

to reinforce the bonding strength). Said high temperature induces recrystallization of the polycrystalline silicon layer, the underlying HR silicon substrate – which is monocrystalline – acting as a seed for such recrystallization. In other words, a recrystallization front propagates through the polysilicon layer from the interface with the HR monocrystalline silicon substrate.

When recrystallizing, the polysilicon layer loses its trapping efficiency due to the drop in the number of grain boundaries and larger grain size variation which could results in larger surface roughness and charge trapping uniformity.

In order to limit recrystallization, the thickness of the polysilicon layer can be set to a sufficiently high thickness such that, at the end of the high temperature step(s), at least a part of the polysilicon layer has not recrystallized yet.

Besides, a large deposited thickness is also needed to compensate the fact that the polysilicon layer has to be polished after deposition in order to reduce its roughness, said polishing step removing a certain thickness of the polysilicon layer.

For these reasons, in current enhanced HR-SOI structures, the deposited polysilicon layer typically has a thickness thicker than 2  $\mu\text{m}$ .

However, increasing the thickness of the polysilicon layer has a drawback. Indeed, when the polysilicon layer is deposited using chemical vapour deposition (CVD), the polysilicon first forms nuclei on the surface of the HR silicon substrate, then forms small grains that progressively enlarge in a substantially conical way as the thickness of the polysilicon layer grows. As a result, the surface of the polysilicon layer opposite to the HR silicon substrate comprises less grain boundaries than the surface located at the interface with the HR silicon substrate. Hence, the greater the thickness of the polysilicon layer, the smaller the number of grain boundaries and thus the smaller the trapping efficiency of the polysilicon layer.

## BRIEF DESCRIPTION OF THE INVENTION

~~A goal~~Embodiments of the invention ~~is seek~~ to overcome the above-mentioned problems and in particular to allow reducing the thickness of the polycrystalline silicon layer without deteriorating the trapping efficiency of said layer.

Accordingly, an aspect of the invention provides a structure for radiofrequency applications comprising:

- a monocrystalline substrate,
- a polycrystalline silicon layer directly on the monocrystalline substrate,
- an active layer on the polycrystalline silicon layer, intended to receive radiofrequency components,

said structure being characterized in that at least a first portion of the polycrystalline silicon layer extending from the interface of the polycrystalline silicon layer with the

monocrystalline layer includes carbon and/or nitrogen atoms located at the grain boundaries of the polycrystalline silicon, in a concentration comprised between 2% and 20%.

As will be explained in more detail below, the carbon and/or nitrogen atoms are trapped at grain boundaries of the polycrystalline silicon, which slows down the recrystallization kinetics.

This allows reducing the thickness of the polysilicon layer while still avoiding complete recrystallization of said layer at the end of the heat treatment(s).

Such a polysilicon layer with a reduced thickness comprises, at the surface opposite to the monocrystalline substrate, a greater number of grain boundaries and thus traps more efficiently the electrical charges present at said surface than a thicker layer. In addition, a smaller thickness of the polysilicon induces a limited surface roughness and thus minimizes the polishing step and more uniformity grain size across the wafer and wafer-to-wafer.

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According to an embodiment, the whole polycrystalline silicon layer contains carbon and/or nitrogen atoms.

In such case, the thickness of the polycrystalline silicon layer ranges from 200 to 1000 nm.

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According to another embodiment, the polycrystalline silicon layer further comprises, on the first portion containing carbon and/or nitrogen atoms, a second portion free from carbon and/or nitrogen atoms.

By "free" is meant that the concentration in carbon and/or nitrogen atoms is less than 0.5%.

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In such case, the thickness of the first portion of the polycrystalline silicon layer advantageously ranges from 10 to 200 nm. The whole thickness of the polycrystalline silicon layer thus preferably ranges from 20 to 500 nm.

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According to an embodiment, the monocrystalline substrate comprises at least one of: monocrystalline silicon having an electrical resistivity greater than 500 Ohm.cm, silicon carbide, and/or germanium.

According to an embodiment, the active layer comprises at least one of: a semiconducting material, a dielectric material, a ferroelectric material, and a substructure comprising at least one cavity and at least one suspended element on said cavity.

