

PIEZOELECTRIC COMPONENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to piezoelectric components, and in particular relates to a piezoelectric component such as a trap for eliminating a signal having a specific frequency and a discriminator for discriminating a signal.

2. Description of the Related Art

A piezoelectric component such as a trap and a discriminator utilizing thickness shear vibration and thickness longitudinal vibration generally has a structure comprising a rectangular piezoelectric substrate having vibrating electrodes formed on both principal planes thereof, an accommodating portion formed of a case member material such as alumina for accommodating the piezoelectric substrate, and a lid member for shielding the accommodating portion with the piezoelectric substrate therein, wherein the piezoelectric substrate is supported in the case such that the vibrating portion thereof is vibratile. In the piezoelectric component having such the structure, since thickness shear vibration and so forth are in a vibrating mode having a nodal point at the center of the thickness of the piezoelectric substrate, damping members formed of a

silicone rubber are respectively applied to the principal planes of the piezoelectric substrate with vibrating electrodes formed thereon so that electrical characteristics such as attenuation, group delay characteristics, and a distortion rate are adjusted to have desirable values.

By the way, in a conventional piezoelectric component, damping members are respectively applied to both the principle planes of the piezoelectric substrate, so that applying of the damping member has to be performed twice to the piezoelectric substrate. Therefore, the number of manufacturing processes of the piezoelectric component is increased, resulting in a problem of increased cost of manufacturing of the piezoelectric component.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a low-cost piezoelectric component having easy manufacturability and moreover excellent electrical characteristics.

In order to achieve the above-mentioned object, a piezoelectric component according to the present invention comprises: a piezoelectric element comprising a piezoelectric substrate having vibrating electrodes formed on both principal planes of thereof, the piezoelectric element vibrating in a thickness shear mode; and a damping

member having a predetermined hardness disposed on one of the principal planes of the piezoelectric substrate so as to cover the vibrating electrode formed thereon.

Owing to the above structure, required electrical characteristics can be obtained by arranging the damping member having an appropriate hardness on only one principal surface of the piezoelectric substrate. More specifically, when the damping member having a Shore hardness of 35 to 80 is used, attenuation characteristics and group delay characteristics satisfying the required standard as a trap can be obtained by arranging the damping member on only one principal surface of the piezoelectric substrate.

Also, when the damping member having a Shore hardness of 80 to 100 is used, distortion rate characteristics satisfying the required standard as a discriminator can be obtained by arranging the damping member on only one principal surface of the piezoelectric substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an assembly view of a piezoelectric component according to a first embodiment of the present invention;

Fig. 2 is a perspective view of a piezoelectric element used in the piezoelectric component shown in Fig. 1;

Fig. 3 is a longitudinal sectional view of the piezoelectric component shown in Fig. 1;

Fig. 4 is a graph showing variations in trap attenuation of the piezoelectric component shown in Fig. 1 relative to the hardness of the damping member;

Fig. 5 is a graph showing the relationship between the group delay time of the piezoelectric component shown in Fig. 1 and the hardness of the damping member;

Fig. 6 is an assembly view of a piezoelectric component according to a second embodiment of the present invention;

Fig. 7 is a longitudinal sectional view of the piezoelectric component according to the second embodiment of the present invention;

Fig. 8 is a graph showing the relationship between the distortion rate of the piezoelectric component shown in Fig. 6 and the hardness of the damping member;

Fig. 9 is an assembly view of a piezoelectric component according to a third embodiment of the present invention;
and

Fig. 10 is a perspective view showing an external appearance of the piezoelectric substrate shown in Fig. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Piezoelectric components according to embodiments of the present invention will be described with reference to the attached drawings below.

(A first embodiment, Figs. 1 to 5)

A piezoelectric component according to an embodiment of the present invention applied to a trap is shown in Fig.

1. A piezoelectric trap 10 comprises a piezoelectric element 11, a damping member 12, a supporting substrate 13 for carrying the piezoelectric element 11, and a cover member 14 for covering the piezoelectric element 11 on the supporting substrate 13.

As shown in Fig. 2, the piezoelectric element 11 comprises a rectangular piezoelectric substrate 15 such as PZT, two vibrating electrodes 21a and 22a formed on the top surface of the piezoelectric substrate 15, and two vibrating electrodes 21b and 22b formed on the bottom surface thereof. The vibrating electrodes 21b and 22b respectively oppose the vibrating electrodes 21a and 22a sandwiching the piezoelectric substrate 15 therebetween. On the left end portion of the piezoelectric substrate 15, a terminal electrode 31 is formed extending from the top to the bottom surface. The terminal electrode 31 is connected to the vibrating electrode 21a. On the right end portion of the piezoelectric substrate 15, a terminal electrode 32 is formed extending from the top to the bottom surface. The terminal electrode 32 is connected to the vibrating electrode 22a. Between the vibrating electrodes 21b and 22b formed on the bottom surface of the piezoelectric substrate 15, a terminal electrode 33 is formed, which is connected to

the vibrating electrodes 21b and 22b.

