SUMMARY ~~OF CERTAIN INVENTIVE ASPECTS~~

[0005a] In an aspect, the present disclosure refers to a method of manufacturing singulated bulk acoustic wave components, the method comprising: forming a buffer layer over a substrate of an array of bulk acoustic wave components so as to form exposed streets between individual bulk acoustic wave components; and plasma dicing the bulk acoustic wave components along the exposed streets to thereby singulate the bulk acoustic wave components.

[0005b] In another aspect, the present disclosure refers to a method of manufacturing bulk acoustic wave components, the method comprising: providing a first wafer bonded with a second wafer, the first wafer having bulk acoustic resonators thereon, and the second wafer being over and spaced apart from the bulk acoustic resonators; forming a buffer layer on a side of the first wafer that is opposite to the bulk acoustic wave resonators such that streets are exposed; and plasma dicing through the first wafer and the second wafer along the exposed streets to form singulated bulk acoustic wave components.

[0005c] In another aspect, the present disclosure refers to a method of manufacturing bulk acoustic wave components, the method comprising: forming a buffer layer over a silicon substrate of bulk acoustic wave components such that streets are exposed; and plasma dicing the bulk acoustic wave components along the exposed streets to thereby singulate the bulk acoustic wave components, the singulated bulk acoustic wave components each including a bulk acoustic wave resonator and a cap enclosing the bulk acoustic wave resonator, and the cap including a silicon cap substrate and a sidewall that is spaced apart from an edge of the silicon substrate of the respective singulated bulk acoustic wave component by a distance in a range from 1 micron to 5 microns.

[0006] The innovations described in the claims each have several aspects, no single one of which is solely responsible for its desirable attributes. Without limiting the scope of the claims, some prominent features of this disclosure will now be briefly described.

[0007] One ~~aspect~~ example of this disclosure is a method of manufacturing singulated bulk acoustic wave components. The method includes forming a buffer layer over a substrate of an array of bulk acoustic wave components so as to form exposed streets between individual bulk acoustic wave components. The method also includes plasma dicing the bulk acoustic wave components along the exposed streets to thereby singulate the bulk acoustic wave components.

[0008] Each of the singulated bulk acoustic wave components can include a bulk acoustic wave resonator and a cap enclosing the bulk acoustic wave resonator. The cap can include a sidewall that is 5 microns or less from an edge of the substrate of the respective singulated bulk acoustic wave component. The sidewall can be at least 1 micron from the edge of the respective singulated bulk acoustic wave component. The sidewall can include copper.

[0009] The plasma dicing can include etching through both the substrate and a cap substrate. The bulk acoustic wave component can include a bulk acoustic wave resonator located over the substrate and under the cap substrate. The substrate and the cap substrate can be silicon substrates.

[0010] The method can further include forming a conductor over the substrate. The conductor can extend laterally from a via that extends through the substrate. The conductor can be electrically connected to a conductive layer in the via. Forming the buffer layer can be performed such that the buffer layer is over at least a portion of the conductor. The method can further include forming solder over the conductor such that the solder is non-overlapping with the via.

[0011] The substrate can be a silicon substrate. The buffer layer can be a material that etches at least 30 times slower than silicon during the plasma dicing. The buffer layer can include a resin. Forming the buffer layer can include forming the exposed streets by way of a photolithographic process.

[0012] The bulk acoustic wave components can each include a film bulk acoustic wave resonator.

[0013] Another example ~~aspect~~ of this disclosure is a method of manufacturing bulk acoustic wave components. The method includes providing a first wafer bonded with a second wafer. The first wafer has bulk acoustic resonators thereon. The second wafer is over and spaced apart from the bulk acoustic resonators. The method includes forming a buffer layer on a side of the first wafer that is opposite to the bulk acoustic wave resonators such that streets are exposed. The method includes plasma dicing through the first wafer and the second wafer along the exposed streets to form singulated bulk acoustic wave components.

[0014] The first wafer and the second wafer can be silicon wafers.

