

BRIEF DESCRIPTION OF THE INVENTION

One object of the invention is to provide a process for transferring blocks from a donor substrate to a receiver substrate which allows the above-described drawbacks to be overcome.

5 In particular, the invention aims in particular to provide such a process which is compatible with the transfer of thin layers and with the use of a high-value donor substrate, and which allows more freedom as to the dimensions of the donor substrate and in particular the use of a donor substrate of smaller diameter than the receiver substrate.

Another object of the invention is to allow the donor substrate to be recycled and
10 reused, which is very particularly advantageous in the case of a high-value donor substrate.

To this end, an aspect of the present application provides a process for transferring blocks from a donor substrate to a receiver substrate, comprising the following steps:

- arranging a mask facing a free surface of the donor substrate, the mask having one or more openings that expose the free surface of the donor
15 substrate, these being distributed according to a given pattern, so as to form at least one exposed region of the free surface of the donor substrate, and at least one region covered by the mask,
- forming, by ion implantation through the mask, an embrittlement plane localized in the donor substrate vertically in line with at least one exposed
20 region, said embrittlement plane delimiting, in the thickness of the donor substrate, a respective surface region,
- forming a block that is raised relative to the free surface of the donor substrate localized vertically in line with each respective embrittlement plane, said block comprising the respective surface region,
- 25 - bonding the donor substrate to the receiver substrate via each block located at the bonding interface, after having removed the mask,
- detaching the donor substrate along each localized embrittlement plane in order to transfer each respective block to the receiver substrate.

In the present text, the term "vertically in line" refers to a region located facing another
30 in the direction of the thickness of the substrate, i.e. in a direction perpendicular to the main surface of the substrate. The term "localized vertically in line" means a region which is delimited, in a direction parallel to the main surface of the substrate, by the extent of the other region; in other words, a region localized vertically in line with another does not extend beyond this other region in the direction parallel to the main surface of the substrate.

35 Thus, in particular, in the present process, each block is singulated in the donor substrate by being delimited, in a direction parallel to the main surface of the donor substrate, by a respective embrittlement plane. This allows localized transfer of each block to the receiver substrate.

According to other embodiments, the proposed process has the following various features, which may be implemented alone or in technically feasible combinations thereof:

- according to the process:
 - the steps of arranging the mask, of ion implantation, and of forming each block are repeated one or more times on the same donor substrate in order to form at least a second pattern that is offset relative to the preceding pattern, referred to as the first pattern, and
 - the steps of removing the mask, of bonding, and of detaching are repeated in order to transfer each block from the donor substrate to the same receiver substrate or a different receiver substrate;
- to form the second pattern, the mask is arranged so as to cover the recess left in the thickness of the donor substrate by each previously transferred block;
- according to the process:
 - the steps of arranging the mask, of ion implantation, and of forming each block are repeated one or more times on at least a second donor substrate in order to form at least a second pattern, and
 - the steps of removing the mask, of bonding, and of detaching are repeated in order to transfer each block from the second donor substrate to the same receiver substrate or to a different receiver substrate;
- the operation of forming each block comprises an operation of swelling the material of the donor substrate from the free surface of the donor substrate under the effect of ion implantation;
- the operation of forming each block comprises an operation of depositing an additional layer on the free surface of the donor substrate through the respective opening;
- the operation of depositing the additional layer is performed after ion implantation, at a temperature between 200°C and 250°C;
- the process further comprises a surface treatment that aims to make the exposed surface of the transferred blocks planar and to decrease the roughness thereof;
- the operation of bonding the blocks is accompanied by an operation of thermally annealing the donor substrate and the receiver substrate;
- the operation of detaching the donor substrate is initiated thermally or mechanically by applying a mechanical stress with a view to separating the donor substrate from the receiver substrate;
- the process further comprises a step of recycling the donor substrate after transferring the blocks by treating the free surface of said donor substrate with a view to making it planar and decreasing the roughness thereof;

CLAIMS

1. Process for transferring blocks from a donor substrate to a receiver substrate, comprising the following steps:
 - 5 - arranging a mask facing a free surface of the donor substrate, the mask having one or more openings that expose the free surface of the donor substrate, these being distributed according to a given pattern, so as to form at least one exposed region of the free surface of the donor substrate, and at least one region covered by the mask,
 - 10 - forming, by ion implantation through the mask, an embrittlement plane localized in the donor substrate vertically in line with at least one exposed region, said embrittlement plane delimiting, in the thickness of the donor substrate, a respective surface region,
 - 15 - forming a block that is raised relative to the free surface of the donor substrate localized vertically in line with each respective embrittlement plane, said block comprising the respective surface region,
 - bonding the donor substrate to the receiver substrate via each block located at the bonding interface, after having removed the mask,
 - 20 - detaching the donor substrate along each localized embrittlement plane in order to transfer each respective block to the receiver substrate.
2. Process according to Claim 1, wherein:
 - 25 - the steps of arranging the mask, of ion implantation, and of forming each block are repeated one or more times on the same donor substrate in order to form at least a second pattern that is offset relative to the preceding pattern, referred to as the first pattern, and
 - the steps of removing the mask, of bonding, and of detaching are repeated in order to transfer each block from the donor substrate to the same receiver substrate or a different receiver substrate.
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3. Process according to Claim 2, wherein to form the second pattern, the mask is arranged so as to cover the recess left in the thickness of the donor substrate by each previously transferred block.
- 35 4. Process according to Claim 1, wherein:
 - the steps of arranging the mask, of ion implantation, and of forming each block are repeated one or more times on at least a second donor substrate in order to form at least a second pattern, and

- the steps of removing the mask, of bonding, and of detaching are repeated in order to transfer each block from the second donor substrate to the same receiver substrate or to a different receiver substrate.

- 5 5. Process according to any one of the preceding claims, wherein the operation of forming each block comprises an operation of swelling the material of the donor substrate from the free surface of the donor substrate under the effect of ion implantation.
- 10 6. Process according to any one of Claims 1 to 4, wherein the operation of forming each block comprises an operation of depositing an additional layer on the free surface of the donor substrate through the respective opening.
- 15 7. Process according to Claim 6, wherein the operation of depositing the additional layer is performed after ion implantation, at a temperature between 200°C and 250°C.
- 20 8. Process according to any one of the preceding claims, further comprising a surface treatment that aims to make the exposed surface of the transferred blocks planar and to decrease the roughness thereof.
- 25 9. Process according to one of the preceding claims, wherein the operation of bonding the blocks is accompanied by an operation of thermally annealing the donor substrate and the receiver substrate.
- 30 10. Process according to any one of the preceding claims, wherein the operation of detaching the donor substrate is initiated thermally or mechanically by applying a mechanical stress with a view to separating the donor substrate from the receiver substrate.
- 35 11. Process according to any one of the preceding claims, further comprising a step of recycling the donor substrate after transferring the blocks by treating the free surface of said donor substrate with a view to making it planar and decreasing the roughness thereof.
- 40 12. Process according to any one of the preceding claims, wherein the receiver substrate is made of silicon and the blocks of the donor substrate are made of III-V semiconductor material.