

PROCESS TANK TEMPERATURE-MEASURING DEVICE AND **SUBSTRATE PROCESSING APPARATUS**

FIELD OF THE INVENTION

The present invention relates to the field of semiconductor wet bench cleaning equipment, and further relates to a process tank temperature-measuring device and a substrate processing apparatus.

BACKGROUND

When a wet bench wafer cleaning equipment is working, it is necessary to monitor the temperature of a chemical solution at different depths inside a process tank in real time, so as to adjust the power of a heater accordingly to achieve closed-loop control of the process temperature. However, there are a lot of strong acid or alkali in the process tank, and an ordinary temperature-measuring probe cannot work for a long time in a strongly corrosive environment. In order to avoid corrosion of the temperature-measuring probe, the existing scheme usually involves wrapping the temperature-measuring probe with a layer of corrosion-resistant material.

Currently, there are two main methods to wrap anti-corrosion material around the probe:

The first method is to sleeve a layer of standard Perfluoroalkoxy (PFA) pipe on the outside of the probe, and then seal off the end that will be immersed in the chemical solution. This method has two disadvantages: 1. Since the PFA pipe is a flexible pipe with weak supportability, this will cause the structure to be easily crushed and leak in the pipeline; 2. Since the end immersed in the chemical solution is a PFA pipe that has undergone subsequent secondary processing, it is easier to cause leakage and corrode the temperature-measuring probe.

The second method is to sleeve a layer of standard quartz straight pipe on the outside of the probe, then seal off the end that will be immersed in the chemical solution, and lead the signal transmission line of the temperature-measuring probe out through a non-standard connector at the other end. This method has two disadvantages: 1. Since

the non-standard connector is positioned directly above the chemical solution tank, acidic or alkaline vapor will invade along the connection between the quartz pipe and the non-standard connector during the production process, thereby corroding the temperature-measuring probe; 2. The processing technology of the non-standard connector is rather complicated, and the processing cost is relatively high.

Therefore, it is necessary to improve the process tank temperature-measuring device of the existing wet bench wafer cleaning equipment to meet the product requirements for a simple structure and strong corrosion resistance.

SUMMARY

In view of the above-described technical problems, the objective of the present invention is to provide a process tank temperature-measuring device having a simple structure and strong corrosion resistance for a substrate processing apparatus. In order to achieve the above objective, the present invention provides a process tank temperature-measuring device and a substrate processing apparatus.

In some embodiments, the above-described process tank temperature-measuring device is used for detecting the temperature of a chemical solution in a process tank. The upper end of the process tank has an opening. The process tank temperature-measuring device comprises: a protective pipe, including a temperature-measuring portion and an extension portion that are sequentially connected and in mutual communication, the end of the temperature-measuring portion away from the extension portion being sealed to form a bottom portion of the protective pipe, the end of the extension portion away from the temperature-measuring portion being opened to form an inlet of the protective pipe, and a preset included angle being formed between the axial direction of the temperature-measuring portion and the axial direction of the extension portion; a temperature-measuring probe, arranged inside the temperature-measuring portion, and positioned at the bottom portion of the protective pipe; wherein, the bottom portion of the protective pipe is configured to be immersed in the chemical solution, so that the temperature-measuring probe detects the temperature of the chemical solution in the process tank, and the inlet of the protective pipe is configured offset from directly above the opening of the process tank.

In some embodiments, the above-described substrate processing apparatus comprises: a process tank, for containing a chemical solution required for a substrate undergoing liquid processing; and the above-described process tank temperature-measuring device.

Compared with the prior art, the process tank temperature-measuring device claimed to be protected by the present application comprises a protective pipe and a temperature-measuring probe. The protective pipe comprises a temperature-measuring portion and an extension portion that are sequentially connected and in mutual communication, the end of the temperature-measuring portion away from the extension portion is sealed to form a bottom portion of the protective pipe, the end of the extension portion away from the temperature-measuring portion is opened to form an inlet of the protective pipe, and a preset included angle is formed between the axial direction of the temperature-measuring portion and the axial direction of the extension portion. The temperature-measuring probe is arranged inside the temperature-measuring portion and is positioned at the bottom portion of the protective pipe. The bottom portion of the protective pipe is configured to be immersed in the chemical solution, so that the temperature-measuring probe detects the temperature of the chemical solution, and the inlet of the protective pipe is configured offset from directly above the opening of the process tank to avoid the inlet of the protective pipe being exposed directly right above the opening of the process tank and being corroded by the chemical solution vapor, thereby preventing the chemical solution from entering the protective pipe and corroding the temperature-measuring probe, and avoiding the erosion of strong acid or strong alkali vapor for a long time. The process tank temperature-measuring device has a simple structure and strong corrosion resistance.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and performance of the present invention are further described by the following embodiments and the accompanying drawings of the embodiments.

