SPECIFICATION

TITLE OF THE INVENTION

ELECTRONIC COMPONENT, ELECTRONIC DEVICE, AND METHOD FOR MANUFACTURING THE ELECTRONIC COMPONENT

Field

[0001] A certain aspect of the present invention relates to an electronic component, an electronic device, and a method for manufacturing the electronic componentdevice.

Background

[0002] An acoustic wave device is used as a filter, a duplexer or the like in mobile communication terminals. Acoustic wave resonators include a surface acoustic wave (SAW) resonator using a surface acoustic wave, a boundary acoustic wave resonator using a boundary acoustic wave, a piezoelectric thin-film resonator using a piezoelectric thin-film. A film bulk acoustic wave resonator (FBAR) is an exemplary piezoelectric thin-film resonator. A functional portion for excitation of acoustic waves includes an electrode such as an interdigital transducer (IDT) in the SAW device, and is a portion in which electrodes face each other through a piezoelectric thin-film. A substrate on which an acoustic wave element is formed may be sealed with resin or the like for the purpose of downsizing the acoustic wave device and protecting the acoustic wave element.

[0003] Japanese Patent Application Publication No. 2008-227748 (Document 1) discloses sealing with epoxy resin. The material for sealing may be polyimide, for example. However, polyimide has a high hygroscopic property and may not protect the acoustic wave element sufficiently. Japanese Patent Application Publication No. 9-326447 (Document 2), Japanese

functional portion, the seal portion being made of liquid crystal polymer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIGs. 1A and 1B are plan views of a ladder type filter in accordance with a first embodiment;

FIG. 2 is a plan view of the ladder type filter of the first embodiment;

FIGs. 3A through 3C are cross-sectional views of the ladder type filter of the first embodiment;

FIGs. 4A and 4B are plan views that illustrate a method for manufacturing the ladder type filter in accordance with the first embodiment;

FIGs. 5A through 5C are cross-sectional views of the method for manufacturing the ladder type filter in accordance with the first embodiment;

FIGs. 6A through 6C are cross-sectional views of the method for manufacturing the ladder type filter in accordance with the first embodiment;

FIG. 7A and 7B are plan views of the method for manufacturing the ladder-type filter in accordance with the first embodiment;

FIGs. 8A through 8C are cross-sectional views of the method for manufacturing the ladder type filter in accordance with the first embodiment;

FIGs. 9A through 9C are cross-sectional views of the method for manufacturing the ladder type filter in accordance with the first embodiment;

FIGs. 10A and 10B are plan views of the method for manufacturing the ladder type filter in accordance with the first embodiment;

FIGs. 11A through 11C are cross-sectional views of the method for manufacturing the

cross-sectional views. FIGs. 3A through 3C are cross-sectional views of the ladder type filter in accordance with the first embodiment. FIG. 3A is a cross-sectional view taken along a line A-A in FIG. 2, FIG. 3B is a cross-sectional view taken along a line B-B in FIG. 2, and FIG. 3C is a cross-sectional view taken along a line C-C in FIG. 2.

[0015] Referring to FIG. 3A, the series resonators 12 and the parallel resonators 14 are exposed to a cavity 33. The metal plate 28 is provided above the series resonators 12 and the parallel resonators 14, and is supported by the support posts 30. The support posts 30 have a height that defines the cavity 33 in corporation with the metal plate 28. The metal plate 28 covers the series resonators 12 and the parallel resonators 14 so that the cavity 33 is defined above the series resonators 12 and the parallel resonators 14. The height of the cavity 33 does not prevent excitation of the acoustic waves. The support posts 30 may have a height of, for example, 1 ~ 30 μm. The seal portion 38 is in contact with and is bonded to the side and upper surfaces of the metal plate 28, the side surfaces of the support posts 30 and the side and upper surfaces 32a of the metal wall 32. The metal plate 28 has the same height as the metal wall 32~~plate 28~~ with respect to the upper surface of the piezoelectric substrate 10.

[0016] As illustrated in FIG. 3B, an insulative layer 17 is provided on one of the signal lines 20, and one of the support posts 30 is provided on the insulative layer 17. A spacing 34 is formed between the signal lines 20 and the metal plate 28. The signal lines 20 are spaced apart from the metal plate 28 and the support posts 30 and are isolated therefrom.

[0017] As illustrated in FIG. 3C, the transmission terminal 22 includes an underlying layer 40a, a post terminal 42a and one solder ball 36. The underlying layer 40a is provided on the piezoelectric substrate 10, and the post terminal 42a is provided on the underlying layer 40a. The solder ball 36 that is exposed to the sealing portion 38 is provided on the post terminal 42a.

the post terminals 42a and 42b and the metal wall 32, and a spacing between the post terminals 42a and 42b. As described above, the liquid crystal polymer sheet is bonded to the metal plate 28, the metal wall 32 and the post terminals 42a and 42b by thermocompression, whereby the seal portion 38 is formed. Since liquid crystal polymer has high viscosity, it is prevented from flowing in the insides of the metal plate 28 and the support posts 30, and the cavity 33 can be secured. As the liquid crystal polymer sheet, "Vecstar" by Kuraray Co., LTD. or "BIAC" by Japan Gore Tex Incorporated may be used, for example.

