ELECTRONIC DEVICE FOR RADIOFREQUENCY OR POWER APPLICATIONS AND PROCESS FOR MANUFACTURING SUCH A DEVICE

FIELD OF THE INVENTION

The present invention relates to an electronic device for radiofrequency or power applications, comprising a semiconductor layer supporting electronic components on a support substrate, and processes for manufacturing such a device.

BACKGROUND OF THE INVENTION

The production of microelectronic devices, particularly for applications in the field of radiofrequency or power, requires the placing of components on a support substrate having a high electrical resistivity and good thermal conductivity.

Indeed, a high resistivity makes it possible to limit high-frequency interactions between transistors (the field line penetration in the substrate causing parasitic effects).

A good thermal conductivity is necessary to discharge the heat generated by high-frequency or high-power device operation.

According to a known solution, these devices may be produced on SOI (an acronym of the term "Silicon On Insulator") type substrates, wherein the silicon support substrate (or a part thereof) is highly resistive.

In this way, document US 2009/321,873 describes a structure successively comprising a silicon support substrate, a layer of high-resistivity silicon, a layer of silicon oxide and a thin layer of silicon wherein the components are formed.

Document US 2007/032,040 describes an SOI substrate comprising a silicon support substrate having an electrical resistivity greater than 3000 Ohm.cm, a layer of silicon oxide and a thin layer of silicon wherein the components are formed.

However, these substrates involve the drawback of having a low thermal conductivity, particularly due to the presence of a relatively thick layer of silicon oxide (SiO_2), which is a poor heat conductor.

The thermal conductivity of such SOI substrates, since the oxide thickness exceeds about 50 nm, may then be limited by the conductivity of this silicon oxide, of the order of 1 to 2 W/m K, which is insufficient for the intended applications.

According to a second known solution, the components may be produced on a first substrate, for example a silicon substrate, and after the production thereof said components may be transferred onto a final support substrate made of sapphire which is a material having an electrical resistivity of the order of 10^{14}Ohm.cm.

Such an approach is presented for example in document US 6,944,375.

However, sapphire has a thermal conductivity of 30 to 40 W/m K, which is considered to have scope for improvement for the intended applications.

An oxide layer is inserted between the layer supporting the components and the sapphire substrate, to facilitate bonding.

However, as explained above, this oxide layer may form a thermal barrier preventing heat dissipation within the sapphire substrate.

Moreover, sapphire substrates are relatively costly, particularly for diameters larger than 150 mm.

One aim of the present invention is thus of providing a support substrate for a device for radiofrequency or power applications.

More specifically, this support substrate may have both a high electrical resistivity, i.e. greater than 3000 Ohm.cm, and a thermal conductivity at least equally as good as that of silicon (preferably greater than 30 W/m K), while being less costly than sapphire.

This substrate should be suitable for being manufactured to form large wafers, i.e. typically having a diameter greater than 150 mm.

This support substrate should also be suitable for the manufacturing process of the device, and particularly have the required thermal properties (in particularly, in terms of thermal expansion coefficient and temperature resistance) according to the process defined.

BRIEF DESCRIPTION OF THE INVENTION

A first aspect of the invention provides an electronic device for radiofrequency or power applications, comprising a semiconductor layer supporting electronic components

on a support substrate, characterised in that it comprises a bonding layer between the support substrate and the layer supporting the components, said bonding layer consisting of a silicon oxide layer having a thickness of less than 50 nm, a layer of AlN, of alumina or of high-resistivity polycrystalline silicon, and in that the support substrate comprises a base layer having a thermal conductivity of at least 30 W/m K and a superficial layer having a thickness of at least 5 µm, said superficial layer having an electrical resistivity of at least 3000 Ohm.cm and a thermal conductivity of at least 30 W/m K.

Said superficial layer is between the base layer and the semiconductor layer.

According to an embodiment of the invention, the support substrate is a bilayer substrate comprising a superficial layer of AlN, alumina or amorphous diamond-like carbon having a thickness greater than 5 µm on a silicon base substrate.

According to an embodiment of the invention, the support substrate is a silicon substrate comprising a porous surface region having a thickness greater than 5 µm.

According to an embodiment of the invention, the support substrate is an aluminium substrate encased with an AlN or alumina coating having a thickness greater than 5 µm.

According to an embodiment of the invention, the support substrate is a silicon substrate comprising a surface region doped with gold, with a concentration greater than 10^{15} at/cm^3 and having a thickness greater than 5 µm.

