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Jin et al.

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(54) **ULTRASONIC PROBE AND MANUFACTURING METHOD THEREOF**

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(30) **Foreign Application Priority Data**

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B06B 1/06 (2006.01)

(52) **U.S. Cl.**
CPC .. ***A61B 8/42*** (2013.01); ***B06B 1/06*** (2013.01)

(58) **Field of Classification Search**
CPC A61B 8/42; B06B 1/06
USPC 600/300, 407, 424, 437, 440, 443, 447, 600/459, 472; 310/311, 322, 327, 334, 335; 361/749, 760, 777
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2003/0085635 A1* 5/2003 Davidsen B06B 1/0607 310/334
2008/0303381 A1* 12/2008 Yuuya C08K 3/22 310/327
2010/0241004 A1* 9/2010 Jung B06B 1/0622 600/459

FOREIGN PATENT DOCUMENTS

KR 10-2010-0047394 A 5/2010
KR 10-2010-0104534 A 9/2010

OTHER PUBLICATIONS

Korean Office Action issued in Korean Patent Application No. KR 10-2012-0017002 dated Jul. 1, 2013.

* cited by examiner

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(57) **ABSTRACT**

The present application relates to an ultrasonic probe including a connector capable of applying an electrical signal to a piezoelectric material and disposed at the outside of a backing layer, and a method of manufacturing the same. The ultrasonic probe includes a piezoelectric material, a backing layer installed on the rear surface of the piezoelectric material, and a first connector installed on at least one side surface of the backing layer and electrically connected to the piezoelectric material.

