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(54) **ELECTRONIC DEVICE AND MANUFACTURING METHOD THEREOF, ELECTRONIC APPARATUS, AND MOVING BODY**

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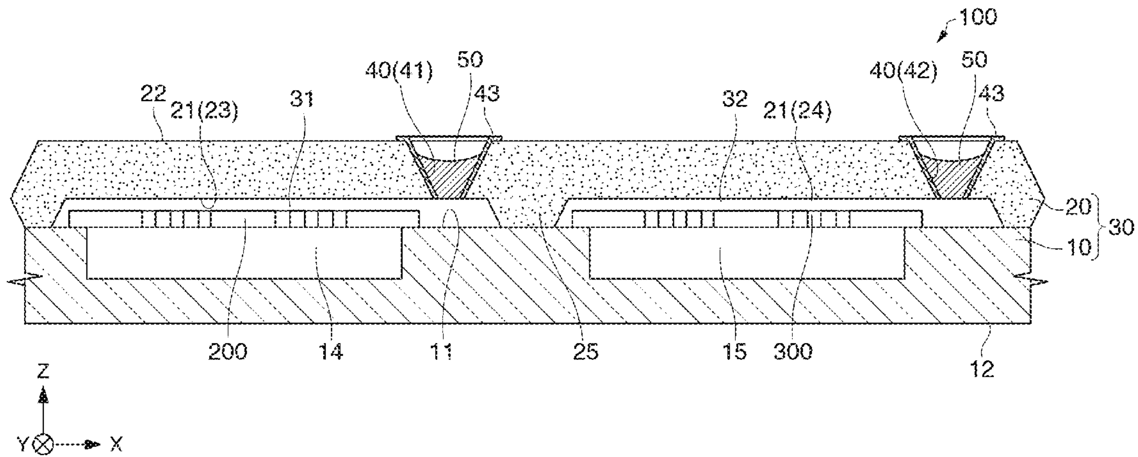
USPC **361/679.01**; 29/592.1

(57) **ABSTRACT**

An electronic device includes a substrate, a cover body which is placed on the substrate, a first cavity which is surrounded by the substrate and the cover body, and a second cavity which is surrounded by the substrate and the cover body, wherein an inner portion of the first cavity is sealed in a first air pressure atmosphere, and an inner portion of the second cavity is sealed in a second air pressure atmosphere which has a difference of air pressure with respect to the first air pressure atmosphere, a first through-hole, which communicates with the first cavity and is blocked by a seal member, is provided in at least one of the substrate and the cover body, and the first cavity and the second cavity are isolated from each other by a partition wall portion which is integrally provided to the cover body or the substrate.