The layer supporting the components is preferably made of silicon, germanium or a group III-V alloy.

Alternatively, a layer of AlN, alumina, amorphous diamond-like carbon or high-resistivity polycrystalline silicon may be inserted between the support substrate and the layer supporting the components.

The device may be a wafer having a diameter greater than or equal to 150 mm.

Alternatively, the device may be a chip.

Another aspect of the invention provides a process for manufacturing a device for radiofrequency or power applications, comprising a layer supporting electronic components on a support substrate, said process comprising the following successive steps:

a) formation of a structure comprising a semiconductor layer on the support substrate via a bonding layer formed on the semiconductor layer, said bonding layer consisting of a silicon oxide layer having a thickness of less than 50 nm, a layer of AlN, of alumina or of high-resistivity polycrystalline silicon,

(b) manufacture of the components in the semiconductor layer,

characterised in that in step (a), a support substrate comprising a base layer having a thermal conductivity of at least 30 W/m K and a superficial layer having a thickness of at least 5 µm, said superficial layer having an electrical resistivity of at least 3000 Ohm.cm and a thermal conductivity of at least 30 W/m K, is used.

According to an embodiment, the support substrate is a bilayer substrate comprising a layer of AlN, alumina or amorphous diamond-like carbon having a thickness greater than 5 µm on a silicon base substrate.

According to another embodiment, the support substrate is a silicon substrate comprising a porous surface region having a thickness greater than 5 µm.

Another aspect of the invention provides a process for manufacturing a device for radiofrequency or power applications, comprising a layer supporting electronic components on a support substrate, comprising the following successive steps:

(a) manufacturing of the components in a semiconductor layer of a donor substrate,

(b) bonding of the semiconductor layer supporting the components on an intermediate substrate,

(c) removal of the remainder of the donor substrate to transfer the layer supporting the components onto the intermediate layer,

(d) bonding of the layer supporting the components on the support substrate,

(e) removal of the intermediate substrate,

characterised in that a bonding layer being at the interface between the support substrate and the layer supporting the components, said bonding layer consisting of a silicon oxide layer having a thickness of less than 50 nm, a layer of AlN, of alumina or of high-resistivity polycrystalline silicon, and in that, in step (d), a support substrate comprising a base layer having a thermal conductivity of at least 30 W/m K and a superficial layer having a thickness of at least 5 µm, said superficial layer having an electrical resistivity of at least 3000 Ohm.cm and a thermal conductivity of at least 30 W/m K, is used.

According to an embodiment, the support substrate is a bilayer substrate comprising a layer of AlN, alumina or amorphous diamond-like carbon having a thickness greater than 5 µm on a silicon base substrate.

According to an embodiment, the support substrate is a silicon substrate comprising a porous surface region having a thickness greater than 5 µm.

According to another embodiment, the support substrate is an aluminium substrate encased with an AlN or alumina coating having a thickness greater than 5 µm.

According to another embodiment, the support substrate is a silicon substrate comprising a surface region doped with gold, with a concentration greater than 10^{15} at/cm^3 and having a thickness greater than 5 µm.

Particularly preferably, the donor substrate successively comprises a first substrate, a silicon oxide layer having a thickness less than 50 nm and the semiconductor layer, and, during step (c), said silicon oxide layer is left on the layer supporting the components.

BRIEF DESCRIPTION OF THE FIGURES

Further features and advantages of the invention will emerge from the detailed description hereinafter, with reference to the appended figures wherein:

- figures 1A to 1E illustrate schematically the main steps of a first process for manufacturing a device according to the invention,

- figure 2 is a schematic view of an embodiment of a device according to the invention,

- figure 3 is a schematic view of another embodiment of a device according to the invention,

- figures 4A to 4F illustrate schematically the main steps of a second process for manufacturing a device according to the invention.

It is specified that, to facilitate the illustration of the devices, the ratios of the thicknesses of the various layers have not necessarily been observed.

DETAILED DESCRIPTION OF THE INVENTION

The device may be manufactured according to two main processes, described hereinafter with reference to figures 1A to 1E and 4A to 4F respectively.

<u>First process: manufacture of components in a semiconductor layer on the support substrate</u>

A first process generally consists of first manufacturing a structure comprising the support substrate and the thin semiconductor layer for receiving the components, and manufacturing the components in said semiconductor layer.