11 Claims, 14 Drawing Sheets

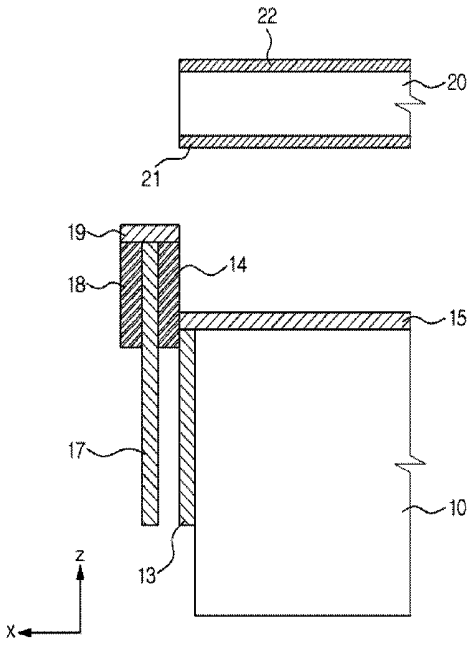


FIG. 1

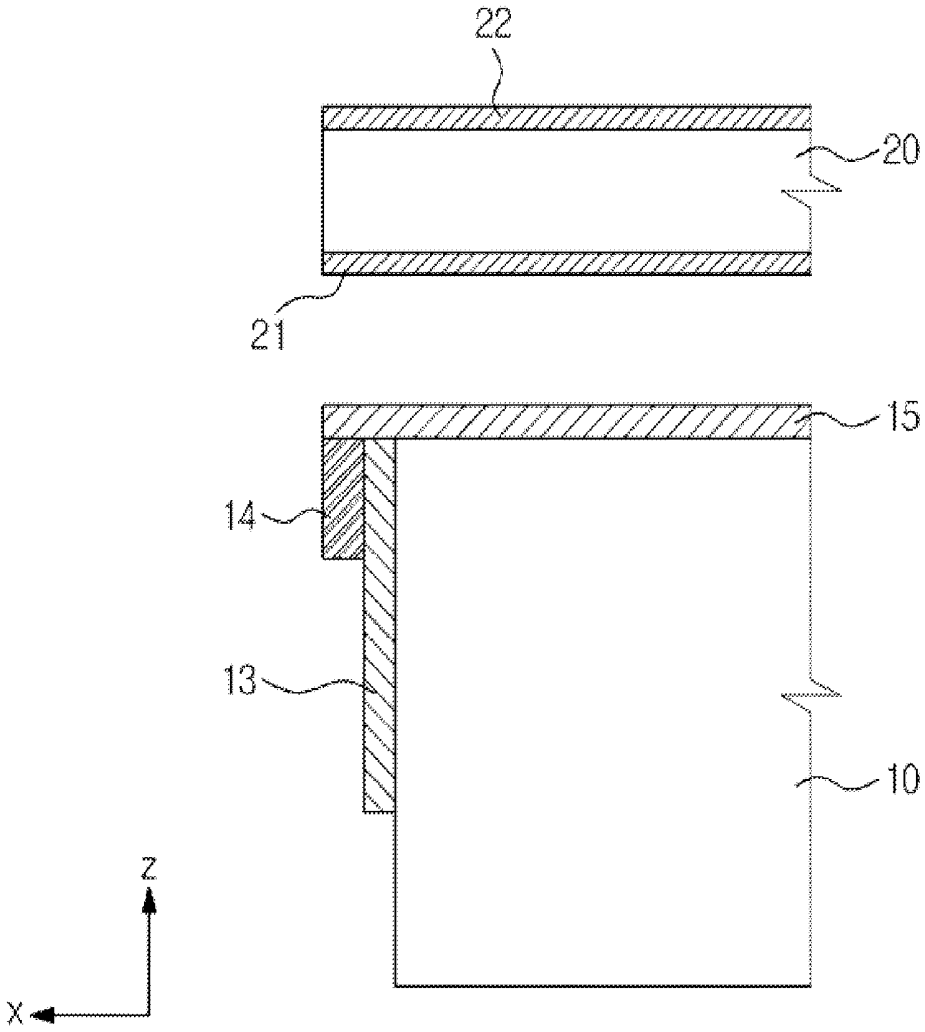


FIG. 2

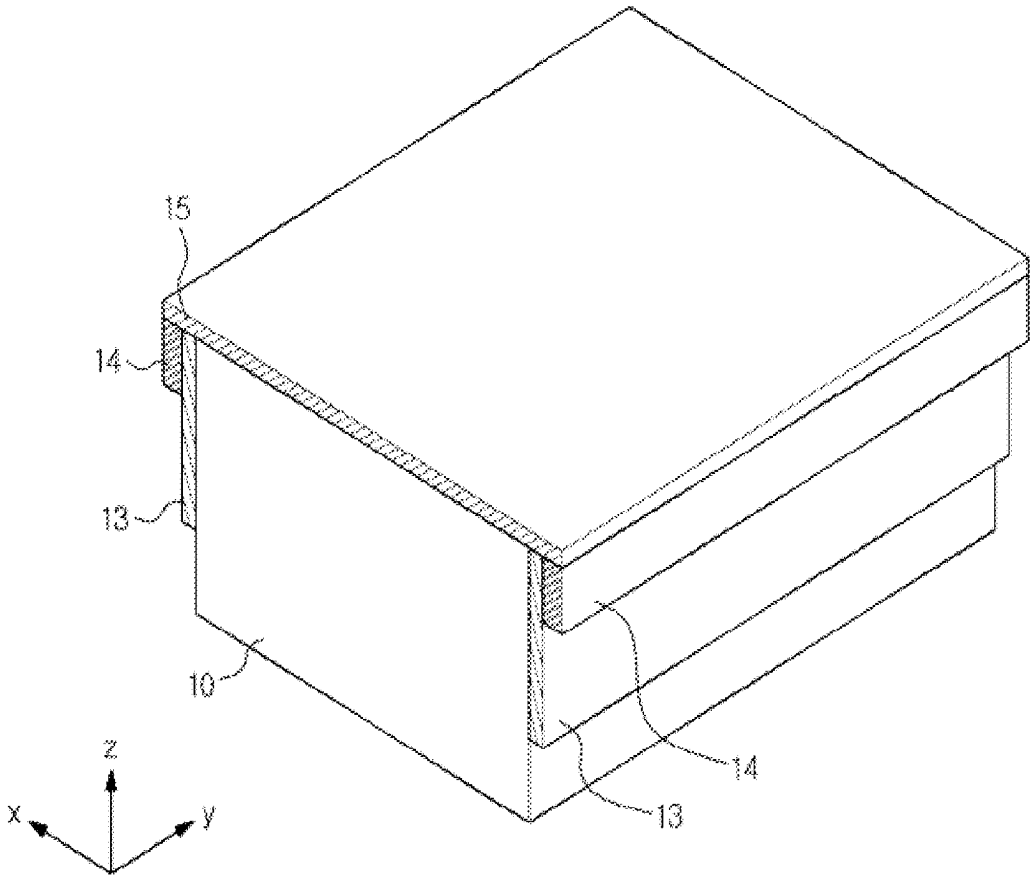


FIG. 3

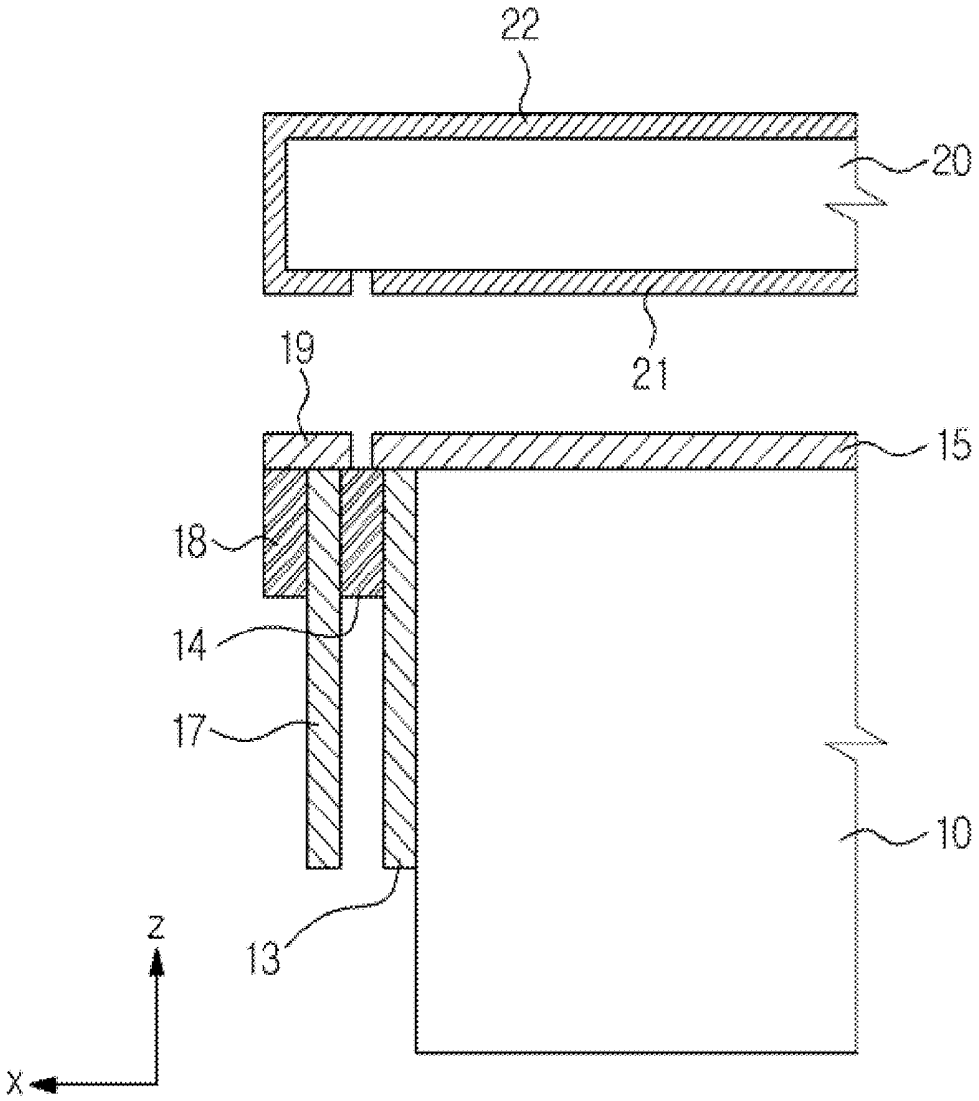


FIG. 4

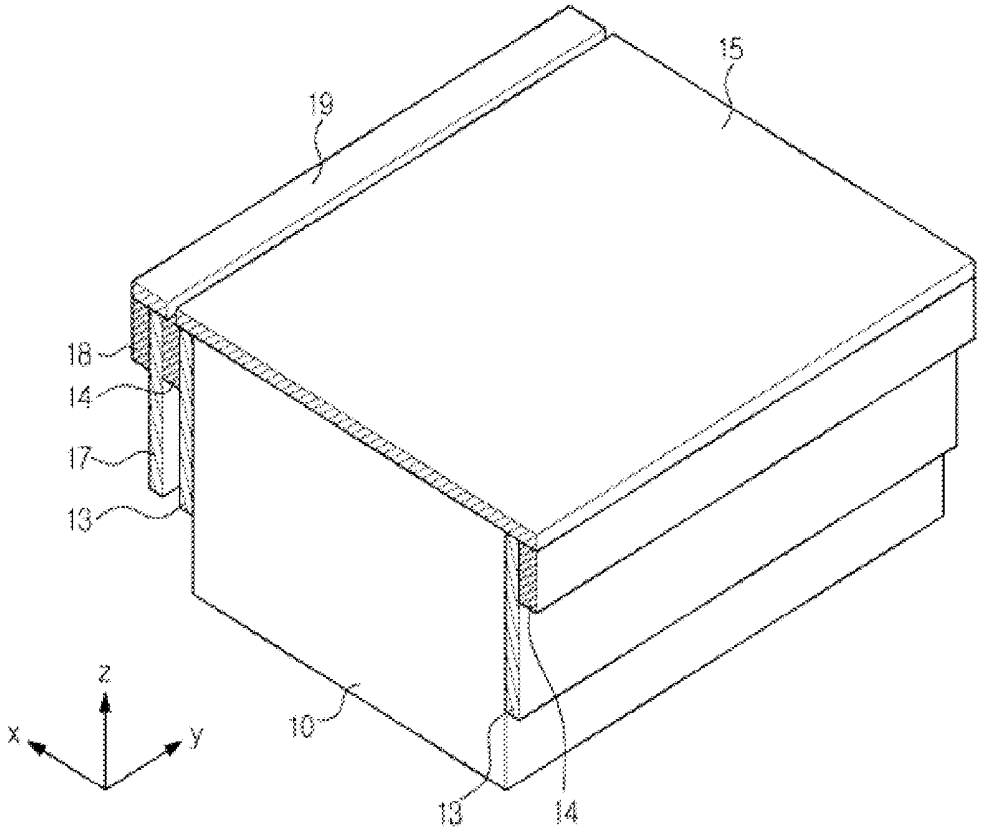


FIG. 5

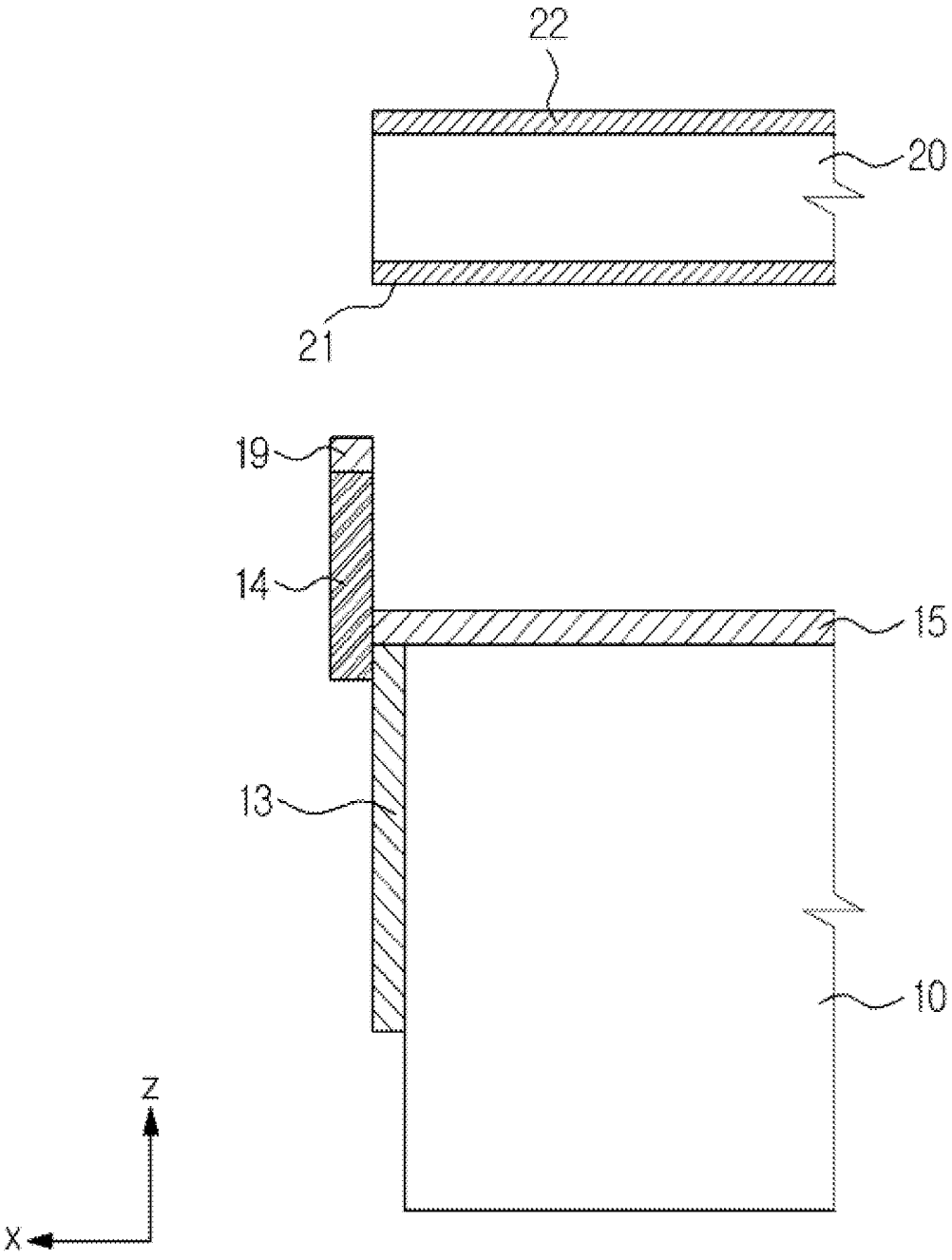


FIG. 6

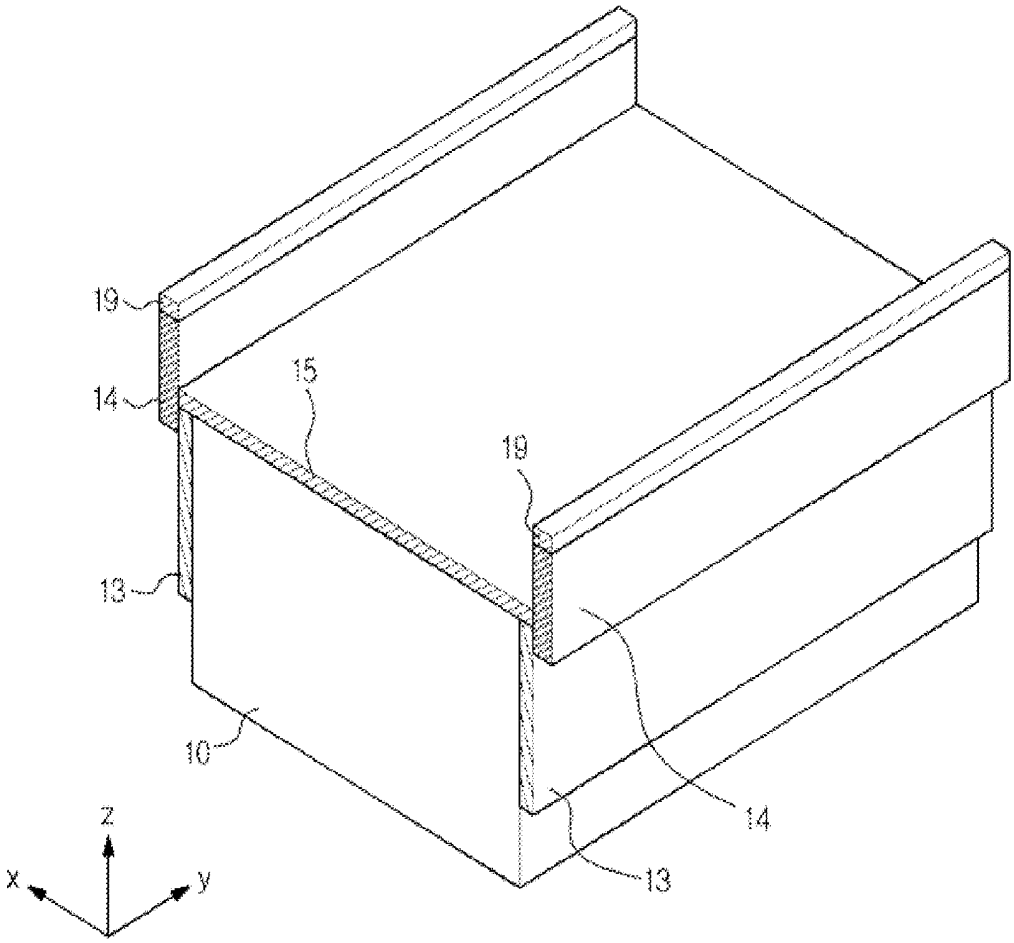


FIG. 7

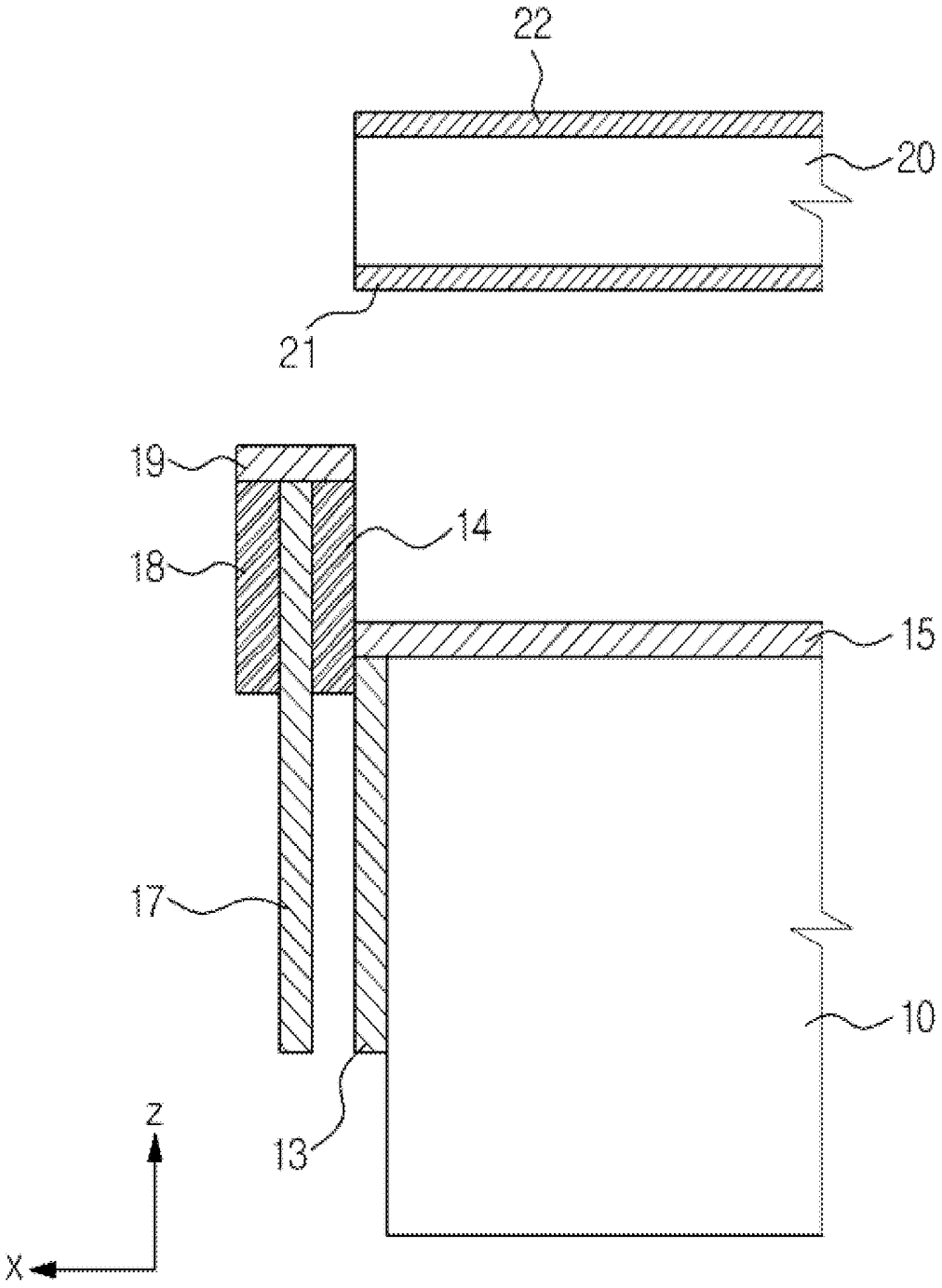


FIG. 8

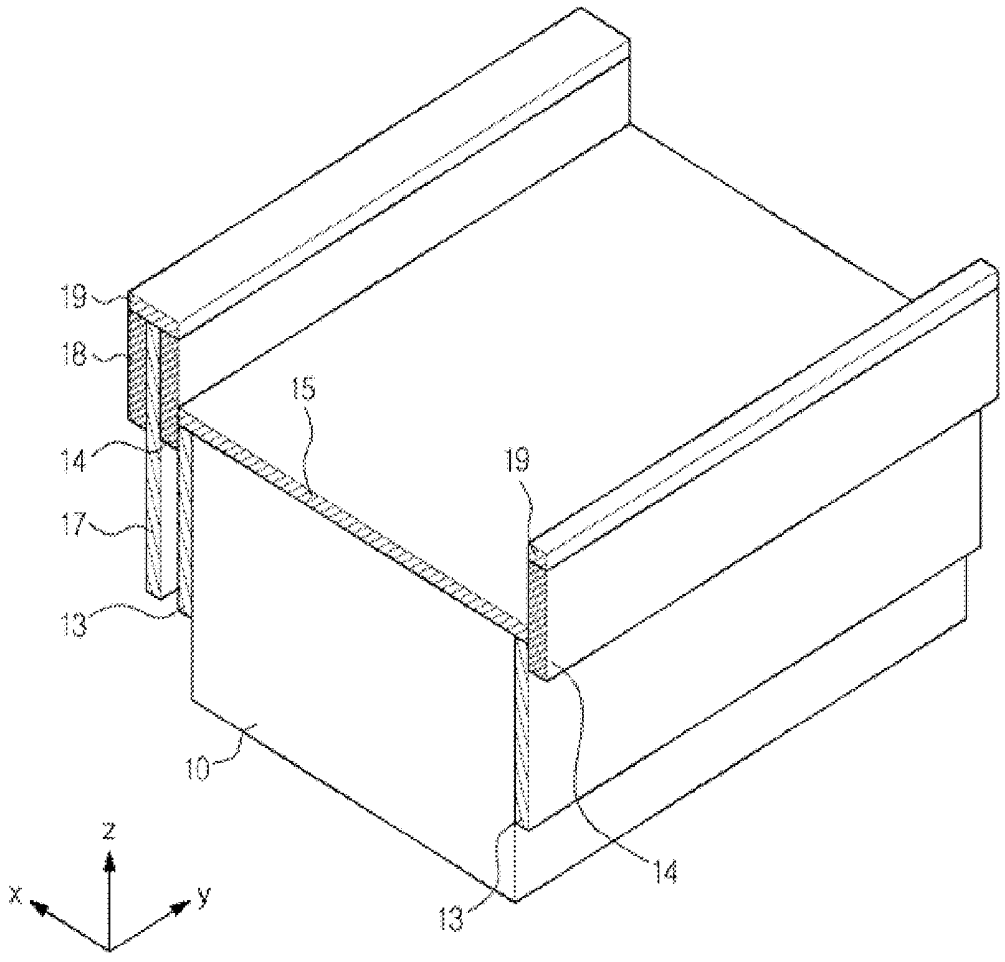


FIG. 9

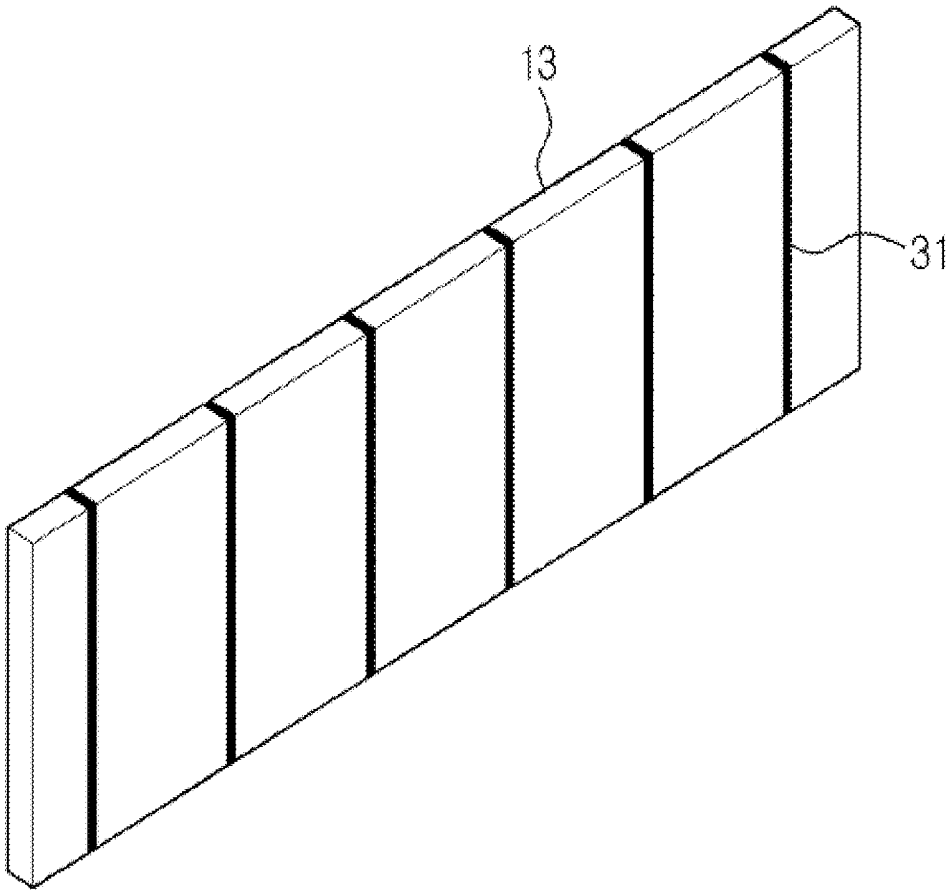


FIG. 10