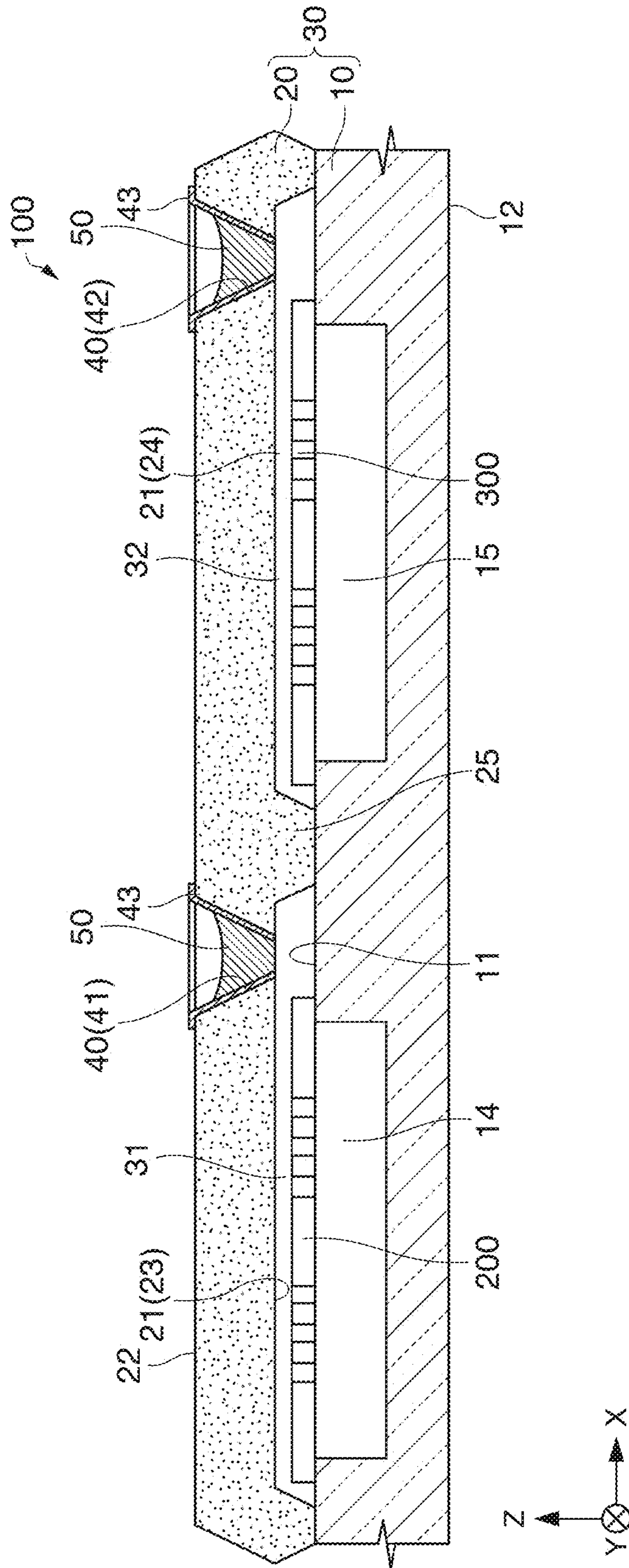


FIG. 1

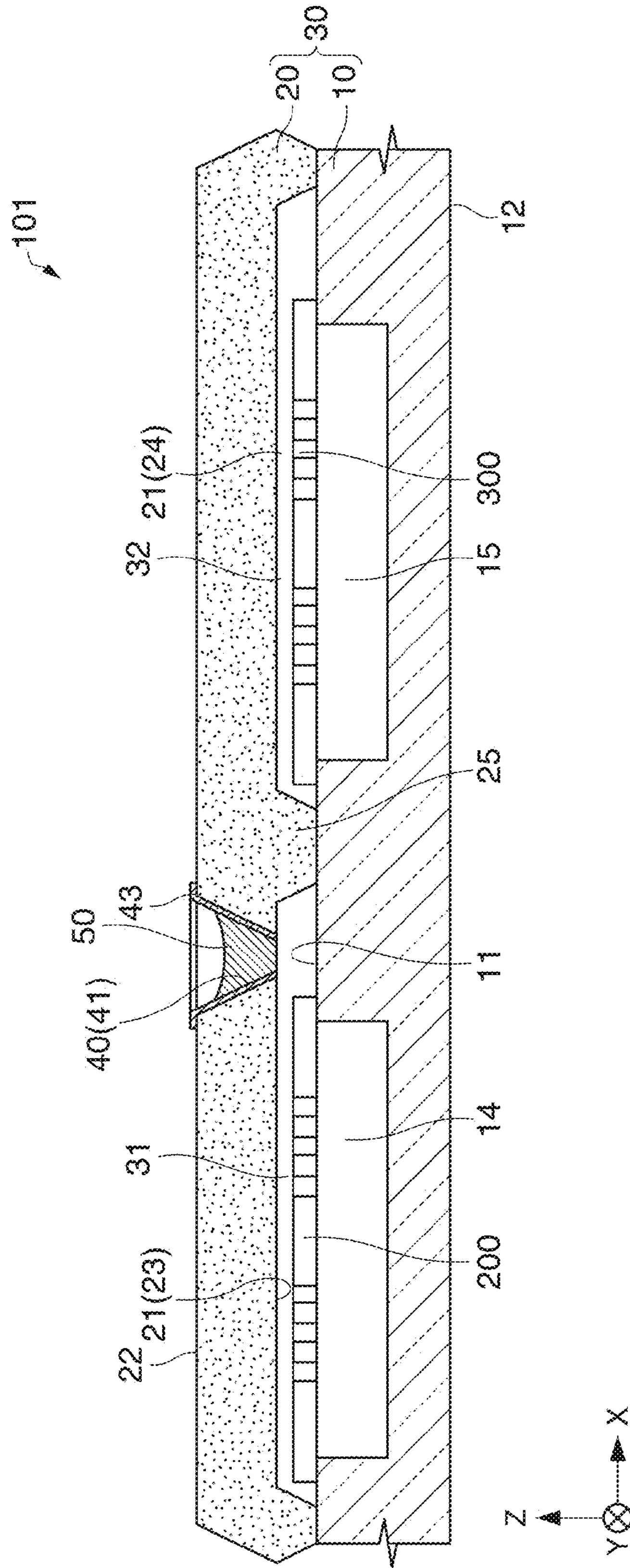


FIG. 2

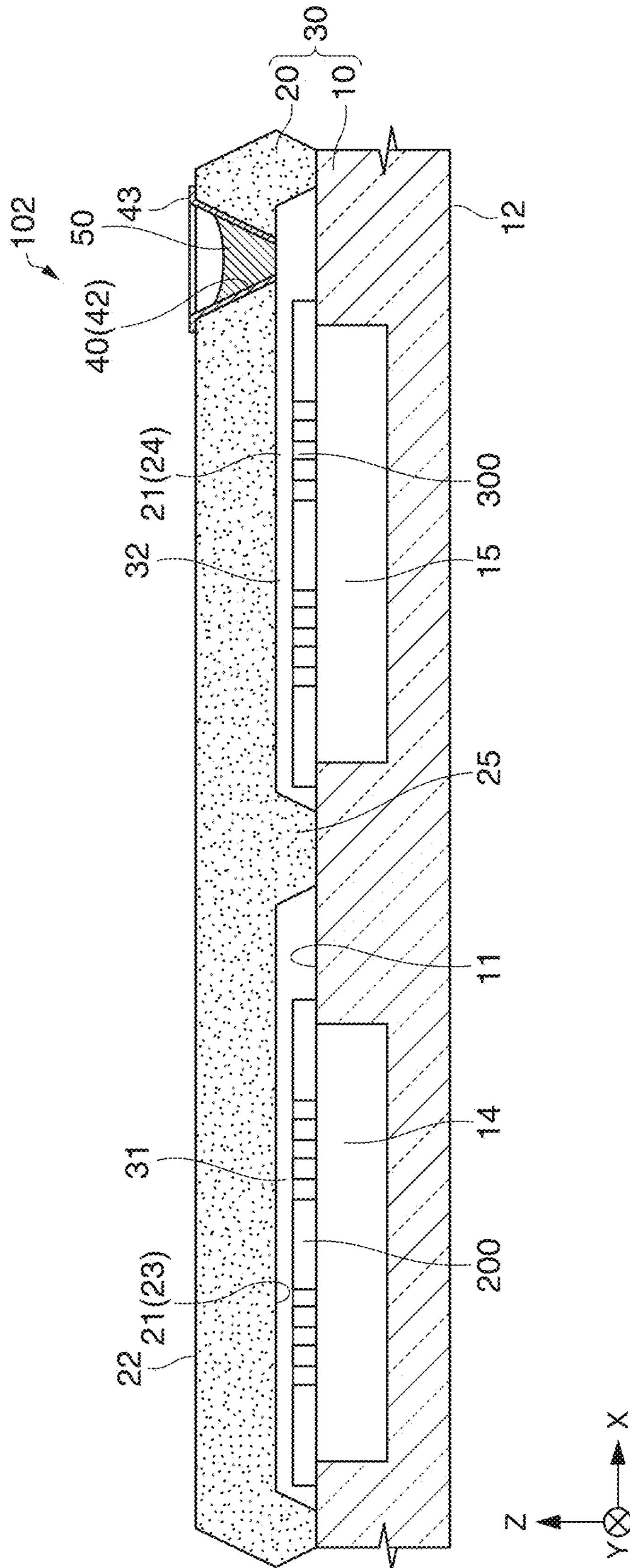


FIG. 3

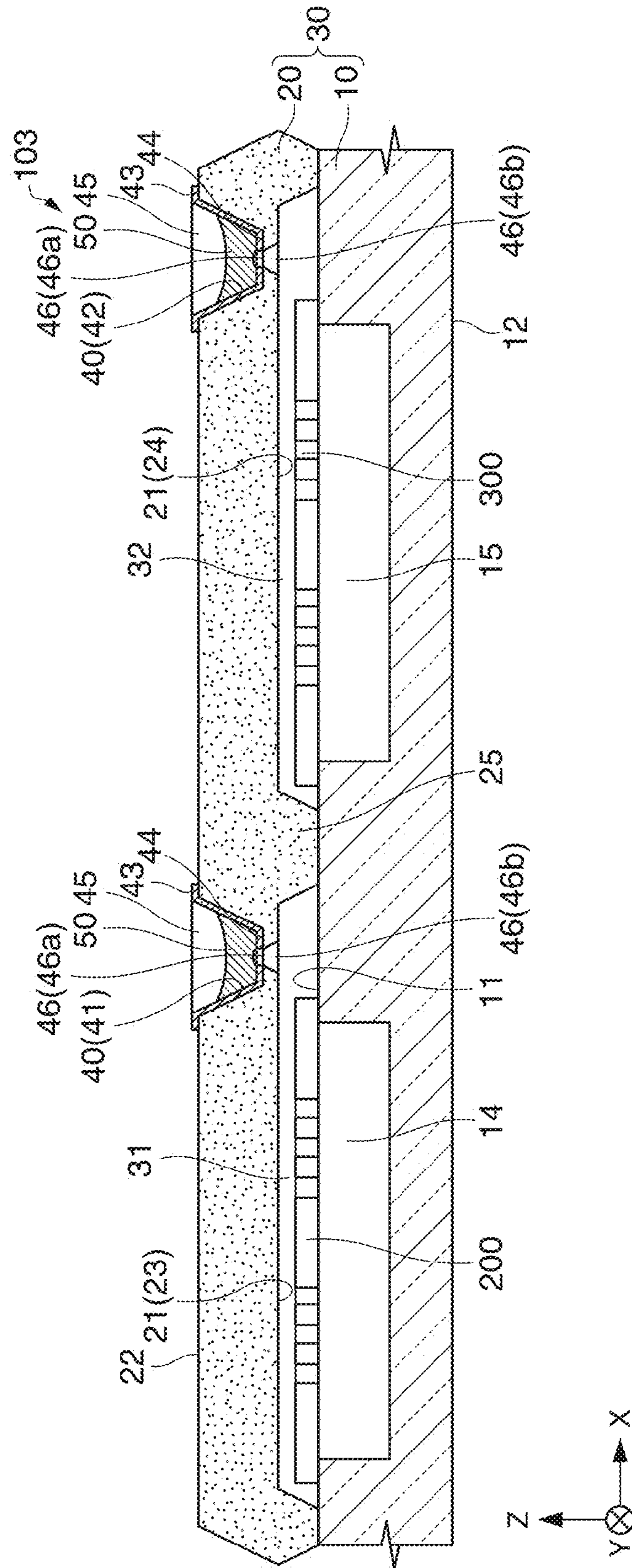


FIG. 4

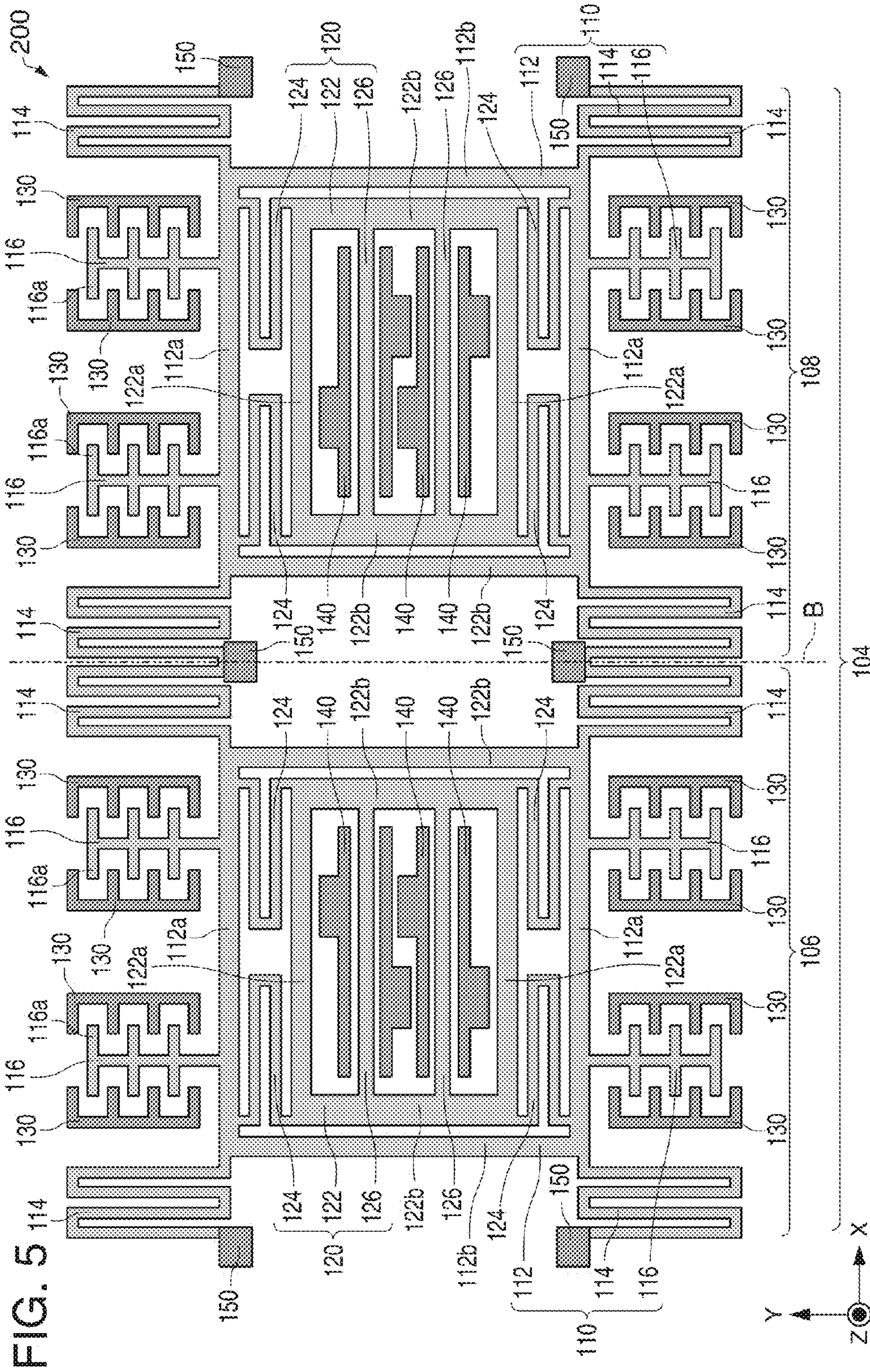


FIG. 5
200
104
106
108
110
112
112a
112b
114
116
116a
120
122
122a
122b
124
126
130
140
150
B
X
Y
Z

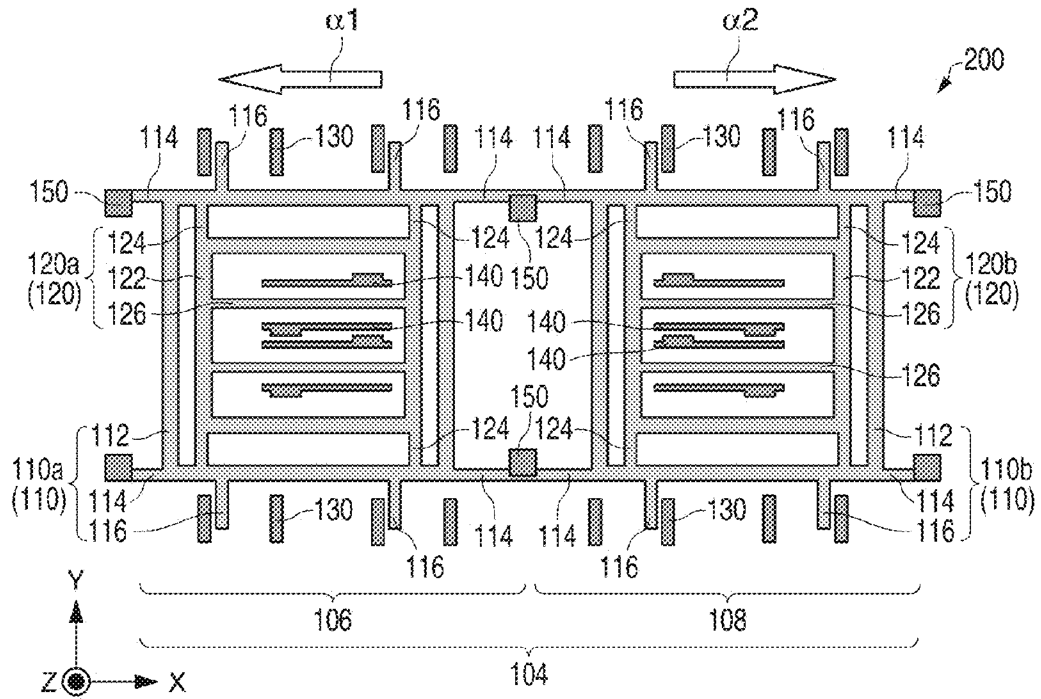


FIG. 6

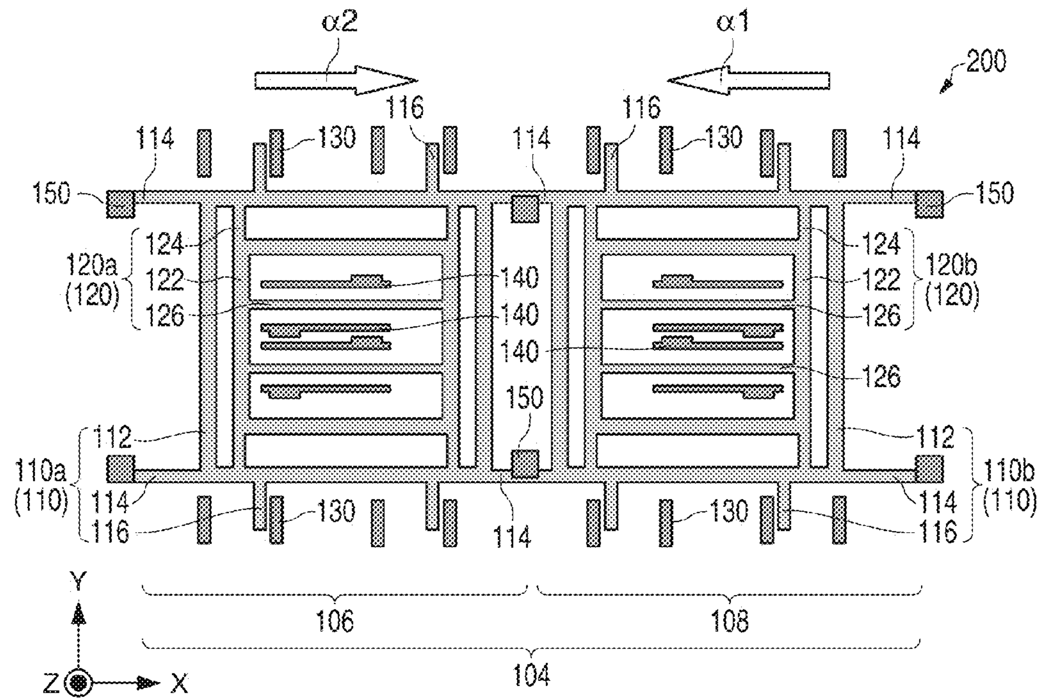


FIG. 7

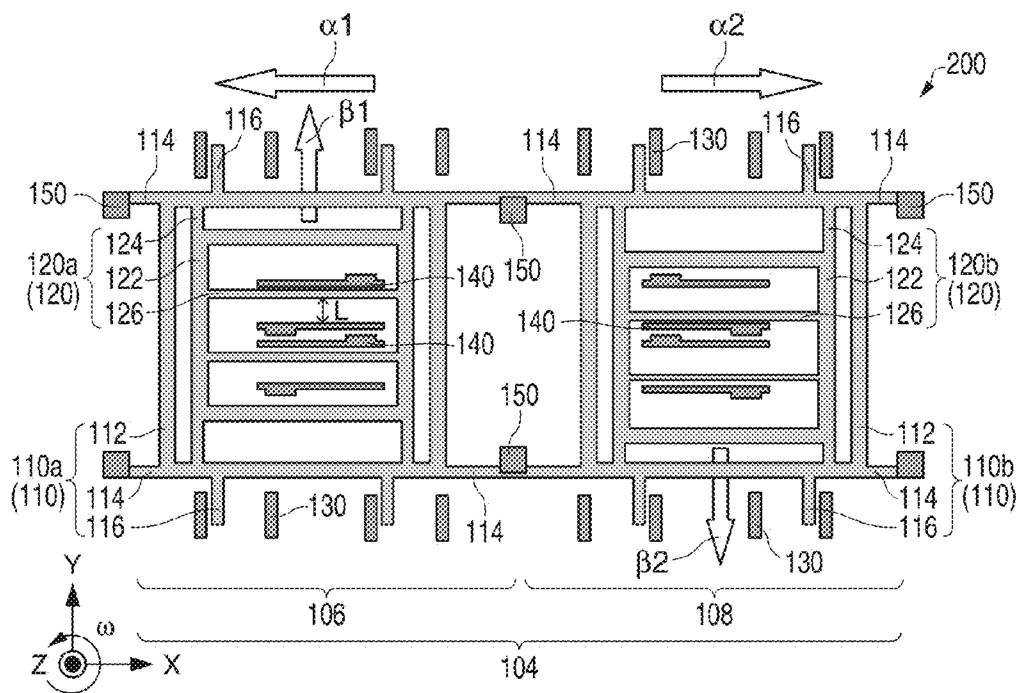


FIG. 8

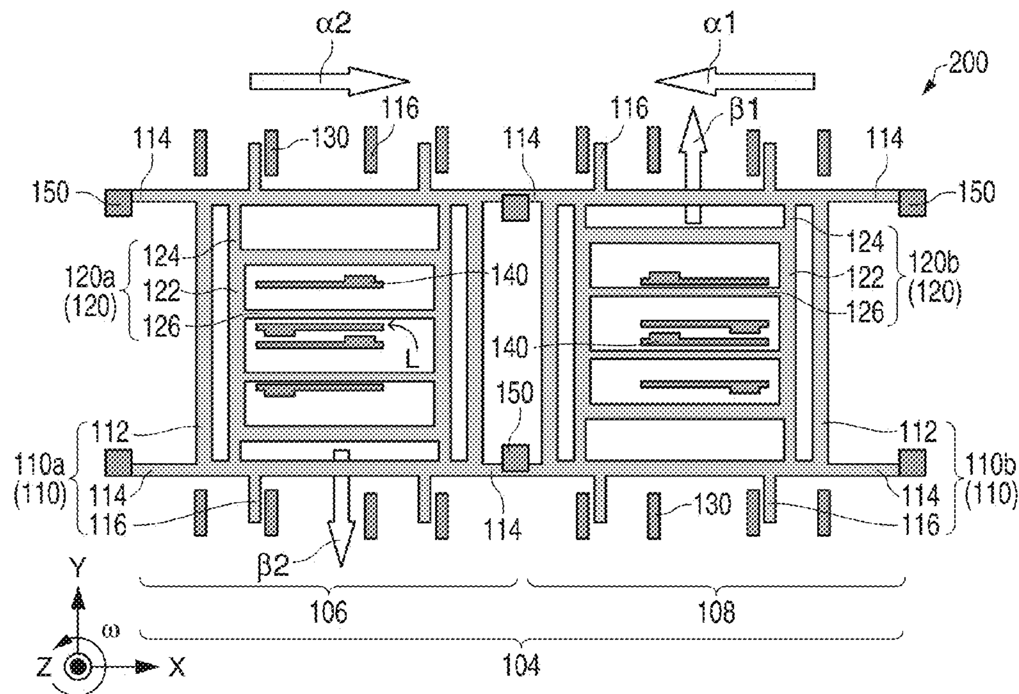


FIG. 9

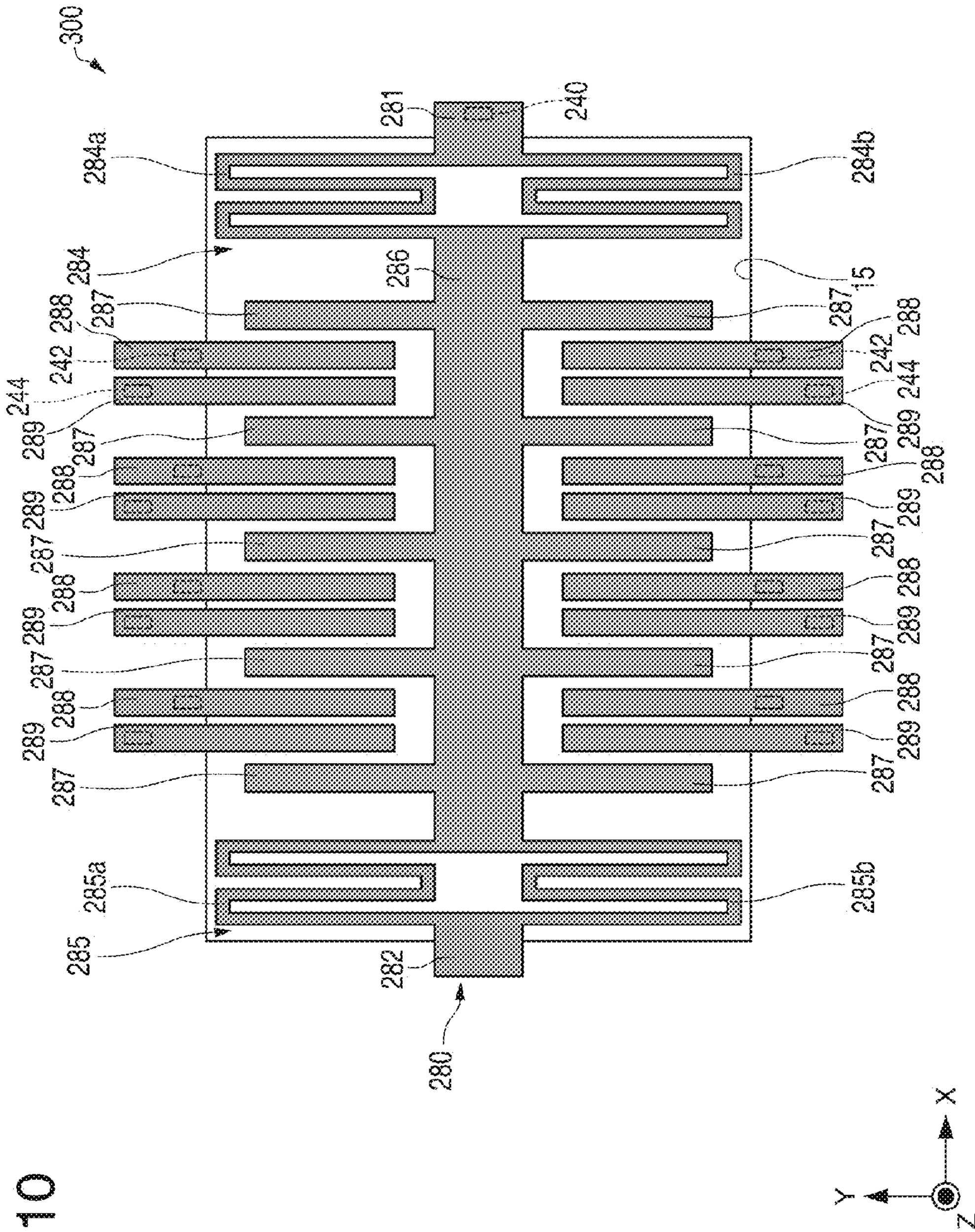


FIG. 10
300
281
240
284a
284b
284
286
15
287
288
242
244
289
285a
285b
285
282
280
X
Y
Z