The techniques for manufacturing components involve high temperatures, i.e. typically greater than 1000°C.

Therefore, this means that the support substrate needs to be able to withstand such temperatures.

Moreover, the support substrate should have a thermal expansion coefficient at the temperature in question which of the same order as that of the material of the semiconductor layer supporting the components, to prevent stress generation in the structure during the manufacture thereof.

In this way, for a semiconductor layer supporting the components made of silicon, and a process for manufacturing the structure requiring exposure at 800°C, the thermal expansion coefficient of the support substrate is between 1 and $5x10^{-6}$ K^{-1}.

With reference to figure 1A, a support substrate 1 selected from the substrates described in detail hereinafter is provided.

With reference to figure 1B, a donor substrate 20 comprising a semiconductor layer 2 is provided.

The thickness of the semiconductor layer 2 is typically between 10 nm and 10 µm.

The semiconductor layer 2 preferably comprises silicon, germanium or a nitride of one or a plurality of group III elements (for example, gallium nitride) or a group III-V alloy such as InP or AsGa.

The layer 2 may be an integral part of the donor substrate, particularly in the case of a bulk substrate.

In an alternative embodiment, the layer 2 may have been formed on a substrate 22 by epitaxy (the material of the substrate 22 being in this case suitable for the epitaxial growth of the material of the layer 2) or bonded onto the substrate 22.

With reference to figure 1C, the semiconductor layer 2 is bonded on the support substrate 1.

Optionally, a layer (not illustrated here) may be formed on said semiconductor layer 2 to facilitate bonding.

This bonding layer may be produced in a material having electrical and/or thermal properties that are compatible with the intended application and enabling bonding: for example, it may consist of alumina, AlN, high electrical resistivity polycrystalline silicon, or silicon oxide provided that the thickness thereof does not exceed 50 nm.

With reference to figure 1D, a part 22 of the donor substrate 20 is removed so as to only retain the semiconductor layer 2 on the support substrate 1.

This transfer may typically be performed by means of a Smart-Cut™ process, whereby (as illustrated in figure 1B) the donor substrate 20 will have previously undergone implantation of atomic species at a depth corresponding to the thickness of the layer 2 to be transferred, so as to form an embrittlement zone 21. After bonding, the application of thermal and/or mechanical stress to the embrittlement zone enables the cleavage of the donor substrate, with a view to the detachment thereof from the rest of the structure.

Alternatively, the donor substrate may be removed by thinning via the rear face thereof, obtained by means of chemical and/or physical etching.

With reference to figure 1E, components are formed in the semiconductor layer 2, by any technique known to those skilled in the art.

Support substrates suitable for the implementation of this process and having both a good electrical resistivity and a good thermal conductivity will now be described with reference to figures 2 and 3.

The support substrate 1 advantageously comprises a base layer that constitutes a mechanical support for the electronic device, and a superficial layer that is chosen so as to have both a high thermal conductivity and a high electrical resistivity.

By "superficial" is meant that the layer is located on the side of the base layer that is closest to the semiconductor layer 2.

However, in some embodiments, depending on the way of forming the superficial layer, the base layer may be encapsulated by the superficial layer. Alternatively, the superficial layer may be deposited on both sides of the base layer.

The superficial layer has a thickness of at least 5 μm.

The superficial layer has both a high thermal conductivity and a high electrical resistivity.

Preferably, the thermal conductivity of the superficial layer is of at least 30 W/m K and its electrical resistivity is of at least 3000 Ohm.cm.

The base layer has a thickness selected so as to provide a sufficient stiffness to the electronic device.

The base layer preferably has a high thermal conductivity (i.e. at least 30 W/m K) in order to allow heat dissipation through the whole support substrate.

However, since the base layer is relatively far from the semiconductor layer (from which it is separated by the at least 5 µm thick superficial layer), it does not require to present any particular electrical resistivity.

In particular, the base layer may have an electrical resistivity that is less than the electrical resistivity of the superficial layer.

In this respect, the base layer can be made of a material that is available in large diameters and that is less expensive than sapphire, while presenting a higher thermal conductivity.

By uncoupling the requirements of thermal conductivity and electrical resistivity, it is thus possible to define a support substrate that presents a high electrical resistivity in the 5 µm thick layer that is closest to the components, and a high thermal conductivity.

Therefore, it is possible to choose independently the layer that provides the electrical resistivity and the layer that provides the thermal conductivity.

