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PRESSURE SENSOR AND MANUFACTURING METHOD THEREFOR

Abstract

There is provided a pressure sensor, including a top cover assembly, an upper seat (**120**), and a movable membrane (**200**); each of a top and a bottom of the upper seat (**120**) is provided with an opening, the top cover assembly seals the opening at the top of the upper seat, and the movable membrane (**200**) seals the opening at the bottom of the upper seat (**120**); the top cover assembly, the upper seat (**120**), and the movable membrane (**200**) form a pressure reference chamber (**100**), and the pressure sensor detects a gas pressure on a side of the movable membrane (**200**) away from the top cover assembly based on a state of the movable membrane (**200**); at least one gas guide passage (**510**) is formed at the top cover assembly, and is configured to connect the pressure reference chamber (**100**) to the outside; the top cover assembly includes at least one blocking member (**521**) configured to seal the gas guide passage (**510**); and the blocking member (**521**) seals the gas guide passage (**510**) after being heated to a temperature higher than a preset melting temperature to be at least partially melted and being cooled to solidify. A manufacturing method for a pressure sensor is further provided. The pressure sensor has high manufacturing efficiency, stable structure, and high pressure detection precision.

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Background/Summary

TECHNICAL FIELD
[0001] The present disclosure relates to the field of semiconductor process equipment, and in particular, to a pressure sensor and a manufacturing method for a pressure sensor.
BACKGROUND
[0002] In the semiconductor field, high-precision monitoring of pressure of a process gas is generally required when chips are produced by etching or with other methods, so as to accurately control the pressure and flow of the gas, thereby producing high-quality products.
[0003] However, existing pressure sensors are complicated in manufacturing process and low in manufacturing efficiency, and are usually faced with the problem of decline in precision in use. Therefore, how to provide a pressure sensor structure which has high stability and can be easily manufactured is an urgent technical problem to be solved in the prior art.
SUMMARY
[0004] The present disclosure aims to provide a pressure sensor and a manufacturing method for a pressure sensor, and the pressure sensor has high manufacturing efficiency, stable structure, and high pressure detection precision.
[0005] In order to achieve the above objective, in one aspect of the present disclosure, there is provided a pressure sensor, including a top cover assembly, an upper seat, and a movable membrane, each of a top and a bottom of the upper seat is provided with an opening, the top cover assembly seals the opening at the top of the upper seat, the movable membrane seals the opening at the bottom of the upper seat, the top cover assembly, the upper seat, and the movable membrane form a pressure reference chamber, the pressure sensor is configured to detect a gas pressure on a side of the movable membrane away from the top cover assembly based on a state of the movable membrane, at least one gas guide passage is formed at the top cover assembly, and is configured to connect the pressure reference chamber to the outside, the top cover assembly includes at least one blocking member configured to seal the gas guide passage, wherein, the blocking member seals the gas guide passage after being heated to a temperature higher than a preset melting temperature to be at least partially melted and being cooled to solidify.
[0006] Optionally, the top cover assembly includes a top cover body, which seals the opening at the top of the upper seat, the gas guide passage penetrating through the top cover body along a thickness direction of the top cover body is formed at the top cover body, and the blocking member before melting is disposed on the top cover body and corresponds to the gas guide passage.
[0007] Optionally, a size of a cross section of the gas guide passage at any position is smaller than or equal to a size of a cross section of the gas guide passage at a side of the gas guide passage away

from the movable membrane.

[0008] Optionally, the gas guide passage includes an accommodating hole formed on a top surface of the top cover body, and a through hole penetrating through the top cover body to a bottom surface of the top cover body from a bottom end of the accommodating hole, and a diameter of the accommodating hole is larger than a diameter of the through hole; and the blocking member before melting extends along a direction around an axis of the through hole and is disposed in the accommodating hole.

[0009] Optionally, the gas guide passage further includes a variable-diameter hole connected between the accommodating hole and the through hole, and a diameter of the variable-diameter hole gradually increases along a direction departing from the movable membrane.

[0010] Optionally, a diameter of the gas guide passage gradually increases along a direction departing from the movable membrane, and the blocking member before melting is disposed in the gas guide passage.

[0011] Optionally, the top cover assembly further includes a flow guide member disposed in the gas guide passage; the blocking member before melting is disposed on the flow guide member, and after the blocking member is formed by melting, cooling, and solidifying, the blocking member together with the flow guide member seal the gas guide passage; and the flow guide member is provided with at least one flow guide through hole for connecting the pressure reference chamber to the outside.

[0012] Optionally, the top cover assembly includes a top cover body and a gas absorption assembly disposed on the top cover body, the gas absorption assembly includes a pump housing and a getter disposed in the pump housing, the top cover body is provided with a communication passage which connects the pump housing to the pressure reference chamber, and a bottom end of the pump housing is disposed in the communication passage, wherein [0013] the gas guide passage includes the communication passage and a communication hole penetrating through a sidewall of the bottom end of the pump housing, the pressure reference chamber is communicated with the outside sequentially through the communication passage and the communication hole, the blocking member before melting is disposed on the top cover body and corresponds to the communication hole, and a position of the communication hole is lower than a top surface of the top cover body; and/or [0014] the gas guide passage includes the communication passage and a gap between the bottom end of the pump housing and the top cover body, the pressure reference chamber is communicated with the outside sequentially through the communication passage and the gap, and the blocking member before melting is disposed outside the pump housing and on the top cover body.

[0015] Optionally, a material of the blocking member includes at least one of tin, aluminum, or silver; and a bonding material layer is provided on a surface of the flow guide member and/or an inner wall of the gas guide passage, and a material of the bonding material layer includes at least one of copper or nickel.

[0016] In a second aspect of the present disclosure, there is provided a manufacturing method for a pressure sensor for manufacturing the pressure sensor described above, including: [0017] placing the blocking member before melting at a position corresponding to the gas guide passage; [0018] placing at least one pressure sensor that is not blocked in a process chamber; [0019] vacuumizing the process chamber to make a gas pressure in the process chamber lower than a preset pressure; [0020] heating the process chamber to make a temperature in the process chamber not lower than the preset melting temperature; and [0021] cooling the process chamber to enable the blocking member, which is formed by melting and solidifying the blocking member before melting, to block the gas guide passage.