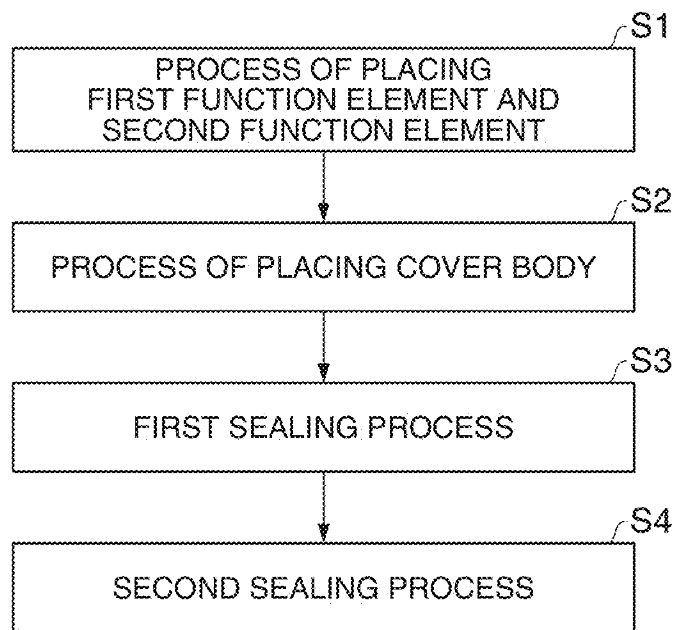


FIG. 11

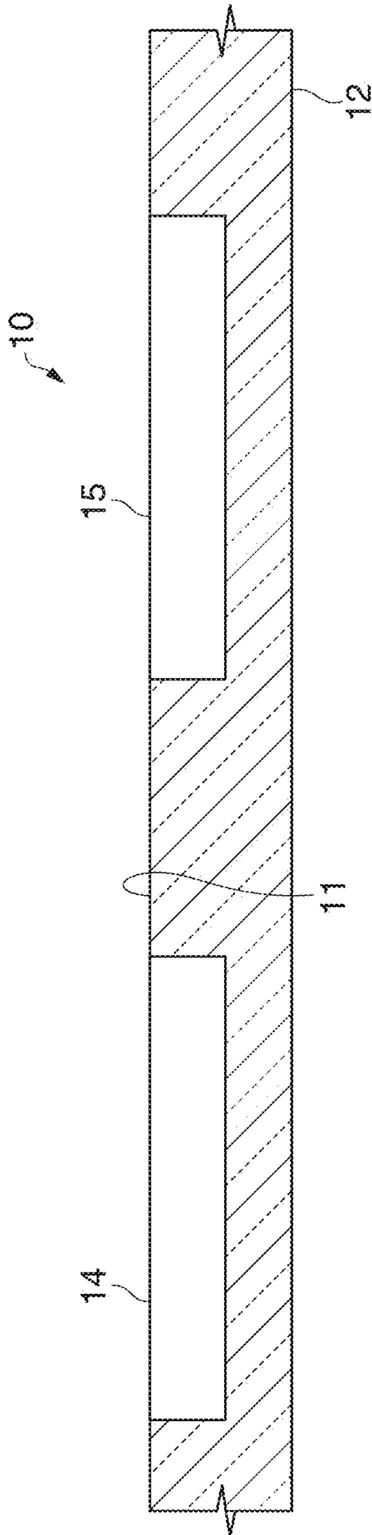


FIG. 12

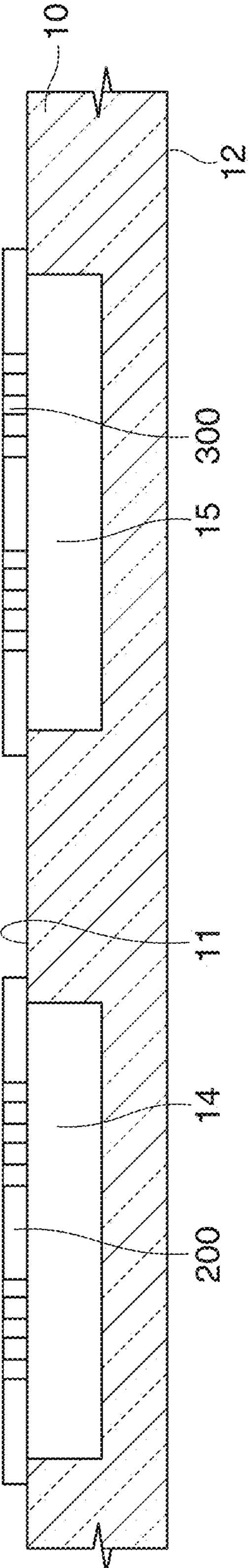
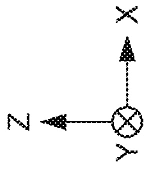


