Claims

1. A preparation method for a resonator, wherein the method comprises:

providing a first single crystal substrate;

firstly forming a single crystal piezoelectric layer on the first single crystal substrate, and then performing ion implantation on the first single crystal substrate by the single crystal piezoelectric layer to sequentially divide the first single crystal substrate into a first layer, a damaged layer located above the first layer, and a second layer located above the damaged layer and the second layer located in contact with the single crystal piezoelectric layer;

forming a lower electrode layer on the single crystal piezoelectric layer;

forming a second substrate on the lower electrode layer by a bonding process;

splitting the first layer from the second layer at the damaged layer by heating process;

removing the second layer to expose the single crystal piezoelectric layer; and

forming an upper electrode layer on the single crystal piezoelectric layer;

wherein after forming the upper electrode layer on the single crystal piezoelectric layer, the method further comprises:

forming a first sacrificial layer on the upper electrode layer;

forming a first protective layer on the first sacrificial layer, wherein the first protective layer covers a top wall and a side wall of the first sacrificial layer; and releasing the first sacrificial layer to form a first cavity located between the first protective layer and the upper electrode layer; wherein an orthographic projection of the upper electrode layer and the lower electrode layer on the single crystal piezoelectric layer has an overlapping region and a non-overlapping region, and after forming the upper electrode layer on the single crystal piezoelectric layer, the method further comprises:

forming an extraction hole penetrating the lower electrode layer on a side surface, away from the lower electrode layer, of the single crystal piezoelectric layer by etching, wherein the extraction hole is located in the non-overlapping region of the lower electrode layer; and

forming an extraction electrode connected with the lower electrode layer by the extraction hole.

2. The preparation method for the resonator according to claim 1, wherein removing the second layer to expose the single crystal piezoelectric layer comprises:

removing the second layer by trimming and wet-etching.

3. The preparation method for the resonator according to claim 1, wherein removing the second layer to expose the single crystal piezoelectric layer comprises:

removing the second layer by trimming and dry-etching.

4. The preparation method for the resonator according to claim 1, wherein the thickness ratio of the first layer to the second layer is greater than 1.

5. The preparation method for the resonator according to claim 1, wherein after releasing the first sacrificial layer to form the first cavity located between the first protective layer and the upper electrode layer, the method further comprises:

forming a back cavity penetrating the lower electrode layer on a side surface, away from the lower electrode layer, of the second substrate by etching.

6. The preparation method for the resonator according to claim 1, wherein forming the second substrate on the lower electrode layer by the bonding process comprises:

forming a second sacrificial layer on the lower electrode layer;

forming a first bonding layer on the second sacrificial layer;

forming a second bonding layer on the second substrate; and

bonding the first bonding layer and the second bonding layer to form the second substrate on the lower electrode layer.

7. The preparation method for the resonator according to claim 6, wherein after forming the upper electrode layer on the single crystal piezoelectric layer, the method further comprises:

forming a through hole penetrating the second sacrificial layer on a side surface, away from the lower electrode layer, of the upper electrode layer by etching;

forming a third sacrificial layer on the upper electrode layer in contact with the second sacrificial layer by the through hole;

forming a second protective layer on the third sacrificial layer, wherein the second protective layer covers a top wall and a side wall of the third sacrificial layer; and

sequentially releasing the third sacrificial layer and the second sacrificial layer to respectively form a second cavity located between the second protective layer and the upper electrode layer, and a third cavity located between the first bonding layer and the lower electrode layer.

8. The preparation method for the resonator according to claim 1, wherein the first single crystal

substrate is ion-implanted with single crystal ions for many times to form the damaged layer with a target thickness, as to reduce the lattice damage of the single crystal piezoelectric layer.

9. The preparation method for the resonator according to claim 8, wherein an ion displacement region of the first single crystal substrate is detected, and while the ion damage degree of the ion displacement region is greater than a threshold value, many times of the ion implantation is stopped.

10. The preparation method for the resonator according to claim 8, wherein a direction of ion implantation is consistent with a crystal axis direction of the single crystal piezoelectric layer.

11. The preparation method for the resonator according to claim 10, wherein after the many times of the ion implantation is stopped, the first layer, the damaged layer, and the second layer are thermally annealed, as to reduce the damage of an ion implantation layer.

12. The preparation method for the resonator according to claim 1, wherein before firstly forming the single crystal piezoelectric layer on the first single crystal substrate, the method further comprises etching a groove in the non-overlapping region preset on the first single crystal substrate; and

filling the groove with a fourth sacrificial layer, so that the height of the fourth sacrificial layer is higher than the surface of the first single crystal substrate.

13. The preparation method for the resonator according to claim 1, wherein before forming the second substrate on the lower electrode layer by the bonding process, further comprising:

forming a bonding layer between the overlapping region of the first single crystal substrate and the lower electrode layer.

14. The preparation method for the resonator according to claim 12, wherein after forming the upper electrode layer on the single crystal piezoelectric layer, further comprising:

releasing the fourth sacrificial layer to generate the resonator.

15. A resonator, wherein it is prepared by using the preparation method for the resonator according to claim 1.

16. The resonator according to claim 15, wherein a first sacrificial layer is formed on the upper electrode layer;

a first protective layer is formed on the first sacrificial layer, and the first protective layer covers a top wall and a side wall of the first sacrificial layer; and

the first sacrificial layer is released to form a first cavity located between the first protective layer

and the upper electrode layer.

17. The resonator according to claim 16, wherein a second sacrificial layer is formed on the lower electrode layer;

a first bonding layer is formed on the second sacrificial layer;

a second bonding layer is formed on the second substrate; and

the first bonding layer and the second bonding layer are bonded to form the second substrate on the lower electrode layer.

18. A resonator, wherein it is prepared by using the preparation method for the resonator according to claim 12.