The supporting substrate 13 is formed of an insulating material such as alumina with connecting electrodes 41 to 43 formed on the top surface thereof respectively corresponding to the terminal electrodes 31 to 33 on the piezoelectric element 11. Both end portions 41a of the connecting electrode 41 extend inside notches 13a respectively formed on two edges of the supporting substrate 13. Both end portions 42a of the connecting electrode 42 extend inside notches 13b respectively formed on two edges of the supporting substrate 13. Both end portions 43a of the connecting electrode 43 extend inside notches 13c respectively formed on two edges of the supporting substrate 13.

Conductive adhesives 16 (see Fig. 3) are respectively coated on the connecting electrodes 41 to 43 of the supporting substrate 13 by printing, etc., to which the terminal electrodes 31 to 33 on the piezoelectric element 11 are respectively bonded with the adhesives 16. Thereby, the piezoelectric element 11 is carried on the supporting substrate 13 with its vibrating portions having a gap to the supporting substrate 13 created by the thicknesses of the adhesives 16.

On the surface of the piezoelectric substrate 15, the damping member 12 formed of a silicone rubber having a Shore

hardness of 35 to 80 is applied covering the vibrating electrodes 21a and 22a by a method such as printing.

A glass paste film 17 is formed around the periphery on the top surface of the supporting substrate 13 by printing, etc. The cover member 14 formed of a metallic material is bonded to the glass paste film 17 so as to cover the piezoelectric element 11. The cover member 14 is electrically connected to the connecting electrode 43 for grounding through holes 18 formed on the glass paste film 17 with conductive adhesives, etc. Thereby, the piezoelectric element 11 is electromagnetically shielded.

In the piezoelectric trap 10 formed as above, the damping member 12 dampens thickness shear vibration generated in the piezoelectric element 11 from the top surface on which the vibrating electrodes 21a and 22a are formed. By using a material having a Shore hardness of 35 to 80 as the damping member 12, as also understood from Figs. 4 and 5, the piezoelectric trap 10 having exceeding 50 dB (= a lower limit of the standard value) of trap attenuation and a group delay time of below 100 msec (= an upper limit of the standard value) can be obtained.

(A second embodiment, Figs. 6 to 8)

A piezoelectric component according to an embodiment

of the present invention applied to a discriminator is shown in Fig. 6. A piezoelectric discriminator 50 comprises a piezoelectric element 51, a damping member 52, a case 53 for accommodating the piezoelectric element 51, and a lid member 54 for shielding opening of the top surface of the case 53.

The piezoelectric element 51 is formed of a rectangular piezoelectric substrate 55 having a vibrating electrode 61 formed on the top surface thereof and a vibrating electrode 62 formed on the bottom surface thereof. The vibrating electrodes 61 and 62 are formed on the central portion of the piezoelectric substrate 55 so as to oppose each other. An extending portion 61a of the vibrating electrode 61 extends from the top surface to the bottom surface in the left end side of the piezoelectric substrate 55. An extending portion 62a of the vibrating electrode 62 extends from the bottom surface to the top surface in the right end side of the piezoelectric substrate 55.

The case 53 is formed of an insulating material such as alumina and has a recessed portion 56 for accommodating the piezoelectric element 51. In both end-portions of the recessed portion 56, step portions 57 and 58 for respectively placing both end-portions of the piezoelectric element 51 thereon are respectively formed. Owing to the step portions 57 and 58, as shown in Fig. 7, the piezoelectric element 51 is supported thereon in a state

having a gap between its vibrating portion and the top surface 59 of the recessed portion 56.

In the case 53, connecting electrodes 62 and 63 extended from the respective step portions 57 and 58 to the outer peripheral surface thereof are formed. Conductive adhesives 64 are applied to the step portions 57 and 58 such that the extending portions 61a and 62a of the vibrating electrodes 61 and 62 in the piezoelectric element 51 are respectively and electrically connected to the connecting electrodes 62 and 63 with the conductive adhesives 64.

On the surface of the piezoelectric substrate 55, the damping member 52 formed of a silicone rubber having a Shore hardness of 80 to 100 is applied covering the vibrating electrode 61 except the extending portion 61a.

The lid member 54 is bonded to the periphery of the top opened surface of the case 53. In both end-portions of the lid member 54, connecting electrodes 65 and 66 for respectively and electrically connecting to the connecting electrodes 62 and 63 of the case 53 are also formed.

