CLAIMS

1. Process for thinning the active silicon layer (2) of a "silicon on insulator" (SOI) substrate (1), intended for applications in the field of electronics, optics and/or optoelectronics, and which comprises an insulator layer (4) buried between said active silicon layer (2) and a support (3), this process comprising at least one step of sacrificial thinning of said active silicon layer (2) by formation of a sacrificial silicon oxide layer (20) by sacrificial thermal oxidation and deoxidation of this layer (20), characterized in that it also comprises:

- a step of forming an oxide layer (5), referred to as a "complementary" oxide layer, on said active silicon layer (2), using an oxidizing plasma, this complementary oxide layer (5) having a thickness profile complementary, or substantially complementary, to that of said sacrificial silicon oxide layer (20), so that the sum of the thicknesses of the complementary oxide layer (5) and of the sacrificial silicon oxide layer (20) are constant, or substantially constant, over the entire surface of the treated substrate (1),

- a step of deoxidation of this complementary oxide layer (5),

so as to thin said active silicon layer (2) by a uniform thickness, at the end of all of these steps.

2. Process according to Claim 1, characterized in that the step of forming the complementary oxide (5) using an oxidizing plasma is carried out in a

reactive-ion etching type reactor with capacitive coupling and adjustable magnetron effect, at a pressure of the order of 10 to 200 mTorr (i.e. from 1 to 30 Pa) of pure oxygen, for a duration of 10 to 90 s, with an RF power density between 0.3 and 3 W/cm^2.

3. Process according to Claim 1 or 2, characterized in that the formation of the sacrificial silicon oxide layer (20) is carried out by wet oxidation at a temperature between 750°C and 1200°C.

4. Process according to Claim 1 or 2, characterized in that the formation of the sacrificial silicon oxide layer (20) is carried out by dry oxidation at a temperature between 750°C and 1200°C.

5. Process according to one of the preceding claims, characterized in that the sacrificial silicon oxide layer (20) has a thickness that is larger in its central portion and progressively smaller going towards its annular periphery, and in that the complementary oxide layer (5) is produced so as to have a thickness that is smaller in its central portion and progressively larger going towards its annular periphery.

6. Process according to one of Claims 1 to 4, characterized in that the sacrificial silicon oxide layer (20) has a thickness that is smaller in its central portion and progressively larger going towards its annular periphery, and in that the complementary oxide layer (5) is produced so as to have a thickness that is larger in its central portion and progressively smaller going towards its annular periphery.

7. Process according to Claim 5 or 6, characterized in that a density gradient of the ionized species

and/or of the radicals of the oxidizing plasma is created between the central portion and the annular periphery of the substrate (1), by injecting less gas into the portion where it is desired to obtain a lesser thickness and progressively more gas on going towards the portion where it is desired to obtain a larger thickness.

8. Process according to Claim 5 or 6, characterized in that a density gradient of the ionized species and/or of the radicals of the oxidizing plasma is created between the central portion and the annular periphery of the substrate (1), by defocusing these ionized species and/or these radicals in the portion where it is desired to obtain a lesser thickness and by progressively concentrating the latter on going towards the portion where it is desired to obtain a larger thickness, by virtue of magnets surrounding the plasma chamber.

9. Process according to Claim 5 or 6, characterized in that a density gradient of the ionized species and/or of the radicals of the oxidizing plasma is created between the central portion and the annular periphery of the substrate (1), by placing said substrate on a base comprising several independent heating zones and by maintaining a temperature that is lower in the portion where it is desired to obtain a lesser thickness and that is gradually higher on going towards the portion where it is desired to obtain a larger thickness.

10. Process according to Claim 5 or 6, characterized in that a density gradient of the ionized species and/or of the radicals of the oxidizing plasma is created between the central portion and the annular periphery of the substrate (1), by placing

the substrate (1) on an electrode composed of several sub-electrodes that are powered independently of one another and by powering the sub-electrodes located at the portion where it is desired to obtain a lesser thickness at a given power and by progressively powering those located going towards the portion where it is desired to obtain a larger thickness, at a higher power.

11. Process according to one of the preceding claims, characterized in that the deoxidation of the sacrificial silicon oxide layer (20) and/or of the complementary oxide layer (5) is carried out by treatment with hydrofluoric acid (HF).

12. Process according to one of the preceding claims, characterized in that the steps of forming the complementary oxide layer (5) and of removing the latter are carried out before the sacrificial thinning step.

13. Process according to one of Claims 1 to 11, characterized in that the steps of forming the complementary oxide layer (5) and of removing the latter are carried out after the sacrificial thinning step.

14. Process according to one of Claims 1 to 11, characterized in that the steps of forming the complementary oxide layer (5) and the sacrificial silicon oxide layer (20) are carried out before a single step of a sacrificial deoxidation of these two layers (5, 20).

15. Process according to one of the preceding claims, characterized in that the active silicon layer (2) of the SOI substrate (1) was obtained by detachment along a weakened interface formed in a "donor" substrate, and transfer to said support

(3), in that the process comprises two steps of smoothing by rapid thermal annealing (RTA), and in that the sacrificial thinning step is carried out between the first and the second rapid thermal annealing (RTA) step, and the steps of forming the complementary oxide layer (5) and of the deoxidation thereof are carried out after the second rapid thermal annealing (RTA) step.

16. Process according to Claim 15, characterized in that the rapid thermal annealing (RTA) treatment consists in subjecting said substrate (1) to a temperature between 950°C and 1350°C for 10 to 90 seconds approximately.

