

This multidomain character of the ferroelectric material is problematic, since it makes the characteristics of the material inhomogeneous, which may affect the performance of the devices which are to be formed on/in the thin layer. This is particularly the case for surface acoustic wave (SAW) devices, the propagation of the waves being affected by the polarity of the piezoelectric material through which they pass.

This is why it is generally not recommended to expose a layer made of ferroelectric material to a temperature which exceeds its Curie temperature.

Document FR2914492 teaches a process for producing a thin layer of ferroelectric material using the Smart Cut technique. This document applies an electric field to the thin layer so as to improve or restore its ferroelectric properties.

However, to be applied easily, this process requires having electrodes on each of the faces of the thin layer, which is not always the case.

#### **SUBJECT MATTER OF THE INVENTION**

Embodiments of the invention seek to provide a process for preparing a thin layer of ferroelectric material which is based on alkali metal and is single domain.

#### **BRIEF DESCRIPTION OF THE INVENTION**

An aspect of the invention provides a process for preparing a thin layer made of ferroelectric material based on alkali metal, exhibiting a determined Curie temperature, transferred from a donor substrate to a carrier substrate using a transfer technique including implanting atomic species into the donor substrate in order to

produce an embrittlement plane, the thin layer having a first, free face and a second face which is arranged on the carrier substrate.

According to this aspect of the invention, the process for preparing the thin layer comprises a first heat treatment of the transferred thin layer at a temperature higher than the determined Curie temperature, the thin layer exhibiting a multidomain character upon completion of the first heat treatment. The process also comprises introducing, after the first heat treatment, protons into the thin layer, followed by applying a second heat treatment of the thin layer at a temperature lower than the determined Curie temperature in order to generate an internal electric field that results in the thin layer being made single domain.

According to non-limiting embodiments of the invention, considered alone or according to any technically feasible combination:

- the implanted atomic species are hydrogen ions and/or helium ions;
- the transfer technique includes joining the donor substrate to the carrier substrate and detaching the thin layer at the level of the embrittlement plane;
- the introduction of protons into the thin layer is achieved by means of proton exchange;
- the proton exchange is carried out by immersing at least the thin layer in a bath of benzoic acid at a temperature typically between 200 and 300°C for 10 min to 30 h;
- the introduction of the protons into the thin layer is achieved by means of ion implantation or by means of plasma implantation;

**CLAIMS**

1. Process for preparing a thin layer made of ferroelectric material based on alkali metal, exhibiting a determined Curie temperature, transferred from a donor substrate to a carrier substrate using a transfer technique including implanting atomic species into the donor substrate in order to produce an embrittlement plane, the thin layer having a first, free face and a second face which is arranged on the carrier substrate; the process for preparing the thin layer being characterized in that it comprises:
  - a first heat treatment of the transferred thin layer at a temperature higher than the determined Curie temperature, the thin layer exhibiting a multidomain character upon completion of the first heat treatment;
  - introducing, after the first heat treatment, protons into the thin layer, followed by applying a second heat treatment of the thin layer at a temperature lower than the determined Curie temperature in order to generate an internal electric field that results in the thin layer being made single domain.
2. Process according to the preceding claim, wherein the implanted atomic species are hydrogen and/or helium ions.
3. Process according to either of the preceding claims, wherein the transfer technique includes joining the donor substrate to the carrier substrate and detaching the thin layer at the level of the embrittlement plane.
4. Process according to one of the preceding claims, wherein the introduction of protons into the thin layer is achieved by means of proton exchange.
5. Process according to the preceding claim, wherein the proton exchange is carried out by immersing at least the thin layer in a bath of benzoic acid at a temperature typically between 200 and 300°C for 10 min to 30 h.

- 5 6. Process according to one of Claims 1 to 3, wherein the introduction of the protons into the thin layer is achieved by means of ion implantation or by means of plasma implantation.
- 10 7. Process according to one of the preceding claims, wherein the first heat treatment is carried out for a duration of between 30 minutes and 10 hours.
- 15 8. Process according to one of the preceding claims, wherein the first and the second heat treatments are carried out under an oxidizing or neutral atmosphere.
- 20 9. Process according to one of the preceding claims, wherein the second heat treatment is carried out at a temperature less than 100°C, preferably less than 50°C or than 10°C from the determined Curie temperature and for a duration of between 30 min and 10 hours.
- 25 10. Process according to one of the preceding claims, wherein the process for preparing the thin layer comprises a polishing step applied to the first face of the thin layer.
- 30 11. Process according to one of the preceding claims, wherein the polishing is carried out after the first heat treatment or after the second heat treatment.
- 35 12. Process according to one of the preceding claims, wherein the donor substrate is made of a ferroelectric material based on lithium.
13. Process according to the preceding claim, wherein the donor substrate is made of  $\text{LiTaO}_3$  or of  $\text{LiNbO}_3$ .
14. Process according to one of the preceding claims, wherein the ferroelectric material exhibits a  $42^\circ\text{RY}$  crystal orientation.

15. Process according to one of the preceding claims, wherein the material of the carrier substrate is silicon.