[0022] Optionally, while vacuumizing the process chamber to make the gas pressure in the process chamber lower than the preset pressure, the manufacturing method further includes heating the process chamber to a first preset temperature, which is lower than the preset melting temperature.

[0023] In the pressure sensor provided in embodiments of the present disclosure, the top cover assembly, the upper seat, and the movable membrane form the pressure reference chamber, the top cover assembly is provided with the gas guide passage capable of connecting the interior of the pressure reference chamber to the outside, and the blocking member is used to seal the gas guide passage after being heated to the temperature higher than the preset melting temperature to be at least partially melted and being cooled to solidify. In this way, only by vacuumizing the pressure reference chamber before the blocking member is mounted and heating and cooling the pressure sensor after the blocking member is mounted, the blocking member formed by being melted and cooled to solidify can block the gas guide passage, so that the interior of the pressure reference chamber can be isolated from the external environment, thereby obtaining the pressure sensor capable of being used for pressure detection. During a manufacturing process of the pressure sensor provided in the present disclosure, there is no need to assemble structures such as a vacuum pump and a copper tube, so that manufacturing efficiency of the pressure sensor is increased. Moreover, compared with an exposed cut-off portion of the copper tube, the structure of blocking the gas guide passage with the blocking member, which can be at least partially melted and cooled to solidify to seal the gas guide passage, in the present disclosure is more stable, so that stability of an overall structure of the pressure sensor is improved, thereby effectively avoiding gas leakage of the pressure reference chamber, and ensuring pressure detection precision of the pressure sensor.
[0024] In addition, a plurality of pressure sensors provided in the present disclosure can be simultaneously subjected to a sealing process on the pressure reference chambers, thereby increasing the manufacturing efficiency of the pressure sensor.

Description

BRIEF DESCRIPTION OF DRAWINGS
[0025] The accompany drawings are intended to provide a further understanding of the present disclosure and constitute a part of the specification. Together with the following specific embodiments, the drawings are used to explain the present disclosure, but do not constitute any limitation to the present disclosure. In the drawings:
[0026] FIG. **1** is a schematic structural diagram of an existing pressure sensor;
[0027] FIG. **2** is a sectional view of the pressure sensor of FIG. **1**;
[0028] FIG. **3** is a schematic diagram illustrating a state after a copper tube of the pressure sensor of FIG. **1** is cut off;
[0029] FIG. **4** is a schematic structural diagram of a pressure sensor according to an embodiment of the present disclosure;
[0030] FIG. **5** is a sectional view of the pressure sensor of FIG. **4**;
[0031] FIG. **6** is a schematic diagram illustrating a principle of a manufacturing method for a pressure sensor according to an embodiment of the present disclosure;
[0032] FIG. **7** is a schematic diagram of structures of a top cover part of a pressure sensor according to an embodiment of the present disclosure;
[0033] FIG. **8** is a partially enlarged view of an area I of FIG. **7**;
[0034] FIG. **9** is a schematic diagram of structures of a top cover part of a pressure sensor according to an embodiment of the present disclosure;
[0035] FIG. **10** is a partially enlarged view of an area II of FIG. **9**;
[0036] FIG. **11** is a schematic diagram of a partial structure of a pressure sensor according to another embodiment of the present disclosure;
[0037] FIG. **12** is a schematic diagram illustrating a principle of blocking a gas guide passage by a melting member of FIG. **11** after the melting member is melted and solidified;
[0038] FIG. **13** is a schematic diagram of a partial structure of a pressure sensor according to

another embodiment of the present disclosure;
[0039] FIG. **14** is a schematic diagram illustrating a principle of blocking a gas guide passage by a melting member of FIG. **13** after the melting member is melted and solidified;
[0040] FIG. **15** is a schematic diagram of a partial structure of a pressure sensor according to another embodiment of the present disclosure;
[0041] FIG. **16** is a schematic diagram illustrating a principle of blocking a gas guide passage by a melting member of FIG. **15** after the melting member is melted and solidified;
[0042] FIG. **17** is a schematic structural diagram of a gas absorption assembly in a pressure sensor according to an embodiment of the present disclosure;
[0043] FIG. **18** is a schematic diagram of a partial structure of a pressure sensor according to another embodiment of the present disclosure; and
[0044] FIG. **19** is a schematic diagram of a partial structure of a pressure sensor according to another embodiment of the present disclosure.
TABLE-US-00001 Reference numerals: 100: pressure reference chamber 110: top cover body 120: upper seat 200: movable membrane 300: pin 400: mounting member 410: inner electrode 510: gas guide passage 511: accommodating hole 512: through hole 513: variable-diameter hole 520: melting member 521: blocking member 530: flow guide member 600: gas absorption assembly 610: pump housing 611: communication hole 620: getter 630: filter screen 700: lower seat
DETAIL DESCRIPTION OF EMBODIMENTS
[0045] The specific embodiments of the present disclosure are described in detail below with reference to the drawings. It should be understood that the specific embodiments described herein are only used to describe and explain the present disclosure, rather than limiting the present disclosure.
[0046] As shown in FIG. **1** and FIG. **2** which are schematic structural diagrams of an existing pressure sensor, the pressure sensor includes a pressure reference chamber **100**, a pin **300**, an inner electrode **410**, and a copper tube **50**, a movable membrane **200** is sealed at a bottom opening of the pressure reference chamber **100**, a top of the pressure reference chamber **100** is sealed by a top cover body **110**, the inner electrode **410** is fixedly disposed in the pressure reference chamber **100** and is spaced apart and parallel to the movable membrane **200**, one end of the pin **300** is connected to the inner electrode **410**, the other end of the pin **300** penetrates through and extends outside the pressure reference chamber **100**, the copper tube **50** is fixedly connected to the top cover body **110** of the pressure reference chamber **100**, one end of the copper tube **50** is communicated with an interior of the pressure reference chamber **100**, and the other end of the copper tube **50** is communicated with the outside.
[0047] Before the pressure sensor is put into use, a gas in the pressure reference chamber **100** needs to be drawn out through the copper tube **50**, so as to generate a low-pressure environment inside the pressure reference chamber **100**; and then the copper tube **50** is cut off, as shown in FIG. **3**, at this time, the pressure reference chamber **100** is completely isolated from the external environment, so that the low pressure inside the pressure reference chamber **100** may be maintained, thereby obtaining the useable pressure sensor.
[0048] When the pressure sensor is placed in an environment to be measured, the movable membrane **200** deforms under the action of a pressure difference between the internal pressure of the pressure reference chamber **100** and an external pressure, so that a distance between the movable membrane **200** and the inner electrode **410** is changed. The higher the external pressure is, the smaller the distance between the movable membrane **200** and the inner electrode **410** is; and the lower the external pressure is, the larger the distance between the movable membrane **200** and the inner electrode **410** is, so that a capacitance value of a capacitor structure formed by the movable membrane **200** and the inner electrode **410** is correspondingly changed. At this time, a detection circuit is electrically connected to the inner electrode **410** through the pin **300**, so that a gas pressure of the environment where the pressure sensor is located may be determined in response to

the change of the capacitance between the movable membrane **200** and the inner electrode **410**, thereby performing a pressure detection function.