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According to another embodiment, the structure further comprises a dielectric layer on the polycrystalline silicon layer, the active layer being on said dielectric layer.

Another ~~object aspect~~ of the invention ~~relates to~~provides a process for manufacturing ~~such a structure for radio frequency applications~~.

Said process comprises:

- providing a monocrystalline substrate,
- depositing, on said monocrystalline substrate, a polycrystalline silicon layer,
- providing a donor substrate comprising an active layer intended to receive radiofrequency components,

5       - bonding the monocrystalline substrate and the donor substrate such that the polycrystalline silicon layer and the active layer are at the bonding interface,

      - transferring the active layer onto the monocrystalline substrate and the polycrystalline silicon layer,

      said process being characterized in that during deposition of at least a first portion of the polycrystalline silicon layer located at the interface with the monocrystalline substrate, carbon and/or nitrogen atoms are deposited in said first portion.

Advantageously, the polycrystalline silicon layer is deposited by Low-Pressure Chemical Vapor Deposition (LPCVD) in a reactor.

      A gas containing carbon and/or nitrogen atoms is introduced in the LPCVD reactor to form at least the first portion.

      According to an embodiment, said gas is introduced in the LPCVD reactor during the deposition of the whole polycrystalline silicon layer.

      The thickness of the polycrystalline silicon layer thus preferably ranges from 200 to 1000 nm.

20       According to another embodiment, after the first portion has been deposited, the process comprises stopping the introduction of the gas containing the carbon and/or nitrogen atoms in the LPCVD reactor and further depositing a carbon and/or nitrogen-free second portion of the polycrystalline layer, the concentration in carbon and/or nitrogen in the second portion being less than 0.5%.

25       The thickness of the first region of the polycrystalline silicon layer thus preferably ranges from 10 to 200 nm.

      According to another embodiment, the process further comprises forming a dielectric layer on the polycrystalline silicon layer and/or on the active layer of the donor substrate.

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## **BRIEF DESCRIPTION OF THE DRAWINGS**

Further features and advantages of the invention will become apparent from the detailed description that follows, based on the appended drawings, wherein:

35       - FIG. 1 shows a cross sectional view of a known semiconductor on insulator structure comprising a polysilicon layer;

      - FIG. 2 shows a cross sectional view of a structure according to an embodiment of the invention;

9. Structure according to one of claims 1 to 8, wherein said structure further comprises a dielectric layer on the polycrystalline silicon layer, the active layer being on said dielectric layer.

5 10. Process for manufacturing a structure for radiofrequency applications, comprising:

- providing a monocrystalline substrate,
- depositing, on said monocrystalline substrate, a polycrystalline silicon layer,
- providing a donor substrate comprising an active layer intended to receive

10 radiofrequency components,

- bonding the monocrystalline substrate and the donor substrate such that the polycrystalline silicon layer and the active layer are at the bonding interface,

- transferring the active layer onto the monocrystalline substrate and the polycrystalline silicon layer,

15 said process being characterized in that during deposition of at least a first portion of the polycrystalline silicon layer located at the interface with the monocrystalline substrate, carbon and/or nitrogen atoms are deposited in said first portion.

20 11. Process according to claim 10, wherein the polycrystalline silicon layer is deposited by Low-Pressure Chemical Vapor Deposition (LPCVD) in a reactor.

12. Process according to claim 11, wherein a gas containing carbon and/or nitrogen atoms is introduced in the LPCVD reactor to form at least the first portion.

25 13. Process according to one of claim 12, wherein said gas is introduced in the LPCVD reactor during the deposition of the whole polycrystalline silicon layer.

14. Process according to claim 13, wherein the thickness of the polycrystalline silicon layer ranges from 200 to 1000 nm.

30 15. Process according to claim 12, wherein after the first portion has been deposited, the process comprises stopping the introduction of the gas containing the carbon and/or nitrogen atoms in the LPCVD reactor and further depositing a carbon and/or nitrogen-free second portion of the polycrystalline layer, the concentration in carbon and/or nitrogen in the second portion being less than 0.5%.

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16. Process according to claim 15, wherein the thickness of the first region of the polycrystalline silicon layer ranges from 10 to 200 nm.