7 weight%, and

wherein a volume ratio of the mixed solution comprising the hydrofluoric acid, the nitric acid, and the acetic acid is approximately 1:2:10.

9. The reprocessing method of a semiconductor substrate according to claim 1,

wherein an etching selectivity of the damaged semiconductor region to the

non-damaged semiconductor region is 1.7 or higher in the second etching treatment.

10. A reprocessing method of a semiconductor substrate, comprising the steps of:

separating a part of a semiconductor substrate as a semiconductor layer through irradiation with ions and heat treatment;

subjecting the separated semiconductor substrate in which a projection including a damaged semiconductor region and an insulating layer remain in a peripheral portion to a first etching treatment for removing the insulating layer; and

subjecting the separated semiconductor substrate to a second etching treatment for selectively removing the damaged semiconductor region with a non-damaged semiconductor region left,

wherein the second etching treatment uses a mixed solution comprising:

nitric acid;

a substance dissolving a semiconductor material included in the semiconductor substrate and oxidized by the nitric acid;

a substance controlling a speed of oxidation of the semiconductor material and a speed of dissolution of the oxidized semiconductor material, and

nitrous acid, and

wherein a concentration of the nitrous acid is higher than or equal to 10 mg/l and lower than or equal to 1000 mg/l.

11. The reprocessing method of a semiconductor substrate according to claim 10,

wherein the irradiation with the ions is performed without mass separation.

12. The reprocessing method of a semiconductor substrate according to claim 10,

wherein the ions include H_3^+.

13. The reprocessing method of a semiconductor substrate according to claim 10,

wherein hydrofluoric acid is used as the substance dissolving the semiconductor material included in the semiconductor substrate and oxidized by the nitric acid, and

wherein acetic acid is used as the substance controlling the speed of oxidation and the speed of dissolution of the semiconductor material.

14. A manufacturing method of a reprocessed semiconductor substrate,

wherein a reprocessed semiconductor substrate is manufactured from the semiconductor substrate using the method according to claim 10.

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

forming an embrittlement region by adding ions to a reprocessed semiconductor substrate manufactured by the method according to claim 14;

bonding the reprocessed semiconductor substrate and a base substrate with an insulating layer provided therebetween; and

forming a semiconductor layer over the base substrate by separating the reprocessed semiconductor substrate by heat treatment.

16. The reprocessing method of a semiconductor substrate according to claim 10,

wherein the concentration of the nitrous acid is higher than or equal to 50 mg/l and lower than or equal to 300 mg/l.

17. The reprocessing method of a semiconductor substrate according to claim 10,

wherein the projection further comprising a first region corresponding to the edge roll off region and a second region corresponding to a chamfer portion,

wherein the first region is located at a distance longer than or equal to 0.2 mm and shorter than or equal to 0.9 mm from the end of the separated semiconductor substrate, and

wherein the second region is located at a distance shorter than 0.2 mm from the end of the separated semiconductor substrate.

18. The reprocessing method of a semiconductor substrate according to claim 10,

wherein a temperature of the mixed solution is 10 °C to 40 °C.

19. The reprocessing method of a semiconductor substrate according to claim 13,

wherein a concentration of the hydrofluoric acid is 50 weight%,

wherein a concentration of the nitric acid is 70 weight%,

wherein a concentration of the acetic acid is 97.7 weight%, and

wherein a volume ratio of the mixed solution comprising the hydrofluoric acid, the nitric acid, and the acetic acid is approximately 1:2:10.

20. The reprocessing method of a semiconductor substrate according to claim 10,

wherein an etching selectivity of the damaged semiconductor region to the non-damaged semiconductor region is 1.7 or higher in the second etching treatment.

WHAT IS CLAIMED IS:

1. A reprocessing method of a silicon substrate, comprising the steps of:

subjecting a silicon substrate in which a projection comprising a damaged silicon region and an insulating layer is provided in a peripheral portion to a first etching treatment for removing the insulating layer; and

subjecting the silicon substrate to a second etching treatment for removing selectively the damaged silicon region with a non-damaged silicon region left,

wherein the second etching treatment uses a mixed solution comprising:

nitric acid;

hydrofluoric acid;

acetic acid; and

nitrous acid,

wherein a concentration of the nitrous acid in the mixed solution is higher than or equal to 10 mg/l and lower than or equal to 1000 mg/l, and

wherein the mixed solution is prepared before the step of subjecting the silicon substrate to the second etching treatment.

