Method For Manufacturing A Crystalline Layer Of PZT Material, And Substrate For Epitaxially Growing A Crystalline Layer Of PZT Material

FIELD OF THE INVENTION

The present invention relates to a process for producing a crystalline layer of lead zirconate titanate (PZT) material and a substrate for the epitaxial growth of such a crystalline layer of PZT material.

PRIOR ART

Certain materials are not currently available as a crystalline substrate let alone 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 crystalline layer of PZT material, preferably a monocrystalline layer of PZT material, and a substrate for the epitaxial growth of such a crystalline layer of PZT material, preferably of such a monocrystalline layer of PZT material. In this way it is possible to address the problem of size of the crystalline or even monocrystalline substrates of PZT material currently available.

An aspect of the present invention provides a process for producing a crystalline layer of PZT 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 crystalline layer of PZT 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.

In advantageous embodiments, the crystalline layer of PZT material is monocrystalline.

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 $SrTiO_3$ 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 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.

Another aspect of the present invention provides a substrate for epitaxial growth of a crystalline layer of PZT material, characterized in that it comprises a monocrystalline seed layer of $SrTiO_3$ material on a carrier substrate of silicon 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..

In advantageous embodiments, the crystalline layer of PZT material is monocrystalline.

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

There is also disclosed a process for producing a crystalline layer of material comprising PMN-PT and/or PZN-PT having a lattice parameter close to that of the PZT 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 crystalline layer of PMN-PT or PZN-PT material.

There is also disclosed a process for producing a crystalline layer of material comprising PMN-PT and/or PZN-PT having a lattice parameter close to that of the PZT 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 the crystalline layer of PMN-PT or PZN-PT material.

There is also disclosed a substrate for epitaxial growth of a crystalline layer of material comprising PMN-PT and/or PZN-PT having a lattice parameter close to that of the PZT 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, sapphire, Ni or Cu material.

CLAIMS

1. A process for producing a crystalline layer of PZT 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 crystalline layer of PZT 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 $SrTiO_3$ 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.

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 $SrTiO_3$ 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 $SrTiO_3$ 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 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.

9. A substrate for epitaxial growth of a crystalline layer of PZT material characterized in that it comprises a monocrystalline seed layer of $SrTiO_3$ 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 crystalline layer of PZT material as claimed in claim 9, wherein the monocrystalline seed layer of $SrTiO_3$ material is present in the form of a plurality of tiles.