mainly due to the variability of surface roughness (high and low frequencies) after separation.

[0006] To improve the quality of the thin films in the final stacked structure, it remains important to reduce the surface roughness (whatever the spatial frequency) of these layers after transfer.

[0007] It is known from US2010/330779 to form a local unbonded area at the bonding interface, bordered by a bonded region, to constitute a separation trigger and thus limit the roughness of a thin silicon layer transferred onto a glass support substrate. The local unbonded area is obtained by creating a topology corresponding to a cavity and/or dome (or peak) on the face of the donor substrate (silicon) or support substrate (glass) to be bonded. Cavities and/or peaks of the order of 2 to 3 micrometers are formed on the glass substrate, to create an unbonded area of several tens of mm^2.

OBJECT OF THE INVENTION

[0008] The present invention proposes a transfer method using a particular fracture initiation point, enabling improved surface roughness of the thin film after separation, to achieve excellent surface quality after the finishing steps of the stacked structure. The method is particularly advantageous for the manufacture of SOI structures.

SUMMARY

[0008A] In accordance with an aspect of the present disclosure, there is provided a method for transferring a thin film to a support substrate. The method includes assembling a donor substrate and the support substrate, by direct bonding at their respective front faces and following a bonding interface, to form a bonded assembly having a local unbonded area within this bonding interface, the donor substrate further including a buried brittle plane,

separating along the buried brittle plane, initiated at the local unbonded area after microcrack growth in said plane by thermal activation, the separation resulting in the transfer of a thin film from the donor substrate to the support substrate. The local unbonded area is generated by at least one roughened area produced by scanning a laser beam over at least one of the front faces of the donor and support substrates prior to their assembly, the scanning extending over an area of at least 100 micrometers by 100 micrometers and at most 500 micrometers by 500 micrometers.

[0009] The present disclosure relates to a method for transferring a thin film to a support substrate, comprising:

[0010] - assembling a donor substrate and the support substrate, by direct bonding at their respective front faces and following a bonding interface, to form a bonded assembly having a local unbonded area within this bonding interface, the donor substrate further comprising a buried brittle plane,

- separating along the buried brittle plane, initiated at the local unbonded area after microcrack growth in said plane by thermal activation, the separation resulting in the transfer of a thin film from the donor substrate to the support substrate.

[0011] According to the disclosure, the local unbonded area is generated by at least one roughened area produced by scanning a laser beam over at least one of the front faces of the donor and support substrates prior to their assembly, the scanning extending over an area of at least 100 micrometers by 100 micrometers and at most 500 micrometers by 500 micrometers.

[0012] According to advantageous features of the disclosure, taken alone or in any feasible combination:

- the roughened area is produced by surface fusion of a material making up the donor substrate and/or the support substrate, on the side of their respective front faces;

- the laser beam scan has a duration of between 20 microseconds and 100 microseconds, during which the beam has an energy density of between 5 mJ/m^2 and 7 mJ/m^2;

- the laser beam has a wavelength of 355 nm.

- the laser beam has a size inscribed in a circle 80 micrometers in diameter;

- the local unbonded area is generated by a plurality of elementary roughened areas separated from one another, each produced by scanning the laser beam over an area of at least 100 micrometers by 100 micrometers and at most 200 micrometers by 200 micrometers;

- the roughened area is formed on the front face of the donor substrate, before the formation of the buried brittle plane in said donor substrate;

- the donor substrate is formed from a first material on its front face, and a preliminary roughened area is formed on the surface of said material, and thermal oxidation of the first material of the donor substrate is carried out after formation of the preliminary roughened area and before formation of the buried brittle plane, to form an insulating layer that will be assembled on the support

Claims

[Claim 1] A method for transferring a thin film (10) to a support substrate (2), comprising:

- assembling a donor substrate (1) and the support substrate (2), by direct bonding at their respective front faces (1a, 2a) and following a bonding interface (3), to form a bonded assembly (100) having a local unbonded area (31) within this bonding interface (3), the donor substrate (1) further comprising a buried brittle plane (11),

- separating along the buried brittle plane (11), initiated at the local unbonded area (31) after microcrack growth in said plane (11) by thermal activation, the separation resulting in the transfer of a thin film (10) from the donor substrate (1) to the support substrate (2),

wherein the local unbonded area (31) is generated by at least one roughened area (31a) produced by scanning a laser beam over at least one of the front faces (1a, 2a) of the donor (1) and support (2) substrates prior to their assembly, the scanning extending over an area of at least 100 micrometers by 100 micrometers and at most 500 micrometers by 500 micrometers.