[0015] Each of the singulated bulk acoustic wave components can include a bulk acoustic wave resonator of the bulk acoustic wave resonators and a cap enclosing the bulk acoustic wave resonator. The cap can include a sidewall. The sidewall can be in a range from 1 micron to 5 microns away from an edge of a substrate of the respective singulated bulk acoustic wave component, in which the substrate corresponds to a portion of the first wafer prior to plasma dicing.

[0016] Another example ~~aspect~~ of this disclosure is a method of manufacturing bulk acoustic wave components. The method includes forming a buffer layer over a silicon substrate of bulk acoustic wave components such that streets are exposed. The method also includes plasma dicing the bulk acoustic wave components along the exposed streets to thereby singulate the bulk acoustic wave components. The singulated bulk acoustic wave components each include a bulk acoustic wave resonator and a cap enclosing the bulk acoustic wave resonator. The cap includes a silicon cap substrate and a sidewall that is spaced apart from an edge of the silicon substrate of the respective singulated bulk acoustic wave component by a distance in a range from 1 micron to 5 microns.

[0017] The sidewall can include copper. The he buffer layer can include a resin. The bulk acoustic wave resonator can be a film bulk acoustic wave resonator.

[0018] Another example ~~aspect~~ of this disclosure is a bulk acoustic wave component that includes a substrate, at least one bulk acoustic wave resonator on the substrate, and a cap enclosing the at least one bulk acoustic wave resonator. The cap includes a sidewall spaced

apart from an edge of the substrate. The sidewall is 5 microns or less from the edge of the substrate.

[0019] The sidewall can be 3 microns or less from the edge of the substrate. The sidewall can be at least 1 micron from the edge of the substrate.

[0020] The bulk acoustic wave component can further include a via extending through the substrate, a conductive layer in the via, and a buffer layer in the via.

[0021] The bulk acoustic wave component can further include a via extending through the substrate, a conductor extending laterally from the via and electrically connected with conductive layer in the via, and solder on the conductor and located laterally from the via.

[0022] The at least one bulk acoustic wave resonator can include a film bulk acoustic wave resonator. The at least one bulk acoustic wave resonator can include a solidly mounted resonator.

[0023] The substrate can be a silicon substrate. A top portion of the cap can include a silicon cap substrate.

[0024] The sidewall can include copper.

[0025] The at least one bulk acoustic wave resonator can include a plurality of bulk acoustic wave resonators included in a filter arranged to filter a radio frequency signal. The plurality of bulk acoustic wave resonators can include at least 10 bulk acoustic wave resonators.

[0026] Another example ~~aspect~~ of this disclosure is a bulk acoustic wave component that includes a silicon substrate, at least one bulk acoustic wave resonator on the silicon substrate, and a cap enclosing the at least one bulk acoustic wave resonator. The cap includes a cap substrate and a sidewall. The cap substrate includes silicon. The sidewall is spaced apart from an edge of the silicon substrate by a distance in a range from 1 micron to 5 microns.

[0027] The bulk acoustic wave component can further include a via extending through the silicon substrate, a conductive layer in the via, and a buffer layer in the via.

[0028] The bulk acoustic wave component can further include a via extending through the substrate, a conductor extending laterally from the via and electrically connected with conductive layer in the via, and solder on the conductor and located laterally from the via.

[0029] The sidewall can include copper. The at least one bulk acoustic wave resonator can include at least 10 bulk acoustic wave resonators included in an acoustic wave filter arranged to filter a radio frequency signal.

[0030] Another example ~~aspect~~ of this disclosure is a wireless communication device that includes an antenna and a bulk acoustic wave component. The bulk acoustic wave component includes a substrate, bulk acoustic wave resonators on the substrate, and a cap enclosing the bulk acoustic wave resonators. The cap includes a sidewall that is spaced apart from an edge of the substrate by 5 microns or less. The bulk acoustic wave resonators is included in a filter in communication with the antenna.

[0031] The wireless communication device can be a mobile phone.

[0032] The wireless communication device can further include a radio frequency amplifier in communication with the filter and a switch coupled between the filter and the antenna.