FIG. 13



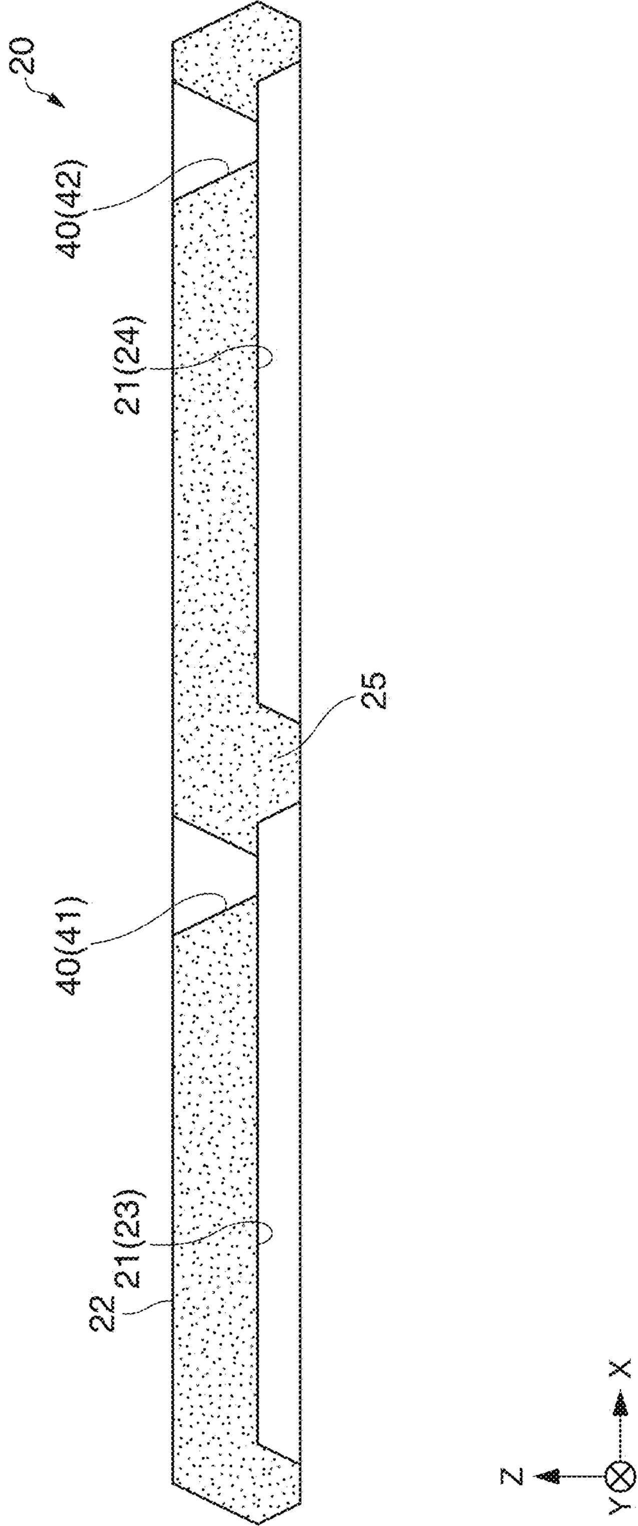


FIG. 14

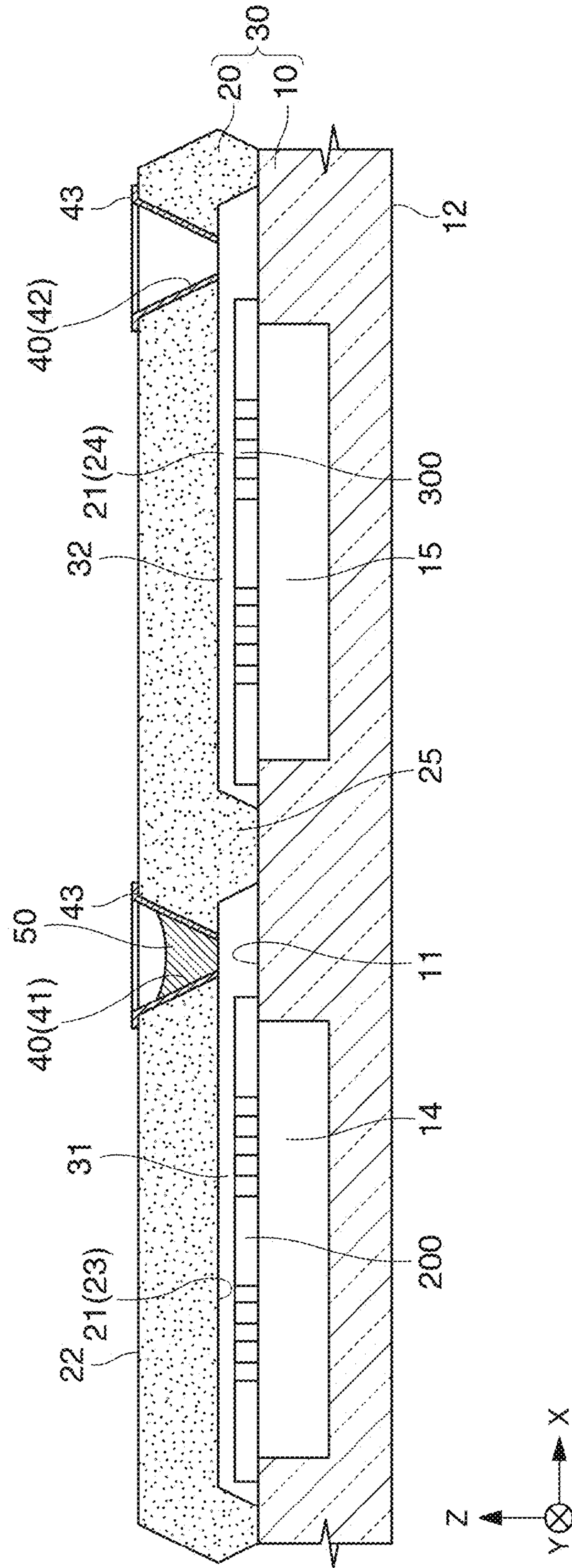


FIG. 15

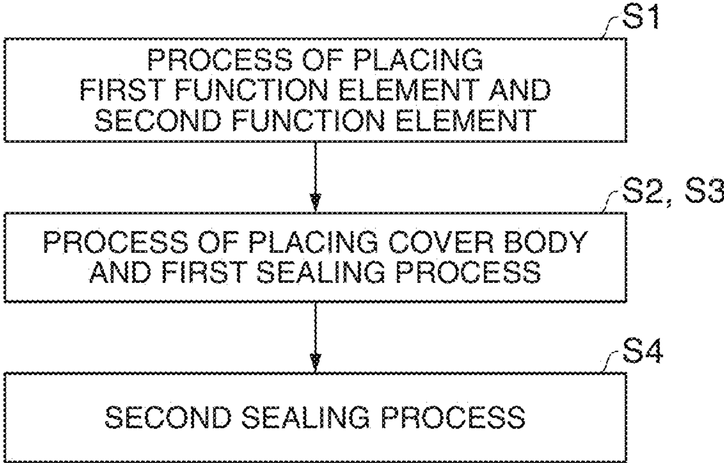


FIG. 16

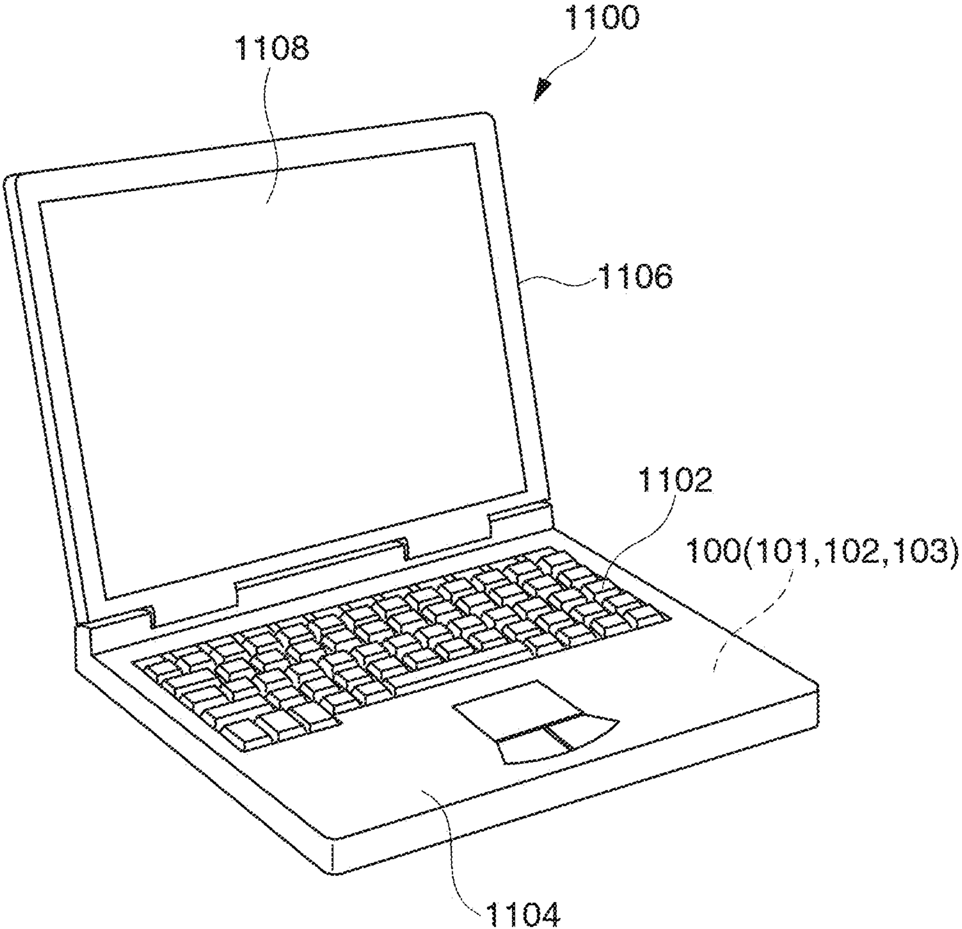


FIG. 17

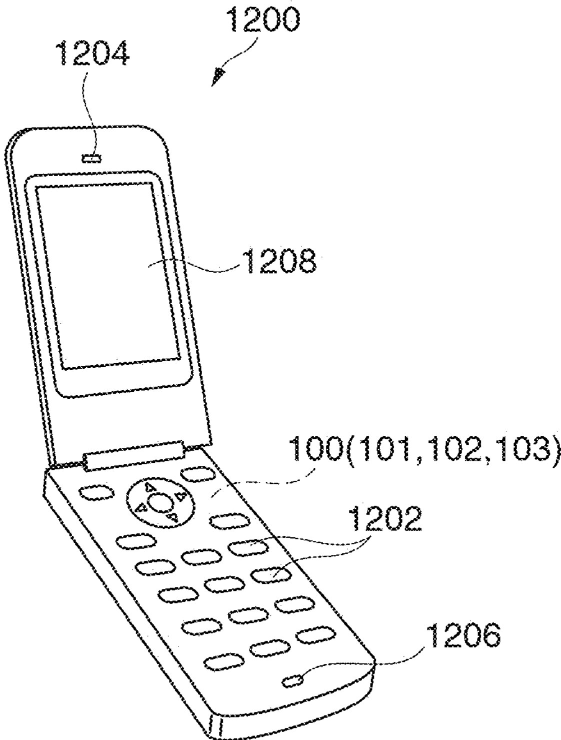


FIG. 18

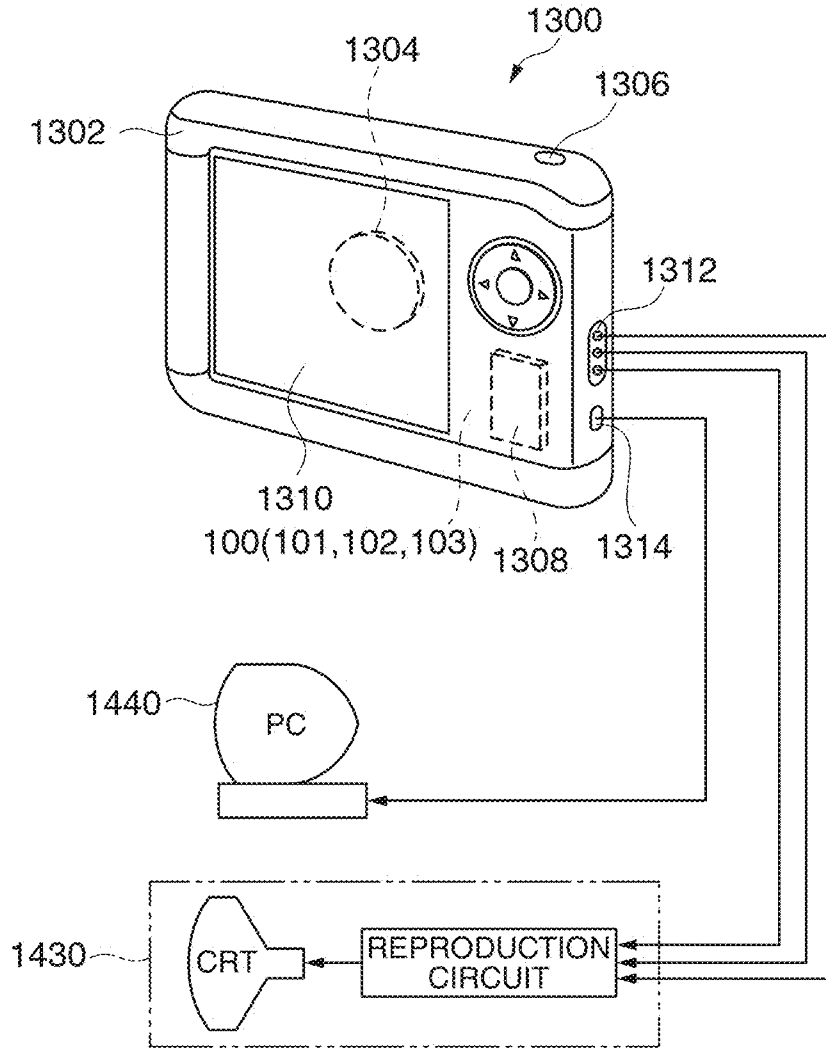


FIG. 19

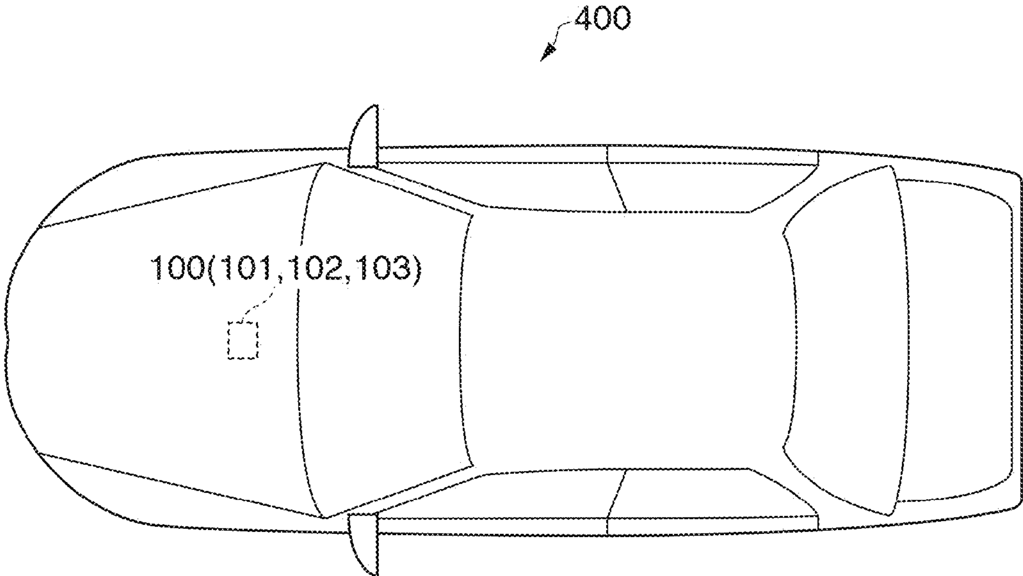


FIG. 20

ELECTRONIC DEVICE AND MANUFACTURING METHOD THEREOF, ELECTRONIC APPARATUS, AND MOVING BODY

BACKGROUND

[0001] 1. Technical Field

[0002] The present invention relates to an electronic device and a manufacturing method thereof, an electronic apparatus, and a moving body.

[0003] 2. Related Art

[0004] Recently, for example, an electronic device such as an inertial sensor, which detects physical quantity using technology of silicon Micro Electro Mechanical System (MEMS), has been developed. In JP-A-2002-5950, for example, an electronic device (combined sensor element) which includes an angular velocity sensor and an acceleration sensor is disclosed. For example, the above-described electronic device is used for a camera shake correction function of a digital still camera (DSC), a navigation system of an automobile, an operation input device at a game machine, or the like.

[0005] In this way, according to the electronic device in which a plurality of physical quantity detection sensors are mounted into the same package (the same substrate), it is possible to meet demands for size reduction and space saving. Moreover, since a process which electrically connects the substrates, on which sensors are mounted, by lamination or the like can be omitted, it can contribute to simplification of the production process and reduction of the production cost.

[0006] In the above-described electronic device, since the acceleration sensor is designed considering viscosity (damping) which is generated between inertial mass and atmospheric pressure, the acceleration sensor is sealed at an atmospheric pressure atmosphere. On the other hand, since gas viscosity becomes a cause which damps vibration when air (or other gas and the like) exists, the angular velocity sensor is sealed at a decompression atmosphere such as a vacuum atmosphere. According to this, since cavities, in which the inner pressures are different from each other in the same package, are formed, when bonding reliability between members is decreased, airtightness of the cavities is decreased, and disadvantages occur in the electronic device. In the combined sensor element disclosed in JP-A-2002-5950, a base and a division wall portion, and the division wall portion and a cover member are bonded to each other respectively, and thus, airthightness of cavities is secured. In this case, since the plurality of bonded portions exist, if a second bonding is performed after a first bonding is performed, there is a concern that the first bonding state may be unstable, and it is difficult to secure bonding reliability between each member. From the above, in the above-described electronic device, an electronic device having improved reliability and a manufacturing method thereof are required.

SUMMARY

[0007] An advantage of some aspects of the invention is to provide an electronic device having improved reliability. Another advantage of some aspects of the invention is to provide a manufacturing method of the electronic device. Still another advantage of some aspects of the invention is to provide an electronic apparatus and a moving body which include the electronic device.

[0008] The invention can be implemented as the following embodiments or application examples

Application Example 1

[0009] This application example is directed to an electronic device including: a substrate; a cover body which is placed on the substrate; a first function element which is provided in a first cavity which is surrounded by the substrate and the cover body; and a second function element which is provided in a second cavity which is surrounded by the substrate and the cover body, wherein an inner portion of the first cavity is sealed in a first air pressure atmosphere, and an inner portion of the second cavity is sealed in a second air pressure atmosphere which has a difference of air pressure with respect to the first air pressure atmosphere, a first through-hole, which communicates with the first cavity and is blocked by a seal member, is provided in at least one of the substrate and the cover body, and the first cavity and the second cavity are isolated from each other by a partition wall portion which is integrally provided to the cover body or the substrate.

[0010] In an electronic device in which cavities having inner pressures different from each other are formed in the same package, when airtightness of the cavities is decreased, defects occur in the function elements accommodated in the cavities, and there is a concern that reliability of the electronic device itself may be decreased. Therefore, it is necessary to securely isolate each cavity and secure high airtightness of the cavities.

[0011] According to the electronic device according to the application example, the first cavity and the second cavity are isolated from each other by the partition wall portion which is integrally provided in the cover body or the substrate. According to this, the first cavity and the second cavity are configured by only two members of the substrate and the cover body without a seal member. In other words, the bond interface between members, which is required for configuring two cavities in the same package, includes only the bond surface between the substrate and the cover body. Therefore, compared to an electronic device in which a partition wall member other than the substrate and the cover body isolates between the cavities having inner pressures different from each other, an electronic device having improved reliability can be provided.

Application Example 2

[0012] The electronic device according to the application example may include a second through-hole, which communicates with the second cavity and is blocked by a seal member.

[0013] According to the electronic device of this application example, since the through-hole is provided in the first cavity and the second cavity in at least one of the substrate and the cover body, the air pressure atmosphere of each cavity can be set to the air pressure atmosphere which is different from the air pressure atmosphere in which the cover body and the substrate are bonded.

Application Example 3

[0014] The electronic device according to the application example may be configured such that the first through-hole does not overlap with the first function element and the second function element in a plan view of the electronic device.

Application Example 4

[0015] The electronic device according to the application example may be configured such that the first through-hole and the second through-hole do not overlap with the first function element and the second function element in a plan view of the electronic device.

[0016] According to the electronic device of the application example, splash (spray), which is generated at a time in the sealing process when the seal members are melted, cannot easily influence the first and second function elements, and thus, reliability of the electronic device can be improved.

Application Example 5

[0017] The electronic device according to the application example may be configured such that a material of the substrate is glass and a material of the cover body is silicon.

Application Example 6

[0018] The electronic device according to the application example may be configured such that the first function element detects physical quantities different from the second function element.

Application Example 7

[0019] This application example is directed to a manufacturing method of an electronic device, including: placing a first function element and a second function element on a substrate; placing a cover body on the substrate, accommodating the first function element in a first cavity which is surrounded by the substrate and the cover body, and accommodating the second function element in a second cavity which is surrounded by the substrate and the cover body; and sealing the first cavity in a first air pressure atmosphere and sealing the second cavity in a second air pressure atmosphere which has a difference of air pressure with respect to the first air pressure atmosphere, wherein the first cavity and the second cavity are isolated from each other by a partition wall portion which is integrally provided to the cover body or the substrate.

[0020] According to the manufacturing method of the electronic device of this application example, the first cavity and the second cavity are isolated from each other by the partition wall portion which is integrally provided in the cover body or the substrate. According to this, it is not necessary to separately prepare a member for isolating the cavities so as to bond the cover body and the substrate. Therefore, the manufacturing process is more simplified, and the manufacturing method which can manufacture the electronic device having more improved reliability can be provided.

Application Example 8

[0021] The manufacturing method of the electronic device according to the application example may be configured such that a first through-hole which communicates with the first cavity and a second through-hole which communicates with the second cavity are provided in at least one of the substrate and the cover body, the sealing includes a first sealing of sealing the first cavity by blocking the first through-hole by a seal member in the first air pressure atmosphere, and a second sealing of sealing the second cavity by blocking the second through-hole by a seal member in the second air pressure atmosphere after the first sealing, and the first air pressure atmosphere is air pressure lower than the second air pressure atmosphere.

[0022] According to the manufacturing method of the electronic device of this application example, after the first cavity is sealed under the first air pressure atmosphere, the second cavity is sealed under the second air pressure atmosphere which is air pressure higher than the first air pressure atmosphere. According to this, the pressure of the direction toward the inside of first cavity can be applied to the package of the electronic device under the second air pressure atmosphere. Thereby, adhesiveness of the seal member which blocks the first through-hole and adhesiveness between the cover body and the substrate are improved, and an electronic device having more improved reliability can be provided.

Application Example 9

[0023] The manufacturing method of the electronic device according to the application example may be configured such that a through-hole which communicates with the first cavity is provided in at least one of the substrate and the cover body, and the sealing includes a first sealing of sealing the second cavity in the second air pressure atmosphere by performing the placing and the accommodating in the second air pressure atmosphere, and a second sealing of sealing the first cavity by blocking the through-hole by the seal member in the first air pressure atmosphere after the first sealing.

[0024] According to the manufacturing method of the electronic device of this application example, the sealing of the cavity with which the through-hole does not communicate can be performed in the placing and the accommodating. According to this, the material costs of the seal member which is formed of alloy such as AuGe are reduced, and the sealing process of the through-hole, which requires a temperature control having high accuracy, can be simplified. Therefore, the manufacturing method of the electronic device, which can contribute to reduction of the production costs and simplification of the production processes, can be provided.

[0025] In addition, according to the manufacturing method of the electronic device of this application example, in the sealing which seals two cavities, the sealing of sealing the through-hole by the seal member is once, and it is not necessary to heat the package plural times. According to this, it is possible to prevent the seal member from being remelted due to the plurality of times of sealing and airtightness from being decreased. Accordingly, compared to the manufacturing method of the electronic device in which the plurality of times of sealing is performed in the same package, the manufacturing method, in which the electronic device having higher reliability is manufactured, can be provided.

Application Example 10

[0026] The manufacturing method of the electronic device according to the application example may be configured such that the second air pressure atmosphere is air pressure lower than the first air pressure atmosphere.

[0027] According to the manufacturing method of the electronic device of this application example, after the second cavity is sealed under the second air pressure atmosphere, the first cavity is sealed under the first air pressure atmosphere which is air pressure higher than the second air pressure atmosphere. According to this, the pressure of the direction

toward the inside of second cavity can be applied to the package of the electronic device under the first air pressure atmosphere. Thereby, adhesiveness between the cover body and the substrate is improved, and an electronic device having more improved reliability can be provided.

Application Example 11

[0028] The manufacturing method of the electronic device according to the application example may be configured such that the second air pressure atmosphere is air pressure higher than the first air pressure atmosphere.

Application Example 12

[0029] The manufacturing method of the electronic device according to the application example may be configured such that a material of the substrate is glass and a material of the cover body is silicon.

Application Example 13

[0030] The manufacturing method of the electronic device according to the application example may be configured such that the first function element detects physical quantities different from the second function element.

Application Example 14

[0031] This application example is directed to an electronic apparatus including electronic devices according to the above-described Application Examples.

Application Example 15

[0032] This application example is directed to a moving body including the electronic device according to the application example.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

[0034] FIG. **1** is a cross-sectional view schematically showing an electronic device according to a first embodiment.

[0035] FIG. **2** is a cross-sectional view schematically showing an electronic device according to a second embodiment.

[0036] FIG. **3** is a cross-sectional view schematically showing the electronic device according to the second embodiment.

[0037] FIG. **4** is a cross-sectional view schematically showing a Modification Example of the electronic devices according to the first and second embodiments.

[0038] FIG. **5** is a plan view schematically showing an example of a first function element which is placed on the electronic device according to the present embodiment.

[0039] FIG. **6** is a plan view illustrating an operation of the first function element which is placed on the electronic device according to the embodiment.

[0040] FIG. **7** is a plan view illustrating the operation of the first function element which is placed on the electronic device according to the embodiment.

[0041] FIG. **8** is a plan view illustrating the operation of the first function element which is placed on the electronic device according to the embodiment.

[0042] FIG. **9** is a plan view illustrating the operation of the first function element which is placed on the electronic device according to the embodiment.

[0043] FIG. **10** is a plan view schematically showing an example of a second function element which is placed on the electronic device according to the present embodiment.

[0044] FIG. **11** is a flowchart showing a manufacturing method of the electronic device according to the first embodiment.

[0045] FIG. **12** is a cross-sectional view schematically showing the manufacturing method of the electronic device according to the first embodiment.

[0046] FIG. **13** is a cross-sectional view schematically showing the manufacturing method of the electronic device according to the first embodiment.

[0047] FIG. **14** is a cross-sectional view schematically showing the manufacturing method of the electronic device according to the first embodiment.

[0048] FIG. **15** is a cross-sectional view schematically showing the manufacturing method of the electronic device according to the first embodiment.

[0049] FIG. **16** is a flowchart showing a manufacturing method of the electronic device according to the second embodiment.

[0050] FIG. **17** is a perspective view schematically showing an electronic apparatus.

[0051] FIG. **18** is a perspective view schematically showing an electronic apparatus.

[0052] FIG. **19** is a perspective view schematically showing an electronic apparatus.

[0053] FIG. **20** is a top view schematically showing a moving body.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0054] Hereinafter, preferred embodiments of the invention will be described in detail with reference to the drawings. Moreover, the embodiments described below do not unjustly limit the contents described in aspects of the invention. In addition, all configurations described below are not essential constituent conditions of the invention.

1. Electronic Device

1-1. Configuration of Electronic Device

First Embodiment

[0055] First, an electronic device according to a first embodiment will be described with reference the drawings. FIG. **1** is a cross-sectional view schematically showing an electronic device **100** according to the first embodiment. For convenience, in the drawings, an X axis, a Y axis, and a Z axis are shown as three axes perpendicular to one another.

[0056] As shown in FIG. **1**, the electronic device **100** includes a package **30** which has a substrate **10** and a cover body **20**, a through-hole **40** (**41** and **42**) which is provided in the package **30**, a seal member **50** which seals the through-hole **40**, and a first and second function elements **200** and **300** which are accommodated in the package **30**. Moreover, for convenience, in FIG. **1**, the first and second function elements **200** and **300** are shown so as to be simplified.

[0057] The first and second function elements **200** and **300**, which are accommodated in the electronic device **100**, are sensor elements which detect physical quantities different

from each other respectively. That is, the first function element **200** is different from the second function element **300**. Accordingly, the electronic device **100** is a combined sensor element in which a plurality of physical quantity detection sensors are mounted in the same package (the same substrate). Moreover, the details of the function elements are described below.