[0027] FIG. 15 is a cross-sectional view taken along a line C-C in FIG. 13B. Referring to FIGs. 13B and 15, openings 39a, 39b and 39c are formed in the seal portion 38 by laser a trimming or desmear process, for example. As illustrated in FIG. 13B, the opening 39a is formed in an area in which the transmission terminal 22 is to be provided. The openings 39b are formed in an area in which the ground terminals 26 are to be provided. The opening 39c is formed in an area in which the antenna terminal 24 is to be provided. The post terminal 42a is exposed in the opening 39a. The post terminals 42b are exposed in the openings 39b. The post terminal 42c is exposed in the opening 39c.

[0028] FIG. 17A is a cross-sectional view taken along a line A-A in FIG. 16, FIG. 17B is a cross-sectional view taken along a line B-B in FIG. 16, and FIG. 17C is a cross-sectional view taken along a line C-C in FIG. 16. Referring to FIGs. 16 and 17C, solder balls 36 are formed in the openings 39a, 39b and 39c by printing of solder paste and solder reflow, for example. As indicated by arrows in FIGs. 17A through 17C, the wafer is divided into multiple piezoelectric substrates 10 by dicing along dicing lines 11. Thus, multiple acoustic wave devices are produced from the wafer.

[0029] The ladder type filter 100 of the first embodiment is configured so that the metal wall

[0032] For example, as illustrated in FIGs. 3A through 3C, the seal portion 38 contacts the upper surfaces of ~~the seal portion 38,~~ the metal plate 28, the metal wall 32, and the post terminals 42a and 42b. The seal portion 38 contacts the side surfaces of the metal plate 28, the support posts 30, the metal wall 32, and the post terminals 42a and 42b. Generally, the liquid crystal polymer sheet that forms the seal portion 38 has an orientation, as described Document 3. Thus, when the liquid crystal polymer sheet is bonded to a member having a roughness by thermocompression, the orientation of the liquid crystal polymer sheet may be displaced on a side surface of the member. In contrast, the orientation is kept in portions of the liquid crystal polymer sheet that contact the upper surfaces of the above structural parts in parallel. However, the orientation of the liquid crystal polymer sheet may be destroyed in portions that contact the side surfaces of the structural parts. The properties of the liquid crystal polymer sheet that include the hygroscopic property are those under the condition that the liquid crystal polymer sheet is oriented in the sheet extruding direction of the machine. Therefore, the adhesive property of the seal portion 38 with respect to the upper surfaces of the structural parts is higher than that to the side surfaces thereof. Since the seal portion 38 contacts the upper surface 32a of the metal wall 32, it is more difficult for the seal portion 38 from being removed, and an improved hygroscopic property is realized. The upper surface 32a of the metal wall 32 are parallel to the sheet extruding direction of the machine, and are parallel to the orientation direction of the seal portion 38. The orientation direction and the direction of the upper surface 32a may be nearly parallel to each other at an angle of, for example, 5 degrees or less, and is more preferably parallel to each other.

[0033] The metal wall 32 may be varied so as not to completely surround the series resonators 12, the parallel resonators 14, the signal lines 20, the ground lines 23, the transmission

terminal 22, the antenna terminal 24 and the ground terminals 26. That is, the outer periphery of the piezoelectric substrate 10 may have a portion in which the metal wall 32 is not provided. In this case, however, the outer periphery of the piezoelectric substrate 10 has a portion in which the seal portion 38 is not bonded to the upper surface32a of the metal wall 32 but is bonded to the side surface of the metal wall 32. Since the liquid crystal polymer sheet has the orientation as has been described previously, the adhesive property between the seal portion 38 and the side surface of the metal wall 32 is lower than that between the seal portion 38 and the upper surface 32a of the metal wall 32. Therefore, there is a possibility that moisture may enter into the device via the interface between the seal portion 38 and the side surface of the metal wall 32. In order to suppress entering of the moisture, it is preferable that the metal wall 32 completely surrounds the series resonators 12, the parallel resonators 14, the signal lines 20, the ground lines 23, the transmission terminal 22, the antenna terminal 24 and the ground terminals 26. It is thus possible to seal the ladder type filter 100 with the seal portion 38 that contacts the upper surface 32a of the metal wall 32 and to effectively increase the hygroscopic property of the ladder type filter 100.

[0034] Since the metal wall 32 is provided in the outer periphery of the piezoelectric substrate 10, it is difficult to lead the terminals on the upper surface of the piezoelectric substrate 10 outwards. The transmission terminal 22, the antenna terminal 24 and the ground terminals 26 pierce the seal portion 38, whereby electric connections between the ladder type filter 100 and an external circuit can be made.

