Method For Producing A Single-Crystal Film Of AlN Material And Substrate For The Epitaxial Growth Of A Single-Crystal Film Of AlN Material

FIELD OF THE INVENTION

The present invention relates to a process for producing a monocrystalline layer of aluminum nitride (AlN) material and a substrate for the epitaxial growth of such a monocrystalline layer of AlN material.

PRIOR ART

Certain materials are not currently available as a monocrystalline substrate in the form of a large-diameter wafer. Moreover, certain materials may be available in large diameter but not with certain characteristics or specifications in terms of quality, in particular with regard to the density of defects or the required electrical or optical properties.

SUMMARY OF THE INVENTION

Embodiments of the present invention aim to overcome these limitations of the prior art by providing a process for producing a monocrystalline layer of AlN material and a substrate for the epitaxial growth of such a monocrystalline layer of AlN material. In this way it is possible to address the problem of size of the monocrystalline substrates of AlN material currently available.

An aspect of the invention provides a process for producing a monocrystalline layer of AlN material comprising the transfer of a monocrystalline seed layer of SiC-6H material to a carrier substrate of silicon material followed by epitaxial growth of the monocrystalline layer of AlN material. The carrier substrate of silicon material comprises a detachable interface configured to be detached by means of a laser debonding technique and/or chemical attack and/or by means of mechanical stress.

In advantageous embodiments, the monocrystalline seed layer has a thickness of less than 10 μm, preferably less than 2 μm, and more preferably less than 0.2 μm.

In advantageous embodiments, the transfer of the monocrystalline seed layer of SiC-6H material to the carrier substrate of silicon material comprises a step of joining a monocrystalline substrate of SiC-6H material to the carrier substrate followed by a step of thinning of said monocrystalline substrate of SiC-6H material.

In advantageous embodiments, the thinning step comprises the formation of a weakened zone delimiting a portion of the monocrystalline substrate of SiC-6H material intended to be transferred to the carrier substrate of silicon material.

In advantageous embodiments, the formation of the weakened zone is obtained by implanting atomic and/or ionic species.

In advantageous embodiments, the thinning step comprises detaching at the weakened zone so as to transfer said portion of the monocrystalline substrate of SiC-6H material to the carrier substrate of silicon material, in particular the detaching comprises the application of thermal and/or mechanical stress.

In advantageous embodiments, the joining step is a molecular adhesion step.

In advantageous embodiments, the monocrystalline seed layer of SiC-6H material is in the form of a plurality of tiles each transferred to the carrier substrate of silicon material.

Another aspect of the invention provides a substrate for epitaxial growth of a monocrystalline layer of AlN material, characterized in that it comprises a monocrystalline seed layer of SiC-6H material on a carrier substrate of silicon material. The carrier substrate of silicon material comprises a detachable interface configured to be detached by means of a laser debonding technique and/or chemical attack and/or by means of mechanical stress.

In advantageous embodiments, the monocrystalline seed layer of SiC-6H material is in the form of a plurality of tiles.

There is also disclosed a process for producing a monocrystalline layer of $Al_xIn_yGa_zAs_lP_mN_n$ material having a lattice parameter close to that of the AlN material comprising the transfer of a monocrystalline seed layer of $SrTiO_3$ material to a carrier substrate of silicon material followed by epitaxial growth of a monocrystalline layer of $Al_xIn_yGa_zAs_lP_mN_n$ material.

There is also disclosed a process for producing a monocrystalline layer of $Al_xIn_yGa_zAs_lP_mN_n$ material having a lattice parameter close to that of the AlN material comprising the transfer of a monocrystalline seed layer of YSZ or CeO_2 or MgO or Al_2O_3 material, to a carrier substrate of silicon material followed by epitaxial growth of a monocrystalline layer of $Al_xIn_yGa_zAs_lP_mN_n$ material.

There is also disclosed a substrate for epitaxial growth of a monocrystalline layer of $Al_xIn_yGa_zAs_lP_mN_n$ material having a lattice parameter close to that of the AlN material, characterized in that it comprises a monocrystalline seed layer of $SrTiO_3$ or YSZ or CeO_2 or MgO or Al_2O_3 material on a carrier substrate of silicon material.

DESCRIPTION OF THE FIGURES

Other features and advantages of the invention will be better understood from reading the following detailed description with reference to the appended drawings, in which:

CLAIMS

1. A process for producing a monocrystalline layer of AlN material comprising the transfer of a monocrystalline seed layer of SiC-6H material to a carrier substrate of silicon material followed by epitaxial growth of the monocrystalline layer of AlN material, wherein the carrier substrate of silicon material comprises a detachable interface configured to be detached by means of a laser debonding technique and/or chemical attack and/or by means of mechanical stress.

2. The process as claimed in claim 1, wherein the monocrystalline seed layer has a thickness of less than 10 µm, preferably less than 2 µm, and more preferably less than 0.2 µm.

3. The process as claimed in claim 1 or 2, wherein the transfer of the monocrystalline seed layer of SiC-6H material to the carrier substrate of silicon material comprises a step of joining a monocrystalline substrate of SiC-6H material to the carrier substrate followed by a step of thinning said monocrystalline substrate of SiC-6H material.

4. The process as claimed in claim 3, wherein the thinning step comprises the formation of a weakened zone delimiting a portion of the monocrystalline substrate of SiC-6H material intended to be transferred to the carrier substrate of silicon material.

5. The process as claimed in claim 4, wherein the formation of the weakened zone is obtained by implanting atomic and/or ionic species.

6. The process as claimed in claim 4 or 5, wherein the thinning step comprises detaching at the weakened zone so as to transfer said portion of the monocrystalline substrate of SiC-6H material to the carrier substrate of silicon material, in particular the detaching comprises the application of a thermal and/or mechanical stress.

7. The process as claimed in any one of claims 3 to 6, wherein the joining step is a molecular adhesion step.

8. The process as claimed in any one of the preceding claims, wherein the monocrystalline seed layer of SiC-6H material is in the form of a plurality of tiles each transferred to the carrier substrate of silicon material.

9. A substrate for epitaxial growth of a monocrystalline layer of AlN material characterized in that it comprises a monocrystalline seed layer of SiC-6H material on a carrier substrate of silicon material, wherein the carrier substrate of silicon material includes a detachable interface configured to be detached by means of a laser debonding technique and/or chemical attack and/or by means of mechanical stress.

10. The substrate for epitaxial growth of a monocrystalline layer of AlN material as claimed in claim 9, wherein the monocrystalline seed layer of SiC-6H material is present in the form of a plurality of tiles.