[0058] For example, as the substrate **10**, a glass substrate, a silicon substrate, and a quartz substrate may be used. The substrate **10** includes a first surface **11** which is a surface of a side to which the cover body **20** is bonded, and a second surface **12** of a side opposite to the first surface **11**. The substrate **10** supports the first and second function elements **200** and **300**. More specifically, a first concave portion **14** and a second concave portion **15** are formed on the first surface **11** of the substrate **10**, the first function element **200** is placed above the first concave portion **14**, and the second function element **300** is placed above the second concave portion **15**. Here, as shown in FIG. **1**, the first function element **200** and the second function element **300** may be disposed so as to be adjacent to each other along an X axis direction. Due to the first concave portion **14** and the second concave portion **15**, the first and second function elements **200** and **300** can move in only a desired direction without being interfered with the substrate **10**.

[0059] The cover body **20** is placed on the substrate **10** and bonded to the substrate **10**. In some cases, the cover body **20** may be bonded to only a portion of the first and second function elements **200** and **300**. As shown in the drawings, the cover body **20** includes a first surface **21** in which a portion becomes a bond surface in the surface of the substrate **10** side, and a second surface **22** which defines a surface (outer surface) of the package **30** in the surface of the side opposite to the first surface **21**.

[0060] A first concave portion **23** and a second concave portion **24** may be formed on the first surface **21** of the cover body **20**. A first cavity **31** which accommodates the first function element **200** may be formed by the first concave portion **23** and the first surface **11** of the substrate **10**. Therefore, the first concave portion **23** configures the inner wall of the first cavity **31**. Moreover, a second cavity **32** which accommodates the second function element **300** may be formed by the second concave portion **24** and the first surface **11** of the substrate **10**. Therefore, the second concave portion **24** configures the inner wall of the second cavity **32**.

[0061] As shown in FIG. **1**, a partition wall portion **25** which becomes a convex portion of the first surface **21** is formed between the first concave portion **23** and the second concave portion **24**. Thereby, the first cavity **31** and the second cavity **32** can be spatially isolated from each other. Moreover, the tip surface of the partition wall portion **25**, which is integrally provided to the cover body **20**, becomes a bond surface to the substrate **10**. Therefore, it is not necessary to separately provide a member for isolating the plurality of cavities. Since the first cavity **31** and the second cavity **32** are bonded to each other by a small bond surface, an isolation property can be increased.

[0062] Here, when a silicon substrate is used as the cover body **20**, if a glass substrate is appropriately used as the substrate **10**, the first surface **11** of the substrate **10** and the first surface **21** of the cover body **20** can use a bonding method such as an anodic bonding. For example, when a silicon substrate is used as the cover body **20**, the through-hole **40** or the partition wall portion **25** which is integrally provided in the cover body **20** can be accurately formed using anisotropic etching by potassium hydroxide (KOH). This is because an etching rate of a (111) surface which is a crystal surface of a silicon is late, and a dimension control having high accuracy can be performed using the difference of the etching rate according to the crystal surface. On the other hand, when a glass substrate is used as the cover body **20**, if a glass substrate is appropriately used as the substrate **10**, the first surface **11** of the substrate **10** and the first surface **21** of the cover body **20** can use a bonding method such as a glass bonding.

[0063] Moreover, the bonding method between the substrate **10** and the cover body **20** is not particularly limited, and for example, a bonding such as an anodic bonding or a bonding by means of low-melting glass (glass paste) may be used, or a bonding by means of soldering may be used. In addition, a metallic thin film (not shown) is formed on the bonded portion of each of the substrate **10** and the cover body **20**, and the substrate **10** and the cover body **20** may be bonded by eutectic-bonding the metallic thin films.

[0064] A planar shape (a shape when viewed in the Z axis direction) of the package **30** which includes the substrate **10** and the cover body **20** is not particularly limited if the package can accommodate the first and second function elements **200** and **300**, and may be an oblong shape (more specifically, a rectangular shape), for example.

[0065] The first through-hole **41** which communicates with the first cavity **31** and the second through-hole **42** which communicates with the second cavity **32** are formed in at least one of the substrate **10** and the cover body **20**. In the shown example, the first and second through-holes **41** and **42** are formed in the cover body **20**. In the shown example, the first and second through-holes **41** and **42** penetrate the cover body **20** in the Z axis direction.

[0066] Here, as shown in FIG. **1**, the first through-hole **41** and the second through-hole **42** may be disposed so as to have the same position relationship in the cover body **20**. Due to the fact that the first through-hole **41** and the second through-hole **42** are disposed at equal intervals, since the pitch of the laser irradiation can be set at equal intervals, productivity can be improved.

[0067] Moreover, as shown in FIG. **1**, the through-hole **40** may be disposed at a position which is not overlapped with the first and second function elements **200** and **300**. That is, the through-hole **40** may be disposed outside the outer edges of the first and second function elements **200** and **300**. According to this, splash (spray), which is generated at a time in the sealing process when the seal members **50** are melted, cannot easily influence the first and second function elements **200** and **300**, and thus, reliability of the electronic device can be improved.

[0068] As shown in drawings, the inner wall surface of the through-hole **40** (first through-hole **41** and second through-hole **42**) may be a taper shape. Specifically, the through-hole **40** may have a shape in which the opening area of the cavity side is smaller than the opening area of the outside. The planar shape (the shape when viewed in the Z axis direction) of the opening portion of the through-hole **40** is not particularly limited, and may be a circular shape or an oblong shape (for example, a square). For example, when the silicon substrate is used as the cover body **20**, the silicon substrate is processed by anisotropic wet etching using potassium hydroxide (KOH), and the opening portion of the through-hole **40** can be formed in an oblong shape with more precision. For example, when a glass substrate is used for the cover body, as means for

forming the through-hole, there are an isotropic wet etching method which uses hydrofluoric acid (HF), a blast method which sprays powder, and the like. In the isotropic wet etching method, not only the shape cannot be minutely controlled but also roughness occurs in the end surface. Moreover, in the blast method, the end portion is easily chipped. That is, the isotropic wet etching method and the blast method have difficulty as means for securing airtightness of the cavity. However, due to the fact that the silicon is used as the cover body, the difficulty can be solved. On the other hand, when a glass substrate is used as the cover body **20**, the glass substrate is processed by isotropic wet etching using hydrofluoric acid (HF), and the opening portion of the through-hole **40** can be formed in a circular shape.

[0069] A conductive layer **43** may be formed on the inner wall surface of the through-hole **40**. For example, as the conductive layer **43**, a layer, in which a chrome layer and a gold layer are laminated in the above order from the side surface side of the through-hole **40**, may be used. Due to the conductive layer **43**, adhesiveness between the inner wall surface of the through-hole **40** and the seal member **50** can be improved. The thickness of the conductive layer **43** is not particularly limited. However, for example, the thickness is approximately 30 nm to 200 nm.

[0070] In addition, the material of the conductive layer **43** may be appropriately changed according to the material of the seal member **50**. Moreover, although not shown in the drawings, the conductive layer **43** may be formed on the entire surface of the cover body **20**.

[0071] The seal member **50** is disposed in each of the first through-hole **41** and the second through-hole **42** and blocks the through-hole **40**. The first cavity **31** and the second cavity **32** can be sealed respectively by the seal member **50**. For example, the material of the seal member **50** is alloy such as AuGe, AuSi, AuSn, SnPb, PbAg, SnAgCu, or SnZnBi.

[0072] The seal state inside the first cavity **31** and the second cavity **32** which are sealed by the seal member **50** is appropriately selected according to the kind of the function element which is accommodated in the cavities. For example, when the first function element **200** is a vibration type gyro sensor, it is preferable that the first cavity **31** be a decompression state (more preferably, a vacuum state). Thereby, a vibration phenomenon of the gyro sensor can be suppressed from being damped by air viscosity. Moreover, for example, when the second function element **300** is an acceleration sensor, it is preferable that the second cavity **32** be an atmospheric pressure state and an inert gas atmosphere (for example, nitrogen gas). Thereby, a desired damping (viscosity) is generated between the inertial mass of the acceleration sensor and the atmosphere pressure, and an acceleration sensor having a predetermined detection sensitivity can be realized.

[0073] Moreover, in the shown example, the first concave portion **23** and the second concave portion **24**, which become the first cavity **31** and the second cavity **32**, are formed on the cover body **20**. However, the concave portions may be formed on the substrate **10**, the first function element **200** and the second function element **300** are accommodated respectively in two concave portions formed on the substrate **10**, the concave portions are sealed by the cover body **20**, and thus, the function elements may be accommodated. However, when the material of the substrate **10** is glass and the material of the cover body **20** is silicon, workability of MEMS of the cover body **20** is higher than that of the substrate **10**. In other words, the cover body **20** is more easily processed than the substrate **10**. Therefore, compared to the case where the concave portion which accommodates the function element is provided in the substrate **10** side, the electronic device in which workability is further improved can be provided.

[0074] Moreover, in the above-described example, the configuration is described in which the electronic device **100** according to the first embodiment can accommodate two function elements. However, the number of the function elements which are accommodated in the same package **30** is not particularly limited, a third cavity is further provided, and a third function element may be accommodated.

Second Embodiment

[0075] Next, an electronic device according to a second embodiment will be described with reference to the drawings.

[0076] FIGS. **2** and **3** are cross-sectional views schematically showing electronic devices **101** and **102** according to the second embodiment. The electronic devices **101** and **102** according to the second embodiment are different from the electronic device **100** according to the first embodiment only in the configuration of the through-hole **40** (first through-hole **41** and second through-hole **42**). In descriptions below, only matters in which the electronic devices **101** and **102** according to the second embodiment are different from the device **100** according to the first embodiment will be described. The same reference numerals are attached to the configurations which are previously described, and the detailed descriptions are omitted.

[0077] In the second embodiment, any one of the first through-hole **41** and the second through-hole **42** is provided. Accordingly, in the second embodiment, the through-hole which communicates with any one of the first cavity **31** and the second cavity **32** is not provided, and the inner surface of the cavity is configured only by the substrate **10** and the cover body **20**.

[0078] For example, in the electronic device **101** according to the second embodiment, as shown in FIG. **2**, only the first through-hole **41** which communicates with the first cavity **31** is provided, and the second through-hole **42** which communicates with the second cavity **32** is not provided. Moreover, in the electronic device **102** according to the second embodiment, as shown in FIG. **3**, only the second through-hole **42** which communicates with the second cavity **32** is provided, and the first through-hole **41** which communicates with the first cavity **31** is not provided.

[0079] In the second embodiment, a process in which the cover body **20** is placed on the substrate **10** is performed under a desired air pressure atmosphere, and after the cavity with which the through-hole **40** does not communicate is sealed at the desired air pressure atmosphere, the through-hole **40** is blocked by the seal member under other air pressure atmosphere, and thus, the cavity with which the through-hole **40** communicates is sealed. Therefore, in the second embodiment, the cover body **20** is placed on the substrate **10** under the desired air pressure atmosphere in the cavity with which the through-hole **40** does not communicate.

[0080] Hereinafter, the bonding method between the substrate **10** and the cover body **20** when a gyro sensor described below is adopted as the first function element **200** accommodated in the first cavity **31** and an acceleration sensor (electrostatic capacitance type MEMS acceleration sensor element) described below is adopted as the second function element **300** accommodated in the second cavity **32** will be described. In the above case, the desired air pressure atmo-

sphere of the first cavity **31** becomes a decompression atmosphere (for example, 10 Pa or less, and more preferably a vacuum atmosphere of 1 Pa or less), and the desired air pressure atmosphere of the second cavity **32** becomes an atmospheric pressure atmosphere.

[0081] As shown in FIG. **2**, in the electronic device **101** in which the second through-hole **42** which communicates with the second cavity **32** is not provided, the bonding between the cover body **20** and the substrate **10** is performed at a second air pressure atmosphere (atmospheric pressure atmosphere) of the second cavity **32**. Thereby, the second cavity **32** can be sealed at the atmospheric pressure atmosphere.

[0082] In the case of the electric device **101** shown in FIG. **2**, in the bonding between the cover body **20** and the substrate **10**, since the bonding is performed in the atmosphere, low-melting glass (not shown) which is stronger than the bonding by means of the anodic bonding is appropriately adopted. For example, when a lead glass material is used as the material of the low-melting glass, since the bonding in the atmosphere can be performed at low temperature (for example, approximately 320° C. to 360° C.), oxidative damage with respect to peripheral members such as wirings can be reduced during the bonding process.

[0083] In the sealing process of the first cavity **31** of the electronic device **101**, for example, the atmosphere of the sealing process is set to a decompression state (preferably, a vacuum state) of 10 Pa or less, and the sealing is performed using the seal member **50**. Heating and melting of the seal member **50** are performed by laser irradiation. In this case, the first cavity **31** is sealed under the decompression atmosphere in the state where the second cavity **32** is maintained to the atmospheric pressure. However, since the bonding by means of the low-melting glass is stronger than the bonding by means of the anodic bonding, the problem that the bonding strength is decreased does not occur.

[0084] Next, as shown in FIG. **3**, in the electronic device **102** in which the first through-hole **41** which communicates with the first cavity is not provided, the bonding between the cover body **20** and the substrate **10** is performed at a first air pressure atmosphere (at decompression atmosphere, and more preferably, a vacuum atmosphere) of the first cavity **31**. Thereby, the first cavity **31** can be sealed in the decompression atmosphere.

[0085] In the case of the electric device **102** shown in FIG. **3**, in the bonding between the cover body **20** and the substrate **10**, the anodic bonding (not shown) in which the strong bonding is possible even under the decompression atmosphere (for example, 10 Pa or less) is appropriately adopted. When the bonding by means of low-melting glass such as a lead glass material is performed under the decompression atmosphere, since oxygen which is needed in the adhesive response is not sufficiently supplied, there is a concern that time may be necessary for the adhesive response, or the bonding strength may be decreased due to the insufficient adhesive response. However, since the anodic bonding using a covalent bond can perform the bonding without receiving the influence of the decompression atmosphere, the bonding reliability of the anodic bonding is higher than the low-melting glass under the decompression atmosphere. Moreover, even when the material of the first function element and the second function element use a material in which oxidation should be avoided, since the bonding processing is performed under the decompression atmosphere, oxidative damages do not easily occur during the process.

[0086] In the sealing process of the second cavity **32** of the electronic device **102**, the atmosphere of the sealing process is set to an atmospheric pressure state, and the second cavity **32** is sealed using the seal member **50**. The heating and melting of the seal member **50** are performed by laser irradiation. In this case, since stress is generated from the outside toward the inside in the first cavity **31** which is sealed in the decompression atmosphere, the bonding strength between the substrate **10** and the cover body **20** can be increased.

[0087] In the case of the electronic device **102** shown in FIG. **3**, the bonding between the substrate **10** and the cover body **20** may use leadless low-melting glass in addition to the anodic bonding.

Modification Example

[0088] Next, Modification Example of the electronic device according to the first and second embodiments will be described with reference to drawings. FIG. **4** is a cross-sectional view schematically showing an electronic device **103** according to the Modification Example. The electronic device **103** according to the Modification Example is different from the electronic devices according to the first and second embodiments only in the configuration of the through-hole **40** (first through-hole **41** and second through-hole **42**). In descriptions below, only matters which are different from the devices according to the first and second embodiments will be described. The same reference numerals are attached to the configurations which are previously described, and the detailed descriptions are omitted.

[0089] In the electronic device **103** according to the Modification Example, the through-hole **40** includes a bottom surface **44** and communicates with the cavity through a communication hole **46** provided on the bottom surface **44**.

[0090] As shown in FIG. **4**, the through-hole **40** includes a first opening **45** which is provided on the first surface **22** of the cover body **20**. The first surface **22** of the cover body **20** is a surface of the cover body **20** and is a surface which forms the outline of the package **30**. The first surface **22** of the cover body **20** is a surface of the side opposite to the second surface **24** of the cover body **20**. The second surface **24** of the cover body **20** is a surface which defines the cavity **32** (the bottom of the concave portion which becomes the cavity).

[0091] The through-hole **40** has a shape in which the cross-sectional area (the area in the XY plane) is gradually increased from the bottom surface **44** toward the first opening **45**. That is, the area of the first opening **45** is larger than the area of the bottom surface **44**. The bottom surface **44** of the through-hole **40** is also referred to as the surface of the cover body **20** which defines the bottom of the through-hole **40**. For example, the bottom surface **44** of the through-hole **40** is flat. In the shown example, the bottom surface **44** of the through-hole **40** is parallel to the first surface **22** of the cover body **20**.