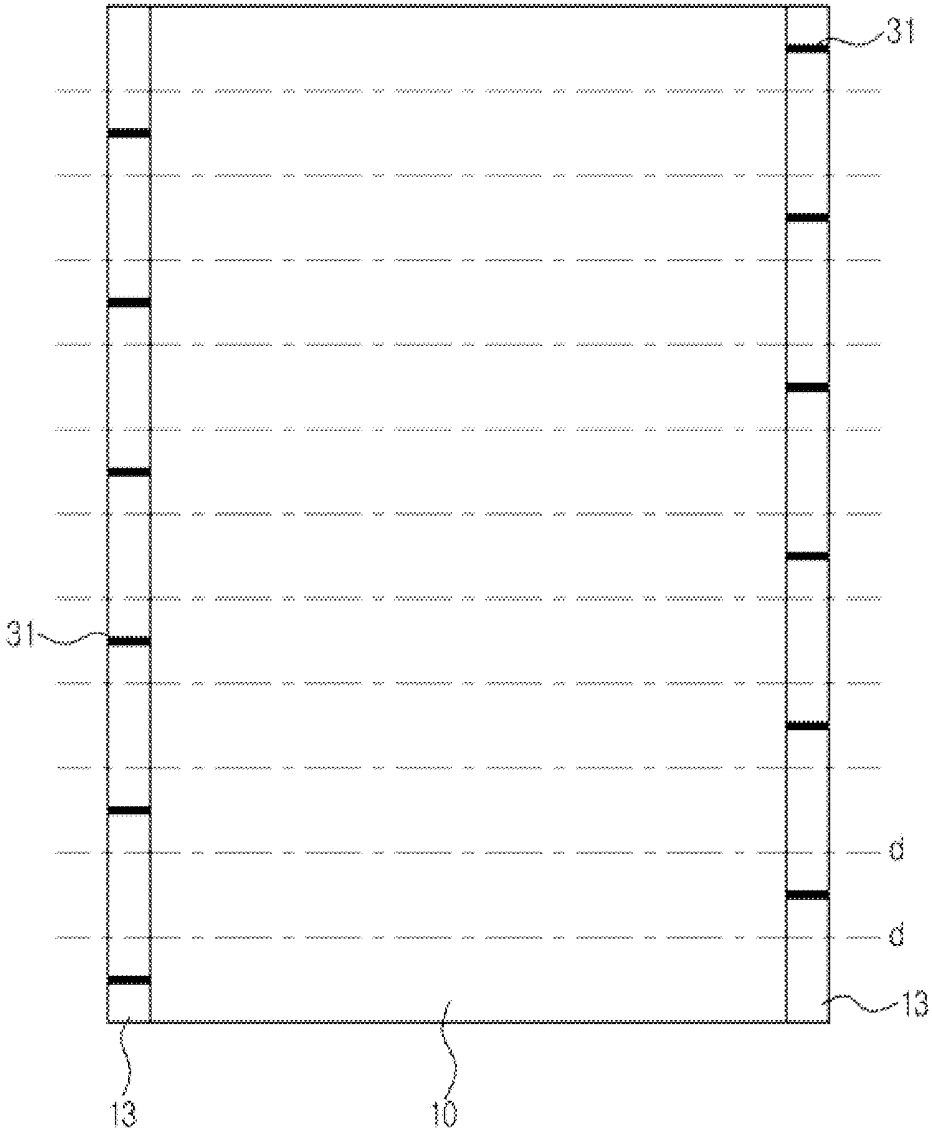


FIG. 11

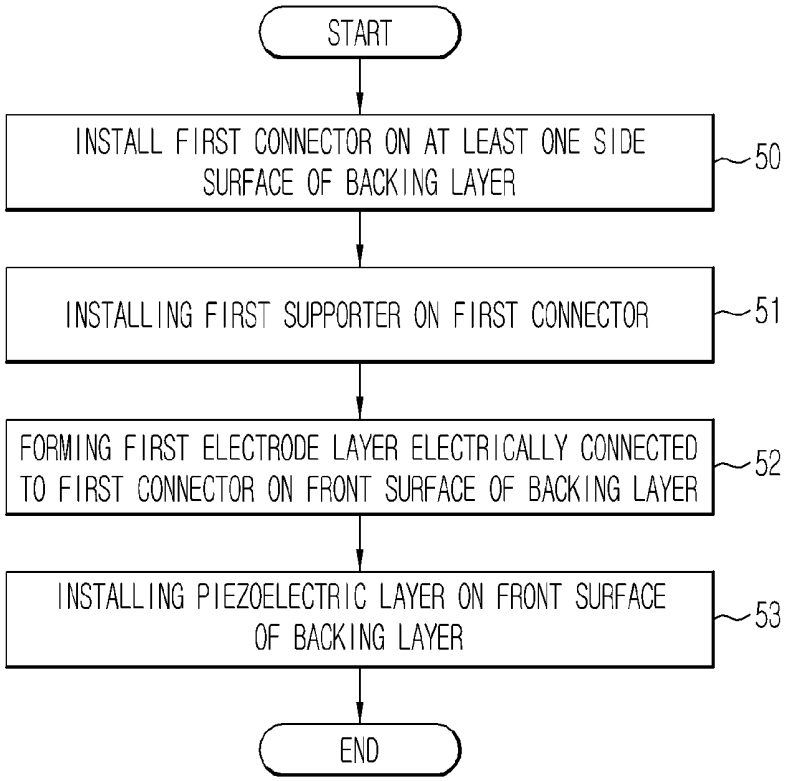

START
INSTALL FIRST CONNECTOR ON AT LEAST ONE SIDE SURFACE OF BACKING LAYER
50
INSTALLING FIRST SUPPORTER ON FIRST CONNECTOR
51
FORMING FIRST ELECTRODE LAYER ELECTRICALLY CONNECTED TO FIRST CONNECTOR ON FRONT SURFACE OF BACKING LAYER
52
INSTALLING PIEZOELECTRIC LAYER ON FRONT SURFACE OF BACKING LAYER
53
END

FIG. 12

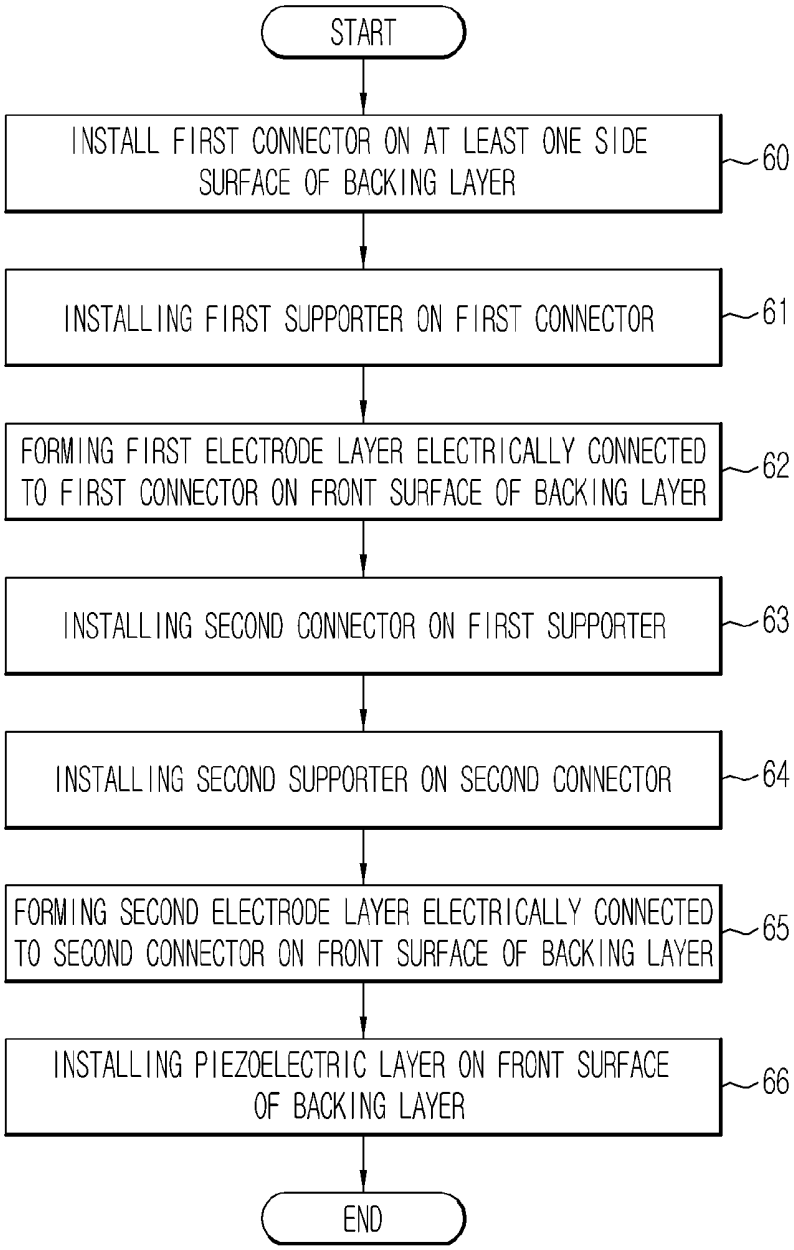

START
INSTALL FIRST CONNECTOR ON AT LEAST ONE SIDE SURFACE OF BACKING LAYER