Several embodiments of the support substrate are described below.

Bilayer support substrate

By "bilayer" is meant in the present text that the support substrate comprises at least two layers having different thermal conductivity and electrical resistivity.

Said at least two layers may be made of different materials.

Referring to figure 2, the support substrate 1 comprises a base substrate 12 made of a first material having a high thermal conductivity, coated with a superficial layer 13 made of a second material which also has a high thermal conductivity but above all a high electrical resistivity.

The second material preferably further has a good adherence with respect to the semiconductor material of the thin layer 2.

Failing this, a bonding layer as mentioned above may be provided on the surface thereof.

This substrate 1 is manufactured by depositing a thick layer 13 (i.e. having a thickness typically greater than 10 µm, and in any event greater than 5 µm) of the second material on a substrate 12 of the first material.

According to one preferred embodiment, the first material is silicon and the second material is AlN or amorphous diamond-like carbon (also known as DLC).

The techniques for the deposition of these materials are known to those skilled in the art.

The AlN deposition may include chemical vapour deposition (CVD) and particularly the high temperature chemical vapour deposition (HTCVD) process.

A further process suitable for AlN deposition is pulsed DC sputtering.

For the amorphous diamond-like carbon deposition, the following techniques may be mentioned: plasma-enhanced chemical vapour deposition (PECVD), the filtered cathodic vacuum arc (FCVA) technique, pulsed laser deposition (PLD).

Optionally, in view of bonding the layer 2 on the thick layer 13 of the substrate 1, a fine silicon oxide layer 3 may be formed on the layer 2.

As mentioned in the previous case, the oxide layer has a thickness of less than 50 nm.

Support substrate having a modified surface region

An alternative embodiment for obtaining a support substrate according to the invention comprises the application, to a bulk substrate, of a surface treatment giving a surface region of the substrate enhanced properties in terms of thermal conductivity and/or electrical resistivity.

In this respect, the base layer and the superficial layer may be made of the same material, but the material of the superficial layer is structurally and/or chemically and/or physically modified so that the electrical resistivity and/or the thermal conductivity of said layer is different from the electrical resistivity and/or the thermal conductivity of the base layer.

More specifically, the surface of a bulk silicon substrate may be porosified to form, on the surface, a thick porous superficial layer, i.e. having a thickness of the order of 5 µm.

The porous superficial layer is formed for example by means of an electrochemical reaction in an HF type electrolyte.

Obtaining a high resistivity in the porosified region is associated with the morphology of this region.

Therefore, it is possible to ensure that a surface region of the substrate having a very high electrical resistivity is formed.

Figure 3 illustrates a device comprising a layer 2' of components on such a support substrate 1, wherein the region 14 of the substrate 1 situated under the layer 2' has a very high resistivity.

Moreover, since the substrate is made of silicon, it has a satisfactory thermal conductivity for the intended applications.

Second process: transfer of layer supporting components onto the support substrate

A second process generally consists of manufacturing the components in a semiconductor layer of a substrate referred to as the donor substrate, and carrying out a double transfer to transfer the layer comprising the components onto the final support substrate.

As illustrated in figure 4A, a donor substrate 20 comprising a semiconductor layer 2 is provided.

The thickness of the semiconductor layer 2 is typically between 10 nm and 10 µm.

The semiconductor layer 2 preferably comprises silicon, germanium or a nitride of one or a plurality of group III elements (for example, gallium nitride) or a group III-V alloy such as InP or AsGa.

The layer 2 may be an integral part of the donor substrate, particularly in the case of a bulk substrate.

In an alternative embodiment, the layer 2 may have been formed on a substrate 22 by epitaxy (the material of the substrate 22 being in this case suitable for the epitaxial growth of the material of the layer 2) or bonded onto the substrate 22 to form the donor substrate 20.

The material of the donor substrate is suitable for withstanding the high temperatures used for the manufacture of the components.

It should also provide the whole with sufficient rigidity for handling during the various steps of the process.

According to one preferred embodiment of the invention, the donor substrate is a semiconductor on insulator (SOI) type substrate, i.e. successively comprising a first substrate 22 acting as a mechanical substrate, an embedded layer 23 which may be a layer of silicon oxide having a thickness less than 50 nm or a layer of AlN, alumina or high-resistivity polycrystalline silicon, and the layer 2 wherein the components are to be manufactured.