FIG. 1 is an embodiment of the process tank temperature-measuring device according to the present invention;

FIG. 2 is an embodiment of the process tank temperature-measuring device

according to the present invention;

FIG. 3A is a three-dimensional structural schematic view of the fixing bracket in the process tank temperature-measuring device according to an embodiment of the present invention;

FIG. 3B is an exploded view of FIG. 3A;

FIG. 4 is an exploded structural view of the process tank temperature-measuring device according to an embodiment of the present invention;

FIG. 5 is a full-section structural view of the process tank temperature-measuring device according to an embodiment of the present invention before assembly;

FIG. 6 is a full-section structural view of the process tank temperature-measuring device according to an embodiment of the present invention after assembly.

PREFERRED EMBODIMENTS OF THE INVENTION

In order to more clearly explain the embodiments of the present invention or the technical solutions in the prior art, specific embodiments of the present invention will be described below with reference to the accompanying drawings. It is obvious that the drawings in the following description are only some embodiments of the present invention, and for those of ordinary skill in the art, other drawings and other embodiments can be obtained from these drawings without making creative efforts.

To simplify the drawings, only the parts related to the invention are schematically shown in each drawing, and the parts do not represent the actual structure of a product. Furthermore, for clarity and ease of understanding of the drawings, in some drawings, only one of the components with the same structure or function is schematically illustrated or marked. Herein, "one" can mean not only "one" but also "more than one."

Herein, it should be noted that unless otherwise clearly specified and defined, terms "mount," "interconnect," and "connect" should be interpreted broadly, for example, the connection can be a fixed connection, a detachable connection, or an integral connection; the connection can be a mechanical connection or an electrical

connection; the connection can be a direct connection, an indirect connection through an intermediate medium, or an internal connection between two elements. For those of ordinary skill in the art, the specific meanings of the above terms in the present invention can be understood according to specific circumstances.

Besides, in the description of the present application, terms such as "first" and "second" are used for distinguishing description only, and should not be construed as indicating or implying relative importance.

As shown in FIG. 1, a process tank temperature-measuring device 200 according to an embodiment of the present invention is disclosed. In actual use, the process tank temperature-measuring device 200 is mounted on a process tank 100 and is used to measure the temperature of a chemical solution in the process tank 100. Specifically, the process tank temperature-measuring device 200 comprises a protective pipe 210 and a temperature-measuring probe 220, wherein one end of the protective pipe 210 is positioned in the process tank 100, and the other end of the protective pipe 210 is positioned outside the process tank 100. The temperature-measuring probe 220 is disposed inside the protective pipe 210 and is positioned at the end of the protective pipe 210 in the process tank 100, so as to detect the temperature of the chemical solution in the process tank 100.

Specifically, the protective pipe 210 is in the shape of a hollow curved pipe, and the protective pipe 210 comprises a temperature-measuring portion 211 and an extension portion 212 that are sequentially connected and in mutual communication. The end of the temperature-measuring portion 211 away from the extension portion 212 is sealed to form a bottom portion 214 of the protective pipe, the end of the extension portion 212 away from the temperature-measuring portion 211 is opened to form an inlet 213 of the protective pipe, and a preset included angle is formed between the axial direction of the temperature-measuring portion 211 and the axial direction of the extension portion 212. The temperature-measuring probe 220 is mounted inside the temperature-measuring portion 211 and is positioned at the bottom portion 214 of the protective pipe.

As shown in FIGS. 1 and 4, the temperature-measuring probe 220 is in the shape of an elongated strip and has a certain length. One end of the temperature-measuring

probe 220 is positioned at the bottom portion 214 of the protective pipe, and the other end is positioned in the pipeline of the temperature-measuring portion 211. In some embodiments, one end of the temperature-measuring probe 220 abuts against the bottom portion 214 of the protective pipe. Since the temperature-measuring probe 220 usually has a certain rigidity, the length of the temperature-measuring portion 211 should be greater than the length of the temperature-measuring probe 220, so that the temperature-measuring probe 220 is completely vertical when the process tank temperature-measuring device 200 is in use. The temperature-measuring portion 211 can fix the temperature-measuring probe 220 at a preset height to detect the temperature of the chemical solution within the corresponding height range, and the temperature-measuring probe 220 is prevented from being corroded by the chemical solution in the process tank 100 by the protective pipe 210.