2. The reprocessing method of a silicon substrate according to claim 1,

wherein the concentration of the nitrous acid is higher than or equal to 50 mg/l and lower than or equal to 300 mg/l.

3. The reprocessing method of a silicon substrate according to claim 1,

wherein the projection further comprising a first region corresponding to the edge roll off region and a second region corresponding to a chamfer portion,

wherein the first region is located at a distance longer than or equal to 0.2 mm and shorter than or equal to 0.9 mm from the end of the silicon substrate, and

wherein the second region is located at a distance shorter than 0.2 mm from the end of the silicon substrate.

4. The reprocessing method of a silicon substrate according to claim 1,

wherein a temperature of the mixed solution is 10 °C to 40 °C.

5. The reprocessing method of a silicon substrate according to claim 1,

wherein a concentration of the hydrofluoric acid in the mixed solution is 50 weight %,

wherein a concentration of the nitric acid in the mixed solution is 70 weight %,

wherein a concentration of the acetic acid in the mixed solution is 97.7 weight %, and

wherein a volume ratio of the mixed solution comprising the hydrofluoric acid, the nitric acid, and the acetic acid is approximately 1:2:10.

6. The reprocessing method of a silicon substrate according to claim 1,

wherein an etching selectivity of the damaged silicon region to the non-damaged silicon region is 1.7 or higher in the second etching treatment.

7. A reprocessing method of a silicon substrate, comprising the steps of:

separating a part of a silicon substrate as a silicon layer through irradiation with ions and heat treatment;

subjecting the separated silicon substrate in which a projection including a damaged silicon region and an insulating layer remain in a peripheral portion to a first etching treatment for removing the insulating layer; and

subjecting the separated silicon substrate to a second etching treatment for selectively removing the damaged silicon region with a non-damaged silicon region left,

wherein the second etching treatment uses a mixed solution comprising:

nitric acid;

hydrofluoric acid;

acetic acid, and

nitrous acid,

wherein a concentration of the nitrous acid in the mixed solution is higher than or equal to 10 mg/l and lower than or equal to 1000 mg/l, and

wherein the mixed solution is prepared before the step of subjecting the silicon substrate to the second etching treatment.

8. The reprocessing method of a silicon substrate according to claim 7,

wherein the irradiation with the ions is performed without mass separation.

9. The reprocessing method of a silicon substrate according to claim 7, wherein the ions include H_3^+.

10. The reprocessing method of a silicon substrate according to claim 7, wherein the concentration of the nitrous acid is higher than or equal to 50 mg/l and lower than or equal to 300 mg/l.

11. The reprocessing method of a silicon substrate according to claim 7, wherein the projection further comprising a first region corresponding to the edge roll off region and a second region corresponding to a chamfer portion,

wherein the first region is located at a distance longer than or equal to 0.2 mm and shorter than or equal to 0.9 mm from the end of the separated silicon substrate, and

wherein the second region is located at a distance shorter than 0.2 mm from the end of the separated silicon substrate.

12. The reprocessing method of a silicon substrate according to claim 7, wherein a temperature of the mixed solution is 10 °C to 40 °C.

13. The reprocessing method of a silicon substrate according to claim 7, wherein a concentration of the hydrofluoric acid in the mixed solution is 50 weight %,

wherein a concentration of the nitric acid in the mixed solution is 70 weight %,

wherein a concentration of the acetic acid in the mixed solution is 97.7 weight %, and

wherein a volume ratio of the mixed solution comprising the hydrofluoric acid, the nitric acid, and the acetic acid is approximately 1:2:10.

14. The reprocessing method of a silicon substrate according to claim 7, wherein an etching selectivity of the damaged silicon region to the non-damaged silicon region is 1.7 or higher in the second etching treatment.

15. The reprocessing method of a silicon substrate according to claim 1,

wherein the silicon substrate after the step of subjecting the silicon substrate to the second etching treatment is used for a reprocessed silicon substrate.

16. The reprocessing method of a silicon substrate according to claim 7,

wherein the silicon substrate after the step of subjecting the silicon substrate to the second etching treatment is used for a reprocessed silicon substrate.

17. The reprocessing method of a silicon substrate according to claim 1,

wherein the mixed solution is prepared by subjecting a dummy substrate to wet etching treatment using a mixed solution which includes nitric acid, hydrofluoric acid, and acetic acid.

18. The reprocessing method of a silicon substrate according to claim 7,

wherein the mixed solution is prepared by subjecting a dummy substrate to wet etching treatment using a mixed solution which includes nitric acid, hydrofluoric acid, and acetic acid.