[0033] For purposes of summarizing the disclosure, certain aspects, advantages and novel features of the innovations have been described herein. It is to be understood that not necessarily all such advantages may be achieved in accordance with any particular embodiment. Thus, the innovations may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other advantages as may be taught or suggested herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] Embodiments of this disclosure will now be described, by way of non-limiting example, with reference to the accompanying drawings.

[0035] Figure 1 is a flow diagram of an example process of manufacturing bulk acoustic wave components according to an embodiment.

[0036] Figures 2A to 2E are a cross sectional views illustrating a process of manufacturing of bulk acoustic wave components according to an embodiment.

[0037] Figure 3A is a cross sectional diagram of a bulk acoustic wave component according to an embodiment.

[0038] Figure 3B is a cross sectional diagram of a bulk acoustic wave component according to another embodiment.

WHAT IS CLAIMED IS:

1. A method of manufacturing singulated bulk acoustic wave components, the method comprising:

forming a buffer layer over a substrate of an array of bulk acoustic wave components so as to form exposed streets between individual bulk acoustic wave components; and

plasma dicing the bulk acoustic wave components along the exposed streets to thereby singulate the bulk acoustic wave components.

2. The method of claim 1 wherein each of the singulated bulk acoustic wave components includes a bulk acoustic wave resonator and a cap enclosing the bulk acoustic wave resonator, and the cap includes a sidewall that is 5 microns or less from an edge of the substrate of the respective singulated bulk acoustic wave component.

3. The method of claim 2 wherein the sidewall is at least 1 micron from the edge of the respective singulated bulk acoustic wave component.

4. The method of claim 2 wherein the sidewall includes copper.

5. The method of claim 1 wherein the plasma dicing includes etching through both the substrate and a cap substrate, the bulk acoustic wave component including a bulk acoustic wave resonator located over the substrate and under the cap substrate.

6. The method of claim 5 wherein the substrate and the cap substrate are silicon substrates.

7. The method of claim 1 further comprising forming a conductor over the substrate, the conductor extending laterally from a via that extends through the substrate, and the conductor being electrically connected to a conductive layer in the via.

8. The method of claim 7 wherein the forming the buffer layer is performed such that the buffer layer is over at least a portion of the conductor.

9. The method of claim 7 further comprising forming solder over the conductor such that the solder is non-overlapping with the via.

10. The method of claim 1 wherein the substrate is a silicon substrate.

11. The method of claim 10 wherein the buffer layer is a material that etches at least 30 times slower than silicon during the plasma dicing.

12. The method of claim 1 the forming the buffer layer includes forming the exposed streets by way of a photolithographic process.

13. The method of claim 1 wherein the bulk acoustic wave components each include a film bulk acoustic wave resonator.

14. A method of manufacturing bulk acoustic wave components, the method comprising:

providing a first wafer bonded with a second wafer, the first wafer having bulk acoustic resonators thereon, and the second wafer being over and spaced apart from the bulk acoustic resonators;

forming a buffer layer on a side of the first wafer that is opposite to the bulk acoustic wave resonators such that streets are exposed; and

plasma dicing through the first wafer and the second wafer along the exposed streets to form singulated bulk acoustic wave components.

15. The method of claim 14 wherein the first wafer and the second wafer are silicon wafers.

16. The method of claim 14 wherein each of the singulated bulk acoustic wave components includes a bulk acoustic wave resonator of the bulk acoustic wave resonators and a cap enclosing the bulk acoustic wave resonator, the cap including a sidewall.

17. The method of claim 16 wherein the sidewall is in a range from 1 micron to 5 microns away from an edge of a substrate of the respective singulated bulk acoustic wave component, the substrate corresponding to a portion of the first wafer prior to plasma dicing.

18. A method of manufacturing bulk acoustic wave components, the method comprising:

forming a buffer layer over a silicon substrate of bulk acoustic wave components such that streets are exposed; and

plasma dicing the bulk acoustic wave components along the exposed streets to thereby singulate the bulk acoustic wave components, the singulated bulk acoustic wave components each including a bulk acoustic wave resonator and a cap enclosing the bulk acoustic wave resonator, and the cap including a silicon cap substrate and a sidewall that is spaced apart from an edge of the silicon substrate of the respective singulated bulk acoustic wave component by a distance in a range from 1 micron to 5 microns.