[0092] The through-hole **40** communicates with the cavity through the communication hole **46** which is formed on the bottom surface **44**. The communication hole **46** includes a second opening **46*a*** which is provided in a portion of the bottom surface **44** and a third opening **46*b*** of the cavity side. The third opening **46*b*** is provided on the second surface **24** of the cavity body **20**. Moreover, the third opening **46*b*** is not disposed at a position which is overlapped with the function elements **200** and **300** in a plan view as shown in FIG. **4**. That is, the third opening **46*b*** is disposed outside the outer edges of the function elements **200** and **300**. The communication hole **46** has a shape in which the cross-sectional area (the area in

the XY plane) is gradually increased from the second opening **46***a* toward the third opening **46***b*. That is, the area of the third opening **46***b* is larger than the area of the second opening **46***a*.

[0093] When the seal members such as a solder ball are melted in the through-holes **40** at a time by laser irradiation in the sealing process, there is a concern that spray referred to as splash may be diffused in the cavity. The spray may deteriorate resonance frequency or sensitivity of the function element which is accommodated in the electronic device.

[0094] On the other hand, according to the electronic device **103** in which the through-hole **40** includes the bottom surface **41** and communicates with the cavity by the communication hole **46** provided on the bottom surface **41**, when the seal member disposed in the through-hole is melted and seals the cavity, a portion of the seal member can be suppressed from being scattered in the cavity and attached to the function element. As a result, the electronic device **103** can have improved characteristics. Accordingly, the electronic device **103** according to the Modification Example is applied to the through-holes **40** of the electronic devices **100**, **101**, and **102** according to the first and second embodiments, and thus, the electronic device having higher reliability can be provided.

1-2. Configuration of Function Element

[0095] The first and second function elements **200** and **300** are mounted on the substrate **10**, and are placed (accommodated) respectively in the first cavity **31** and the second cavity **32** which are formed by the substrate **10** and the cover body **20** (are surrounded by the substrate **10** and the cover body **20**). For example, the first and second function element **200** and **300** which are accommodated in the package **30** may be bonded to the substrate **10** by anodic bonding or direct bonding or by adhesive.

[0096] If the first and second function elements **200** and **300** detect physical quantities different from each other and move in the cavities which are sealed in a decompression state or an inert gas atmosphere, the aspects of the first and second function elements are not particularly limited and may include various function elements such as a gyro sensor, an acceleration sensor, vibrator, a surface acoustic wave (SAW) element, or a micro-actuator, for example.

[0097] For example, the materials of the first and second function elements **200** and **300** are silicon in which impurities such as phosphorus or boron are doped and thus, conductivity is applied.

[0098] Hereinafter, as an example of the electronic device **100** according to the present embodiment, an aspect is described in which a gyro sensor is adopted as the first function element **200** and an acceleration sensor (electrostatic capacitance type MEMS acceleration sensor element) is adopted as the second function element **300**. FIG. **5** is a plan view schematically showing the first function element **200** which is placed on the electronic device **100** according to the present embodiment. In addition, FIG. **10** is a plan view schematically showing the second function element **300** which is placed on the electronic device **100** according to the present embodiment. However, the aspects of the first and second function elements **200** and **300** are not limited to the following aspects and may include the aspects of the known function elements. Moreover, for convenience, in FIG. **5**, the X axis, the Y axis, and the Z axis are shown as three axes perpendicular to one another. This is similarly applied to FIG. **6** to FIG. **10** described below.

Configuration of Gyro Sensor

[0099] As shown in FIG. **5**, the first function element **200** may include a vibration system structure **104**, fixed electrodes for driving **130**, fixed electrode for detecting **140**, and fixing portions **150**.

[0100] For example, the vibration system structure **104** is integrally formed by processing a silicon substrate which is bonded to the substrate **10**. Thereby, a fine process technology which is used in manufacturing of a silicon semiconductor device can be applied, and thus, the size reduction of the vibration system structure **104** can be improved.

[0101] The vibration system structure **104** is supported by the fixing portions **150** which are fixed to the substrate **10** and is disposed so as to be separated from the substrate **10**. The vibration system structure **104** may include a first vibration body **106** and a second vibrating body **108**. The first vibrating body **106** and the second vibrating body **108** are connected to each other along the X axis.

[0102] The first vibrating body **106** and the second vibrating body **108** may include shapes which are symmetrical with respect to a boundary line B (a straight line along the Y axis) of both. Therefore, hereinafter, the configuration of the first vibrating body **106** will be described, and the description of the configuration of the second vibrating body **108** will be omitted.

[0103] The first vibrating body **106** includes a drive portion **110** and a detection portion **120**. The drive portion **110** may include a support portion for driving **112**, a spring portion for driving **114**, and a movable electrode for driving **116**.

[0104] For example, the support portion for driving **112** has a frame-like shape, and the detection portion **120** is disposed inside the support portion for driving **112**. In the shown example, the support portion for driving **112** is configured by first extension portions **112***a* which are extended along the X axis and second extension portions **112***b* which are extended along the Y axis.

[0105] The spring portion for driving **114** is disposed outside the support portion for driving **112**. In the shown example, one end of the spring portion for driving **114** is connected to the vicinity of a corner portion (a connection portion between the first extension portion **112***a* and the second extension portion **112***b*) of the support portion for driving **112**. The other end of the spring portion for driving **114** is connected to the fixing portion **150**.

[0106] In the shown example, four spring portions for driving **114** are provided in the first vibrating body **106**. Thereby, the first vibrating body **106** is supported by four fixing portions **150**. In addition, the fixing portions **150** on the boundary line B between the first vibrating body **106** and the second vibrating body **108** may not be provided.

[0107] The spring portion for driving **114** has a shape which is extended along the X axis while reciprocating along the Y axis. The plurality of spring portions for driving **114** are provided so as to be symmetrical with respect to a virtual line (not shown) along the X axis passing through the center of the support portion for driving **112** and a virtual line (not shown) along the Y axis passing through the center of the support portion for driving **112**. Since the spring portions for driving **114** have the above-described shape, the spring portions for driving **114** are suppressed from being deformed in the Y axis direction and the Z axis direction, and the spring portions for driving **114** can be smoothly expanded and contracted in the X axis direction which is a vibration direction of the drive portion **110**. Moreover, according to the expansion and con-

traction of the spring portions for driving **114**, the support portion for driving **112** (drive portion **110**) can be vibrated along the X axis. In addition, the number of the spring portions for driving **114** is not particularly limited if the spring portion can vibrate the support portion for driving **112** along the X axis.

[0108] The movable electrode for driving **116** is disposed so as to be connected to the support portion for driving **112** outside the support portion for driving **112**. More specifically, the movable electrode for driving **116** is connected to the first extension portion **112***a* of the support portion for driving **112**.

[0109] The fixed electrode for driving **130** is disposed outside the support portion for driving **112**. The fixed electrode for driving **130** is fixed on the substrate **10**. In the shown example, the plurality of fixed electrodes for driving **130** are provided and disposed so as to be opposite to each other via the movable electrode for driving **116**. In the shown example, each of the fixed electrodes for driving **130** has a comb-like shape, and each of the movable electrodes for driving **116** includes protrusions **116***a* which can be inserted between comb teeth of each of the fixed electrodes for driving **130**. Due to the fact that the distances (gaps) between the fixed electrodes for driving **130** and the protrusions **116***a* are decreased, an electrostatic force, which is operated between the fixed electrodes for driving **130** and the movable electrode for driving **116**, can be increased.

[0110] If voltage is applied to the fixed electrodes for driving **130** and the movable electrode for driving **116**, an electrostatic force can be generated between the fixed electrodes for driving **130** and the movable electrode for driving **116**. Thereby, the support portion for driving **112** (drive portion **110**) can be vibrated along the X axis while spring portions for driving **114** are expanded and contracted along the X axis. At this time, since the vibration system structure **104** exists in a decompression atmosphere, particularly, in 10 Pa or less, efficiency of the vibration is increased.

[0111] Moreover, in the shown example, four movable electrodes for driving **116** are provided in the first vibrating body **106**. However, the number of the movable electrodes is not particularly limited if the movable electrode can vibrate the support portion for driving **112** along the X axis. Moreover, in the shown example, the fixed electrodes for driving **130** are disposed so as to be opposite to each other via the movable electrode for driving **116**. However, the fixed electrode for driving **130** may be disposed only one side of the movable electrode for driving **116** if the fixed electrode can vibrate the support portion for driving **112** along the X axis.

[0112] The detection portion **120** is connected to the drive portion **110**. In the shown example, the detection portion **120** is disposed inside the support portion for driving **112**. The detection portion **120** may include a support portion for detecting **122**, a spring portion for detecting **124**, and a movable electrode for detecting **126**. Moreover, although not shown, if the detection portion **120** is connected to the drive portion **110**, the detection portion may be disposed outside the support portion for driving **112**.

[0113] For example, the support portion for detecting **122** has a frame-like shape. In the shown example, the support portion for detecting **122** is configured by third extension portions **122***a* which are extended along the X axis and fourth extension portions **122***b* which are extended along the Y axis.

[0114] The spring portion for detecting **124** is disposed outside the support portion for detecting **122**. The spring portion for detecting **124** connects the support portion for detecting **122** and the support portion for driving **112**. More specifically, one end of the spring portion for detecting **124** is connected to the vicinity of a corner portion (a connection portion between the third extension portion **122***a* and the fourth extension portion **122***b*) of the support portion for detecting **122**. The other end of the spring portion for detecting **124** is connected to the first extension portion **112***a* of the support portion for driving **112**.

[0115] The spring portion for detecting **124** has a shape which is extended along the Y axis while reciprocating along the X axis. In the shown example, four spring portions for detecting **124** are provided in the first vibrating body **106**. The plurality of spring portions for detecting **124** are provided so as to be symmetrical with respect to a virtual line (not shown) along the X axis passing through the center of the support portion for detecting **122** and a virtual line (not shown) along the Y axis passing through the center of the support portion for detecting **122**. Since the spring portions for detecting **124** have the above-described shape, the spring portions for detecting **124** are suppressed from being deformed in the X axis direction and the Z axis direction, and the spring portions for detecting **124** can be smoothly expanded and contracted in the Y axis direction which is a vibration direction of the detection portion **120**. Moreover, according to the expansion and contraction of the spring portions for detecting **124**, the support portion for detecting **122** (detection portion **120**) can be displaced along the Y axis. In addition, the number of the spring portions for detecting **124** is not particularly limited if the spring portion can displace the support portion for detecting **122** along the Y axis.

[0116] The movable electrode for detecting **126** is disposed so as to be connected to the support portion for detecting **122** inside the support portion for detecting **122**. In the shown example, the movable electrode for detecting **126** is extended along the X axis and is connected to two fourth extension portions **122***b* of the support portion for detecting **122**.

[0117] The fixed electrode for detecting **140** is disposed inside the support portion for detecting **122**. The fixed electrode for detecting **140** is fixed on the substrate **10**. In the shown example, the plurality of fixed electrodes for detecting **140** are provided and disposed so as to be opposite to each other via the movable electrode for detecting **126**.

[0118] The number and the shapes of the movable electrodes for detecting **126** and the fixed electrodes for detecting **140** are not particularly limited if the movable electrode and the fixed electrode can detect the change of electrostatic capacitance between the movable electrode for detecting **126** and the fixed electrode for detecting **140**.

[0119] Next, an operation of the first function element **200** will be described. FIGS. **6** to **9** are views for illustrating the operation of the first function element **200** which is accommodated in the electronic device according to the present embodiment. Moreover, for convenience, in FIGS. **6** to **9**, each portion of the first function element **200** is shown so as to be simplified.

[0120] If voltage is applied to the fixed electrodes for driving **130** and the movable electrodes for driving **116** by a power source (not shown), electrostatic forces are generated between the fixed electrode for driving **130** and the movable electrodes for driving **116**. Thereby, as shown in FIGS. **6** and **7**, the spring portions for driving **114** can be expanded and contracted along the X axis and the drive portion **110** can be vibrated along the X axis.

[0121] More specifically, a first alternating voltage is applied between the movable electrodes for driving **116** and the fixed electrodes for driving **130** of the first vibrating body **106**, and a second alternating voltage, in which the phase is shifted by 180° with respect to the first alternating voltage, is applied between the movable electrodes for driving **116** and the fixed electrodes for driving **130** of the second vibrating body **108**. Thereby, a first drive portion **110***a* of the first vibrating body **106** and a second drive portion **110***b* of the second vibrating body **108** can be vibrated along the X axis with reverse phases to each other and a predetermined frequency. That is, the first drive portion **110***a* and the second drive portion **110***b*, which are connected to each other along the X axis, are vibrated with reverse phases to each other along the X axis. In the example shown in FIG. **6**, the first drive portion **110***a* is displaced in a α1 direction and the second drive portion **110***b* is displaced in a α2 direction which is a direction opposite to the α1 direction. In the example shown in FIG. **7**, the first drive portion **110***a* is displaced in the α2 direction and the second drive portion **110***b* is displaced in the Ca direction.

[0122] Moreover, since the detection portion **120** is connected to the drive portion **110**, the detection portion **120** is also vibrated along the X axis according to the vibration of the drive portion **110**. That is, the first vibrating body **106** and the second vibrating body **108** are displaced in directions opposite to each other along the X axis.

[0123] As shown in FIGS. **8** and **9**, if angular velocity w around the Z axis is applied to the function element **200** in a state where the drive portions **110***a* and **110***b* perform a first vibration, Coriolis force is operated, and thus, the detection portion **120** is displaced along the Y axis. That is, a first detection portion **120***a* which is connected to the first drive portion **110***a* and a second detection portion **120***b* which is connected to the second drive portion **110***b* are displaced in directions opposite to each other along the Y axis by the first vibration and Coriolis force. In the example shown in FIG. **8**, the first detection portion **120***a* is displaced in a β1 direction and the second detection portion **120***b* is displaced in a β2 direction which is a direction opposite to the β1 direction. In the example shown in FIG. **9**, the first detection portion **120***a* is displaced in the β2 direction and the second detection portion **120***b* is displaced in the β1 direction.

[0124] Since the detection portions **120***a* and **120***b* are displaced along the Y axis, the distance L between the movable electrode for detecting **126** and the fixed electrode for detecting **140** is changed. Thereby, the electrostatic capacitance between the movable electrode for detecting **126** and the fixed electrode for detecting **140** is changed. In the first function element **200**, by applying voltage to the movable electrodes for detecting **126** and the fixed electrodes for detecting **140**, an amount of change of the electrostatic capacitances between the movable electrodes for detecting **126** and the fixed electrodes for detecting **140** is detected, and the angular velocity ω around the Z axis can be obtained.

[0125] Moreover, in the above description, the aspect (electrostatic drive type) in which the drive portion **110** is driven by the electrostatic force is described. However, the method for driving the drive portion **110** is not particularly limited, and a piezoelectric drive type, an electromagnetic drive type which uses Lorentz force of a magnetic field, or the like may be applied. In addition, the configuration of the gyro sensor, since the atmosphere is set to decompression, improved vibration characteristics and detection characteristics can be obtained.

Configuration of Acceleration Sensor

[0126] The second function element **300** is supported on the first surface **11** of the substrate **10** (on the substrate **10**). As shown in FIG. **10**, the second function element **300** includes fixing portions **281** and **282**, connection portions **284** and **285**, a movable portion **286**, movable electrode portions **287**, and fixed electrode portions **288** and **289**.

[0127] The movable portion **286** is displaced in the X axis direction (+X direction or −X direction) while elastically deforming the connection portions **284** and **285** according to the change of acceleration in the X axis direction. According to this change, the intervals between the movable electrode portions **287** and the fixed electrode portions **288**, and the sizes of the intervals between the movable electrode portions **287** and the fixed electrode portions **289** are changed. That is, according to this change, electrostatic capacitances between the movable electrode portions **287** and the fixed electrode portions **288**, and magnitudes of the electrostatic capacitances between the movable electrode portions **287** and the fixed electrode portions **289** are changed. The second function element **300** can detect the acceleration in the X axis direction based on the change of the electrostatic capacitances.

[0128] The fixed portions **281** and **282** are bonded to the first surface **11** of the substrate **10**. In the shown example, the fixing portions **281** and **282** are provided so as to straddle the outer circumferential edge of the second concave portion **15** in a plan view.

[0129] The movable portion **286** is provided between the fixing portion **281** and the fixing portion **282**. In the example shown in FIG. **10**, the planar shape of the movable portion **286** is a rectangular shape which has a long side along the X axis.