[0035] The seal portion 38 covers the metal plate 28 supported by the support posts 30. In other words, the metal plate 28 and the support posts 30 support the seal portion 38. Therefore, it is possible to prevent the seal portion 38 from contacting the series resonators 12 and the

[0038] Besides the ladder type filter, the present device includes a multimode filter, a dual filter, and a duplexer. Besides the SAW elements, boundary acoustic wave elements or piezoelectric thin-film resonators may be used. For the piezoelectric thin-film resonators, a substrate made of, for example, silicon, is used instead of the piezoelectric substrate 10. Further, the IDT 18 is replaced with a functional portion in which a piezoelectric thin-film is sandwiched between the upper and lower electrodes. The present device includes an electronic component in which a cavity is defined above a functional portion formed on a substrate.

Second Embodiment

[0039] A second embodiment is an exemplary acoustic wave device (electronic device) equipped with a ladder type filter. FIG. 18A is a cross-sectional view of an acoustic wave device in accordance with the second embodiment. The cross-sectional view of FIG. 18A is taken along the line C-C in FIG. 1A that illustrates the ladder type filter 100.

[0040] Referring to FIG. 18A, an acoustic wave device 200 in accordance with the second embodiment has the ladder type filter 100, printed-circuit boards 70 and molded resin 76. The printed-circuit boards 70 may be made of resin, and have interconnection lines 72. The printed-circuit boards 70 are stacked, and the interconnection lines 72 are interconnected by via interconnections 74. The ladder type filer 100 is electrically connected to the interconnection lines 72 by the solder balls 36. The ladder type filter 100 is flip-chip mounted on the uppermost one of the printed-circuit boards 70. The molded resin 76 with which the ladder type filter 100 is sealed is provided on the uppermost printed-circuit board 70.

[0041] According to the second embodiment, the seal portion 38 of the ladder type filter 100 of the acoustic wave device 200 is hardly removed. Thus, the hygroscopic property of the acoustic wave device 200 is improved. The series resonators 12 and the parallel resonators 14

CLAIMS

What is claimed is:

1. An electronic component comprising:

a substrate;

a functional portion provided on the substrate;

an interconnection line provided on the substrate and electrically connected to the functional portion;

a metal wall provided on the substrate so as to surround the functional portion and the interconnection line; and

a seal portion that contacts the metal wall and covers the functional portion and the interconnection line so as to define a cavity above the functional portion, the seal portion being made of liquid crystal polymer.

2. The electronic component according to claim 1, wherein the metal wall is made of copper.

3. The electronic component according to claim 1, wherein the metal wall has a surface roughness of 0.1 ~ 10 μm.

4. The electronic component according to claim 1, wherein the metal wall completely surrounds the functional portion and the interconnection line.

5. The electronic component according to claim 1, wherein the functional portion includes an acoustic wave device.

6. The electronic component according to claim 1, further comprising a metal plate that covers the functional portion so as to define the cavity above the functional portion, wherein the seal portion covers the metal plate.

7. The electronic component according to claim 1, wherein the seal portion has an orientation and contacts an upper surface of the metal wall, and a direction of the orientation of the seal portion is parallel to a direction of the upper surface of the metal wall

8. The electronic component according to claim 1, further comprising a terminal that is electrically connected to the interconnection line and vertically passes through the seal portion.

9. The electronic component according to claim 8~~1~~, wherein the terminal includes a ground terminal electrically connected to the metal wall.

10. An electronic device comprising:

a printed-circuit board; and

the~~an~~ electronic component according to claim 1 provided on the printed-circuit board.~~,~~

~~the electronic component including:~~

~~a substrate;~~

~~a functional portion provided on the substrate;~~

~~an interconnection line provided on the substrate and electrically connected to the functional portion;~~

~~a metal wall provided on the substrate so as to surround the functional portion and the interconnection line; and~~

~~a seal portion that contacts the metal wall and covers the functional portion and the interconnection line so as to define a cavity above the functional portion, the seal portion being made of liquid polymer.~~

11. The electronic device according to claim 10, wherein the electronic component is buried in the printed-circuit board, and the seal portion covers the whole electronic component.

12. A method for manufacturing an electronic component, comprising:

providing, on a substrate, a functional portion and an interconnection line electrically connected to the functional portion;

providing, by plating, a metal wall on the substrate so as to surround the functional portion and the interconnection line;

sealing the functional portion and the interconnection line with a seal portion so as to define a cavity above the functional portion,

the sealing portion being made of liquid crystal polymer and contacting the metal wall.

13. The method according to claim 12, further comprising:

providing, after the providing of the functional portion and the interconnection line, a first resist so as to cover the functional portion and the interconnection line so that an area of the