This embodiment is illustrated in figures 4A to 4F.

With reference to figure 4B, the required components are manufactured in and/or on the semiconductor layer 2, using processes known to those skilled in the art.

With reference to figure 4C, the semiconductor layer 2' comprising the components is bonded onto an intermediate substrate 4.

In this case, the components of the semiconductor layer 2' are found in an inverted position with respect to the configuration wherein they were manufactured.

With reference to figure 4D, the remainder of the donor substrate 22 is removed so as only to leave, on the intermediate substrate 4, the layer 2' supporting the components coated with the layer 23.

In this donor substrate removal step, which is typically carried out by means of mechanical etching followed by chemical etching, the layer 23 acts as a barrier layer with respect to the etching agent and makes it possible to protect the layer 2'.

With reference to figure 4E, the structure obtained in the previous step is bonded onto the support substrate 1, which is the final support substrate of the device, the layer 23 being situated at the interface.

Said support substrate 1 is a substrate according to the invention, i.e. having both a high electrical resistivity, at least in the 5 µm thick superficial layer, and a high thermal conductivity.

Provided that the donor substrate bonding and thinning treatments are implemented at lower temperatures than the manufacture of the components, the thermal stress applied to the support substrate are lower than for the first process.

In this way, the support substrate should withstand temperatures between 400 and 600°C, and the influence of the thermal expansion coefficient thereof is also lower than in the case of the first process.

Support substrates suitable for the implementation of the process will be described below.

Naturally, support substrates devised for the implementation of the first process are also suitable for use in the second process, since the thermal stress applied is lower.

In this bonding step, the layer 23 acts as a bonding layer to facilitate the adhesion of the layer 2' on the support substrate 1.

With reference to figure 4F, the intermediate substrate 4 is removed so as only to leave, on the support substrate 1, the layer 23, which is again embedded, and the semiconductor layer 2' comprising the components.

The components are thus restored to the configuration wherein they were manufactured.

This removal step may be implemented using any technique known to those skilled in the art.

For example, the donor substrate may be thinned via the rear face thereof, comprising material removal by means of chemical and/or physical etching (polishing).

For the implementation of this transfer process of the layer supporting the components, reference may also be made to document US 6,911,375 describing an example of implementation thereof.

It should be noted that, if the layer 23 is a layer of silicon oxide, it is sufficiently thin so as not to form a thermal barrier in the device.

A plurality of support substrates having both a high electrical resistivity and a high thermal conductivity, suitable for use in this process, will now be described.

Support substrate having a modified surface layer

A further embodiment, illustrated in figure 3, comprises the use of a bulk substrate subjected to a surface treatment giving a surface layer of the substrate enhanced properties in terms of thermal conductivity and/or electrical resistivity.

In this respect, the silicon support substrate having a porous surface layer is suitable for the implementation of this second process.

According to one alternative, an aluminium substrate is anodised or nitrided.

An anodising treatment results in the formation of an alumina coating 14 of up to several tens of μm thick about the substrate.

Moreover, the thicker the layer formed, the higher the porosity thereof.

A nitriding treatment of the aluminium substrate gives rise to the formation of an AlN coating 14 about the substrate.

A further means of obtaining such an AlN layer consists of performing carboreduction of an alumina layer coating the substrate.

The thickness of this AlN layer is high, i.e. having a thickness typically greater than 5 μm.

A further option is that of diffusing gold over a relatively significant thickness (i.e. at least 5 μ and preferably several tens of μm) of the top face of a silicon substrate, so as to obtain a gold concentration greater than 10^{15} at/cm^3 in this layer.

Such a support substrate is obtained for example by depositing a gold layer on the top face of a silicon substrate, and by applying a heat treatment giving rise to the diffusion of the gold atoms in the thickness of the silicon substrate.

The heat treatment conditions, particularly the duration thereof, are determined such that gold only diffuses in a surface layer of the substrate, over a thickness of approximately 5 μm, and not throughout the thickness thereof.

The article "Semi-insulating silicon for microwave devices", D.M. Jordan et al, Solid State Phenomena Vols 156-158 (2010) pp 101-106 discloses a process for doping a silicon substrate by diffusing gold throughout the substrate but requires, for the formation of an SOI type structure, the use of an encapsulation layer.