[0130] The connection portions **284** and **285** connect the movable portion **286** to the fixing portions **281** and **282**. The connection portions **284** and **285** have a desired spring constant and are configured so as to displace the movable portion **286** in the X axis direction. In the example shown in FIG. **10**, the connection portion **284** is configured by two beams **284***a* and **284***b* which meander in the Y axis direction and are formed so as to be extended in the X axis direction. Similarly, the connection portion **285** is configured by two beams **285***a* and **285***b* which meander in the Y axis direction and are formed so as to be extended in the X axis direction.

[0131] The movable electrode portions **287** are connected to the movable portion **286**. The plurality of movable electrode portions **287** are provided. The movable electrode portions **287** protrude in +Y direction and −Y direction from the movable portion **286** and are arranged in the X axis direction so as to form a shape of comb teeth.

[0132] In each of the fixed electrode portions **288** and **289**, one end is bonded to the first surface **11** of the substrate **10** as a fixed end, and the other end is extended to the movable portion **286** side as a free end. The plurality of fixed electrode portions **288** and **289** are provided respectively. The fixed electrode portions **288** are electrically connected to wirings (not shown), and the fixed electrode portions **289** are electrically connected to wirings (not shown). The fixed electrode portions **288** and **289** are alternately arranged in the X axis direction so as to form a shape of comb teeth. The fixed electrode portions **288** and **289** are provided so as to be

opposite to the movable electrode portions **287** with intervals, the fixed electrode portions **288** are disposed in one side (−X direction side) of the movable electrode portions **287**, and the fixed electrode portions **289** are disposed in the other end (+X direction side).

[0133] The fixing portions **281** and **282**, the connection portions **284** and **285**, the movable portion **286**, and the movable electrode portions **287** are integrally formed.

[0134] The fixing portion **281** includes a contact portion **240** which is connected to wirings (not shown). Thereby, the fixing portion **281** is electrically connected to an external connection terminal. Moreover, the fixed electrode portions **288** include contact portions **242** which are connected to wirings (not shown). Thereby, the fixed electrode portions **288** are electrically connected to the external connection terminal. In addition, the fixed electrode portions **289** include contact portions **244** which are connected to wirings (not shown). Thereby, the fixed electrode portions **289** are electrically connected to the external connection terminal.

[0135] In the second function element **300**, the electrostatic capacitances between the movable electrode portions **287** and the fixed electrode portions **288** can be measured using the external connection thermal which is electrically connected. Moreover, in the second function element **300**, the electrostatic capacitances between the movable electrode portions **287** and the fixed electrode portions **289** can be measured using the external connection terminal which is electrically connected. In this way, in the second function element **300**, the electrostatic capacitances between the movable electrode portions **287** and the fixed electrode portions **288**, and the electrostatic capacitances between the movable electrode portions **287** and the fixed electrode portions **289** are separately measured, and based on the measured results, physical quantity (acceleration) can be detected with high accuracy. Moreover, in the configuration of the acceleration sensor, the atmosphere is set to atmospheric pressure, air viscosity is used, and thus, improved detection characteristics can be obtained.

[0136] For example, the electronic devices **100**, **101**, **102**, and **103** according to the present embodiments have the following characteristics.

[0137] According to the electronic devices **100**, **101**, and **102**, the first cavity **31** and the second cavity **32** are isolated from each other by the partition wall portion **25** which is integrally provided in the cover body **20** or the substrate **10**.

[0138] As described above, since the electronic devices **100**, **101**, **102**, and **103** are electronic devices in which the plurality of physical quantity detection sensors (first function element **200** and second function element **300**) are mounted in the same package **30** (the same substrate), it is possible to meet the demands for size reduction and the space saving. Moreover, since the process, which electrically connects the substrates on which the sensors are mounted by lamination or the like, can be omitted, it can contribute to simplification of the production processes or reduction of the production costs.

[0139] Here, in an electronic device in which cavities having inner pressures different from each other are formed in the same package, when airtightness of the cavities is decreased, defects occur in the function elements accommodated in the cavities, and there is a concern that reliability of the electronic device itself may be decreased. Therefore, it is necessary to securely isolate each cavity and secure high airtightness of the cavities.

[0140] According to the electronic devices **100**, **101**, **102**, and **103**, the first cavity **31** and the second cavity **32** are isolated from each other by the partition wall portion **25** which is integrally provided in the cover body **20** or the substrate **10**. According to this, the first cavity **31** and the second cavity **32** are configured by only two members of the substrate **10** and the cover body **20** without a seal member. In other words, the bond interface between members, which is required for configuring two cavities in the same package, includes only the bond surface between the substrate **10** and the cover body **20**. Therefore, compared to an electronic device in which a partition wall portion other than the substrate and the cover body isolates between the cavities having inner pressures different from each other, an electronic device having improved reliability can be provided.

[0141] From the above, an electronic device which meets the demands for size reduction, the space saving, and reduction of the production costs can be provided, and an electronic device having improved reliability can be provided.

[0142] In addition, according to the electronic devices **101** and **102**, only any one of the first through-hole **41** and the second through-hole **42** is formed. As a result, the through-hole which communicates with any one of the first cavity **31** or the second cavity **32** is not provided, and the inner surface of the cavity is configured by only the substrate **10** and the cover body **20**.

[0143] Generally, in the sealing process which uses the through-holes, for example, the seal members which are formed of alloy such as AuGe are disposed in the through-holes, the seal members are heated to high temperature of approximately 300° C. by laser or the like, the seal members are melted at a time, the through-holes are blocked, and the cavities are sealed in a desired atmosphere.

[0144] When each through-hole is provided in each cavity in the same package, laser irradiation is performed respectively, the seal member is heated and melted to approximately 300° C., for example, and thus, the through-hole is sealed. In the sealing process, in order to prevent remelting of the heated seal member, it is necessary to control the heating temperature of the seal member in the through-hole after the second location to temperature lower than the heating temperature at the first location.

[0145] According to the electronic devices **101** and **102**, since only one through-hole for sealing is formed in the electronic devices which include two cavities in the same package, the material costs of the seal member which is formed of alloy such as AuGe are reduced, and the sealing process of the through-hole, which requires a temperature control having high accuracy, can be decreased. Therefore, an electronic device, which can contribute to reduction of the production costs and simplification of the production processes, can be provided.

[0146] In addition, according to the electronic devices **101** and **102**, since the plurality of through-holes are not provided, it is not necessary to heat the package plural times in order to seal the through-hole. According to this, it is possible to prevent the seal member from being remelted due to the plurality of times of sealing processes and airtightness from being decreased. Accordingly, compared to the electronic device in which the plurality of through-holes are provided in the same package due to the reason of the manufacturing process, an electronic device having higher airtight reliability can be provided.

[0147] Moreover, according to the electronic devices **103**, the through-hole **40** includes the bottom surface **41** and communicates with the cavity through the communication hole **46** provided on the bottom surface **41**. Thereby, when the seal member disposed in the through-hole **40** is melted and the cavity is sealed, a portion of the seal member can be suppressed from being scattering into the cavity and attached to the function element. As a result, an electronic device having higher reliability can be provided.

2. Manufacturing Method of Electronic Device

[0148] Next, a manufacturing method of the electronic device according to the embodiment of the invention will be described. A manufacturing method of the electronic device according to the embodiment of the invention includes: a process in which the first function element **200** and the second function element **300** are placed on the substrate **10**; an accommodation process in which the cover body **20** is placed on the substrate **10**, the first function element **200** is accommodated in the first cavity **31** which is surrounded by the substrate **10** and the cover body **20**, and the second function element **300** is accommodated in the second cavity **32** which is surrounded by the substrate **10** and the cover body **20**; and a sealing process in which the first cavity **31** is sealed at a first air pressure atmosphere, and the second cavity **32** is sealed at a second air pressure atmosphere having differences of air pressure with respect to the first air pressure atmosphere, and the first cavity and the second cavity are isolated from each other by the partition wall portion which is integrally provided in the cover body or the substrate.

[0149] According to the manufacturing method of the electronic device according to the embodiment of the invention, the first cavity **31** and the second cavity **32** are isolated from each other by the partition wall portion **25** which is integrally provided in the cover body **20** or the substrate **10**. According to this, it is not necessary to separately prepare a member for isolating the cavities so as to bond the cover body and the substrate. Therefore, the manufacturing process is more simplified, and the manufacturing method which can manufacture the electronic device having more improved reliability can be provided.

[0150] Hereinafter, the manufacturing method of the electronic device **100** according to the first embodiment and the manufacturing methods of the electronic devices **101** and **102** according to the second embodiment will be described with reference to the drawings.

Manufacturing Method of Electronic Device according to First Embodiment

[0151] FIG. **11** is a flowchart of the manufacturing process of the electronic device **100** according to the first embodiment.

[0152] FIGS. **12** to **14** are cross-sectional views schematically showing the manufacturing process of the electronic device **100** according to the first embodiment and are corresponding to FIG. **1**.

[0153] As shown in FIG. **11**, the manufacturing process of the electronic device **100** according to the first embodiment includes: a process (S**1**) of placing the first function element **200** and the second function element **300** on the substrate **10**; a process (S**2**) of placing the cover body **20** on the substrate **10**, accommodating the first function element **200** in the first cavity **31** which is surrounded by the substrate **10** and the cover body **20**, and accommodating the second function element **300** in the second cavity **32** which is surrounded by the substrate **10** and the cover body **20**; a first sealing process (S**3**) of sealing the first cavity **31** in the first air pressure atmosphere; and a second sealing process (S**4**) of sealing the second cavity **32** in a second air pressure atmosphere after the first sealing process.

[0154] First, the substrate **10** is prepared. As shown in FIG. **12**, the first concave portion **14** and the second concave portion **15** are formed on the first surface **11** of the substrate **10**. At this time, a groove (not shown) may be formed around the first concave portion **14** and the second concave portion **15**. For example, the first concave portion **14** and the second concave potion **15** are formed by a photolithography technology and an etching technology. Thereby, the substrate **10** in which the first concave portion **14** and the second concave portion **15** are provided on the first surface **11** can be prepared.

[0155] Here, although not shown, wirings, which electrically connect to the first and second function elements **200** and **300**, may be formed on the substrate **10** which includes the inner portions of the first concave portion **14** and the second concave portion **15**. For example, after a film is formed by a sputtering method, Chemical Vapor Deposition (CVD) method, or the like, the film is patterned by the photolithography technology and the etching technology, and thus, the wirings are formed.

[0156] Subsequently, as shown in FIG. **13**, the first function element **200** and the second function element **300** are placed on the substrate **10** (S**1**). Specifically, a silicon substrate (not shown) is placed (bonded) on the first substrate **11** of the substrate **10**, and after the silicon substrate is thinned, the silicon substrate is patterned, and thus, the first function element **200** and the second function element **300** are formed. The patterning is performed by the photolithography technology and the etching technology. For example, the bonded between the silicon substrate and the substrate **10** is performed by anodic bonding.

[0157] Subsequently, as shown in FIG. **14**, the cover body **20** is prepared. The cover body **20** is formed by preparing a silicon substrate, and by forming the first concave portion **14** and the second concave portion **15** on the first surface **22** by the photolithography technology and the etching technology. Moreover, the first through-hole **41** and the second through-hole **42** which communicate with the first concave portion **14** and the second concave portion **15** are also formed by the similar process. Here, the first through-hole **41** and the second through-hole **42** are formed by anisotropic wet etching, and thus, the inner wall surfaces of the first through-hole **41** and the second through-hole **42** can be formed in taper shapes.

[0158] Moreover, although not shown, the conductive layer **43**, which covers the inner wall surfaces of the first through-hole **41** and the second through-hole **42**, may be formed. For example, after a film is formed by a sputtering method, Chemical Vapor Deposition (CVD) method, or the like, the film is patterned by the photolithography technology and the etching technology, and thus, the conductive layer **43** is formed.

[0159] Subsequently, as shown in FIG. **15**, the substrate **10** and the cover body **20** are bonded, and the first function element **200** and the second function element **300** are accommodated respectively in the first cavity **31** and the second cavity **32** which are surrounded by the substrate **10** and the cover body **20** (S**2**). For example, the bonding between the substrate **10** and the cover body **20** is performed by anodic bonding.

[0160] Subsequently, the first cavity **31** is sealed in the first air pressure atmosphere (first sealing process: S**3**). For example, in this process, as shown in FIG. **15**, the seal member **50** is formed in the first through-hole **41** in a decompression atmosphere. More specifically, a spherical solder ball (not shown) is disposed in the first through-hole **41**, the solder ball is melted by laser irradiation, and thus, the seal member **50** is formed. According to this process, the first cavity **31** can be sealed by the seal member **50**.

[0161] Subsequently, the second cavity **32** is sealed in the second air pressure atmosphere (second sealing process: S**4**). For example, in this process, the seal member **50** is formed in the second through-hole **42** in an inert gas atmosphere such as nitrogen gas (refer to FIG. **1**). More specifically, a spherical solder ball (not shown) is disposed in the second through-hole **42**, the solder ball is melted by laser irradiation, and thus, the seal member **50** is formed. According to this process, the second cavity **32** can be sealed by the seal member **50** (refer to FIG. **1**).

[0162] According to the above-described processes, the electronic device **100** can be manufactured.

[0163] For example, according to the manufacturing method of the electronic device **100**, the following characteristics are provided.

[0164] According to the manufacturing method of the electronic device **100**, an electronic device having improved reliability can be provided. According to the manufacturing method of the electronic device **100**, the first cavity **31** and the second cavity **32** are isolated from each other by the partition wall portion **25** which is integrally provided in the cover body **20**. According to this, since it is not necessary to separately prepare a member for isolating the cavities, an electronic device having more improved reliability can be manufactured by more simple method.

[0165] In addition, according to the manufacturing method of the electronic device **100**, the second sealing process (S**4**) under the second air pressure atmosphere is performed after the first sealing process (S**3**) under the first air pressure atmosphere. At this time, the second air pressure atmosphere performs the sealing process under air pressure higher than the first air pressure atmosphere. Here, if the sealing process is performed in a state where the second air pressure atmosphere is lower than the first air pressure atmosphere, pressure in a direction from the inside of the first cavity **31** toward the outside is applied to the substrate **10**, the cover body **20**, the partition wall portion **25**, the seal member **50**, or the like which seals the first cavity **31**. That is, the pressure is operated in the direction in which the first cavity **31** is expanded. This becomes a cause which generates a leak pass in the bond surface between the substrate **10** and the cover body **20**, the bond surface between the substrate **10** and the partition wall portion **25**, the bond surface between the cover body **20** and the seal member **50**, and the like. Therefore, airtightness of the first cavity **31** may be decreased. On the other hand, according to the manufacturing method of the electronic device **100**, in the second sealing process (S**4**), pressure in the direction from the outside of the first cavity **31** toward the inside can be applied to the seal member **50** which seals the first cavity **31** in the first sealing process (S**3**). Thereby, a decrease in the bonding reliability of the substrate **10**, the cover body **20**, and the seal member **50** which surround the first cavity **31** is not generated. Moreover, the bonding reliability of the seal member **50** which seals the second cavity **32** can be further increased. Thereby, an electronic device having more improved reliability can be provided.

[0166] For example, the first function element **200** which is a gyro sensor is disposed in the first cavity **31**, and is sealed in a decompression atmosphere which is the first air pressure atmosphere, for example, in 10 Pa or less. Subsequently, the second function element **300** which is an acceleration sensor is disposed in the second cavity **32**, and is sealed in an atmospheric pressure atmosphere which is the second air pressure atmosphere, for example, approximately 1013 hPa. At this time, since the first cavity **31** is returned from the decompression atmosphere to the atmospheric pressure state, the pressure from the outside is applied to the substrate or the cover body, and thus, reliability of the bond surface can be increased.

[0167] Moreover, according to the manufacturing method of the electronic device **100**, the material of the substrate **10** may be glass, and the material of the cover body **20** may be silicon. According to this, the cover body **20** is formed of the material having better workability than the substrate **10**. Therefore, compared to a case where the concave portion which accommodates the function element is provided in the substrate **10** side, the electronic device can be manufactured by the more simple method.

Manufacturing Method of Electronic Device according to Second Embodiment

[0168] Next, the manufacturing method of the electronic device according to the second embodiment will be described with reference to the drawings. FIG. **16** is a flowchart of the manufacturing processes of the electronic devices **101** and **102** according to the second embodiment. As shown in FIG. **16**, the manufacturing method of the electronic device according to the second embodiment is different from the manufacturing method of the electronic device according to the first embodiment in that the first sealing process (S**3**) is performed concurrently with the process (S**2**) of placing the cover body **20**. In the descriptions below, only the matters in which the manufacturing method of the electronic device according to the second embodiment is different from the manufacturing method of the device according to the first embodiment will be described. The detailed descriptions with respect to the processes previously described are omitted.