60
INSTALLING FIRST SUPPORTER ON FIRST CONNECTOR
61
FORMING FIRST ELECTRODE LAYER ELECTRICALLY CONNECTED TO FIRST CONNECTOR ON FRONT SURFACE OF BACKING LAYER
62
INSTALLING SECOND CONNECTOR ON FIRST SUPPORTER
63
INSTALLING SECOND SUPPORTER ON SECOND CONNECTOR
64
FORMING SECOND ELECTRODE LAYER ELECTRICALLY CONNECTED TO SECOND CONNECTOR ON FRONT SURFACE OF BACKING LAYER
65
INSTALLING PIEZOELECTRIC LAYER ON FRONT SURFACE OF BACKING LAYER
66
END

FIG. 13

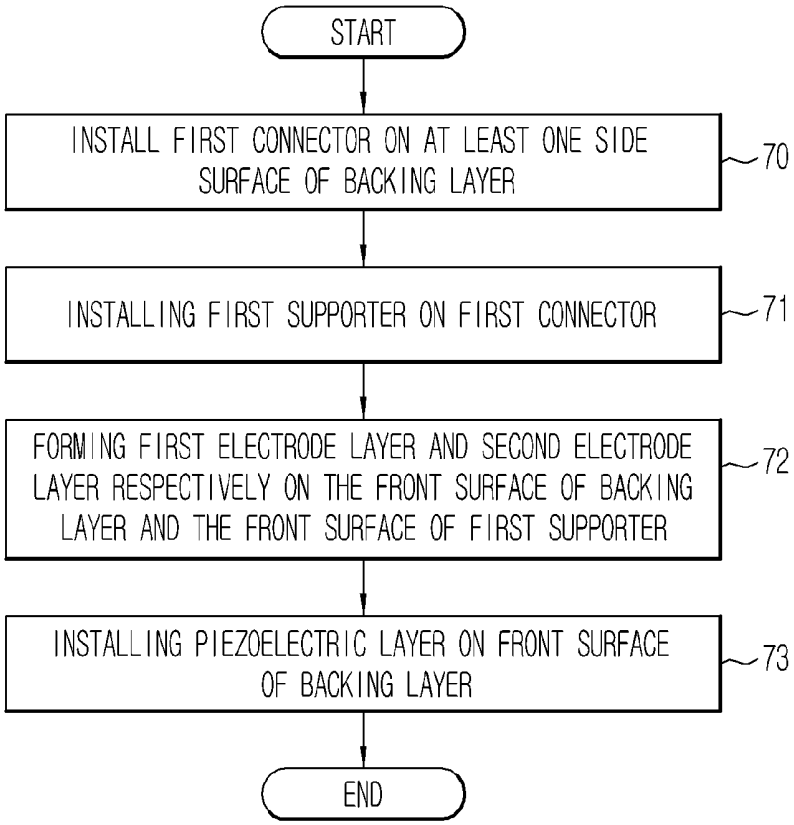
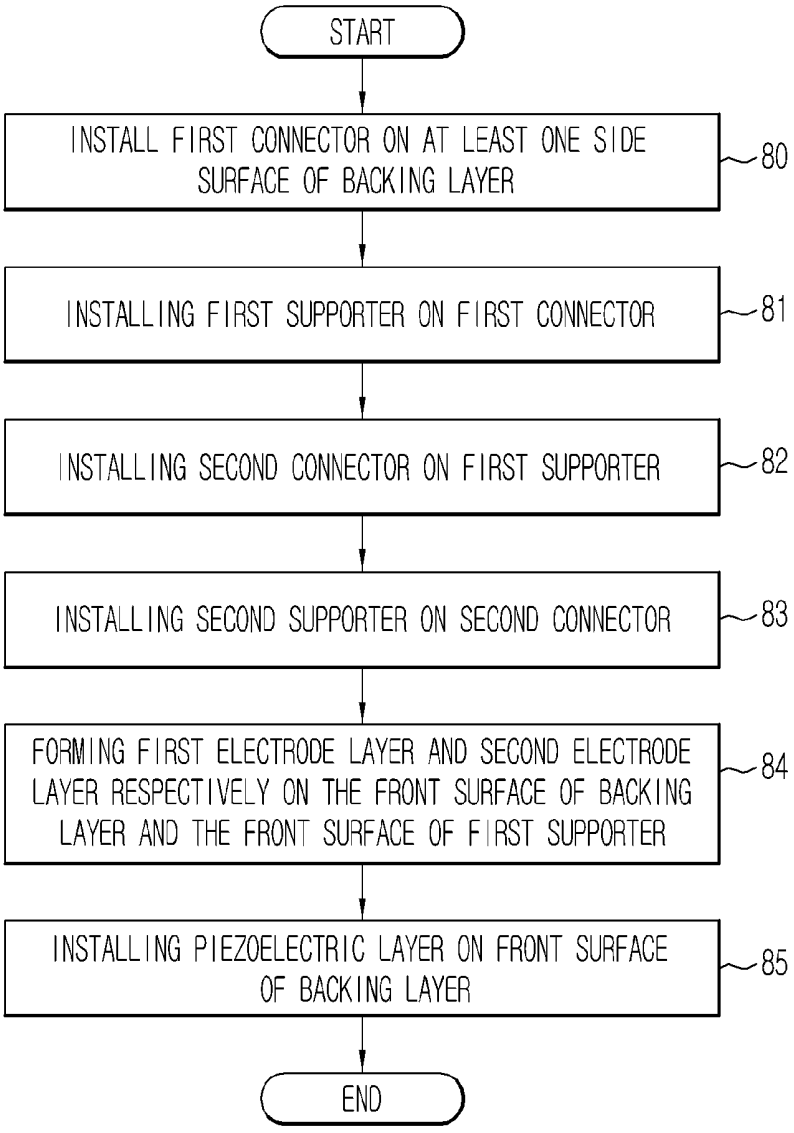