Device obtained

As illustrated generally in figures 1E and 4F, a wafer is thus obtained, comprising the thin layer 2' supporting the components, on a support substrate 1 having both a high electrical resistivity at least on the layer closest to the semiconductor layer supporting the components and a high thermal conductivity.

In particular, said wafer does not comprise, in the structure thereof, a thermal barrier, since the optional bonding layer arranged between the layer supporting the components and the support substrate is either made of a material not acting as a heat insulator (for example Al, AlN or high-resistivity

polycrystalline silicon), or sufficiently fine silicon oxide (i.e. having a thickness less than 50 nm) so that the heat insulating nature thereof does not impair heat dissipation within the support substrate.

Figures 2 and 3 illustrate various embodiments of the wafer, according to the nature of the support substrate.

Said wafer advantageously has a diameter greater than 150 mm, preferably greater than 200 mm.

The wafer may then be cut along the thickness thereof in order to separate individual chips, the cutting technical being known to those skilled in the art.

The formation of the chips may also comprise thinning of the support substrate.

Indeed, said substrate is provided with a relatively significant thickness (typically of the order of 1 mm) to display sufficient rigidity during the steps for implementing the process, but the chips may function with the thinner support substrate (typically of the order of 50, or 20 µm).

Finally, it is clear that the examples given above are merely specific illustrations which are in no way limitative in respect to the fields of application of the invention.

CLAIMS

1. Electronic device for radiofrequency or power applications, comprising a semiconductor layer supporting electronic components on a support substrate, characterized in that it comprises a bonding layer between the support substrate and the layer supporting the components, said bonding layer consisting of a silicon oxide layer having a thickness of less than 50 nm, a layer of AlN, of alumina or of high-resistivity polycrystalline silicon, and in that the support substrate comprises a base layer having a thermal conductivity of at least 30 W/m K and a superficial layer having a thickness of at least 5 µm, said superficial layer having an electrical resistivity of at least 3000 Ohm.cm and thermal conductivity of at least 30 W/m K.

2. Electronic device according to claim 1, wherein the support substrate comprises a silicon base substrate.

3. Electronic device according to claim 1, wherein the support substrate is an aluminum substrate encased with an AlN or alumina coating having a thickness greater than 5 µm.

4. Device according to claim 1, wherein the layer supporting the components is made of silicon, germanium or a group III-V alloy.

5. Device according to claim 1, wherein it is a wafer having a diameter greater than or equal to 150 mm.

6. Device according to claim 1, wherein it is a chip.

7. Device according to claim 1, wherein the superficial layer is between the base layer and the semiconductor layer.

8. Process for manufacturing a device for radiofrequency or power applications, comprising a layer supporting electronic components on a support substrate, comprising the following successive steps :
   a. formation of a structure comprising a semiconductor layer bonded on the support substrate via a bonding layer formed on the semiconductor layer, said bonding layer consisting of a silicon oxide layer having a thickness of less than 50 nm, a layer of AlN, of alumina or of high-resistivity polycrystalline silicon,
   b. manufacture of the components in the semiconductor layer,

   characterized in that in step, a support substrate comprising a base layer having a thermal conductivity of at least 30 W/m K and a

superficial layer having a thickness of at least 5 μm, said superficial layer having an electrical resistivity of at least 3000 Ohm.cm and thermal conductivity of at least 30 W/m K, is used.

9. Process according to claim 8, wherein the support substrate comprises silicon base substrate.

10. Process for manufacturing a device for radiofrequency or power applications, comprising a layer supporting electronic components on a support substrate, comprising the following successive steps :
    a. manufacture of the components in the semiconductor layer of a donor substrate,
    b. bonding the semiconductor layer supporting the components on an intermediate substrate,
    c. removal of the remainder of the donor substrate to transfer the layer supporting the components onto the intermediate substrate,
    d. bonding of the layer supporting the components on the support substrate,
    e. removal of the intermediate substrate,

    characterized in that a bonding layer being at the interface between the support substrate and the layer supporting the components, said bonding layer consisting of a silicon oxide layer having a thickness of less than 50 nm, a layer of AlN, of alumina or of high-resistivity polycrystalline silicon, and in that, in step (d), a support substrate comprising a base layer having a thermal conductivity of at least 30 W/m K and a superficial layer having a thickness of at least 5 μm, said superficial layer having an electrical resistivity of at least 3000 Ohm.cm and thermal conductivity of at least 30 W/m K, is used.

11. Process according to claim 10, wherein the support substrate comprises silicon base substrate.