19. The method of claim 18 wherein the sidewall includes copper and the buffer layer includes a resin.

20. The method of claim 18 wherein the bulk acoustic wave resonator is a film bulk acoustic wave resonator.

~~21. A bulk acoustic wave component comprising:~~

~~a substrate;~~

~~at least one bulk acoustic wave resonator on the substrate; and~~

~~a cap enclosing the at least one bulk acoustic wave resonator, the cap including a sidewall spaced apart from an edge of the substrate, the sidewall being 5 microns or less from the edge of the substrate.~~

~~22. The bulk acoustic wave component of claim 21 wherein the sidewall is 3 microns or less from the edge of the substrate.~~

~~23. The bulk acoustic wave component of claim 21 wherein the sidewall is at least 1 micron from the edge of the substrate.~~

~~24. The bulk acoustic wave component of claim 21 further comprising a via extending through the substrate, a conductive layer in the via, and a buffer layer in the via.~~

~~25. The bulk acoustic wave component of claim 21 further comprising a via extending through the substrate, a conductor extending laterally from the via and electrically connected with conductive layer in the via, and solder on the conductor and located laterally from the via.~~

~~26. The bulk acoustic wave component of claim 21 wherein the at least one bulk acoustic wave resonator includes a film bulk acoustic wave resonator.~~

~~27. The bulk acoustic wave component of claim 21 wherein the at least one bulk acoustic wave resonator includes a solidly mounted resonator.~~

~~28. The bulk acoustic wave component of claim 21 wherein the substrate is a silicon substrate.~~

~~29. The bulk acoustic wave component of claim 28 wherein a top portion of the cap includes a silicon cap substrate.~~

~~30. The bulk acoustic wave component of claim 21 wherein the sidewall includes copper.~~

~~31. The bulk acoustic wave component of claim 21 wherein the at least one bulk acoustic wave resonator includes a plurality of bulk acoustic wave resonators included in a filter arranged to filter a radio frequency signal.~~

~~32. The bulk acoustic wave component of claim 31 wherein the plurality of bulk acoustic wave resonators include at least 10 bulk acoustic wave resonators.~~

~~33. A bulk acoustic wave component comprising:~~

~~a silicon substrate;~~

~~at least one bulk acoustic wave resonator on the silicon substrate; and~~

~~a cap enclosing the at least one bulk acoustic wave resonator, the cap including a cap substrate and a sidewall, the cap substrate including silicon, the sidewall spaced apart from an edge of the silicon substrate by a distance in a range from 1 micron to 5 microns.~~

~~34. The bulk acoustic wave component of claim 33 further comprising a via extending through the silicon substrate, a conductive layer in the via, and a buffer layer in the via.~~

~~35. The bulk acoustic wave component of claim 33 further comprising a via extending through the silicon substrate, a conductor extending laterally from the via and electrically connected with conductive layer in the via, and solder on the conductor and located laterally from the via.~~

~~36. The bulk acoustic wave component of claim 33 wherein the sidewall includes copper.~~

~~37. The bulk acoustic wave component of claim 33 wherein the at least one bulk acoustic wave resonator includes at least 10 bulk acoustic wave resonators included in an acoustic wave filter arranged to filter a radio frequency signal.~~

~~38. A wireless communication device comprising:~~

~~an antenna; and~~

~~a bulk acoustic wave component including a substrate, bulk acoustic wave resonators on the substrate, and a cap enclosing the bulk acoustic wave resonators, the cap including a sidewall that is spaced apart from an edge of the substrate by 5 microns or less, and the bulk acoustic wave resonators being included in a filter in communication with the antenna.~~

~~39. The wireless communication device of claim 38 wherein the wireless communication device is configured as a mobile phone.~~

~~40. The wireless communication device of claim 38 further comprising a radio frequency amplifier in communication with the filter and a switch coupled between the filter and the antenna.~~