CLAIMS

1. A method for thinning an active silicon layer of a silicon-on-insulator (SOI) substrate having an insulator layer buried between the active silicon layer and a support, the method comprising:

forming a sacrificial silicon oxide layer by sacrificial thermal oxidation of a portion of the active silicon layer;

forming a complementary oxide layer on the active silicon layer using an oxidizing plasma, the complementary oxide layer having a thickness profile at least substantially complementary to a thickness profile of the sacrificial silicon oxide layer such that a sum of the thicknesses of the complementary oxide layer and the sacrificial silicon oxide layer are at least substantially constant over the entire surface of the SOI substrate; and

removing the sacrificial silicon oxide layer; and

removing the complementary oxide layer;

wherein the thinned active silicon layer has an at least substantially uniform thickness after forming and removing each of the sacrificial silicon oxide layer and the complementary oxide layer.

2. The method of claim 1, wherein forming the complementary oxide layer using the oxidizing plasma is carried out in a reactive-ion etching reactor with capacitive coupling and adjustable magnetron effect, at a pressure on the order of 10 to 200 mTorr (from 1 to 30 Pa) of pure oxygen, for a duration of 10 to 90 seconds, with an RF power density between 0.3 and 3 W/cm^2.

3. The method of claim 1, wherein forming the sacrificial silicon oxide layer is carried out by wet oxidation at a temperature between 750˚C. and 1200˚C.

4. The method of claim 1, wherein forming the sacrificial

silicon oxide layer is carried out by dry oxidation at a temperature between 750˚C. and 1200˚C.

5. The method of claim 1, wherein the sacrificial silicon oxide layer is relatively thicker in a central portion thereof and progressively relatively thinner towards an annular periphery thereof, and wherein the complementary oxide layer is thinner in a central portion thereof and progressively relatively thicker toward an annular periphery thereof.

6. The method of claim 5, further comprising creating a density gradient of at least one of ionized species and radicals of the oxidizing plasma between a central portion and an annular periphery of the SOI substrate by injecting less gas into a region where it is desired to obtain a lesser thickness of the complementary oxide layer and progressively more gas toward a region where it is desired to obtain a larger thickness of the complementary oxide layer.

7. The method of claim 5, further comprising creating a density gradient of at least one of ionized species and radicals of the oxidizing plasma between a central portion and an annular periphery of the SOI substrate by defocusing the at least one of the ionized species and the radicals in a region where it is desired to obtain a lesser thickness of the complementary oxide layer and by progressively concentrating the at least one of ionized species and radicals toward a region where it is desired to obtain a larger thickness of the complementary oxide layer using magnets surrounding the plasma chamber.

8. The method of claim 5, further comprising creating a density gradient of at least one of ionized species and radicals of the oxidizing plasma between a central portion and an annular periphery of the SOI substrate by placing the SOI substrate on a base having two or more independent heating zones and

maintaining a relatively lower temperature in a region where it is desired to obtain a lesser thickness of the complementary oxide layer and a relatively higher temperature in a region where it is desired to obtain a larger thickness of the complementary oxide layer.

9. The method of claim 5, further comprising creating a density gradient of at least one of ionized species and radicals of the oxidizing plasma between a central portion and an annular periphery of the SOI substrate by placing the SOI substrate on an electrode having two or more independently powered sub-electrodes, and powering at least one of the sub-electrodes located in a region where it is desired to obtain a lesser thickness of the complementary oxide layer at a relatively lower power and powering at least one of the sub-electrodes located in a region where it is desired to obtain a larger thickness of the complementary oxide layer at a relatively higher power.

10. The method of claim 1, wherein the sacrificial silicon oxide layer is thinner in a central portion thereof and progressively thicker toward an annular periphery thereof, and wherein the complementary oxide layer is thicker in a central portion thereof and progressively thinner toward an annular periphery thereof.

11. The method of claim 1, wherein at least one of removing the sacrificial silicon oxide layer and removing the complementary oxide layer comprises treating with hydrofluoric acid (HF).

12. The method of claim 1, wherein the forming of the complementary oxide layer and the removing of the complementary oxide layer are carried out prior to the forming of the sacrificial silicon oxide layer and the removing of the sacrificial silicon oxide layer.

13. The method of claim 1, wherein the forming of the sacrificial silicon oxide layer and the removing of the sacrificial silicon oxide layer are carried out prior to the forming of the complementary oxide layer and the removing of the complementary oxide layer.

14. The method of claim 1, wherein the forming of the sacrificial silicon oxide layer and the forming of the complementary oxide layer are carried out prior to the removing of the sacrificial silicon oxide layer and the removing of the complementary oxide layer.

15. The method of claim 1, wherein the removing of the sacrificial silicon oxide layer and the removing of the complementary oxide layer are carried out in a single removal process.

16. The method of claim 1, further comprising forming the SOI substrate, forming the SOI substrate including transferring the active silicon layer to the support from a donor substrate by fracture of the donor substrate along a weakened interface formed in the donor substrate, and wherein the method further comprises smoothing a surface of the active silicon layer by first and second rapid thermal annealing (RTA) treatments, and wherein the forming of the sacrificial silicon oxide layer and the removing of the sacrificial silicon oxide layer are carried out between the first and the second RTA treatments, and wherein the fainting of the complementary oxide layer and the removing of the complementary oxide layer are carried out after the second RTA treatment.

17. The method of claim 16, wherein each of the first and the second RTA treatments comprises subjecting the SOI substrate to a temperature between 950˚C. and 1350˚C. for approximately 10 to 90 seconds.