Wherein, the bottom portion 214 of the protective pipe is configured to be immersed in the chemical solution in the process tank 100, so that the temperature-measuring probe 220 detects the temperature of the chemical solution in the process tank 100, and the inlet 213 of the protective pipe is configured offset from directly above the opening of the process tank 100. As shown in FIG. 1, the inlet 213 of the protective pipe extends towards the direction away from the opening 110 of the process tank, which can prevent the inlet 213 of the protective pipe from being exposed directly right above the opening 110 of the process tank and being corroded by the chemical solution vapor, thereby preventing the chemical solution from entering the protective pipe 210 and corroding the temperature-measuring probe 220.

The present application does not limit the lengths of the temperature-measuring portion 211 and the extension portion 212. According to FIG. 1, the length of the temperature-measuring portion 211 should ensure that the bottom portion 214 of the protective pipe can reach below the level of the chemical solution and that the temperature-measuring probe 220 is entirely positioned inside the process tank 100, and the length of the extension portion 212 should ensure that the inlet 213 of the protective pipe is away from the opening 110 of the process tank.

The fixing method of the protective pipe 210 is not limited to the present application. The protective pipe 210 may be fixed above the process tank 100 by, for example, a bracket, a hanging device, or the like.

In some embodiments, the process tank temperature-measuring device 200 of the present application further comprises an interface assembly 240, the interface assembly 240 is mounted at the end of the extension portion 212 close to the inlet 213 of the protective pipe, and is used to protect the inlet 213 of the protective pipe. Accordingly, the interface assembly 240 is also positioned in a spatial position away from the opening 110 of the process tank. According to this arrangement, it is possible to prevent the interface assembly 240 mounted at the inlet 213 of the protective pipe from being exposed directly right above the opening 110 of the process tank and from being corroded by the chemical solution vapor, thereby preventing the chemical solution from penetrating into the protective pipe 210 via the interface assembly 240 and corroding the temperature-measuring probe 220.

In the assembly process of the process tank temperature-measuring device 200, the temperature-measuring probe 220 is first inserted into the protective pipe 210 through the inlet 213 of the protective pipe, passes through the extension portion 212 and enters the temperature-measuring portion 211, and then the interface assembly 240 is mounted at the end of the extension portion 212 close to the inlet 213 of the protective pipe. The data transmission line and the power supply line connected to the temperature-measuring probe 220 can sequentially pass through the inside of the temperature-measuring portion 211, the extension portion 212, and the interface assembly 240, be led out to the outside of the protective pipe 210, and be connected to the control device or the power supply device. Preferably, the above-described temperature-measuring portion 211 and the extension portion 212 constitute an integrated quartz protective pipe 210, and the axial direction of the temperature-measuring portion 211 and the axial direction of the extension portion 212 are perpendicular to each other, that is, the temperature-measuring portion 211 and the extension portion 212 form a preset included angle of 90° along the axial direction. Besides, the connection between the temperature-measuring portion 211 and the extension portion 212 is provided with an arc-shaped arc transition portion 215, which facilitates the smooth passage of the temperature-measuring probe 220 at the connection between the temperature-measuring portion 211 and the extension portion 212 during the process of mounting the temperature-measuring probe 220 inside the protective pipe 210.

In the present application, the process tank temperature-measuring device 200 is not limited to the configuration of one protective pipe 210, for example, in the embodiment shown in FIG. 1, the process tank temperature-measuring device 200 is configured with only one protective pipe 210; for another example, as shown in the embodiment in FIG. 2, a plurality of protective pipes 210 can be mounted in the same process tank temperature-measuring device 200. As shown in FIG. 2, the process tank temperature-measuring device 200 comprises four protective pipes 210, each protective pipe 210 is provided with one interface assembly 240, and each protective pipe 210 is provided with one temperature-measuring probe 220 inside. It is worth noting that the lengths of the temperature-measuring portions 211 of the four protective pipes 210 are different, and the heights of the temperature-measuring probes 220 correspondingly mounted in the respective protective pipes 210 in the process tank 100 are also different, so as to simultaneously monitor the temperature of the chemical solution at different heights in the process tank 100. In particular, in the process of adding or replenishing the chemical solution into the process tank 100, since the temperature of the chemical solution newly added into the process tank 100 is different from the temperature of the original chemical solution in the process tank 100, the temperatures of the new chemical solution and the original chemical solution are not uniform when the new chemical solution and the original chemical solution are not sufficiently mixed, and the new chemical solution and the original chemical solution cannot be directly supplied to subsequent processes for use. At this time, the temperature difference of the chemical solutions at different heights in the process tank 100 can be detected by the above-described temperature-measuring probes 220 at different heights, so as to detect whether the temperatures of the chemical solutions in the process tank 100 have reached a uniform state, and thus determine whether the chemical solutions can be supplied to subsequent processes for use.