[0169] First, similar to the first embodiment, the substrate **10** is prepared, and the first function element **200** and the second function element **300** are placed on the substrate **10** (refer to S**1** and FIGS. **12** and **13**). Subsequently, the cover body **20** is prepared. In the manufacturing method according to the second embodiment, the cover body **20** which is shown in FIG. **2** or **3** is prepared. Here, the cover body **20**, in which the through-hole which communicates with any one of the first cavity **31** or the second cavity **32** is not provided, is prepared.

[0170] Subsequently, as shown in FIG. **16**, the process (S**2**) of placing the cover body **20** and the first sealing process (S**3**) are simultaneously performed. In the manufacturing method of the electronic device according to the second embodiment, the cover body **20** is placed on the substrate **10** (S**2**) under the appropriate air pressure atmosphere of the function element which is accommodated in the cavity with which the through-hole does not communicate, and thereby, the cavity with which the through-hole does not communicate is sealed (first sealing process: S**3**). Accordingly, in the manufacturing method according to the embodiment, the cover body **20** is placed on the substrate **10** under the air pressure atmosphere

in the cavity with which the through-hole **40** does not communicate. For example, when the electronic device **101** in which the second through-hole **42** which communicates with the second cavity is not provided is manufactured as shown in FIG. **2**, the bonding between the cover body **20** and the substrate **10** is performed in the second air pressure atmosphere of the second cavity **32**. Thereby, the second cavity **32** can be sealed in the second air pressure atmosphere. Moreover, when the electronic device **102** in which the first through-hole **41** which communicates with the first cavity is not provided is manufactured as shown in FIG. **3**, the bonding between the cover body **20** and the substrate **10** is performed in the first air pressure atmosphere of the first cavity **31**. Thereby, the first cavity **31** can be sealed in the first air pressure atmosphere.

[0171] The sealing atmosphere of the first sealing process (S**3**) which is performed concurrently with the placing process (S**2**) is appropriately selected according to the type of the function element which is accommodated in the cavity with which the through-hole **40** does not communicate. When a gyro sensor described above is adopted as the first function element **200** accommodated in the first cavity **31** and an acceleration sensor (electrostatic capacitance type MEMS acceleration sensor element) described above is adopted as the second function element **300** accommodated in the second cavity **32**, the first air pressure atmosphere which is a desired sealing atmosphere in the first cavity **31** becomes a decompression atmosphere (more preferably, vacuum atmosphere), and the second air pressure atmosphere which is a desired sealing atmosphere in the second cavity **32** becomes an atmospheric pressure atmosphere.

[0172] When the electronic device **101** is manufactured, in the bonding between the cover body **20** and the substrate **10**, since the bonding is performed in the atmosphere, low-melting glass (not shown) which is stronger than the bonding by means of the anodic bonding is appropriately adopted. For example, when a lead glass material is used as the material of the low-melting glass, since the bonding in the atmosphere can be performed at low temperature (for example, approximately 320° C. to 360° C.), oxidative damage with respect to peripheral members such as wirings can be reduced during the bonding process.

[0173] After the first sealing process (S**3**), for example, the atmosphere of the manufacturing process is set to a decompression state (preferably, a vacuum state) of 10 Pa or less, and the first cavity **31** with which the first through-hole **41** communicates is sealed using the seal member **50** (second sealing process: S**4**). Heating and melting of the seal member **50** are performed by laser irradiation. In this case, the first cavity **31** is sealed under the decompression atmosphere in the state where the second cavity **32** is maintained to the atmospheric pressure. However, since the bonding by means of the low-melting glass is stronger than the bonding by means of the anodic bonding, the problem that the bonding strength is decreased does not occur.

[0174] In the case of the electric device **102**, in the bonding between the cover body **20** and the substrate **10**, the anodic bonding (not shown) in which the strong bonding is possible even under the decompression atmosphere (for example, 10 Pa or less) is appropriately adopted. When the bonding by means of low-melting glass such as a lead glass material is performed under the decompression atmosphere, since oxygen which is needed in the adhesive response is not sufficiently supplied, there is a concern that time may be necessary for the adhesive response, or the bonding strength may be decreased due to the insufficient adhesive response. However, since the anodic bonding using a covalent bond can perform the bonding without receiving the influence of the decompression atmosphere, the bonding reliability of the anodic bonding is higher than the low-melting glass under the decompression atmosphere. Moreover, even when the material of the first function element and the second function element use a material in which oxidation should be avoided, since the bonding processing is performed under the decompression atmosphere, oxidative damages do not easily occur during the process.

[0175] After the first sealing process (S**3**), the atmosphere of the manufacturing process is set to an atmospheric pressure state, and the second cavity **32** with which the second through-hole **42** communicates is sealed using the seal member **50** (second sealing process: S**4**). The heating and melting of the seal member **50** are performed by laser irradiation. In this case, since stress is generated from the outside toward the inside in the first cavity **31** which is sealed in the decompression atmosphere, the bonding strength between the substrate **10** and the cover body **20** can be increased.

[0176] Moreover, in the manufacturing method of the electronic device **102** shown in FIG. **3**, the bonding between the substrate **10** and the cover body **20** may use leadless low-melting glass in addition to the anodic bonding.

[0177] According to the above-described processes, the electronic devices **101** and **102** can be manufactured.

[0178] For example, according to the manufacturing methods of the electronic devices **101** and **102**, the following characteristics are provided.

[0179] According to the manufacturing methods of the electronic devices **101** and **102**, the first sealing process of the cavity with which the through-hole does not communicate can be performed in the accommodating process. According to this, the material costs of the seal member which is formed of alloy such as AuGe are reduced, and the sealing process of the through-hole, which requires a temperature control having high accuracy, can be simplified. Therefore, the manufacturing method of the electronic device, which can contribute to reduction of the production costs and simplification of the production processes, can be provided.

[0180] In addition, according to the manufacturing methods of the electronic devices **101** and **102**, in the sealing process which seals two cavities, the process which seals the through-hole by the seal member is once (second sealing process), and it is not necessary to heat the package in plural times. According to this, it is possible to prevent the seal member from being remelted due to the plurality of times of sealing processes and airtightness from being decreased. Accordingly, compared to the manufacturing method of the electronic device in which the plurality of times of sealing processes are performed in the same package, the manufacturing method of the electronic device, in which the electronic device having higher airtight reliability is manufactured, can be provided.

[0181] Moreover, according to the manufacturing method of the electronic device **102** (FIG. **3**), after the second cavity **32** is sealed under the second air pressure atmosphere, the first cavity **31** is sealed under the first air pressure atmosphere which is air pressure higher than the second air pressure atmosphere. According to this, the pressure of the direction toward the inside of second cavity can be applied to the package of the electronic device under the first air pressure

atmosphere. Thereby, adhesiveness between the cover body and the substrate is improved, and an electronic device having more improved reliability can be provided.

3. Electronic Apparatus

[0182] Next, an electronic apparatus according to the embodiment will be described with reference to the drawings. The electronic apparatus according to the embodiment includes the electronic device **100** (or any one of **101**, **102**, and **103**) according to the embodiment of the present invention.

[0183] FIG. **17** is a perspective view schematically showing a mobile type (or note-type) personal computer **1100** as the electronic apparatus according to the embodiment.

[0184] As shown in FIG. **17**, the personal computer **1100** is configured by a main body portion **1104** which includes a keyboard **1102** and a display unit **1106** which includes a display portion **1108**, and the display unit **1106** is supported so as to rotate via a hinge structure with respect to the main body portion **1104**.

[0185] The electronic device **100** is built in the above-described personal computer **1100**.

[0186] FIG. **18** is a perspective view schematically showing a portable phone **1200** (which also includes PHS) as the electronic apparatus according to the embodiment.

[0187] As shown in FIG. **18**, the portable phone **1200** includes a plurality of operation buttons **1202**, an ear piece **1204**, and a mouth piece **1206**, and a display portion **1208** is disposed between the operation buttons **1202** and the ear piece **1204**.

[0188] The electronic device **100** (or any one of **101**, **102**, and **103**) is built in the above-described portable phone **1200**.

[0189] FIG. **19** is a perspective view schematically showing a digital still camera **1300** as the electronic apparatus according to the embodiment. Moreover, FIG. **19** also shows the connection with external equipment in a simplified manner.

[0190] Here, in a general camera, a silver salt photographic film is exposed by the light image of a subject. On the other hand, in the digital still camera **1300**, the light image of the subject is photo-electrically converted by an imaging element such as Charge Coupled Device (CCD), and imaging signals (image signals) are generated.

[0191] A display portion **1310** is provided on the rear surface of a case (body) **1302** in the digital still camera **1300** and configured so as to perform display based on imaging signals by the CCD, and the display portion **1310** functions as a finder which displays the subject as electronic images.

[0192] In addition, a light receiving unit **1304**, which includes optical lenses (an imaging optical system), the CCD, and the like, is provided on the front surface side (the rear surface side in the drawing) of the case **1302**.

[0193] If a photographer confirms the subject image which is displayed on the display portion **1310** and presses a shutter button **1306**, the imaging signals of the CCD at that time is transmitted and stored to a memory **1308**.

[0194] Moreover, in the digital still camera **1300**, a video signal output terminal **1312** and an input and output terminal for data communication **1314** are provided on the side surface of the case **1302**. In addition, if necessary, a television monitor **1430** is connected to the video signal output terminal **1312** and a personal computer **1440** is connected to the input and output terminal for data communication **1314**. Moreover, the imaging signals which are stored in the memory **1308** are output to the television monitor **1430** or the personal computer **1440** according to a predetermined operation.

[0195] The electronic device **100** is built in the above-described digital still camera **1300**.

[0196] The above-described electronic apparatuses **1100**, **1200**, and **1300** can include the electronic device **100** having improved reliability.

[0197] Moreover, for example, the electronic apparatus which includes the above-described electronic device **100** (or any one of **101**, **102**, and **103**) may be applied to an ink jet type ejecting apparatus (for example, an ink jet printer), a laptop type personal computer, a television, a video camera, a video tape recorder, various navigation apparatuses, a pager, an electronic organizer (with a communication function), an electronic dictionary, an electronic calculator, an electronic game machine, a head mount display, a word processor, a work station, a videophone, a television monitor for crime prevention, an electronic binoculars, a POS terminal, a medical device (for example, an electronic thermometer, a sphygmomanometer, a blood sugar meter, an electrocardiogram measurement device, ultrasonic diagnostic device, an electronic endoscope), a fish-finder, a various measurement devices, meters (for example, meters of a vehicle, an airplane, a rocket, and a ship), an attitude control of a robot, a human body, or the like, a flight simulator, or the like, in addition to the personal computer (mobile type personal computer) shown in FIG. **17**, the portable phone shown in FIG. **18**, and the digital still camera shown in FIG. **19**.

4. Moving Body

[0198] FIG. **20** is a view (a top view) showing an example of a moving body of the embodiment. A moving body **400** shown in FIG. **20** is configured so as to include the electronic device **100** (or any one of **101**, **102**, and **103**) according to the embodiment of the invention. Moreover, the moving body of the embodiment may be configured so as to omit or modify a portion of components (each portion) of FIG. **20**, and to add other components.

[0199] In the above-described moving body **400**, a plurality of physical quantity sensors such as a gyro sensor or an acceleration sensor are mounted on a navigation system or the like and perform controls which are required in the movement of the moving body, and thus, high reliability is needed.

[0200] As the electronic device for the moving body, the electronic device **100** (or any one of **101**, **102**, and **103**) of the above-described each embodiment is applied, and thus, high reliability can be secured.

[0201] As the above-described moving body **400**, various moving bodies are considered, and for example, there are an automobile (which also includes an electric automobile), an airplane such as a jet plane or helicopter, a ship, a rocket, an artificial satellite, or the like.

[0202] The above-described embodiments and Modification Examples are examples and are not limited thereto. For example, each embodiment and each Modification Example may be appropriately combined.

[0203] The invention includes configurations which are substantially the same as the configurations described in the embodiments (for example, the configurations in which the function, the method, and the results are the same, or the configurations in which the object and the effects are the same). Moreover, the invention includes configurations in which no essential portions of configurations described in the embodiments are replaced. In addition, the invention includes

configurations which express the same effects as the configurations described in the embodiments, or configurations in which the same object as the configurations described in the embodiments can be achieved. Moreover, the invention includes configurations in which known technologies are added to the configurations described in the embodiments.

[0204] The entire disclosure of Japanese Patent Application Nos. 2012-085863, filed Apr. 4, 2012 and 2013-028186, filed Feb. 15, 2013 are expressly incorporated by reference herein.

What is claimed is:

1. An electronic device comprising:
- a substrate;
- a cover body which is placed above the substrate;
- a first function element which is provided in a first cavity which is formed by the substrate and the cover body; and
- a second function element which is provided in a second cavity which is formed by the substrate and the cover body,
- wherein an inner portion of the first cavity is sealed in a first air pressure atmosphere, and an inner portion of the second cavity is sealed in a second air pressure atmosphere which has a difference of air pressure with respect to the first air pressure atmosphere,
- a first through-hole, which communicates with the first cavity and is blocked by a seal member, is provided in at least one of the substrate and the cover body, and
- the first cavity and the second cavity are isolated from each other by a partition wall portion which is integrally provided to the cover body or the substrate.

2. The electronic device according to claim **1**,
- wherein a second through-hole, which communicates with the second cavity and is blocked by a seal member, is provided in at least one of the substrate and the cover body.

3. The electronic device according to claim **1**,
- wherein the first through-hole does not overlap with the first function element and the second function element in a plan view of the electronic device.

4. The electronic device according to claim **2**,
- wherein the first through-hole and the second through-hole do not overlap with the first function element and the second function element in a plan view of the electronic device.

5. The electronic device according to claim **1**,
- wherein a material of the substrate is glass and a material of the cover body is silicon.

6. The electronic device according to claim **1**,
- wherein the first function element detects physical quantities different from the second function element.

7. A manufacturing method of an electronic device, comprising:
- placing a first function element and a second function element above a substrate;
- placing a cover body on the substrate, accommodating the first function element in a first cavity which is formed by the substrate and the cover body, and accommodating the second function element in a second cavity which is formed by the substrate and the cover body; and
- sealing the first cavity in a first air pressure atmosphere and sealing the second cavity in a second air pressure atmosphere which has a difference of air pressure with respect to the first air pressure atmosphere,
- wherein the first cavity and the second cavity are isolated from each other by a partition wall portion which is integrally provided to the cover body or the substrate.

8. The manufacturing method of an electronic device according to claim **7**,
- wherein a first through-hole which communicates with the first cavity and a second through-hole which communicates with the second cavity are provided in at least one of the substrate and the cover body,
- the sealing includes a first sealing of sealing the first cavity by blocking the first through-hole by a seal member in the first air pressure atmosphere, and a second sealing of sealing the second cavity by blocking the second through-hole by a seal member in the second air pressure atmosphere after the first sealing, and
- the first air pressure atmosphere is air pressure lower than the second air pressure atmosphere.

9. The manufacturing method of an electronic device according to claim **7**,
- wherein a through-hole which communicates with the first cavity is provided in at least one of the substrate and the cover body, and
- the sealing includes a first sealing of sealing the second cavity in the second air pressure atmosphere by performing the placing and the accommodating in the second air pressure atmosphere, and a second sealing of sealing the first cavity by blocking the through-hole by the seal member in the first air pressure atmosphere after the first sealing.

10. The manufacturing method of an electronic device according to claim **9**,
- wherein the second air pressure atmosphere is air pressure lower than the first air pressure atmosphere.

11. The manufacturing method of an electronic device according to claim **9**,
- wherein the second air pressure atmosphere is air pressure higher than the first air pressure atmosphere.

12. The manufacturing method of an electronic device according to claim **7**,
- wherein a material of the substrate is glass and a material of the cover body is silicon.

13. The manufacturing method of an electronic device according to claim **7**,
- wherein the first function element detects physical quantities different from the second function element.

14. An electronic apparatus comprising the electronic device according to claim **1**.

15. An electronic apparatus comprising the electronic device according to claim **2**.

16. An electronic apparatus comprising the electronic device according to claim **3**.

17. An electronic apparatus comprising the electronic device according to claim **4**.

18. A moving body comprising the electronic device according to claim **1**.

19. A moving body comprising the electronic device according to claim **2**.

20. A moving body comprising the electronic device according to claim **3**.

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