START
INSTALL FIRST CONNECTOR ON AT LEAST ONE SIDE SURFACE OF BACKING LAYER
70
INSTALLING FIRST SUPPORTER ON FIRST CONNECTOR
71
FORMING FIRST ELECTRODE LAYER AND SECOND ELECTRODE LAYER RESPECTIVELY ON THE FRONT SURFACE OF BACKING LAYER AND THE FRONT SURFACE OF FIRST SUPPORTER
72
INSTALLING PIEZOELECTRIC LAYER ON FRONT SURFACE OF BACKING LAYER
73
END

FIG. 14


START
INSTALL FIRST CONNECTOR ON AT LEAST ONE SIDE SURFACE OF BACKING LAYER
80
INSTALLING FIRST SUPPORTER ON FIRST CONNECTOR
81
INSTALLING SECOND CONNECTOR ON FIRST SUPPORTER
82
INSTALLING SECOND SUPPORTER ON SECOND CONNECTOR
83
FORMING FIRST ELECTRODE LAYER AND SECOND ELECTRODE LAYER RESPECTIVELY ON THE FRONT SURFACE OF BACKING LAYER AND THE FRONT SURFACE OF FIRST SUPPORTER
84
INSTALLING PIEZOELECTRIC LAYER ON FRONT SURFACE OF BACKING LAYER
85
END

ULTRASONIC PROBE AND MANUFACTURING METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to Korean Patent Application No. 2012-0017002, filed on Feb. 20, 2012 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present application relates to an ultrasonic probe to generate an image of an internal state of an object using ultrasound.

BACKGROUND

An ultrasonic diagnosis apparatus irradiates an ultrasonic signal toward a target region of the interior of a body of an object from the surface of the body of the object, and non-invasively acquires an image regarding a soft tissue tomogram or a blood stream using information of a reflected ultrasonic signal (e.g., an ultrasonic echo signal).

The ultrasonic diagnosis apparatus is small and inexpensive, executes display in real time and has high safety without radiation exposure, as compared to other image diagnosis apparatuses, such as an X-ray diagnosis apparatus, an X-ray computerized tomography (CT) scanner, a magnetic resonance image (MRI), and a nuclear medicine diagnosis apparatus, and is thus widely used for heart diagnosis, celiac diagnosis, urinary diagnosis, and obstetrical diagnosis.

The ultrasonic diagnosis apparatus includes an ultrasonic probe for transmitting an ultrasonic signal to an object and receiving an ultrasonic echo signal reflected by the object to acquire an ultrasonic image of the object.

The ultrasonic probe includes a piezoelectric layer in which a piezoelectric material vibrates to execute a conversion between an electrical signal and an acoustic signal. A matching layer reduces an acoustic impedance difference between the piezoelectric layer and the object so as to maximally transmit ultrasonic waves generated in the piezoelectric layer to the object. A lens concentrates ultrasonic waves proceeding in the forward direction of the piezoelectric layer on a predetermined point. A backing layer prevents ultrasonic waves from proceeding in the backward direction of the piezoelectric layer to prevent image distortion.

SUMMARY

Therefore, it is an aspect of the present application to provide an ultrasonic probe including a connector capable of applying an electrical signal to a piezoelectric material and disposed at the outside of a backing layer and a method of manufacturing the same.

Additional aspects of the application will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the subject matter described herein.

In accordance with one aspect of the present application, an ultrasonic probe includes a piezoelectric material. A backing layer is installed on the rear surface of the piezoelectric material. A first connector is installed on at least one side surface of the backing layer and is electrically connected to the piezoelectric material.

The ultrasonic probe may further include a first electrode layer formed on the front surface of the backing layer, and the first electrode layer may be electrically connected to the first connector.

The piezoelectric material may include an electrode disposed on at least one surface of the piezoelectric material including the rear surface of the piezoelectric material and electrically connected to the first electrode layer.

The ultrasonic probe may further include a first supporter installed on the first connector to support the first connector by fixing the first connector to one side surface of the backing layer.

The first supporter may be installed to protrude from the front surface of the backing layer and forms a mounting groove, at which the piezoelectric material is installed.

The first supporter may be formed of an insulating material.

The ultrasonic probe may further include a second electrode layer disposed on the front surface of the first supporter.

The piezoelectric material may include an electrode disposed on at least one surface of the piezoelectric material including the front surface of the piezoelectric material and electrically connected to the second electrode layer.

The ultrasonic probe may further include a second connector spaced apart from the first connector and electrically connected to the piezoelectric material.

The second connector may be installed on the first supporter to protrude from the front surface of the backing layer with the first supporter.

The ultrasonic probe may further include a second supporter installed on the second connector to support the second connector by fixing the second connector to one side surface of the backing layer, and the second supporter may be formed of an insulating material.

The ultrasonic probe may further include a second electrode layer disposed on the front surface of the first supporter and electrically connected to the second connector.

The piezoelectric material may include an electrode disposed on at least one surface of the piezoelectric material including the front surface of the piezoelectric material and electrically connected to the second electrode layer.

The ultrasonic probe may further include a second connector spaced apart from the first connector and electrically connected to the piezoelectric material.

The ultrasonic probe may further include a second supporter installed on the second connector to support the second connector by fixing the second connector to one side surface of the backing layer, and the second supporter may be formed of an insulating material.

The first connector and the second connector may include a flexible printed circuit board (FPCB), a printed circuit board (PCB), or a wire.

The ultrasonic probe may further include a second electrode layer disposed on the front surface of the backing layer, and the second electrode layer may be electrically connected to the second connector.

The piezoelectric material may include an electrode disposed on at least one surface of the piezoelectric material including the rear surface of the piezoelectric material and electrically connected to the second electrode layer.

The ultrasonic probe may further include a first electrode layer disposed on the front surface of the backing layer and electrically connected to the first connector, and the first electrode layer may be separated from the second electrode layer.

According to an aspect of the present application, the electrode disposed on the front surface of the backing layer enlarges a contact area between the connector and the piezoelectric material, thereby providing excellent electrical connection properties.

Furthermore, connection between the piezoelectric material and the connector may be easily performed, and performance degradation caused by defective connection.

Additional advantages and novel features will be set forth in part in the description which follows, and in part will become apparent to those skilled in the art upon examination of the following and the accompanying drawings or may be learned by production or operation of the examples. The advantages of the present teachings may be realized and attained by practice or use of various aspects of the methodologies, instrumentalities and combinations set forth in the detailed examples discussed below.

BRIEF DESCRIPTION OF THE DRAWINGS

These and/or other aspects of the application will become apparent and more readily appreciated from the following description of the examples, taken in conjunction with the accompanying drawings of which:

FIG. **1** is a cross-sectional view illustrating an ultrasonic probe according to one example of the present application;

FIG. **2** is a perspective view illustrating a backing layer of the ultrasonic probe of FIG. **1**;

FIG. **3** is a cross-sectional view illustrating an ultrasonic probe according to another example;

FIG. **4** is a perspective view illustrating a backing layer of the ultrasonic probe of FIG. **3**;

FIG. **5** is a cross-sectional view illustrating an ultrasonic probe according to another example of the present application;

FIG. **6** is a perspective view illustrating a backing layer of the ultrasonic probe of FIG. **5**;

FIG. **7** is a cross-sectional view illustrating an ultrasonic probe according to another example of the present application;

FIG. **8** is a perspective view illustrating a backing layer of the ultrasonic probe of FIG. **7**;

FIG. **9** is a perspective view illustrating a first connector according to yet another example of the present application;

FIG. **10** is a top view of a backing layer according to an example of the present application;

FIG. **11** is a flowchart illustrating a method of manufacturing an ultrasonic probe according to an example of the present application;

FIG. **12** is a flowchart illustrating a method of manufacturing an ultrasonic probe according to another example of the present application; and

FIGS. **13** and **14** are flowcharts illustrating methods of manufacturing ultrasonic probes according to another example of the present application.

DETAILED DESCRIPTION

In the following detailed description, numerous specific details are set forth by way of examples in order to provide a thorough understanding of the relevant teachings. However, it should be apparent to those skilled in the art that the present teachings may be practiced without such details. In other instances, well known methods, procedures, components, and/or circuitry have been described at a relatively high-level, without detail, in order to avoid unnecessarily obscuring aspects of the present teachings.

Reference will now be made in detail to the examples of the present application which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

Hereinafter, an ultrasonic probe and a method of manufacturing the same will be described.

FIG. **1** is a cross-sectional view illustrating an ultrasonic probe according to one example. FIG. **2** is a perspective view illustrating a backing layer **10** of the ultrasonic probe of FIG. **1**.

FIG. **3** is a cross-sectional view illustrating an ultrasonic probe according to another example. FIG. **4** is a perspective view illustrating a backing layer **10** of the ultrasonic probe of FIG. **3**,

FIG. **5** is a cross-sectional view illustrating an ultrasonic probe according to another example. FIG. **6** is a perspective view illustrating a backing layer **10** of the ultrasonic probe of FIG. **5**.

FIG. **7** is a cross-sectional view illustrating an ultrasonic probe according to another example. FIG. **8** is a perspective view illustrating a backing layer **10** of the ultrasonic probe of FIG. **7**.