[Claim 2] The transfer method according to the preceding claim, wherein the roughened area is produced by surface fusion of a material making up the donor substrate (1) and/or the support substrate (2), on the side of their respective front faces (1a, 2a).

[Claim 3] The transfer method according to claim 2, wherein the laser beam scan has a duration of between 20 microseconds and 100 microseconds, during which the beam has an energy density of between 5 mJ/m^2 and 7 mJ/m^2.

[Claim 4] The transfer method according to claim 3, wherein the laser beam has a wavelength of 355 nm.

[Claim 5] The transfer method according to one of the preceding claims, wherein the laser beam has a size inscribed in a circle 80 micrometers in diameter.

[Claim 6] The transfer method according to one of the preceding claims, wherein the local unbonded area (31) is generated by a plurality of elementary roughened areas (31a) separated from one another, each produced by scanning the laser beam over an area of at least 100 micrometers by 100 micrometers and at most 200 micrometers by 200 micrometers.

[Claim 7] The transfer method according to one of the preceding claims, wherein the roughened area (31a) is produced on the front face (1a) of the donor substrate (1), prior to the formation of the buried brittle plane (11) in said donor substrate (1).

[Claim 8] The transfer method according to claim 7, wherein:

- the donor substrate (1) is formed from a first material on its front face (1a), and a preliminary roughened area is formed on the surface of said material, and
- thermal oxidation of the first material of the donor substrate (1) is carried out after formation of the preliminary roughened area and before formation of the buried brittle plane (11), to form an insulating layer that will be assembled on the support substrate (2) in the bonded assembly (100), said insulating layer comprising, on its free face, the roughened area (31a) plumb with the preliminary roughened area.

[Claim 9] The transfer method according to one of claims 1 to 6, wherein:

- the support substrate (2) is formed from a first material on its front face (2a), and a preliminary roughened area is formed on the surface of said material, and
- thermal oxidation of the first material of the support substrate (2) is carried out after formation of the preliminary roughened area, to form an

insulating layer that will be assembled on the donor substrate (1) in the bonded assembly (100), said insulating layer comprising, on its free face, the roughened area (31a) plumb with the preliminary roughened area.

[Claim 10] The transfer method according to one of the preceding claims, wherein the local unbonded area (31) has at least one lateral dimension, in the plane of the bonding interface (3), of less than 500 micrometers.

[Claim 11] The transfer method according to one of the preceding claims, wherein the donor substrate (1) and the support substrate (2) have a disc shape with a diameter of 300 mm.

[Claim 12] The transfer method according to one of the preceding claims, wherein the local unbonded area (31) is located at more than 3 mm from the edge of the bonded assembly (100), in the plane of the bonding interface (3).

[Claim 13] The transfer method according to claim 12, wherein the local unbonded area (31) is located at less than 10 mm from the edge of the bonded assembly (100), in the plane of the bonding interface (3).

[Claim 14] The transfer method according to claim 12 or 13, further comprising a step of annealing the bonded assembly (100) to cause separation along the buried brittle plane (11), this step being carried out in a furnace by holding the bonded assembly (100) there vertically and angularly oriented so as to place the roughened area (31a) in an upper portion of the furnace.

[Claim 15] The transfer method according to one of the preceding claims, wherein the thin film (10) from the donor substrate (1) is monocrystalline silicon and the support substrate (2) comprises monocrystalline silicon, to form a stacked SOI structure (110).