In the piezoelectric discriminator 50 formed as above, the damping member 52 dampens thickness shear vibration generated in the piezoelectric element 51 from the top surface on which the vibrating electrode 62 is formed. By using a material having a Shore hardness of 80 to 100 as the damping member 52, as also understood from Fig. 8, the

piezoelectric discriminator 50 having a distortion rate of below one percent (= an upper limit of the standard value) can be obtained.

(A third embodiment, Figs. 9 and 10)

A third embodiment will be described in the context of a monolithic piezoelectric trap. As shown in Fig. 9, a piezoelectric trap 70 comprises a piezoelectric element 71 and protective substrates 74 and 75 for sandwiching the piezoelectric element 71 therebetween to form vibrating spaces.

The piezoelectric element 71 comprises a piezoelectric substrate 80 having vibrating electrodes 81a and 82a formed on the top surface thereof. On the bottom surface of the piezoelectric substrate 80, vibrating electrodes 81b and 82b are formed so as to oppose the vibrating electrodes 81a and 82a, respectively. In the left end portion of the piezoelectric substrate 80, an extending electrode 84 is formed, which is connected to the vibrating electrode 81a. In the right end portion of the piezoelectric substrate 80, an extending electrode 85 is formed, which is connected to the vibrating electrode 82a. Between the vibrating electrodes 81b and 82b on the bottom surface of the piezoelectric substrate 80, an extending electrode 86 is formed, which is connected to the vibrating electrodes 81b and 82b.

On the top surface of the piezoelectric substrate 80, damping members 72 and 73 formed of a silicone rubber having a Shore hardness of 35 to 80 are applied by a method such as printing so as to cover the vibrating electrodes 81a and 82a, respectively. On the central portions of the protective substrates 74 and 75, recessed portions 74a and 75a for forming a vibrating space are respectively formed. The protective substrates 74 and 75 are formed of ceramics or a resin material. In addition, the recessed portions 74a and 75a for forming a vibrating space are not necessarily needed, and the vibrating space may be secured by the thicknesses of the adhesives used for bonding the protective substrates 74 and 75 to the piezoelectric element 71.

The protective substrates 74 and 75 are joined to the piezoelectric element 71 via the adhesive. In this manner, a monolithic body 90 as shown in Fig. 10 having vibrating spaces enclosed inside can be obtained. External electrodes 91 and 92 are respectively formed on both end portions of the monolithic body 90 while an external electrode 93 is formed on the central portion thereof. The external electrodes 91, 92, and 93 are electrically connected to the extending electrodes 84, 85, and 86, respectively.

The piezoelectric trap 70 formed as above produces the same action and effect as those of the above-mentioned piezoelectric trap 10 according to the first embodiment.

(Other embodiments)

The present invention is not limited to the above-mentioned embodiments and various modifications may be made without departing from the scope of the substance of the present invention. For example, the piezoelectric element 11 of the trap according to the first embodiment may be accommodated in the case 53 in the second embodiment, or the piezoelectric element 51 in the second embodiment may be conversely placed on the supporting substrate 13 in the first embodiment. Furthermore, the damping member may be applied to the bottom surface of the piezoelectric substrate instead to the top surface thereof.

As understood from the above description, according to the present invention, since the damping member having a predetermined hardness is applied to one of principal planes of the piezoelectric substrate to thereby dampen the thickness shear vibration of the piezoelectric element to obtain required electrical characteristics, the number of processes for applying the damping member is reduced so as to have easy manufacturability and low-cost piezoelectric components.

For example, when the damping member having a Shore hardness of 35 to 80 is used, attenuation characteristics and group delay characteristics satisfying the required standard as a trap can be obtained, so that traps can be

easily produced, by arranging the damping member on only one principal surface of the piezoelectric substrate.

Also, when the damping member having a Shore hardness of 80 to 100 is used, distortion rate characteristics satisfying the required standard as a trap can be obtained, so that discriminators can be easily produced, by arranging the damping member on only one principal surface of the piezoelectric substrate.



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WHAT IS CLAIMED IS:

1. A piezoelectric component comprising:
a piezoelectric element comprising a piezoelectric substrate having vibrating electrodes formed on both principal planes of thereof, said piezoelectric element vibrating in a thickness shear mode; and
a damping member having a predetermined hardness disposed on one of the principal planes of the piezoelectric substrate so as to cover the vibrating electrode formed thereon.
2. A piezoelectric component according to Claim 1, wherein said damping member has a Shore hardness of 35 to 80.
3. A piezoelectric component according to Claim 1, wherein said damping member has a Shore hardness of 80 to 100.