[0049] However, it is found through research that a cut-off portion of the copper tube **50** of the pressure sensor which is put into use is exposed to the outside and has a thin tube wall, such that the cut-off portion of the copper tube **50** becomes the risk of gas leakage. The copper tube **50** only functions in a vacuumizing step, which causes material waste. Moreover, a manufacturing process of the copper tube **50** is complicated. For example, a through hole needs to be made in advance at the top cover body **110**, the copper tube **50** is welded on the top cover body **110**, the pressure sensor is heated at a high temperature to raise a temperature of the pressure sensor to hundreds of degrees Celsius, and a top end of the copper tube **50** is connected to a vacuum pump, the pressure reference chamber **100** is vacuumized with the vacuum pump to quickly reduce the pressure of the pressure reference chamber **100** to a relative low pressure value, and then the copper tube **50** is cut off and sealed. In the prior art, the above procedures of connecting to the vacuum pump, vacuumizing, cutting off, and sealing are generally required to be sequentially performed on each pressure sensor, so that the pressure sensor products have to be processed one by one, which consumes a large amount of production time. In addition, if the cutting-off and sealing procedures of the copper tube **50** fail, it is difficult to perform a secondary repair on the pressure sensor product, resulting in an increase in manufacturing cost of the pressure sensor.

[0050] In order to solve the above technical problem, in one aspect of the present disclosure, there is provided a pressure sensor. As shown in FIG. **4** and FIG. **5**, the pressure sensor includes a top cover assembly (including a top cover body **110** and some structures disposed thereon), an upper seat **120**, and a movable membrane **200**, each of a top and a bottom of the upper seat **120** is provided with an opening, the top cover assembly seals the opening at the top of the upper seat **120**, the movable membrane **200** seals the opening at the bottom of the upper seat **120**, and the top cover assembly, the upper seat **120**, and the movable membrane **200** form a pressure reference chamber **100**. The pressure sensor is configured to detect a gas pressure on a side of the movable membrane **200** away from the top cover assembly based on a state of the movable membrane **200**. Specifically, the higher the pressure outside the pressure reference chamber **100** is, the more the movable membrane **200** is recessed; and the lower the pressure outside the pressure reference chamber **100** is, the less the movable membrane **200** is recessed, so that the pressure sensor may detect the gas pressure on the side of the movable membrane **200** away from the top cover assembly based on the change of the movable membrane **200**.

[0051] As shown in FIG. **9**, at least one gas guide passage **510** is formed at the top cover assembly, and is configured to connect the pressure reference chamber **100** to the outside. The top cover assembly includes at least one blocking member **521** configured to seal the gas guide passage **510**. As shown in FIG. **7** to FIG. **10**, the blocking member **521** seals the gas guide passage **510** after (a melting member **520**) being heated to a temperature higher than a preset melting temperature to be at least partially melted and being cooled to solidify.

[0052] In the pressure sensor provided in the present disclosure, the top cover assembly is provided with the gas guide passage **510** capable of connecting an interior of the pressure reference chamber **100** to the outside, the melting member **520** is melted (or partially melted) at a high temperature and is then cooled to solidify to form the blocking member **521**, and the gas guide passage **510** is sealed with the blocking member **521**. Thus, only by vacuumizing the pressure reference chamber **100** before the blocking member **521** is formed and heating and cooling the pressure sensor, the melting member **520** can be melted and cooled to solidify to form the blocking member **521** to seal the gas guide passage **510**, so that the interior of the pressure reference chamber **100** can be isolated from the external environment, thereby obtaining the pressure sensor capable of being used for pressure detection. The manufacturing process of the pressure sensor provided in the present disclosure obviates the need to assemble structures such as the vacuum pump and the copper tube, so that manufacturing efficiency of the pressure sensor is increased. Moreover, compared with the exposed cut-off portion of the copper tube, the structure of sealing the gas guide passage **510** with the blocking member **521** formed by melting and cooling to solidify the melting member **520** in the present disclosure is more stable, so that stability of an overall structure of the pressure sensor is improved, thereby effectively avoiding gas leakage of the pressure reference chamber **100**, and ensuring pressure detection precision of the pressure sensor.

[0053] In addition, a plurality of pressure sensors provided in the present disclosure may be simultaneously subjected to a sealing process on the pressure reference chambers **100** (that is, the manufacturing processes of the plurality of pressure sensors may be completed at the same time). Specifically, as shown in FIG. **6**, the plurality of pressure sensors (with unmelted melting members **520**) provided in the present disclosure may be placed in the same process chamber, the process chamber is vacuumized to make a gas pressure in the process chamber to be lower than a preset pressure, and is heated to raise a temperature inside the process chamber to the preset melting temperature, and then the process chamber is cooled, thereby enabling the melting members **520** in the plurality of pressure sensors to solidify to form the blocking members **521** to block the corresponding gas guide passages **510**. In this way, the plurality of pressure sensors provided in the present disclosure can be manufactured in the same process, which greatly increases the manufacturing efficiency of the pressure sensor.

