Description

Title of the invention: Method of implanting atomic species into a piezoelectric substrate

The invention relates to a method of implanting atomic species into a piezoelectric substrate, more particularly, to a high density implantation into bulk piezoelectric substrates.

The fabrication of piezoelectric on insulator wafers (POI) requires the use of an implantation process, in particular of a high density implantation process.

The implanting of ions takes place in an implanting device in which a number of substrates is subjected to an ion beam. To implant over the entire surface the substrates are mounted on a rotating and/or translating implantation wheel so that the entire surface of the substrate passes under the ion beam. Maintaining means, like clips, are used to fix the substrate on the implanting wheel against the rotational forces. Usually the maintaining means are fixed metallic restraints that are also configured to drain electrical charges generated during the ion implantation.

A high density implantation process results in the accumulation of charges in the piezoelectric substrate to be implanted. At the same time, a high temperature gradient is observed in the substrate during implantation leading to a deformation in the form of bow and warp of the piezoelectric substrate. Consequently, charges and heat cannot be sufficiently dissipated into a metallic chuck used in the implantation chamber. To remedy this problem, the piezo electric substrate is placed on an elastomer layer provided over the metallic chuck. This elastomer layer provides a thermal contact between the piezoelectric substrate and the chuck. The fixed metallic restraints are used to provide an electrical contact between the piezoelectric substrate and the chuck. The electrical contact obtained, is, however, only a localized contact between the piezoelectric substrate and the chuck.

However, breakage of piezoelectric substrates is still observed, which is attributed to a still insufficient evacuation of charges.

Therefore, the charge dissipation out of a piezoelectric substrate needs to be further improved.

The object of the invention is achieved by a method of implanting atomic species into a substrate, comprising the steps of a) providing the substrate comprising a piezoelectric portion and an electrically conductive portion, then b) mounting the substrate with

the electrically conductive portion over a chuck, and then c) implanting the atomic species into the piezoelectric portion.

As explained above, the implantation is performed into the piezoelectric portion and results in an accumulation of charges in the piezoelectric portion. The use of an electrically conductive portion in the substrate to be implanted, however, results in an improved evacuation of the charges from the piezoelectric portion as the charges can easier accumulate outside the piezoelectric portion thereby reducing stress and reducing the risk of breakage.

According to a variant, the step b) can comprise providing an elastomer layer between the chuck and the electrically conductive portion of the substrate. Thus, the electrically conductive portion of the substrate is isolated from the chuck.

According to a variant of the invention, the step a) can comprise attaching a piezoelectric substrate forming the piezoelectric portion to an electrically conductive substrate forming the electrically conductive portion of the substrate. Attaching two substrates together, e.g. via molecular adhesion, is a reliable attachment process.

According to a variant of the invention, the step a) can further comprise a step of thinning the piezoelectric substrate to obtain a piezoelectric layer, in particular with a thickness between 1µm and 100µm. Thinning of the piezoelectric substrate reduces the length of the path for charges until they can reach the electrically conductive portion. Thus, the accumulation of charges can be even further reduced.

According to a variant of the invention, the piezoelectric substrate and the electrically conductive substrate are chosen such that the difference in thermal expansion coefficients is less than $50*10^{-6}K^{-1}$, preferably less than $20*10^{-6}K^{-1}$. By matching the thermal expansion coefficients, the use of an electrically conductive substrate with thermal expansion parameters which fit the thermal expansion parameters of the piezoelectric substrate provides a substrate which will withstand thermal gradients without breaking up or showing damages at the interface between the piezoelectric substrate and the electrically conductive substrate.

According to a variant of the invention, the step of attaching the electrically conductive substrate with the piezoelectric substrate is realized using a bonding layer between the two substrates. The use of a bonding layer provides a wider choice of suitable materials for the electrically conductive substrate and the piezoelectric substrates.

Claims

1. A method of implanting atomic species into a substrate, comprising the steps of:
   a) providing the substrate comprising a piezoelectric portion and an electrically conductive portion, then
   b) mounting the substrate with the electrically conductive portion over a chuck, and then
   c) implanting the atomic species into the piezoelectric portion.

2. The method according to claim 1, wherein, in step b), the substrate is oriented such that the electrically conductive portion is located between the piezoelectric portion and the chuck.

3. The method according to claim 1 or 2, wherein the step b) comprises providing an elastomer layer between the chuck and the electrically conductive portion of the substrate.

4. The method according to any one of claims 1 to 3, wherein step a) comprises attaching a piezoelectric substrate forming the piezoelectric portion to an electrically conductive substrate forming the electrically conductive portion of the substrate.

5. The method according to claim 4, wherein the step a) further comprises thinning the piezoelectric substrate to obtain the piezoelectric portion, in particular with a thickness between 1µm and 100µm.

6. The method according to any one of claims 4 or 5, wherein the piezoelectric substrate and the electrically conductive substrate are chosen such that the difference in thermal expansion coefficients is less than $50*10^{-6}K^{-1}$, preferably less than $20*10^{-6}K^{-1}$.

7. The method according to any one of claims 4 to 6, wherein the step of attaching the electrically conductive substrate with the piezoelectric substrate is realized using a bonding layer between the piezoelectric substrate and the electrically conductive substrate.

8. The method according to claim 7, wherein the bonding layer is a conductive bonding layer, in particular a metallic layer.

9. The method according to claim 1, wherein the step of providing the electrically conductive portion comprises providing one or more cavities in the side of

the substrate facing the chuck and filling the one or more cavities with a conductive material, in particular a metal.

10. The method according to one claims 1 to 9, wherein the piezoelectric portion is formed from a bulk piezoelectric substrate, in particular a bulk piezoelectric wafer, preferably with a thickness of more than 20µm, even more in particular with a thickness of more than 100µm.

11. The method according to any one claims of 4 to 8, wherein the electrically conductive substrate has a conductivity of 10^{-4}S/cm or more.

12. The method according to any one of claims 1 to 11, where the step b) of mounting the substrate over the chuck is realized such that the electrically conductive portion is in electrical contact with at least one metallic restraint electrically connected with the chuck.

13. The method according to claim 7 or 8, where the step b) of mounting the substrate over the chuck is realized such that the electrically conductive portion and the bonding layer are in electrical contact with at least one metallic restraint electrically connected with the chuck.

14. The method according to any one of claims 1 to 13, where during step c) a predetermined splitting area formed by a mechanically weakened layer is provided in the piezoelectric portion, and
further comprising a step d) of attaching the piezoelectric portion to a handle substrate and a step e) of detaching a remainder of the piezoelectric portion at the predetermined splitting area, thereby transferring a layer of the piezoelectric portion onto the handle substrate.