

Claims

1. A Process for fabricating a substrate for epitaxial growth of a layer of gallium nitride (GaN), of aluminium gallium nitride (AlGaN) or of indium gallium nitride (InGaN), comprising the following successive steps:
 - providing a base substrate comprising at least one layer ~~(10, 51)~~ of single-crystal silicon carbide,
 - performing epitaxial growth of a layer ~~(11)~~ of semi-insulating SiC on the layer ~~(10, 51)~~ of single-crystal SiC to form a donor substrate,
 - implanting ionic species into the layer ~~(11)~~ of semi-insulating SiC so as to form a weakened region ~~(13)~~ that defines a thin layer ~~(12)~~ of single-crystal semi-insulating SiC to be transferred,
 - bonding the layer ~~(11)~~ of semi-insulating SiC to a receiver substrate ~~(20)~~ having a high electrical resistivity,
 - detaching the donor substrate along the weakened region ~~(13)~~ so as to transfer the thin layer ~~(12)~~ of single-crystal semi-insulating SiC to the receiver substrate ~~(20)~~.
2. The Process according to Claim 1, wherein the receiver substrate ~~(20)~~ has a difference in coefficient of thermal expansion with silicon carbide smaller than or equal to $3 \times 10^{-6} \text{ K}^{-1}$.
3. The Process according to either of Claims 1 and 2, wherein the receiver substrate ~~(20)~~ is chosen from a silicon substrate of high electrical resistivity, a substrate of polycrystalline SiC of high electrical resistivity, a polycrystalline AlN substrate, and a diamond substrate.
4. The Process according to one of Claims 1 to 3, wherein the epitaxial layer ~~(11)~~ of semi-insulating SiC has a thickness larger than or equal to $3 \text{ }\mu\text{m}$, preferably larger than or equal to $5 \text{ }\mu\text{m}$, and even more preferably larger than or equal to $10 \text{ }\mu\text{m}$.
5. The Process according to one of Claims 1 to 4, wherein the thin layer ~~(12)~~ transferred to the receiver substrate ~~(20)~~ has a thickness smaller than $1 \text{ }\mu\text{m}$.
6. The Process according to one of Claims 1 to 5, wherein the layer ~~(11)~~ of semi-insulating SiC is formed by doping with vanadium during the epitaxial growth of the SiC.

7. The Process according to one of Claims 1 to 6, further comprising a step of recycling the segment of donor substrate detached from the transferred layer ~~(12)~~, with a view to forming a new donor substrate.
8. The Process according to Claim 7, wherein said recycling comprises polishing a residual segment ~~(11)~~ of the layer ~~(11)~~ of semi-insulating SiC, the new donor substrate thus obtained being able to be used in a new step of implanting ionic species.
9. The Process according to Claim 7, wherein said recycling comprises polishing a residual segment ~~(11)~~ of the layer ~~(11)~~ of semi-insulating SiC and performing epitaxial regrowth in order to increase the thickness of said layer of semi-insulating SiC to form the new donor substrate.
10. The Process according to Claim 7, wherein said recycling comprises removing a residual segment ~~(11)~~ of the layer ~~(11)~~ of semi-insulating SiC to uncover the carbon face of the layer ~~(10, 51)~~ of single-crystal SiC and performing epitaxial growth of a new layer ~~(11)~~ of semi-insulating SiC on the carbon face ~~(10-C, 51-C)~~ of the layer ~~(10, 51)~~ of single-crystal SiC to form the new donor substrate.
11. The Process according to one of Claims 1 to 10, wherein:
 - the layer ~~(10, 51)~~ of single-crystal silicon carbide of the base substrate has a free carbon face ~~(10-C, 51-C)~~,
 - the epitaxial growth of the layer ~~(11)~~ of semi-insulating SiC is performed on said carbon face ~~(10-C, 51-C)~~ of the layer ~~(10, 51)~~ of single-crystal SiC,
 - the ionic species are implanted through the carbon face ~~(11-C)~~ of the layer ~~(11)~~ of semi-insulating SiC,
 - the carbon face ~~(11-C)~~ of the layer ~~(11)~~ of semi-insulating SiC is bonded to the receiver substrate ~~(20)~~,
 - at the end of the detachment, the silicon face ~~(12-Si)~~ of the transferred layer ~~(12)~~ of single-crystal semi-insulating SiC is uncovered.
12. The Process according to one of Claims 1 to 11, comprising fabricating the base substrate via the following successive steps:
 - providing a start substrate ~~(50)~~ of single-crystal SiC having a silicon face ~~(50-Si)~~,
 - implanting ionic species through the silicon face ~~(50-Si)~~ of the start substrate ~~(50)~~ so as to form a weakened region ~~(52)~~ that defines a thin layer ~~(51)~~ of single-crystal SiC to be transferred,

- bonding the silicon face ~~(50-Si)~~ of the start substrate ~~(50)~~ to an intermediate carrier ~~(40)~~,
 - detaching the start substrate ~~(50)~~ along the weakened region ~~(52)~~ so as to transfer the thin layer ~~(51)~~ of single-crystal SiC to the intermediate carrier ~~(40)~~ and to uncover the carbon face ~~(51-C)~~ of said transferred layer ~~(51)~~ of single-crystal SiC, the intermediate carrier ~~(40)~~ and the transferred layer ~~(51)~~ of single-crystal SiC together forming the base substrate.
13. The P_gprocess according to Claim 12, wherein the intermediate carrier ~~(40)~~ is an SiC substrate having a crystal quality lower than that of the start substrate ~~(50)~~.
 14. The P_gprocess according to either of Claims 12 and 13, wherein the start substrate ~~(50)~~ is bonded directly to the intermediate carrier ~~(40)~~ after activation of each surface to be bonded by bombardment of neutral species.
 15. The P_gprocess according to either of Claims 12 and 13, wherein the start substrate ~~(50)~~ is bonded to the intermediate carrier ~~(40)~~ by way of a refractory bonding layer.
 16. The P_gprocess according to one of Claims 12 to 15, comprising a step of recycling the segment of the start substrate ~~(50')~~ detached from the transferred layer ~~(51)~~, with a view to forming a new start substrate.
 17. A P_gprocess for fabricating by epitaxy a layer of gallium nitride, of aluminium gallium nitride (AlGa_N) or of indium gallium nitride (InGa_N), comprising
 - providing a substrate fabricated using the process according to one of Claims 1 to 16,
 - performing epitaxial growth of the layer ~~(30)~~ of gallium nitride, of aluminium gallium nitride (AlGa_N) or of indium gallium nitride (InGa_N) on the layer ~~(30)~~ of semi-insulating SiC of said substrate.
 18. The P_gprocess according to Claim 17, wherein the layer ~~(30)~~ of gallium nitride, of aluminium gallium nitride (AlGa_N) or of indium gallium nitride (InGa_N) has a thickness comprised between 1 and 2 μm.
 19. A P_gprocess for fabricating a high-electron-mobility transistor (HEMT), comprising:
 - fabricating by epitaxy a layer ~~(30)~~ of gallium nitride, of aluminium gallium nitride (AlGa_N) or of indium gallium nitride (InGa_N) using the process according to either of Claims 17 and 18,

- forming a heterojunction by epitaxy of a layer ~~(30)~~ of a III-N material different from gallium nitride on the layer ~~(60)~~ of gallium nitride, of aluminium gallium nitride (AlGa_N) or of indium gallium nitride (InGa_N),
- forming a channel of the transistor level with said heterojunction,
- forming a source, a drain and a gate of the transistor on the channel.