The ultrasonic probe according to an example includes a piezoelectric layer **20**, a backing layer **10** installed on the rear surface of the piezoelectric layer **20**, and a first connector **13** installed on at least one side surface of the backing layer **10**.

The effect of voltage generation in a designated material in response to applied mechanical pressure and the effect of mechanical deformation in response to applied voltage are respectively referred to as the piezoelectric effect and inverse piezoelectric effect. A material exhibiting such effects is referred to as a piezoelectric material.

That is, the piezoelectric material is a material which converts electrical energy into mechanical vibration energy or converts mechanical vibration energy into electrical energy.

The ultrasonic probe according to one example includes the piezoelectric layer **20** formed of a piezoelectric material that generates ultrasonic waves in response to an electrical signal applied thereto by converting the electrical signal into mechanical vibration.

The piezoelectric material constituting the piezoelectric layer **20** may include PZMT single crystals formed of lead zirconate titanate (PZT) ceramics, a solid solution of lead magnesium niobate, and lead titanate or PZNT single crystals formed of a solid solution of lead zinc niobate and lead titanate.

In addition, the piezoelectric layer **20** may have a single-layered or multi-layered stack structure.

In general, impedance and voltage are easily controlled in the piezoelectric layer **20** having a stack structure, so that excellent sensitivity, a high energy conversion rate, and soft spectrum may be obtained.

In addition, electrodes to which electrical signals are applied may be disposed on the front and rear surfaces of the piezoelectric layer **20**. When the electrodes are disposed on the front and rear surfaces of the piezoelectric layer **20**, one of the electrodes disposed on the front and rear surfaces may be a ground electrode and the other may be a signal electrode.

The electrode may be formed of a highly conductive metal such as gold, silver, or copper by techniques such as deposition, sputtering, plating, or spraying.

Although not shown in the drawings, a matching layer may be installed on the front surface of the piezoelectric layer **20**. The matching layer reduces an acoustic impedance

difference between the piezoelectric layer **20** and an object to match acoustic impedances of the piezoelectric layer **20** and the object. Thus, ultrasonic waves generated in the piezoelectric layer **20** are effectively transmitted to the object.

For this, the matching layer may have a middle value between the acoustic impedances of the piezoelectric layer **20** and the object.

The matching layer may be formed of a glass or resin material. In addition, a plurality of matching layers may be formed, and the matching layers may be formed of different materials in order to change the acoustic impedance stepwise from the piezoelectric layer **20** to the object.

The piezoelectric layer **20** and the matching layer may be processed in a two-dimensional matrix array or in a one-dimensional array by a dicing process to be used as a multi-channel.

In addition, a protective layer (not shown) may be disposed on the front surface of the matching layer. The protective layer may be an RE shield capable of preventing leakage of a high-frequency component generated in the piezoelectric layer **20** to the outside and blocking inflow of an external high-frequency signal.

Furthermore, the protective layer may be formed by coating a conductive material on a surface of a film having moisture resistance and chemical resistance and may be a C/S film capable of protecting internal parts from water and chemicals used in disinfection, and the like.

Also, a lens (not shown) may be disposed on the front surface of the matching layer. The lens may have a convex shape in an ultrasound-radiating direction so as to concentrate the ultrasonic waves. Alternatively, the lens may have a concave shape if the speed of sound is less than that in the human body.

The backing layer **10** is disposed on the rear surface of the piezoelectric layer **20**. The backing layer **10** absorbs and scatters ultrasonic waves generated in the piezoelectric layer **20** and proceeding in the backward direction of the piezoelectric layer **20**. Accordingly, image distortion may be prevented.

The backing layer **10** may be fabricated in a multi-layered structure in order to improve ultrasonic wave attenuation or blocking effects. In addition, the backing layer **10** may be formed of a rubber-containing material to which an epoxy resin and a tungsten powder are added.

As shown in the examples of FIGS. **1** and **2**, the first connector **13** is installed on at least one side surface of the backing layer **10**.

The first connector **13** may include an insulator and an electrode **31**. The electrode **31** may include a plurality of electrodes disposed on the insulator. As shown in FIG. **9**, each of the electrodes **31** extends in the z-axis direction. One end of each electrode **31** is exposed through the front surface of the backing layer **10** to be electrically connected to a first electrode layer **15** disposed on the front surface of the backing layer **10**. The electrodes **31** may be arranged in the y-axis direction to be spaced apart from each other by a predetermined interval.

According to the example, the electrode **31** provided on the first connector **13** is a signal electrode that is electrically connected to the first electrode layer **15** of the backing layer **10** and applies an electrical signal to the piezoelectric layer **20**.

After processing of the piezoelectric layer **20** into an array, the number of the electrodes **31** and the interval therebetween may be determined such that each of the electrodes **31** respectively corresponds to each of the elements constituting the array.

The first connector **13** may be installed on at least one side surface of the backing layer **10**. In FIG. **2**, the first connectors **13** are installed on both side surfaces of the backing layer **10**. However, the first connector **13** may be installed on one side surface of the backing layer **10**.

If the first connectors **13** are installed on both side surfaces of the backing layer **10**, the electrodes **31** of the first connector **13** provided on the left side surface and the electrodes **31** of the first connector **13** provided on the right side surface may be aligned alternately with respect to each other.

Referring to FIG. **10**, the electrodes **31** of the first connector **13** provided on the left side surface are aligned alternately with respect to the electrodes **31** of the first connector **13** provided on the right side surface.

FIG. **10** is a top view of the backing layer **10** before the piezoelectric layer **20** is installed. In FIG. **10**, the first electrode layer **15** and a supporter, shown in FIGS. **1** and **2**, are not illustrated.

As shown in FIG. **10**, if the electrodes **31** of the first connectors **13** provided on both side surfaces of the backing layer **10** are aligned alternately with respect to each other, the first connectors **13** are diced along separation lines d shown in FIG. **10** when the piezoelectric layer **20** is installed on the front surface of the backing layer **10** and divided into an array by a dicing process later. Accordingly, each of the electrodes **31** of the first connectors **13** disposed on the left and right side surfaces of the backing layer **10** may be electrically connected to each of the elements of the piezoelectric layer **20**.

The first connector **13** may include a flexible printed circuit board (FPCB). The first connector **13** may also include a PCB or other known elements capable of supplying an electrical signal.

In addition, a first supporter **14**, which supports the first connector **13** on one side surface thereof, may be disposed on the first connector **13** to fix the first connector **13** to one side surface of the backing layer **10**.

The first supporter **14** may be formed of an insulating material. Different from the backing layer, the first supporter **14** may be preferably formed of a material that does not have the sound absorbing property, or formed of a material having a significantly low level of absorbing property even if formed of the sound absorbing property.

In addition, the first electrode layer **15**, which is electrically connected to the first connector **13** installed on the side surface of the backing layer **10**, may be disposed on the front surface of the backing layer **10**. A first electrode **21**, which is electrically connected to the first electrode layer **15** disposed on the front surface of the backing layer **10**, may be disposed on the rear surface of the piezoelectric layer **20**.

Thus, the first electrode layer **15** is electrically connected to the first electrode **21** disposed on the rear surface of the piezoelectric layer **20**, so that an electrical signal provided from the first connector **13** may be transmitted to the piezoelectric layer **20**. Since the electrode of the first connector **13** is a signal electrode, the first electrode **21** disposed on the rear surface of the piezoelectric layer **20** constitutes a signal electrode (or positive electrode), and an electrode to be disposed on the front surface of the piezoelectric layer **20** constitutes a ground electrode (or negative electrode).

The first electrode layer **15** may be disposed on the front surface of the backing layer **10** using a conductive material

such as gold, silver, or copper by a technique such as coating, deposition, sputtering, plating, or spraying.

FIGS. **3** and **4** illustrate an ultrasonic probe according to another example. Referring to FIGS. **3** and **4**, a first connector **13** and a second connector **17** are installed on at least one side surface of the backing layer **10**.

FIGS. **3** and **4** illustrate that the first connectors **13** are installed on both side surfaces of the backing layer **10**, as shown in FIGS. **1** and **2**. However, the first connector **13** may be installed on one side surface of the backing layer **10**.

The first connector **13** is the same as that of FIGS. **1** and **2**, and thus a detailed description thereof is omitted.

In the ultrasonic probe according to the present example, the second connector **17** is further installed on at least one side surface of the backing layer **10**. The second connector **17** is installed to be spaced apart from the first connector **13** by a predetermined interval.

By installing the second connector **17** on the first supporter **14** that fixes the first connector **13** to one side surface of the backing layer **10**, the second connector **17** is spaced apart from the first connector **13**, and thus the second connector **17** may be electrically isolated from the first connector **13**.

According to the present example, the electrode provided on the first connector **13** is a signal electrode, and an electrode provided on the second connector **17** is a ground electrode.

The second connector **17** may also include an insulator and an electrode in the same manner as the first connector **13**. The electrode may include a plurality of electrodes aligned on the second connector **17** in the same manner as the first connector **13**. Alternatively, the electrode may form the entirety of the second connector **17**.

A second supporter **18**, which supports the second connector **17** on one side surface thereof, may be installed on the second connector **17** to fix the second connector **17** to one side surface of the backing layer **10**. The second supporter **18** may also be formed of an insulating material in the same manner as the first supporter **14**.

In addition, a second electrode layer **19** may be disposed on the front surface of the backing layer **10** to be separated from the first electrode layer **15**, which is electrically connected to the first connector **13**. The second electrode layer **19** is electrically connected to the second connector **17**.

According to the present example, a first electrode **21**, which is electrically connected to the first electrode layer **15** disposed on the front surface of the backing layer **10**, and a second electrode **22**, which is electrically connected to the second electrode layer **19** disposed on the front surface of the backing layer **10** to be separated from the first electrode layer **15**, are disposed on the piezoelectric layer **20**. Here, the first electrode **21** and second electrode **22** are formed to be separated from each other.

In FIGS. **1** and **2**, the first electrode **21** is formed on the rear surface of the piezoelectric layer **20**, and the second electrode **22** is formed on the front surface of the piezoelectric layer **20**. However, according to the embodiment shown in FIGS. **3** and **4**, the first electrode **21** and the second electrode **22** are formed on the rear surface of the piezoelectric layer **20** to be separated from each other. In addition, the second electrode **22** extends from the rear surface to the front surface of the piezoelectric layer **20** along the side surfaces of the piezoelectric layer **20**.

That is, the first electrode **21** of the piezoelectric layer **20** electrically connected to the first electrode layer **15** is electrically connected to the first connector **13**, i.e., a signal electrode. The second electrode **22** of the piezoelectric layer **20** electrically connected to the second electrode layer **19** is electrically connected to the second connector **17**, i.e., a ground electrode. As a result, an electrical signal is applied to the piezoelectric layer **20**.

The second electrode layer **19** may be disposed on the front surface of the backing layer **10** using a conductive material such as gold, silver, or copper by coating, deposition, sputtering, plating, or spraying.

FIGS. **5** and **6** illustrate an ultrasonic probe according to another example of the present application. Referring to FIGS. **5** and **6**, the first connector **13** is installed on at least one side surface of the backing layer **10**.

