This is because it is necessary to implement a polishing operation, thereby increasing the duration and cost of the process.

Another known solution, which does not consume material, consists in temporarily bonding, by means of an adhesive, the handle substrate to the substrate comprising the layer to be transferred.

In this case, during the transfer or treatment, the force associated with the attachment of the layer to be transferred and the handle substrate is withstood by the adhesive.

Once the transfer or treatment has been carried out, the handle substrate may be removed.

A problem arises from use of an adhesive.

This is because adhesives can become unstable if exposed to the high temperatures employed in the treatments carried out on the substrate or during fabrication of semiconductor structures using a transfer.

Moreover, an adhesive layer does not allow sufficiently stable attachment of the substrate for certain treatments to be carried out thereon. This is the case when the substrate, for example, is thinned by grinding to below a thickness threshold, for example, of 200, 50 or 40 microns. The mechanical stress exerted in this step leads to strain in the layer resting on the insufficiently rigid adhesive layer, thereby in turn leading to non-uniform thinning of the substrate.

Furthermore, once the treatment has been carried out, the adhesive is completely removed by means of a chemical removal technique (dissolving in a solvent, for example). Such removal increases the duration of the fabrication process and risks damaging the semiconductor structure obtained.

SUMMARY OF THE INVENTION

Embodiments of tThe invention allows the drawbacks mentioned above to be alleviated.

Thus, according to a first aspect, of the invention, there is provided a method ~~relates to a process~~ for fabricating a semiconductor structure, comprising~~characterized in that it comprises the following steps~~:

- providing a handle substrate comprising a seed substrate and a weakened sacrificial layer covering the seed substrate;
- joining the handle substrate with a carrier substrate;
- ~~optionally~~ treating the carrier substrate while it remains joined to the handle substrate;
- after treating the carrier substrate, joining the carrier substrate to a host substrate while the carrier substrate remains adjoined to the handle substrate;
- after joining the carrier substrate to the host substrate, detaching the handle substrate at the weakened sacrificial layer ~~so as~~ to form the semiconductor structure; and
- removing any residue of the sacrificial layer present on the seed substrate.

By virtue of the process according to embodiments of the invention, on the one hand, the material of the seed substrate of the handle substrate may be chosen from a wide range of materials and, on the other hand, the remaining part of this substrate may be recycled in a particularly easy way in order to be reused in the same way.

Specifically, recycling of the remaining part of the handle substrate after the detachment step can be easily carried out: a simple selective etch of the sacrificial layer may be~~is~~ enough to allow recycling of the handle substrate.

This type of recycling process may be~~is~~ much less expensive than a polishing-based recycling technique, such as is necessarily the result of the process described in document EP 0,786,801, for example.

Another advantage according to embodiment of the invention is that the recycling maydoes not reduce the thickness of the handle substrate since the handle substrate is covered with a sacrificial layer, it being this layer alone that is consumed in the recycling. The handle substrate ~~is~~ *therefore may be theoretically infinitely reusable. It is thus possible to make* cost savings relative to known processes that involve transfer of part of a silicon handle substrate and its recycling, part of the thickness of this substrate being consumed in these processes.

The following are embodiments~~other aspects~~ of the process according to the first aspect of the invention:

- the sacrificial layer is weakened by introducing atomic species into the sacrificial layer of the handle substrate;
- the seed substrate has a thermal expansion coefficient CTE1 near the thermal expansion coefficient CTE2 of the carrier substrate such that $|CTE1-CTE2|/CTE1 < 50\%$;
- the handle substrate comprises an intermediate layer placed between the seed substrate and the sacrificial layer in order to promote adhesion of the material forming the sacrificial layer to the seed substrate;
- the sacrificial layer has a weak zone and defines a layer located between the surface of the handle substrate and the weak zone;
- ~~the process comprises, before the detachment step, a step consisting in joining the carrier substrate to a host substrate;~~
- the seed substrate is chosen so as to have a thermal expansion coefficient CTE1 near the thermal expansion coefficient CTE2 of the host substrate;
- the carrier substrate comprises an integrated-circuit part;
- the detachment step consists in supplying energy by annealing at a temperature of at least 200°C ;
- the introduction of atomic species consists in exposing an area of the handle substrate to atomic species implantation, at a dose of between 1×10^{15} ions/cm^2 and 1×10^{17} ions/cm^2 and at an energy of between 5 keV and 500 keV;
- the introduction of atomic species consists in diffusing atomic species into the handle substrate by bringing the surface of the handle substrate into contact with a chemical species that will penetrate into the handle wafer by chemical diffusion;
- the introduction of atomic species involves:

- before the species introduction, creating a confinement layer in the handle substrate; and
- after the species introduction, exposing the handle substrate to a temperature of at least 200°C with a view to promoting migration of the introduced species towards the *confinement* layer;

- the joining consists in bonding the handle substrate to the carrier substrate;
- the joining is achieved by molecular adhesion;
- the sacrificial layer is a polysilicon layer; and
- the seed substrate is: a single-crystal substrate; or an amorphous or polycrystalline substrate; or a ceramic; or a metal.