[0054] In an alternative embodiment of the present disclosure, the pressure sensor may sense a change of the movable membrane **200** based on an equivalent capacitor structure. Specifically, as shown in FIG. **4** and FIG. **5**, the pressure sensor further includes a pin **300** and an inner electrode **410**, one end of the pin **300** is connected to the inner electrode **410**, and the other end of the pin penetrates through and extends out of the pressure reference chamber **100** and is configured to be connected to a detection circuit (not shown), so that the detection circuit may determine a gas pressure of an environment where the pressure sensor is located in response to a change of capacitance between the movable membrane **200** and the inner electrode **410**. That is, with a position of the inner electrode **410** unchanged, as the pressure outside the pressure reference chamber **100** becomes higher, a distance between the movable membrane **200** and the inner electrode **410** is reduced, and the capacitance between the movable membrane **200** and the inner electrode **410** is accordingly increased; conversely, as the pressure outside the pressure reference chamber **100** becomes lower, the distance between the movable membrane **200** and the inner electrode **410** is increased, and the capacitance between the movable membrane **200** and the inner electrode **410** is accordingly reduced. Therefore, the detection circuit may determine the gas pressure on the side of the movable membrane **200** away from the top cover assembly according to a value of the capacitance.

[0055] In a preferred embodiment of the present disclosure, as shown in FIG. **4** and FIG. **5**, the pressure sensor further includes a lower seat **700**, a top of the lower seat **700** is hermetically connected to the bottom of the upper seat **120**, a dispersion groove corresponding to a position of the movable membrane **200** is formed on a top surface of the lower seat **700**, a connecting pipe is provided at a bottom of the lower seat **700**, and a through hole communicated with connecting pipe is formed at a bottom of the dispersion groove. In this way, with no need to be disposed in a gas environment to be measured, the pressure sensor may be remotely connected to the gas environment to be measured through the connecting pipe.

[0056] For example, a process chamber which is to be subjected to gas pressure detection may be connected to the connecting pipe of the lower seat **700** through a pipeline, which allows the gas pressure on the side of the movable membrane **200** away from the top cover assembly to be the same as a gas pressure in the to-be-measured process chamber, and then the gas pressure of the to-be-measured gas environment may be remotely detected with the pressure sensor. In this way, difficulty in wiring of the pressure sensor can be reduced, a contact area of the pressure sensor with the to-be-measured gas environment can also be reduced, and service life of the pressure sensor can be prolonged.

[0057] In an alternative embodiment of the present disclosure, as shown in FIG. **4** and FIG. **5**, the top cover assembly includes the top cover body **110**, which seals the opening at the top of the upper seat **120**, the gas guide passage **510** penetrating through the top cover body **110** along a thickness direction of the top cover body **110** is formed at the top cover body **110**, and the blocking member **521** before melting (i.e., the melting member **520**) is disposed on the top cover body **110** and corresponds to the gas guide passage **510**.
[0058] In an alternative embodiment of the present disclosure, the top cover body **110** is welded to the upper seat **120** to ensure airtightness of the pressure reference chamber **100**.
[0059] In order to ensure structural strength of the pressure reference chamber **100**, in a preferred embodiment of the present disclosure, the top cover body **110**, the upper seat **120**, and the movable membrane **200** are all made of metal materials.
[0060] It should be noted that the number of gas guide passages **510** may be more than one, so as to increase pumping efficiency during the vacuumizing. In order to ensure sealing property of the pressure reference chamber **100**, the number of opening structures at the top cover body **110** needs to be as less as possible. For example, as shown in FIG. **4**, preferably, only one gas guide passage **510** is provided at the top cover assembly.
[0061] In a preferred embodiment of the present disclosure, as shown in FIG. **4** and FIG. **5**, the top cover assembly further includes a gas absorption assembly **600** disposed on the top cover body **110**. As shown in FIG. **18**, the gas absorption assembly **600** includes a pump housing **610** and a getter **620** disposed in the pump housing **610**, a communication passage for connecting the pump housing **610** to the pressure reference chamber **100** is formed at the top cover body **110**, and a bottom end of the pump housing **610** is disposed in the communication passage and is communicated with the interior of the pressure reference chamber **100**. The getter **620** is capable of continuously absorbing a gas from the pressure reference chamber **100**, so as to maintain a low pressure state inside the pressure reference chamber **100**. In an alternative embodiment of the present disclosure, as shown in FIG. **18**, a horizontal filter screen **630** is provided in the pump housing **610** for preventing the getter from falling into the pressure reference chamber **100**.
[0062] In an alternative embodiment of the present disclosure, as shown in FIG. **5**, a mounting member **400** made of an insulating material is disposed in the pressure reference chamber **100**, the mounting member **400** is provided with an outward-protruding annular boss therearound, an inner wall of the upper seat **120** is provided with an inward-protruding annular boss which surrounds the mounting member **400**, and the annular boss of the mounting member **400** is mounted on the annular boss of the upper seat **120**. The inner electrode **410** is disposed on a bottom surface of the mounting member **400**. For example, the inner electrode **410** may be a metal plating layer formed on the bottom surface of the mounting member **400**.
[0063] Optionally, a conductive through hole penetrating through the mounting member **400** along a height direction is formed in the mounting member **400**, metal layers are formed on a top surface of the mounting member **400** and an inner wall of the conductive through hole, the metal layer on the top surface of the mounting member **400** is electrically connected to the inner electrode **410** through the metal layer on the inner wall of the conductive through hole, and the pin **300** is electrically connected to the metal layer on the top surface of the mounting member **400**.
[0064] In order to ensure a sealing effect of the melted melting member **520** on blocking the gas guide passage **510**, in a preferred embodiment of the present disclosure, the gas guide passage **510** is a non-straight hole, and a size of a cross section of the gas guide passage **510** at any position is smaller than or equal to a size of a cross section of the gas guide passage **510** at a side of the gas guide passage **510** away from the movable membrane **200**, that is, the size of the cross section of the gas guide passage **510** at any one position of the gas guide passage **510** is smaller than or equal to a size of a cross section of the gas guide passage **510** at another position above the any one position. That is, a diameter of the gas guide passage **510** tends to decrease from top to bottom, so as to ensure that a flow direction of the melted melting member **520** is a downward direction along

the gas guide passage **510**, and prevent the melted melting member **520** from dispersively flowing on the top cover body **110**, thereby ensuring that the melting member **520** can block the gas guide passage **510**. Moreover, with the diameter of the gas guide passage **510** reduced at the bottom, when the melted melting member **520** flows downwards, surface tension of a bottom liquid surface can be effectively increased, so that the melted melting member **520** can be effectively prevented from passing through the gas guide passage **510** and falling into the pressure reference chamber **100**, thereby ensuring the sealing effect of the melted melting member **520** on blocking the gas guide passage **510**.