The first connector **13** may include an insulator and an electrode. The electrode may include a plurality of electrodes disposed on the insulator. As shown in FIG. **9**, each of the electrodes extends in the z-axis direction. One end of each electrode is exposed through the front surface of the backing layer **10** to be electrically connected to a first electrode layer **15** disposed on the front surface of the backing layer **10**. The electrodes may be arranged in the y-axis direction to be spaced apart from each other by a predetermined interval.

In this example, the electrode provided on the first connector **13** is a signal electrode that is electrically connected to the first electrode layer **15** of the backing layer **10** and applies an electrical signal to the piezoelectric layer **20**.

After processing of the piezoelectric layer **20** into an array, the number of the electrodes and the interval therebetween may be determined such that each of the electrodes respectively corresponds to each of the elements constituting the array.

The first connector **13** may be installed on at least one side surface of the backing layer **10**. In FIG. **6**, the first connectors **13** are installed on both side surfaces of the backing layer **10**. However, the first connector **13** may be installed on one side surface of the backing layer **10**.

If the first connectors **13** are installed on both side surfaces of the backing layer **10**, the electrodes of the first connector **13** provided on the left side surface and the electrodes of the first connector **13** provided on the right side surface may be aligned alternately with respect to each other.

Referring to FIG. **10**, the electrodes of the first connector **13** provided on the left side surface are aligned alternately with respect to the electrodes of the first connector **13** provided on the right side surface.

FIG. **10** is a top view of the backing layer **10** before the piezoelectric layer **20** is installed. In FIG. **10**, the first electrode layer **15** shown in FIGS. **5** and **6** is not illustrated.

As shown in FIG. **10**, if the electrodes of the first connectors **13** provided on both side surfaces of the backing layer **10** are aligned alternately with respect to each other, the first connectors **13** are diced along separation lines d shown in FIG. **10**, when the piezoelectric layer **20** is installed on the front surface of the backing layer **10** and divided into an array by a dicing process later. Accordingly, each of the electrodes of the first connectors **13** disposed on the left and right side surfaces of the backing layer **10** may be electrically connected to each of the elements of the piezoelectric layer **20**.

The first connector **13** may include a flexible printed circuit board (FPCB). The first connector **13** may also include a PCB or other known elements capable of supplying an electrical signal.

In addition, the first electrode layer **15** electrically connected to the first connector **13** installed on one side surface of the backing layer **10** may be disposed on the front surface of the backing layer **10**. A first electrode **21** electrically

connected to the first electrode layer **15** disposed on the front surface of the backing layer **10** may be disposed on the rear surface of the piezoelectric layer **20**.

Thus, the first electrode layer **15** is electrically connected to the first electrode **21** disposed on the rear surface of the piezoelectric layer **20**, so that an electrical signal provided from the first connector **13** may be transmitted to the piezoelectric layer **20**. Since the electrode of the first connector **13** is a signal electrode, the first electrode **21** disposed on the rear surface of the piezoelectric layer **20** constitutes a signal electrode (or positive electrode)A second electrode **22** to be disposed on the front surface of the piezoelectric layer **20** constitutes a ground electrode (or negative electrode).

The first electrode layer **15** may be disposed on the front surface of the backing layer **10** using a conductive material such as gold, silver, or copper by coating, deposition, sputtering, plating, or spraying.

A first supporter **14**, which supports the first connector **13** on the side surface thereof, may be installed on the first connector **13** to fix the first connector **13** to one side surface of the backing layer **10**.

The first supporter **14** may be formed of an insulating material.

The first supporter **14** is installed such that a portion of the first supporter **14** is attached to the first connector **13** to fix the first connector **13** to one side surface of the backing layer **10** and another portion of the first supporter **14** protrudes from the front surface of the backing layer **10**.

If the first supporters **14** are disposed on both side surfaces of the backing layer **10** to protrude from the front surface of the backing layer **10**, mounting grooves providing mounting positions when the piezoelectric layer **20** is installed on the front surface of the backing layer **10** may be formed. That is, the piezoelectric layer **20** is mounted on the backing layer **10** in a space formed by the first supporters **14** installed to protrude from the front surface of the backing layer **10**.

A second electrode layer **19** may be disposed on the front surface of the first supporter **14**. The second electrode layer **19** may be electrically connected to the second electrode **22** disposed on the front surface of the piezoelectric layer **20**. That is, by installing the first supporter **14** such that a protruding height of the first supporter **14** corresponds to a thickness of the piezoelectric layer **20**, the first electrode **21** (disposed on the front surface of the piezoelectric layer **20**) may be electrically connected to the second electrode layer **19** (disposed on the front surface of the first supporter **14**) when the piezoelectric layer **20** is installed on the front surface of the backing layer **10**.

As described above, since the first connector **13** that is electrically connected to the first electrode **21** (disposed on the rear surface of the piezoelectric layer **20**) functions as a signal electrode, an element, which applies a ground signal, may be electrically connected to the second electrode layer **19** (electrically connected to the second electrode **22** disposed on the front surface of the piezoelectric layer **20**).

The second electrode layer **19** may be disposed on the front surface of the backing layer **10** using a conductive material such as gold, silver, or copper by coating, deposition, sputtering, plating, or spraying.

FIGS. **7** and **8** illustrate an ultrasonic probe according to another example. Referring to FIGS. **7** and **8**, a first connector **13** and a second connector **17** are disposed on at least one side surface of the backing layer **10**.

FIGS. **7** and **8** illustrate that the first connectors **13** are installed on both side surfaces of the backing layer **10**, as shown in FIGS. **5** and **6**. However, the first connector **13** may be installed on one side surface of the backing layer **10**.

The first connector **13** and a first supporter **14** are the same as those of FIGS. **5** and **6**, and thus a detailed description thereof is omitted.

In the ultrasonic probe of this example, the second connector **17** is further installed on at least one side surface of the backing layer **10**. The second connector **17** is installed to be spaced apart from the first connector **13** by a predetermined interval.

By installing the second connector **17** on the first supporter **14** that fixes the first connector **13** to one side surface of the backing layer **10**, the second connector **17** is spaced apart from the first connector **13**. Thus the second connector **17** may be electrically isolated from the first connector **13**.

As shown in the drawings, by installing the second connector **17** on the first supporter **14** protruding from the front surface of the backing layer **10**, the second connector **17** also protrudes from the front surface of the backing layer **10** along with the first supporter **14**.

According to the present example, an electrode provided on the first connector **13** is a signal electrode, and an electrode provided on the second connector **17** is a ground electrode.

The second connector **17** may also include an insulator and an electrode in the same manner as the first connector **13**. The electrode may include a plurality of electrodes aligned on the second connector **17** in the same manner as the first connector **13**, or the electrode may form the entirety of the second connector **17**.

A second supporter **18**, which supports the second connector **17** on one side surface thereof, may be installed on the second connector **17** to fix the second connector **17** to one side surface of the backing layer **10**. The second supporter **18** may also be formed of an insulating material in the same manner as the first supporter **14**.

In addition, as shown in the drawings, the second supporter **18** may be attached to the second connector **17** to protrude from the front surface of the backing layer **10** in the same manner as the first supporter **14**.

A second electrode layer **19** is disposed on the front surface of the first supporter **14** to be electrically connected to the second connector **17**.

In the same manner as the embodiment shown in FIGS. **5** and **6**, in FIGS. **7** and **8**, a first electrode **21** formed on the rear surface of the piezoelectric layer **20** is electrically connected to a first electrode layer **15** formed on the front surface of the backing layer **10**, and a second electrode **22** formed on the front surface of the piezoelectric layer **20** is electrically connected to the second electrode layer **19** formed on the front surface of the first supporter **14**.

In other words, the first electrode **21** of the piezoelectric layer **20** electrically connected to the first electrode layer **15** is electrically connected to the first connector **13**, i.e., a signal electrode. The second electrode **22** of the piezoelectric layer **20** electrically connected to the second electrode layer **19** is electrically connected to the second connector **17**, i.e., a ground electrode. As a result, an electrical signal is applied to the piezoelectric layer **20**.

The second electrode layer **19** may be disposed on the front surface of the backing layer **10** using a conductive material such as gold, silver, or copper by a coating, deposition, sputtering, plating, or spraying process.

FIG. **11** is a flowchart illustrates an example of a method of manufacturing an ultrasonic probe.

A first connector **13** is installed on at least one side surface of a backing layer **10** (Operation **50**).

The first connector **13** may include an insulator and an electrode **31**. The electrode **31** may include a plurality of electrodes disposed on the insulator. As shown in FIG. **9**, each of the electrodes **31** extends in the z-axis direction. One end of each electrode **31** is exposed through the front surface of the backing layer **10** to be electrically connected to a first electrode layer **15** disposed on the front surface of the backing layer **10**. The electrodes **31** may be arranged in the y-axis direction to be spaced apart from each other by a predetermined interval.

In this example, the electrode **31** provided on the first connector **13** is a signal electrode.

In addition, the first connectors **13** may be installed on both side surfaces of the backing layer **10**. The first connector **13** may include a flexible printed circuit board (FPCB). The first connector **13** may also include a PCB or other known elements capable of supplying an electrical signal.

After installation of the first connector **13**, a first supporter **14**, which supports the first connector **13**, is attached to the first connector **13** to fix the first connector **13** to one side surface of the backing layer **10** (Operation **51**).

The first supporter **14** may be formed of an insulating material.

After attachment of the first supporter **14**, the first electrode layer **15** is disposed on the front surface of the backing layer **10** to be electrically connected to the first connector **13** (Operation **52**).

The first electrode layer **15** may be disposed on the front surface of the backing layer **10** using a conductive material such as gold, silver, or copper by coating, deposition, sputtering, plating, or spraying.

After formation of the first electrode layer **15**, a piezoelectric layer **20** including a first electrode **21** and a second electrode **22** respectively formed on the rear and front surfaces thereof is installed on the front surface of the backing layer **10** (Operation **53**).

According to the present example, the electrode **31** provided on the first connector **13** is a signal electrode that is electrically connected to the first electrode layer **15** of the backing layer **10** and applies an electrical signal to the piezoelectric layer **20**. Thus, the first electrode **21** disposed on the rear surface of the piezoelectric layer **20** constitutes a signal electrode.

FIG. **12** is a flowchart illustrating another method of manufacturing an ultrasonic probe.

The process of FIG. **12** is identical to that of FIG. **11** until the first connector **13**, the first supporter **14**, and the first electrode layer **15** are formed, and thus a detailed description of Operations **60** to **62** will be omitted.

A second connector **17** is installed on at least one side surface of the backing layer **10** (Operation **63**).

The second connector **17** is installed to be spaced apart from the first connector **13** by a predetermined interval.

By installing the second connector **17** on the first supporter **14** that fixes the first connector **13** to one side surface of the backing layer **10**, the second connector **17** is spaced apart from the first connector **13**, and thus the second connector **17** may be electrically isolated from the first connector **13**.

According to the present example, the electrode provided on the first connector **13** is a signal electrode, and an electrode provided on the second connector **17** is a ground electrode.