According to a second aspect~~,~~ of the invention, there is provided a method of fabricating a semiconductor structure, comprising:

providing a handle substrate comprising a seed substrate and a weakened sacrificial layer covering the seed substrate, wherein the sacrificial layer comprises a polysilicon layer;

joining the handle substrate with a carrier substrate;

joining the carrier substrate to a host substrate while the carrier substrate remains adjoined to the handle substrate;

after joining the carrier substrate to the host substrate, detaching the handle substrate at the weakened sacrificial layer to form the semiconductor structure; and

removing any residue of the sacrificial layer present on the seed substrate ~~relates to a handle substrate comprising a seed substrate and a weakened sacrificial layer~~.

The following are disclosed hereinother aspects of the handle substrate according to the second aspect of the invention:

- the sacrificial layer contains a density of H and/or of He lying between 1×10^{16} at/cm^3 and 1×10^{20} at/cm^3;
- the sacrificial layer is made of polysilicon;
- the seed substrate is a single-crystal substrate, an amorphous or polycrystalline substrate, a ceramic or a metal;
- it has an RMS surface roughness of 10 Ångströms or less;
- it has an additional surface layer that simplifies subsequent joining of the handle substrate with the carrier substrate; and
- the additional layer is made of silicon oxide.

There is also disclosed~~In addition, according to a third aspect, the invention relates to~~ a process for fabricating a handle substrate comprising the following steps: forming a sacrificial layer on a seed substrate; and introducing an atomic species into the sacrificial layer.

DESCRIPTION OF THE DRAWINGS

CLAIMS

1. Process for fabricating a semiconductor structure, characterized in that it comprises the following steps:
   - providing (E1) a handle substrate (1, 2) comprising a seed substrate (1) and a weakened sacrificial layer (2) covering the seed substrate (1);
   - joining (E2) the handle substrate (1, 2) with a carrier substrate (3);
   - optionally treating (E3) the carrier substrate (3);
   - detaching (E4) the handle substrate at the sacrificial layer (2) so as to form the semiconductor structure; and
   - removing (E5) any residue of the sacrificial layer (2) present on the seed substrate (1).

2. Process according to Claim 1, in which the sacrificial layer (2) is weakened by introducing atomic species into the sacrificial layer (2) of the handle substrate (1, 2).

3. Process according to either one of Claims 1 and 2, in which the seed substrate (1) has a thermal expansion coefficient CTE1 near the thermal expansion coefficient CTE2 of the carrier substrate (3) such that (CTE1-CTE2)/CTE1 < 50%.

4. Process according to one of the preceding claims, in which the handle substrate (1, 2) comprises an intermediate layer (20) placed between the seed substrate (1) and the sacrificial layer (2) in order to promote adhesion of the material forming the sacrificial layer (2) to the seed substrate (1).

5. Process according to one of the preceding claims, in which the sacrificial layer (2) has a weak zone (2''') and defines a layer (2'') located between the surface of the handle substrate (1, 2) and the weak zone (2''').

6. Process according to one of the preceding claims, in which the process comprises, before the detachment step (E3), a step consisting in joining (E30) the carrier substrate (3) to a host substrate (4).

7. Process according to one of the preceding claims, in which the seed substrate (1) is chosen so as to have a thermal expansion coefficient CTE1 near the thermal expansion coefficient CTE2 of the host substrate (4).

8. Process according to one of the preceding claims, in which the carrier substrate (3) comprises an integrated-circuit part.

9. Process according to one of the preceding claims, in which the detachment step consists in supplying energy by annealing at a temperature of at least 200°C.

10. Process according to one of Claims 2 to 9, in which the introduction of atomic species consists in exposing an area of the handle substrate (1, 2) to atomic species implantation, at a dose of between 1×10^{15} ions/cm^2 and 1×10^{17} ions/cm^2 and an energy of between 5 keV and 500 keV.

11. Process according to one of Claims 2 to 10, in which the introduction of atomic species consists in diffusing atomic species into the handle substrate by bringing the handle surface into contact with a chemical species that will penetrate into the handle wafer by chemical diffusion.

12. Process according to either one of Claims 10 and 11, in which the introduction of atomic species involves:
    - before the species introduction, creating a confinement layer in the handle substrate; and
    - after the species introduction, exposing the handle substrate to a temperature of at least 200°C with a view to promoting migration of the introduced species towards the confinement layer.

13. Process according to one of the preceding claims, in which the joining consists in bonding the handle substrate (1, 2) to the carrier substrate (3).

