Method For Manufacturing A Monocrystalline Layer Of Diamond Or Iridium Material, And Substrate For Epitaxially Growing A Monocrystalline Layer Of Diamond Or Iridium Material

FIELD OF THE INVENTION

The present invention relates to a process for producing a monocrystalline layer of diamond or iridium material and a substrate for the epitaxial growth of such a monocrystalline layer of diamond or iridium 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 diamond material and a substrate for the epitaxial growth of such a monocrystalline layer of diamond material. In this way it is possible to address the problem of size of the monocrystalline substrates of diamond material currently available.

An aspect of the invention provides a process for producing a monocrystalline layer of diamond 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 the monocrystalline layer of diamond material. The transfer of the monocrystalline seed layer of $SrTiO_3$ material to the carrier substrate of silicon material comprises a step of joining a monocrystalline substrate of $SrTiO_3$ material to the carrier substrate followed by a step of thinning of said monocrystalline substrate of $SrTiO_3$ material.

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 thinning step comprises the formation of a weakened zone delimiting a portion of the monocrystalline substrate of $SrTiO_3$ 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 $SrTiO_3$ 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 $SrTiO_3$ material is in the form of a plurality of tiles each transferred to the carrier substrate of silicon material.

In advantageous embodiments, 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.

There is also disclosed a substrate for epitaxial growth of a monocrystalline layer of diamond material, characterized in that it comprises a monocrystalline seed layer of $SrTiO_3$ material on a carrier substrate of silicon material.

In advantageous embodiments, the monocrystalline seed layer of $SrTiO_3$ material is in the form of a plurality of tiles.

In advantageous embodiments, 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.

There is also disclosed a process for producing a monocrystalline layer of iridium 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 the monocrystalline layer of iridium material.

There is also disclosed a substrate for epitaxial growth of a monocrystalline layer of iridium material, characterized in that it comprises a monocrystalline seed layer of $SrTiO_3$ material on a carrier substrate of silicon material.

Another aspect of the invention provides a process for producing a monocrystalline layer of diamond material comprising the transfer of a monocrystalline seed layer of YSZ, CeO_2, MgO or Al_2O_3 material to a carrier substrate of silicon, sapphire, Ni or Cu material, followed by epitaxial growth of the monocrystalline layer of diamond material. The transfer of the monocrystalline seed layer of YSZ, CeO_2, MgO or Al_2O_3 material to the carrier substrate of silicon, sapphire, Ni or Cu material includes a step of joining a monocrystalline substrate of $SrTiO_3$ material to the carrier substrate followed by a step of thinning said monocrystalline substrate of YSZ, CeO_2, MgO or Al_2O_3 material.

Another aspect of the invention provides a process for producing a monocrystalline layer of diamond material comprising the transfer of a monocrystalline seed layer of $SrTiO_3$ material to a carrier substrate of silicon, sapphire, Ni or Cu material, followed by epitaxial growth of the monocrystalline layer of diamond material. The transfer of the monocrystalline seed layer of $SrTiO_3$ material to a carrier substrate of sapphire, Ni or Cu material includes a step of joining a monocrystalline substrate of $SrTiO_3$ material to the carrier substrate followed by a step of thinning said monocrystalline substrate of $SrTiO_3$ 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 diamond 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 the monocrystalline layer of diamond material, wherein the transfer of the monocrystalline seed layer of $SrTiO_3$ material to the carrier substrate of silicon material comprises a step of joining a monocrystalline substrate of $SrTiO_3$ material to the carrier substrate followed a step of thinning said monocrystalline substrate of $SrTiO_3$ material.

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, wherein the thinning step comprises the formation of a weakened zone delimiting a portion of the monocrystalline substrate of $SrTiO_3$ material intended to be transferred to the carrier substrate of silicon material.

4. The process as claimed in claim 3, wherein the formation of the weakened zone is obtained by implanting atomic and/or ionic species.

5. The process as claimed in claim 3 or 4, wherein the thinning step comprises detaching at the weakened zone so as to transfer said portion of the monocrystalline substrate of $SrTiO_3$ material to the carrier substrate of silicon material, in particular the detaching comprises the application of a thermal and/or mechanical stress.

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

7. The process as claimed in any one of the preceding claims, wherein the monocrystalline seed layer of $SrTiO_3$ material is in the form of a plurality of tiles each transferred to the carrier substrate of silicon material.

8. The process as claimed in any one of the preceding claims, 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.

9. A process for producing a monocrystalline layer of diamond material comprising the transfer of a monocrystalline seed layer of YSZ, CeO_2, MgO or Al_2O_3 material to a carrier substrate of silicon, sapphire, Ni or Cu material, followed by epitaxial growth of the monocrystalline layer of diamond material, wherein the transfer of the monocrystalline seed layer of YSZ, CeO_2, MgO or Al_2O_3 material to the carrier substrate of silicon, sapphire, Ni or Cu material includes a step of joining a monocrystalline substrate of $SrTiO_3$ material to the carrier substrate followed by a step of thinning said monocrystalline substrate of YSZ, CeO_2, MgO or Al_2O_3 material.

10. A process for producing a monocrystalline layer of diamond material comprising the transfer of a monocrystalline seed layer of $SrTiO_3$ material to a carrier substrate of sapphire, Ni or Cu material, followed by epitaxial growth of the monocrystalline layer of diamond material, wherein the transfer of the monocrystalline seed layer of $SrTiO_3$ material to a carrier substrate of sapphire, Ni or Cu material includes a step of joining a monocrystalline substrate of $SrTiO_3$ material to the carrier substrate followed by a step of thinning said monocrystalline substrate of $SrTiO_3$ material.