[0065] In a preferred embodiment of the present disclosure, the minimum diameter of the gas guide passage **510** is less than 2 mm, so as to ensure that the surface tension of the bottom liquid surface is large enough when the melting member **520** flows to a position corresponding to the minimum diameter, thereby positioning the liquid melting member **520** in the gas guide passage **510**.

[0066] In some embodiments of the present disclosure, the melting member **520** may be directly disposed on the top cover body **110** at a position corresponding to the gas guide passage **510**.

[0067] In order to ensure stability of a position of the melting member **520**, in a preferred embodiment of the present disclosure, as shown in FIG. **11** and FIG. **12**, the gas guide passage **510** includes an accommodating hole **511** formed on a top surface of the top cover body **110**, and a through hole **512** penetrating through the top cover body **110** to a bottom surface of the top cover body **110** from a bottom end of the accommodating hole **511**, and a diameter of the accommodating hole **511** is larger than that of the through hole **512**. The blocking member **521** before melting (i.e., the melting member **520**) extends along a direction around an axis of the through hole **512** and is disposed in the accommodating hole **511**. For example, the accommodating hole **511** and the through hole **512** are sequentially connected to each other from the top surface of the top cover body **110** to the bottom surface of the top cover body **110**, that is, one end of the accommodating hole **511** is located at the top surface of the top cover body **110**, the other end of the accommodating hole **511** is communicated with one end of the through hole **512**, and the other end of the through hole **512** is located at the bottom surface of the top cover body **110**.

[0068] In the embodiments of the present disclosure, the melting member **520** is disposed in the accommodating hole **511** with the maximum diameter, so that a shift in the position of the melting member **520** can be avoided, thereby improving the stability of the position of the melting member **520**. Moreover, the melting member **520** is bent and extends along the direction around the axis of the through hole **512**, so that an orthographic projection of the melting member **520** on a radial section of the through hole **512** can avoid the through hole **512** with the minimum diameter, which can prevent the gas when being blown out through the through hole **512** in the vacuumizing step from changing the position of the melting member **520** and thus avoid an influence on smoothness of the melting member **520** flowing into the through hole **512**.

[0069] In some embodiments of the present disclosure, the melting member **520** may be a sheet-like member, or may be a curved strip-like member. For example, the melting member **520** may be a curved C-shaped member around the axis of the through hole **512**. In order to improve circumferential uniformity of a force applied between the melting member **520** and the gas guide passage **510** to ensure the stability of the position of the melting member **520**, in a preferred embodiment of the present disclosure, a shape of the blocking member **521** before melting (i.e., the melting member **520**) is a ring shape.

[0070] In order to improve the smoothness of the melted melting member **520** flowing downwards along the gas guide passage **510**, in a preferred embodiment of the present disclosure, as shown in FIG. **7**, FIG. **8**, and FIG. **10**, the gas guide passage **510** further includes a variable-diameter hole **513** connected between the accommodating hole **511** and the through hole **512**. A diameter of the variable-diameter hole **513** gradually increases along a direction departing from the movable membrane **200**, so as to make transition between the accommodating hole **511** and the through hole **512** smoother and improve the smoothness of the melted melting member **520** flowing along the accommodating hole **511**, the variable-diameter hole **513**, and the through hole **512**, thereby ensuring the sealing effect of the melted melting member **520** on blocking the gas guide passage **510**.

[0071] In another preferred embodiment of the present disclosure, as shown in FIG. **13** to FIG. **16**, the diameter of the gas guide passage **510** gradually increases along a direction departing from the movable membrane **200**, and the blocking member **521** before melting (i.e., the melting member **520**) is disposed in the gas guide passage **510**, that is, the diameter of the gas guide passage **510** is gradually changed along a height direction, so as to reduce structures such as edges or steps on an inner wall of the gas guide passage **510**, thereby improving the smoothness of the melted melting member **520** flowing downwards along the gas guide passage **51**, and ensuring the sealing effect of the melted melting member **520** on blocking the gas guide passage **510**.

[0072] In some embodiments of the present disclosure, as shown in FIG. **13** and FIG. **14**, a rate of a change of the diameter of the gas guide passage **510** with a height (the amount of the change of the diameter per fixed height change) is unchanged, that is, the gas guide passage **510** is formed into a tapered hole.

[0073] Or, in some embodiments of the present disclosure, the rate of the change of the diameter of the gas guide passage **510** with the height varies along the height direction. For example, as shown in FIG. **15** and FIG. **16**, the rate of the change of the diameter of the gas guide passage **510** with the height may first decrease and then increase, so that a variable-diameter hole having a longitudinal section with an S-shaped profile is formed.

[0074] In order to enhance strength of connection between the melting member **520** and the inner wall of the gas guide passage **510** to ensure a sealing effect of the melting member **520** on the pressure reference chamber **100**, in a preferred embodiment of the present disclosure, an inner surface of the gas guide passage **510** may be processed to enlarge a surface area. For example, internal threads or a structure approximate to the threads may be formed on the inner wall of the gas guide passage **510**, or the inner wall of the gas guide passage **510** may be subjected to a frosting process or a surface corrosion process, so as to increase a surface area of the inner wall of the gas guide passage **510**, thereby increasing a contact area of the inner wall of the gas guide passage **510** with the melting member **520**, improving strength of connection between the melting member **520** and the top cover body **110**, and ensuring the sealing effect of the melting member **520** on the pressure reference chamber **100**.

[0075] In order to further ensure the sealing effect of the melted melting member **520** on blocking the gas guide passage **510**, in a preferred embodiment of the present disclosure, as shown in FIG. **17**, the top cover assembly further includes a flow guide member **530** disposed in the gas guide passage **510**. The blocking member **521** before melting (i.e., the melting member **520**) is disposed on the flow guide member **530**; and after the melting member **520** is melted and cooled to solidify to form the blocking member **521**, the blocking member **521** together with the flow guide member **530** seal the gas guide passage **510**. The flow guide member **530** is provided with at least one flow guide through hole for connecting the pressure reference chamber **100** to the outside.