14. Process according to Claim 13, in which the joining is achieved by molecular adhesion.

15. Process according to one of Claims 1 to 14, in which the sacrificial layer (2) is a polysilicon layer.

16. Process according to one of Claims 1 to 15, in which the seed substrate (1) is:
    - a single-crystal substrate; or
    - an amorphous or polycrystalline substrate; or
    - a ceramic; or
    - a metal.

17. Handle substrate comprising a seed substrate (1) and a weakened polysilicon sacrificial layer (2).

18. Handle substrate according to Claim 17, in which the sacrificial layer (2) contains a density of H and/or of He lying between 1×10^{16} at/cm^3 and 1×10^{20} at/cm^3.

19. Handle substrate according to either one of Claims 17 and 18, in which the seed substrate (1) is a single-crystal substrate, an amorphous or polycrystalline substrate, a ceramic or a metal.

20. Handle substrate according to one of Claims 17 to 19, having an RMS surface roughness of 10 Ångströms or less.

21. Handle substrate according to one of Claims 17 to 20, having an additional surface layer (21) that simplifies subsequent joining of the handle substrate with the carrier substrate.

22. Handle substrate according to Claim 21, in which the additional layer (21) is made of silicon oxide.

23. Process for fabricating a handle substrate comprising the following steps:
    - forming a polysilicon sacrificial layer (2) on a seed substrate (1); and
    - introducing an atomic species into the polysilicon sacrificial layer (2).

CLAIMS

1. A method of fabricating a semiconductor structure, comprising:

providing a handle substrate comprising a seed substrate and a weakened sacrificial layer covering the seed substrate;

joining the handle substrate with a carrier substrate;

treating the carrier substrate while it remains joined to the handle substrate;

after treating the carrier substrate, joining the carrier substrate to a host substrate while the carrier substrate remains adjoined to the handle substrate;

after joining the carrier substrate to the host substrate, detaching the handle substrate at the weakened sacrificial layer to form the semiconductor structure; and

removing any residue of the sacrificial layer present on the seed substrate.

2. The method of claim 1, wherein the sacrificial layer is weakened by introducing atomic species into the sacrificial layer of the handle substrate.

3. The method of claim 1, wherein the seed substrate has a thermal expansion coefficient CTE1 near the thermal expansion coefficient CTE2 of the carrier substrate such that $(CTE1-CTE2)/CTE1 < 50\%$.

4. The method of claim 1, wherein the handle substrate comprises an intermediate layer placed between the seed substrate and the sacrificial layer to promote adhesion of the sacrificial layer to the seed substrate.

5. The method of claim 1, wherein the sacrificial layer has a weak zone and defines a layer located between a surface of the handle substrate and the weak zone.

6. The method of claim 1, wherein the seed substrate is chosen to have a thermal expansion coefficient CTE1 near the thermal expansion coefficient CTE2 of the host substrate.

7. The method of claim 1, wherein the carrier substrate comprises an integrated-circuit.

8. The method of claim 1, wherein detaching the handle substrate at the weakened sacrificial layer comprises supplying energy by annealing at a temperature of at least 200°C.

9. The method of claim 2, wherein introducing atomic species into the sacrificial layer comprises exposing an area of the handle substrate to atomic species implantation at a dose of between 1×10^{15} ions/cm^2 and 1×10^{17} ions/cm^2 and an energy of between 5 keV and 500 keV.

10. The method of claim 2, wherein introducing atomic species into the sacrificial layer comprises diffusing atomic species into the handle substrate by bringing the handle surface into contact with a chemical species and penetrating the chemical species into the handle wafer by chemical diffusion.

11. The method of claim 2, wherein introducing atomic species into the sacrificial layer comprises:

creating a confinement layer in the handle substrate prior to introducing atomic species into the sacrificial layer; and

exposing the handle substrate to a temperature of at least 200°C to promote migration of the introduced species toward the confinement layer after introducing atomic species into the sacrificial layer.

12. The method of claim 1, wherein joining the handle substrate with the carrier substrate comprises bonding the handle substrate to the carrier substrate.

13. The method of claim 12, wherein joining the handle substrate with a carrier substrate comprises bonding the handle substrate with the carrier substrate by molecular adhesion.

14. The method of claim 1, wherein the seed substrate is selected from the group consisting of:

a single-crystal substrate;

an amorphous or polycrystalline substrate;

a ceramic; and

a metal.

15. The method of claim 1, further comprising treating the carrier substrate.

16. A method of fabricating a semiconductor structure, comprising:

providing a handle substrate comprising a seed substrate and a weakened sacrificial layer covering the seed substrate, wherein the sacrificial layer comprises a polysilicon layer;

joining the handle substrate with a carrier substrate;

joining the carrier substrate to a host substrate while the carrier substrate remains adjoined to the handle substrate;

after joining the carrier substrate to the host substrate, detaching the handle substrate at the weakened sacrificial layer to form the semiconductor structure; and

removing any residue of the sacrificial layer present on the seed substrate.