The second connector **17** may also include an insulator and an electrode in the same manner as the first connector **13**. The electrode may include a plurality of electrodes aligned on the second connector **17** in the same manner as the first connector **13**, or the electrode may form the entirety of the second connector **17**.

After installation of the second connector **17**, a second supporter **18**, which supports the second connector **17**, is attached to the second connector **17** to fix the second connector **17** to one side surface of the backing layer **10** (Operation **64**).

The second supporter **18** may be formed of an insulating material in the same manner as the first supporter **14**.

After attachment of the second supporter **18**, a second electrode layer **19** electrically connected to the second connector **17** is installed on the front surface of the backing layer **10** to be isolated from the first electrode layer **15** (Operation **65**).

That is, the second electrode layer **19** is formed to be isolated from the first electrode layer **15** electrically connected to the first connector **13**, and the second electrode layer **19** is electrically connected to the second connector **17**.

The second electrode layer **19** may be disposed on the front surface of the backing layer **10** using a conductive material such as gold, silver, or copper by a coating, deposition, sputtering, plating, or spraying process.

After formation of the second electrode layer **19**, a piezoelectric layer **20** provided with a first electrode **21** and a second electrode **22**, which are separated from each other and respectively electrically connected to the first electrode layer **15** and the second electrode layer **19**, is installed on the front surface of the backing layer **10** (Operation **66**).

According to the present example, a first electrode **21**, which is electrically connected to the first electrode layer **15** disposed on the front surface of the backing layer **10**, and a second electrode **22**, which is electrically connected to the second electrode layer **19** disposed on the front surface of the backing layer **10** to be separated from the first electrode layer **15**, are disposed on the piezoelectric layer **20**. Here, the first electrode **21** and second electrode **22** are formed to be separated from each other.

According to another example, the first electrode **21** is disposed on the rear surface of the piezoelectric layer **20**, and the second electrode **22** is disposed on the front surface of the piezoelectric layer **20**. However, the first electrode **21** and the second electrode **22** are disposed on the rear surface of the piezoelectric layer **20** such that the first electrode **21** is separated from the second electrode **22**. In addition, the second electrode **22** extends from the rear surface to the front surface of the piezoelectric layer **20** along the side surfaces of the piezoelectric layer **20**.

That is, the first electrode **21** of the piezoelectric layer **20** electrically connected to the first electrode layer **15** is electrically connected to the first connector **13**, i.e., a signal electrode. The second electrode **22** of the piezoelectric layer **20** electrically connected to the second electrode layer **19** is electrically connected to the second connector **17**, i.e., a ground electrode. As a result, an electrical signal is applied to the piezoelectric layer **20**.

FIG. **13** is a flowchart illustrating another method of manufacturing an ultrasonic probe.

A first connector **13** is installed on at least one side surface of a backing layer **10** (Operation **70**).

The first connector **13** may include an insulator and an electrode. The electrode may include a plurality of electrodes disposed on the insulator. As shown in FIG. **9**, each of the electrodes extends in the z-axis direction. One end of each electrode is exposed through the front surface of the backing layer **10** to be electrically connected to a first electrode layer **15** disposed on the front surface of the

backing layer **10**. The electrodes may be arranged in the y-axis direction to be spaced apart from each other by a predetermined interval.

According to the present example, the electrode provided on the first connector **13** is a signal electrode.

In addition, the first connectors **13** may be installed on both side surfaces of the backing layer **10** or on one side surface of the backing layer **10**. The first connector **13** may include a flexible printed circuit board (FPCB). The first connector **13** may also include a PCB or other known elements capable of supplying an electrical signal.

After installation of the first connector **13**, a first supporter **14**, which supports the first connector **13**, is attached to the first connector **13** to fix the first connector **13** to one side surface of the backing layer **10** (Operation **71**).

The first supporter **14** is installed such that a portion of the first supporter **14** is attached to the first connector **13** to fix the first connector **13** to one side surface of the backing layer **10** and another portion of the first supporter **14** protrudes from the front surface of the backing layer **10**. In addition, the first supporter **14** may be formed of an insulating material.

After attachment of the first supporter **14**, a first electrode layer **15** is disposed on the front surface of the backing layer **10** to be electrically connected to the first connector **13**, and a second electrode layer **19** is disposed on the front surface of the first supporter **14** (Operation **72**).

The first electrode layer **15** and the second electrode layer **19** may be disposed on the front surface of the backing layer **10** using a conductive material such as gold, silver, or copper by coating, deposition, sputtering, plating, or spraying.

After formation of the first electrode layer **15** and the second electrode layer **19**, a piezoelectric layer **20** provided with a first electrode **21** and a second electrode **22** respectively on the front and rear surfaces thereof is installed on the front surface of the backing layer **10** (Operation **73**).

In this example, the electrode provided on the first connector **13** is a signal electrode that is electrically connected to the first electrode layer **15** of the backing layer **10** and applies an electrical signal to the piezoelectric layer **20**. Thus, the first electrode **21** disposed on the rear surface of the piezoelectric layer **20** constitutes a signal electrode. The second electrode **22** disposed on the front surface of the piezoelectric layer **20** constitutes a ground electrode. The second electrode **22** disposed on the front surface of the piezoelectric layer **20** is electrically connected to the second electrode layer **19** disposed on the front surface of the first supporter **14**.

FIG. **14** is a flowchart illustrating another example of a method of manufacturing an ultrasonic probe.

The process of FIG. **14** is identical to that of FIG. **13** until the first connector **13** and the first supporter **14** are formed, and thus a detailed description of Operations **80** and **81** will be omitted.

A second connector **17** is installed on at least one side surface of the backing layer **10** (Operation **82**).

The second connector **17** is installed to be spaced apart from the first connector **13** by a predetermined interval.

By installing the second connector **17** on the first supporter **14** that fixes the first connector **13** to one side surface of the backing layer **10**, the second connector **17** is spaced apart from the first connector **13**, and thus the second connector **17** may be electrically isolated from the first connector **13**.

The electrode provided on the first connector **13** is a signal electrode, and an electrode provided on the second connector **17** is a ground electrode.

The second connector **17** may also include an insulator and an electrode in the same manner as the first connector **13**. The electrode may include a plurality of electrodes aligned on the second connector **17** in the same manner as the first connector **13**, or the electrode may form the entirety of the second connector **17**.

After installation of the second connector **17**, a second supporter **18**, which supports the second connector **17**, is installed on the second connector **17** to fix the second connector **17** to one side surface of the backing layer **10** (Operation **83**).

The second supporter **18** is attached to the second connector **17** to protrude from the front surface of the backing layer **10** in the same manner as the first supporter **14** as shown in FIG. **13**. The second supporter **18** may be formed of an insulating material in the same manner as the first supporter **14**.

After attachment of the second supporter **18**, a first electrode layer **15** is disposed on the front surface of the backing layer **10** to be electrically connected to the first connector **13**, and a second electrode layer **19** is installed on the front surface of the first supporter **14** to be electrically connected to the second connector **17** (Operation **84**).

That is, the first electrode layer **15** installed to be electrically connected to the first connector **13** is electrically separated from the second electrode layer **19** installed to be electrically connected to the second connector **17**.

The second electrode layer **19** may be disposed on the front surface of the backing layer **10** using a conductive material such as gold, silver, or copper by coating, deposition, sputtering, plating, or spraying.

After formation of the first electrode layer **15** and the second electrode layer **19**, a piezoelectric layer **20** provided with a first electrode **21** and a second electrode **22**, which are separated from each other and respectively electrically connected to the first electrode layer **15** and the second electrode layer **19**, is installed on the front surface of the backing layer **10** (Operation **85**).

The first electrode **21** disposed on the rear surface of the piezoelectric layer **20** is electrically connected to the first electrode layer **15** disposed on the front surface of the backing layer **10**, and the second electrode **22** disposed on the front surface of the piezoelectric layer **20** is electrically connected to the second electrode layer **19** disposed on the front surface of the first supporter **14**.

That is, the first electrode **21** of the piezoelectric layer **20** electrically connected to the first electrode layer **15** is electrically connected to the first connector **13**, i.e., a signal electrode. The second electrode **22** of the piezoelectric layer **20** electrically connected to the second electrode layer **19** is electrically connected to the second connector **17**, i.e., a ground electrode. As a result, an electrical signal is applied to the piezoelectric layer **20**.

While the foregoing has described what are considered to be the best mode and/or other examples, it is understood that various modifications may be made therein and that the subject matter disclosed herein may be implemented in various forms and examples, and that the teachings may be applied in numerous applications, only some of which have been described herein. It is intended by the following claims to claim any and all applications, modifications and variations that fall within the true scope of the present teachings.

What is claimed is:

1. An ultrasonic probe comprising:

a piezoelectric material;

a backing layer installed on a rear surface of the piezoelectric material;

a first connector installed on at least one side surface of an outside of the backing layer, the first connector being electrically connected to an electrode of the piezoelectric material;

a first electrode layer covering the first connector and the backing layer;

a first supporter installed on the first connector to support the first connector by fixing the first connector to one side surface of the backing layer, the first supporter is connected to a side of the first electrode layer and the first connector;

a second connector connected to a side of the first supporter;

a second supporter connected to a side of the second connector; and

a second electrode layer covering an entire top surface of the first supporter.

2. The ultrasonic probe according to claim **1**,

wherein the first electrode layer is disposed on a front surface of the backing layer, and

wherein the first electrode layer is electrically connected to the first connector.

3. The ultrasonic probe according to claim **2**, wherein the piezoelectric material comprises an electrode disposed on at least one surface of the piezoelectric material comprising the rear surface of the piezoelectric material and electrically connected to the first electrode layer.

4. The ultrasonic probe according to claim **1**, wherein the first supporter comprises an insulating material.

5. The ultrasonic probe according to claim **1**,

wherein the second connector is installed to be spaced apart from the first connector and electrically connected to the piezoelectric material.

6. The ultrasonic probe according to claim **5**,

wherein the second supporter is installed on the second connector and supports the second connector to fix the second connector to one side surface of the first supporter, and

wherein the second supporter comprises an insulating material.

7. The ultrasonic probe according to claim **5**, wherein the first connector and the second connector comprise a flexible printed circuit board (FPCB), a printed circuit board (PCB), or a wire.

8. The ultrasonic probe according to claim **5**,

wherein the second electrode layer is disposed on a front surface of the backing layer, and

wherein the second electrode layer is electrically connected to the second connector.

9. The ultrasonic probe according to claim **8**, wherein the piezoelectric material comprises an electrode disposed on at least one surface of the piezoelectric material comprising a rear surface of the piezoelectric material and electrically connected to the second electrode layer.

10. The ultrasonic probe according to claim **8**,

wherein the first electrode layer is disposed on a front surface of the backing layer and electrically connected to the first connector, and

wherein the first electrode layer is separated from the second electrode layer.

11. The ultrasonic probe according to claim **1**, wherein the first supporter includes material that is different from the backing layer.

* * * * *

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摘要(译)

本申请涉及的超声波探头包括能够将电信号施加到压电材料以及设置在背层的外侧的连接器，以及制造其的方法。超声波探头包括一压电材料，安装在压电材料的后表面上的背层，并安装了背层的至少一个侧表面并电连接到所述压电材料上的第一连接器。