In a preferred embodiment of the present invention, according to FIGS. 1 and 2, the process tank temperature-measuring device 200 is further equipped with a fixing bracket 230, specifically, as shown in FIGS. 3A and 3B, the fixing bracket 230 comprises a base 231, a first pressing plate 232, and a second pressing plate 233. Wherein, the facing sides of the base 231 and the first pressing plate 232 are provided with a plurality of interfitting first semicircular recesses 237, the facing sides of the first pressing plate 232 and the second pressing plate 233 are provided with a plurality

of interfitting second semicircular recesses 234. When the first pressing plate 232 is fixed to the base 231, and the second pressing plate 233 is fixed to the first pressing plate 232, a plurality of fixing holes are formed between the base 231 and the first pressing plate 232, and the first pressing plate 232 and the second pressing plate 233, the plurality of fixing holes are arranged in two layers, and the two layers of fixing holes are respectively recorded as a first-layer fixing holes 235 and a second-layer fixing holes 236. The first-layer fixing holes 235 include a plurality of first fixing holes (e.g., 2351, 2352, and 2353), and the second-layer fixing holes 236 include a plurality of second fixing holes (e.g., 2361, 2362, and 2363). The size of the plurality of fixing holes can be the same or different.

Preferably, the process tank temperature-measuring device 200 is further equipped with a cover plate 250 that partially or completely covers the opening 110 of the process tank. According to FIG. 1, the cover plate 250 partially covers the opening 110 of the process tank, and the fixing bracket 230 is mounted on the surface of the cover plate 250. A plurality of fixing holes are arranged on the cover plate 250 for fixing the protective pipe 210 at the opening 110 of the process tank. A plurality of through holes are provided on the surface of the cover plate 250, and the above-described through holes are positioned on the side of the fixing bracket 230 close to the center of the opening 110 of the process tank. The size of the plurality of through holes can be the same or different. The temperature-measuring portion 211 of the protective pipe 210 extends into the process tank 100 through the above-described through holes, the extension portion 212 of the protective pipe 210 is fixed in the fixing holes of the fixing bracket 230, and the inlet 213 of the protective pipe and the interface assembly 240 are positioned on the side of the fixing bracket 230 away from the center of the opening 110 of the process tank. It should be noted that those skilled in the art can also fix the protective pipe 210 to other structures around the process tank 100, such as the side wall of the process tank, so that the bottom portion 214 of the protective pipe is immersed in the chemical solution in the process tank 100, and the inlet 213 of the protective pipe is disposed offset from directly above the opening of the process tank 100.

Specifically, as shown in FIGS. 3A and 3B, the base 231 of the fixing bracket 230 is fixed to the surface of the cover plate 250, and the first pressing plate 232 and the

second pressing plate 233 are sequentially stacked and fixed to the base 231 by screws. In other embodiments, the base 231, the first pressing plate 232, and the second pressing plate 233 can be detachably connected in other ways, such as a snap joint, adhesion, or the like. In addition, as shown in FIG. 1, a first group of through holes 251 and a second group of through holes 252 are provided side by side on the surface of the cover plate 250, the first group of through holes 251 includes a plurality of first through holes (for example, 2511, 2512, and 2513), and the second group of through holes 252 includes a plurality of second through holes (for example, 2521, 2522, and 2523). Moreover, the first-layer fixing holes 235 and the first group of through holes 251 are in one-to-one correspondence and have the same inner diameter, the second-layer fixing holes 236 and the second group of through holes 252 are in one-to-one correspondence and have the same inner diameter, so as to fix the same protective pipe 210, thereby realizing the technical effect that a plurality of protective pipes 210 can be simultaneously mounted on the same process tank temperature-measuring device 200.