[0076] In the embodiments of the present disclosure, the top cover body **110** of the pressure reference chamber **100** is further provided with the flow guide member **530**, and while guiding the flow of the melted melting member **520**, the flow guide member **530** together with the melted melting member **520** seal the gas guide passage **510**. Therefore, combination performance and connection strength of the melting member **520** and the gas guide passage **510** can be improved through the flow guide member **530**, thereby ensuring the sealing effect of the melted melting member **520** on blocking the gas guide passage **510**.

[0077] In addition, the flow guide member **530** may support the blocking member **521** before melting (i.e., the melting member **520**), so as to prevent the melting member **520** from completely blocking the gas guide passage **510**, thereby enabling the gas to successfully flow out from the pressure reference chamber **100**.

[0078] In a preferred embodiment of the present disclosure, the flow guide member **530** is provided with a plurality of flow guide through holes. For example, the flow guide member **530** may be formed into a porous part such as a mesh-like porous part, so as to prevent the melting member **520** from falling into the pressure reference chamber **100** while ensuring that the gas may smoothly flow out from the pressure reference chamber **100**. Moreover, after the melting member **520** is melted, the porous flow guide member **530** can provide greater surface tension to prevent the liquid melting member **520** from flowing into the pressure reference chamber **100** below. In addition, the porous flow guide member **530** can form stable bonding relationship with the melting member **520** after the melting member **520** solidifies, thereby improving product reliability.
[0079] In order to improve manufacturing flexibility of the pressure sensor, in a preferred embodiment of the present disclosure, before the melting member **520** is melted, the flow guide member **530** is fixedly connected to the top cover body **110** in advance, or the flow guide member **530** is fixedly connected to the melting member **520** in advance.
[0080] For example, the flow guide member **530** may be first combined with the gas guide passage **510** (for example, the gas guide passage **510** and the flow guide member **530** are welded together by brazing), and after the melting member **520** is melted and cooled to solidify to form the blocking member **521**, the blocking member **521** is combined with the flow guide member **530** and the gas guide passage **510**.
[0081] Or, the flow guide member **530** may be first combined with the melting member **520** (for example, a small part of the blocking member **521** is first melted and solidified, and then welded together with the flow guide member **530**), and then the melting member **520** is combined with the flow guide member **530** and the gas guide structure **510** after being melted.
[0082] It should be noted that, since the pressure sensor needs to be degassed (i.e., the vacuumizing process) at a high temperature, the preset melting temperature of the melting member **520** cannot be too low, and generally needs to be higher than 200° C. (Celsius); moreover, the melting temperature of the melting member **520** cannot be too high, otherwise the manufacturing cost of the pressure sensor is increased due to the over-high melting temperature (supporting equipment for the pressure sensor, such as a temperature measuring member, needs to be replaced to resist higher temperatures), and the other parts in the pressure sensor is prone to be damaged. In general, the melting temperature needs to be lower than 800° C.
[0083] For example, in an alternative embodiment of the present disclosure, a material of the blocking member **521** before melting (i.e., the melting member **520**) may include at least one metal material with a low melting point, such as tin, aluminum, or silver. Or, the material of the blocking member **521** before melting (i.e., the melting member **520**) may include a non-metallic material with a low melting point, such as glass.
[0084] In order to further ensure the sealing effect of the melted melting member **520** on blocking the gas guide passage **510**, in a preferred embodiment of the present disclosure, a material film layer having good weldability and sealing property relative to the melting member may be disposed on a surface of the flow guide member **530** or the inner wall of the gas guide passage **510**, so as to expand a selection range of the material of the melting member **520** while ensuring the effect of the melting member **520** on blocking the gas guide passage **510**. Specifically, a bonding material layer is provided on the surface of the flow guide member **530** and/or the inner wall of the gas guide passage **510**, and a material of the bonding material layer includes at least one of copper or nickel.
[0085] In an alternative embodiment of the present disclosure, the bonding material layer may be attached to the surface of the flow guide member **530** and/or the inner wall of the gas guide passage **510** by electroplating.
[0086] In order to save material cost and improve sealing performance of the pressure reference chamber **100**, in a preferred embodiment of the present disclosure, the gas guide passage **510** corresponding to the melting member **520** may be a through hole structure at the top cover body **110** which corresponds to another component on the top cover body **110** or a through hole structure

of another component mounted on the top cover body **110**.

[0087] For example, as shown in FIG. **19**, the gas guide passage includes a communication passage and a gap between the bottom end of the pump housing **610** and the top cover body **110**, and the pressure reference chamber **100** may be communicated with the outside sequentially through the communication passage and the gap. The blocking member **521** before melting (i.e., the melting member **520**) is disposed outside the pump housing **610** and on the top cover body **110**.

[0088] In the embodiments of the present disclosure, the gas absorption assembly **600** is communicated with the interior of the pressure reference chamber **100** through the gap between the bottom end of the pump housing **610** and the top cover body **110**. During the vacuumizing process, the gas may be drawn out through the gap between the bottom end of the pump housing **610** and the top cover body **110**. Then, the melting member **520** is melted and is solidified to form the blocking member **521**, and the blocking member **521** blocks the gap between the bottom end of the pump housing **610** and a sidewall of the gas guide passage **510**, thereby sealing the pressure reference chamber **100**.

[0089] In order to improve smoothness of the gas flowing out from pressure reference chamber **100** during the vacuumizing step, in a preferred embodiment of the present disclosure, as shown in FIG. **19**, the gas guide passage **510** further includes a communication hole **611** penetrating through a sidewall of the pump housing **610** and located close to the bottom end of the pump housing **610**, and the sidewall of the pump housing **610** is provided with the communication hole **611** which penetrates through the sidewall of the pump housing **610** along a thickness direction. The pressure reference chamber **100** may be communicated with the outside sequentially through the communication passage and the communication hole **611**, and may be communicated with the outside sequentially through the communication passage and the gap between the bottom end of the pump housing **610** and the top cover body **110**. The blocking member **521** before melting (i.e., the melting member **520**) is disposed on the top cover body **110** and corresponds to the communication hole, and a position of the communication hole is lower than the top surface of the top cover body.