As shown in FIGS. 4, 5, and 6, in a preferred embodiment of the present invention, an interface assembly 240 suitable for the above-described process tank temperature-measuring device 200 comprises a sealing nut 241, a sealing ring 242, a locking nut 243, and a standard connector 244 that are sequentially assembled on an extension portion 212 along the axial direction.

Wherein, the sealing ring 242 has a large end and a small end, the inner diameter of the sealing ring 242 is slightly larger than the outer diameter of a protective pipe 210, and the outer diameter of the sealing ring 242 gradually decreases along the direction from the large end to the small end, that is, the sealing ring 242 as a whole has a wedge-shaped structure. As shown in FIG. 5, the large end of the sealing ring 242 is positioned on the left side of the sealing ring 242 near an arc transition portion 215, and the small end of the sealing ring 242 is positioned on the right side of the sealing ring 242 near an inlet 213 of the protective pipe.

The sealing nut 241 has a first accommodating area 241a for mounting the sealing ring 242, and the first accommodating area 241a has an axial limiting portion 241b inside. A chamfer 241c is provided on the side of the axial limiting portion 241b close to the sealing ring 242, the outer diameter of the large end of the sealing ring 242 is

larger than the inner diameter of the axial limiting portion 241b, and the first accommodating area 241a has an internal thread.

The locking nut 243 has a first end and a second end. The first end described above has a second accommodating area 2431 for mounting the sealing ring 242, and an external thread that fits the internal thread of the sealing nut 241. And the second accommodating area 2431 described above has an axial pressing portion 2431a inside, and the second end described above is in threaded connection with the standard connector 244.

Wherein, the inner diameter of the axial limiting portion 241b is smaller than the outer diameter of the large end of the sealing ring 242; the inner diameter of the axial pressing portion 2431a is larger than the outer diameter of the small end of the sealing ring 242, and the inner diameter of the axial pressing portion 2431a is smaller than the outer diameter of the large end of the sealing ring 242. When the locking nut 243 and the sealing nut 241 are tightened, the sealing ring 242 is positioned between the axial limiting portion 241b and the axial pressing portion 2431a, the large end of the sealing ring 242 abuts against the axial limiting portion 241b, and the small end of the sealing ring 242 abuts against the axial pressing portion 2431a.

On the one hand, in the process of screwing the locking nut 243 into the sealing nut 241, the inner wall of the locking nut 243 gradually increases the radial pressing degree on the sealing ring 242, so that the locking nut 243, the sealing ring 242, and the protective pipe 210 are tightly fitted in the radial direction; on the other hand, in the process of screwing the locking nut 243 into the sealing nut 241, the axial pressing portion 2431a of the locking nut 243 gradually increases the axial pressing degree on the sealing ring 242, so that the locking nut 243, the sealing ring 242, and the sealing nut 241 are tightly fitted in the axial direction, and a better sealing effect is achieved. One end of the standard connector 244 close to the locking nut 243 has an external thread that fits the internal thread of the locking nut 243, and the other end of the standard connector 244 can be connected to the PFA pipe.

In the actual assembly process: First, the sealing nut 241 is sleeved on the extension portion 212 of the protective pipe 210 through the inlet 213 of the protective pipe, and then the sealing ring 242 is sleeved on the protective pipe 210 with the large

end facing inward and the small end facing outward; after that, the locking nut 243 is sleeved at the inlet 213 of the protective pipe, while the locking nut 243 is screwed into the sealing nut 241 through the thread, on the one hand, the locking nut 243 slides from the small end to the large end of the sealing ring 242, and with the gradual increase of the outer diameter of the sealing ring 242, the pressure of the inner surface of the locking nut 243 on the outer surface of the sealing ring 242 gradually increases, so that the inner diameter of the sealing ring 242 is reduced and the protective pipe 210 is pressed to eliminate the gap between the locking nut 243, the sealing ring 242, and the protective pipe 210. On the other hand, when the locking nut 243 presses the sealing ring 242 in the axial direction, the other end of the sealing ring 242 presses the chamfer 241c of the axial limiting portion 241b, and while the other end of the sealing ring 242 presses the chamfer 241c, the chamfer 241c applies a component force to the sealing ring 242 toward the locking nut 243 to eliminate the gap between the locking nut 243, the sealing ring 242, and the sealing nut 241. Finally, the standard connector 244 is screwed into the tail of the locking nut 243, and then the standard connector 244 can be connected to the standard PFA pipe. The signal transmission line of the temperature-measuring probe 220 is led out along the hollow portion of the protective pipe 210 and is connected to other devices (such as the temperature display device).