[0090] Or, the bottom end of the pump housing **610** may be fixedly connected to the top cover body **110** in advance (for example, the bottom end of the pump housing **610** and the top cover body **110** are welded together), that is, there is no gap between the bottom end of the pump housing **610** and the top cover body **110**. The gas guide passage **510** only includes a communication passage and a communication hole **611** penetrating through a sidewall of the pump housing **610** and located close to the bottom end of the pump housing **610**. The pressure reference chamber **100** may be communicated with the outside sequentially through the communication passage and the communication hole **611**. The blocking member **521** before melting (i.e., the melting member **520**) is disposed on the top cover body **110** and corresponds to the communication hole, and a position of the communication hole is lower than the top surface of the top cover body.

[0091] In a second aspect of the present disclosure, there is provided a manufacturing method for a pressure sensor, including: [0092] step S1, placing the blocking member **521** before melting (i.e., the melting member **520**) at a position corresponding to the gas guide passage **510**; [0093] step S2, placing at least one pressure sensor provided in the present disclosure in a process chamber; [0094] step S3, vacuumizing the process chamber to make a gas pressure in the process chamber lower than a preset pressure; [0095] step S4, heating the process chamber to make a temperature in the process chamber not lower than a preset melting temperature; and [0096] step S5, cooling the process chamber to enable the blocking member **521**, which is formed by the melted melting member **520** after the melted melting member **520** solidifies, to block the corresponding gas guide passage.

[0097] In the manufacturing method for the pressure sensor provided in the present disclosure, the top cover assembly of the pressure sensor is provided with the gas guide passage **510** capable of connecting an interior of the pressure reference chamber **100** to the outside, the melting member **520** placed at the position corresponding to the gas guide passage **510** is heated to be at least partially melted, and the melting member **520** which is at least partially melted is cooled to solidify to seal the gas guide passage **510**. In this way, only by vacuumizing the pressure reference chamber **100** before the blocking member **521** is formed and heating and cooling the pressure sensor, the melting member **520** can be melted and cooled to solidify to form the blocking member **521** to seal the gas guide passage **510**, so that the interior of the pressure reference chamber **100** can be isolated from the external environment, thereby obtaining the pressure sensor capable of being used for pressure detection. During the manufacturing process of the pressure sensor provided in the present disclosure, there is no need to assemble structures such as the vacuum pump and the copper tube, so that manufacturing efficiency of the pressure sensor is increased. Moreover, compared with the exposed cut-off portion of the copper tube, the structure of sealing the gas guide passage **510** with the blocking member **521** formed by melting and cooling to solidify the melting member **520** in the present disclosure is more stable, so that stability of an overall structure of the pressure sensor is improved, thereby effectively avoiding gas leakage of the pressure reference chamber **100**, and ensuring pressure detection precision of the pressure sensor.

[0098] Furthermore, with the manufacturing method for the pressure sensor provided in the present disclosure, a plurality of pressure sensors can be simultaneously subjected to a sealing process on the pressure reference chambers **100**, and the plurality of pressure sensors can be manufactured in the same process, thereby greatly increasing the manufacturing efficiency of the pressure sensor.

[0099] Optionally, while vacuumizing the process chamber to make the gas pressure in the process chamber lower than the preset pressure, the manufacturing method further includes heating the process chamber to a first preset temperature, which is lower than the preset melting temperature. That is, the pressure sensor is preliminarily heated, but it needs to be ensured that the melting member **520** is not melted, so as to prevent the gas guide passage **510** from being blocked early. Optionally, the first preset temperature may be from 200° C. to 300° C.

[0100] Optionally, as shown in FIG. **6**, the process chamber includes a chamber body **10**, a heater **20**, and a vacuum pump **30**. The heater **20** is disposed in the chamber body **10**, and is configured to heat a pressure sensor in the chamber body **10** (for example, the heater **20** may heat the pressure sensor by means of infrared light irradiation). The vacuum pump **30** is disposed on an exhaust pipe of the chamber body **10**, and is configured to vacuumize the process chamber (i.e., to draw out a gas from the chamber body **10**).

[0101] In a third aspect of the present disclosure, there is provided a semiconductor process apparatus, including a detection circuit and the pressure sensor provided in the present disclosure. The detection circuit is connected to the pin of the pressure sensor, and is configured to determine a gas pressure of an environment where the pressure sensor is located in response to a change of capacitance between the movable membrane **200** and the inner electrode **410** of the pressure sensor.

[0102] In the semiconductor process apparatus provided in the present disclosure, the top cover body **110** of the pressure reference chamber **100** of the pressure sensor is provided with the gas guide passage **510** which penetrates through the top cover body **110** along a thickness direction, and the melting member **520** is melted and solidified to form the blocking member **521** in the gas guide passage **510** to block the gas guide passage **510**, thereby improve stability of an overall structure of the pressure sensor, effectively avoiding gas leakage of the pressure reference chamber **100**, and ensuring pressure detection precision of the pressure sensor. Moreover, a plurality of pressure sensors can be manufactured simultaneously, thereby increasing manufacturing efficiency of the pressure sensor.

[0103] It should be understood that the above embodiments are merely exemplary embodiments adopted to illustrate the principle of the present disclosure, and the present disclosure is not limited thereto. Various modifications and improvements can be made by those of ordinary sill in the art without departing from the spirit and essence of the present disclosure, and those modifications and improvements are also considered to fall within the scope of the present disclosure.

Claims

1. A pressure sensor, comprising a top cover assembly, an upper seat, and a movable membrane, wherein each of a top and a bottom of the upper seat is provided with an opening, the top cover assembly seals the opening at the top of the upper seat, the movable membrane seals the opening at the bottom of the upper seat, the top cover assembly, the upper seat, and the movable membrane form a pressure reference chamber, the pressure sensor is configured to detect a gas pressure on a side of the movable membrane away from the top cover assembly based on a state of the movable membrane, wherein, at least one gas guide passage is formed at the top cover assembly, and is configured to connect the pressure reference chamber to the outside, the top cover assembly comprises at least one blocking member configured to seal the gas guide passage, wherein the blocking member before melting is disposed in the gas guide passage, and the blocking member seals the gas guide passage after being heated to a temperature higher than a preset melting temperature to be at least partially melted and being cooled to solidify.

2. The pressure sensor of claim 1, wherein the top cover assembly comprises a top cover body, which seals the opening at the top of the upper seat, the gas guide passage penetrating through the top cover body along a thickness direction of the top cover body is formed at the top cover body, and the blocking member before melting is disposed on the top cover body and corresponds to the gas guide passage.

3. The pressure sensor of claim 2, wherein a size of a cross section of the gas guide passage at any position is smaller than or equal to a size of a cross section of the gas guide passage at a side of the gas guide passage away from the movable membrane.

4. The pressure sensor of claim 3, wherein the gas guide passage comprises an accommodating hole formed on a top surface of the top cover body, and a through hole penetrating through the top cover body to a bottom surface of the top cover body from a bottom end of the accommodating hole, and a diameter of the accommodating hole is larger than a diameter of the through hole; and the blocking member before melting extends along a direction around an axis of the through hole and is disposed in the accommodating hole.

5. The pressure sensor of claim 4, wherein the gas guide passage further comprises a variable-diameter hole connected between the accommodating hole and the through hole, and a diameter of the variable-diameter hole gradually increases along a direction departing from the movable membrane.

6. The pressure sensor of claim 3, wherein a diameter of the gas guide passage gradually increases along a direction departing from the movable membrane, and the blocking member before melting is disposed in the gas guide passage.

7. The pressure sensor of claim 3, wherein the top cover assembly further comprises a flow guide member disposed in the gas guide passage; the blocking member before melting is disposed on the flow guide member, and after the blocking member is formed by melting, cooling, and solidifying, the blocking member together with the flow guide member seal the gas guide passage; and the flow guide member is provided with at least one flow guide through hole for connecting the pressure reference chamber to the outside.

8. The pressure sensor of claim 1, wherein the top cover assembly comprises a top cover body and a gas absorption assembly disposed on the top cover body, the gas absorption assembly comprises a pump housing and a getter disposed in the pump housing, the top cover body is provided with a communication passage which connects the pump housing to the pressure reference chamber, and a bottom end of the pump housing is disposed in the communication passage, wherein the gas guide passage comprises the communication passage and a communication hole penetrating through a sidewall of the bottom end of the pump housing, the pressure reference chamber is communicated with the outside sequentially through the communication passage and the communication hole, the blocking member before melting is disposed on the top cover body and corresponds to the communication hole, and a position of the communication hole is lower than a top surface of the top cover body; and/or the gas guide passage comprises the communication passage and a gap between the bottom end of the pump housing and the top cover body, the pressure reference chamber is communicated with the outside sequentially through the communication passage and the gap, and the blocking member before melting is disposed outside the pump housing and on the top cover body.

9. The pressure sensor of claim 7, wherein a material of the blocking member comprises at least one of tin, aluminum, or silver; and a bonding material layer is provided on a surface of the flow guide member and/or an inner wall of the gas guide passage, and a material of the bonding material layer comprises at least one of copper or nickel.

10. A manufacturing method for a pressure sensor for manufacturing the pressure sensor of claim 1, comprising: placing the blocking member before melting at a position corresponding to the gas guide passage; placing at least one pressure sensor that is not blocked in a process chamber; vacuumizing the process chamber to make a gas pressure in the process chamber lower than a preset pressure; heating the process chamber to make a temperature in the process chamber not lower than the preset melting temperature; and cooling the process chamber to enable the blocking member, which is formed by melting and solidifying the blocking member before melting, to block the gas guide passage.

11. The manufacturing method of claim 10, wherein, while vacuumizing the process chamber to make the gas pressure in the process chamber lower than the preset pressure, the manufacturing method further comprises heating the process chamber to a first preset temperature, which is lower than the preset melting temperature.

12. The manufacturing method of claim 10, wherein the top cover assembly comprises a top cover body, which seals the opening at the top of the upper seat, the gas guide passage penetrating through the top cover body along a thickness direction of the top cover body is formed at the top cover body, and the blocking member before melting is disposed on the top cover body and corresponds to the gas guide passage.

13. The manufacturing method of claim 12, wherein a size of a cross section of the gas guide passage at any position is smaller than or equal to a size of a cross section of the gas guide passage at a side of the gas guide passage away from the movable membrane.

14. The manufacturing method of claim 13, wherein the gas guide passage comprises an accommodating hole formed on a top surface of the top cover body, and a through hole penetrating through the top cover body to a bottom surface of the top cover body from a bottom end of the accommodating hole, and a diameter of the accommodating hole is larger than a diameter of the through hole; and the blocking member before melting extends along a direction around an axis of the through hole and is disposed in the accommodating hole.

15. The manufacturing method of claim 14, wherein the gas guide passage further comprises a variable-diameter hole connected between the accommodating hole and the through hole, and a diameter of the variable-diameter hole gradually increases along a direction departing from the movable membrane.

16. The manufacturing method of claim 13, wherein a diameter of the gas guide passage gradually increases along a direction departing from the movable membrane, and the blocking member before melting is disposed in the gas guide passage.

17. The manufacturing method of claim 13, wherein the top cover assembly further comprises a flow guide member disposed in the gas guide passage; the blocking member before melting is disposed on the flow guide member, and after the blocking member is formed by melting, cooling, and solidifying, the blocking member together with the flow guide member seal the gas guide passage; and the flow guide member is provided with at least one flow guide through hole for connecting the pressure reference chamber to the outside.

18. The manufacturing method of claim 10, wherein the top cover assembly comprises a top cover body and a gas absorption assembly disposed on the top cover body, the gas absorption assembly comprises a pump housing and a getter disposed in the pump housing, the top cover body is provided with a communication passage which connects the pump housing to the pressure reference chamber, and a bottom end of the pump housing is disposed in the communication passage, wherein the gas guide passage comprises the communication passage and a communication hole penetrating through a sidewall of the bottom end of the pump housing, the pressure reference chamber is communicated with the outside sequentially through the communication passage and the communication hole, the blocking member before melting is disposed on the top cover body and corresponds to the communication hole, and a position of the communication hole is lower than a top surface of the top cover body; and/or the gas guide passage comprises the communication passage and a gap between the bottom end of the pump housing and the top cover body, the pressure reference chamber is communicated with the outside sequentially through the communication passage and the gap, and the blocking member before melting is disposed outside the pump housing and on the top cover body.
19. The manufacturing method of claim 17, wherein a material of the blocking member comprises at least one of tin, aluminum, or silver; and a bonding material layer is provided on a surface of the flow guide member and/or an inner wall of the gas guide passage, and a material of the bonding material layer comprises at least one of copper or nickel.