The present invention also discloses a substrate processing apparatus, comprising a process tank 100 and the process tank temperature-measuring device 200 in any of the above embodiments. Wherein, the process tank 100 is used to contain a chemical solution required for processing a substrate, and the process tank temperature-measuring device 200 is used to measure the temperature of the chemical solution in the process tank, so as to accurately detect the temperature of the chemical solution in the process tank 100 and reduce corrosion on the equipment by the chemical solution vapor. In addition, the substrate processing apparatus comprises, but is not limited to, a wet bench wafer cleaning equipment, and the chemical solution in the process tank includes, but is not limited to, solutions such as Hydrofluoric Acid (HF), DIO₃ Dissolved Ozone in Deionized Water (DIO₃), Sulfuric Peroxide Mixture (SPM), and Deionized Water (DIW).

It should be noted that all of the above-described embodiments can be freely combined as necessary. The above are only preferred embodiments of the present

invention, and those of ordinary skill in the art can make some improvements and retouches without departing from the principles of the present invention, and these improvements and retouches should also be regarded as falling within the scope of protection of the present invention.

What is claimed is:

1. A process tank temperature-measuring device, for detecting the temperature of a chemical solution in a process tank, the upper end of the process tank being provided with an opening, the process tank temperature-measuring device comprising:

a protective pipe, including a temperature-measuring portion and an extension portion that are sequentially connected and in mutual communication, the end of the temperature-measuring portion away from the extension portion being sealed to form a bottom portion of the protective pipe, the end of the extension portion away from the temperature-measuring portion being opened to form an inlet of the protective pipe, and a preset included angle being formed between the axial direction of the temperature-measuring portion and the axial direction of the extension portion;

a temperature-measuring probe, arranged inside the temperature-measuring portion, and positioned at the bottom portion of the protective pipe;

wherein, the bottom portion of the protective pipe is configured to be immersed in the chemical solution in the process tank, so that the temperature-measuring probe detects the temperature of the chemical solution, and the inlet of the protective pipe is configured offset from directly above the opening of the process tank.

2. The process tank temperature-measuring device according to claim 1, further comprising:

an interface assembly, arranged at the end of the extension portion close to the inlet of the protective pipe.

3. The process tank temperature-measuring device according to claim 2, wherein,

the interface assembly comprises a sealing nut, a sealing ring, a locking nut, and a standard connector assembled in sequence along the axial direction at the extension portion, wherein:

the sealing ring has a large end and a small end, the inner diameter of the sealing ring is slightly larger than the outer diameter of the protective pipe, and the outer

diameter of the sealing ring gradually decreases along the direction from the large end to the small end;

the sealing nut has a first accommodating area for mounting the sealing ring, the first accommodating area has an axial limiting portion inside, and the first accommodating area has an internal thread;

the locking nut has a first end and a second end, the first end has a second accommodating area for mounting the sealing ring, and an external thread that fits the internal thread of the sealing nut, an axial pressing portion is provided in the second accommodating area, and the second end is in threaded connection with the standard connector;

wherein, the inner diameter of the axial limiting portion is smaller than the outer diameter of the large end of the sealing ring; the inner diameter of the axial pressing portion is larger than the outer diameter of the small end of the sealing ring, and the inner diameter of the axial pressing portion is smaller than the outer diameter of the large end of the sealing ring; when the locking nut and the sealing nut are tightened, the sealing ring is positioned between the axial limiting portion and the axial pressing portion, and the large end of the sealing ring abuts against the axial limiting portion, and the small end of the sealing ring abuts against the axial pressing portion.

4. The process tank temperature-measuring device according to claim 3, wherein the axial limiting portion is provided with a chamfer.

5. The process tank temperature-measuring device according to claim 1, further comprising:

a fixing bracket, for fixing the protective pipe to the opening of the process tank.

6. The process tank temperature-measuring device according to claim 5, wherein,

the fixing bracket comprises a base, a first pressing plate, and a second pressing plate that are detachably connected;

the facing sides of the base and the first pressing plate are respectively provided

with a plurality of interfitting first semicircular recesses, and when the first pressing plate is fixed above the base, a plurality of the interfitting first semicircular recesses form a plurality of first-layer fixing holes;

the facing sides of the first pressing plate and the second pressing plate are respectively provided with a plurality of interfitting second semicircular recesses, and when the second pressing plate is fixed above the first pressing plate, a plurality of the interfitting second semicircular recesses form a plurality of second-layer fixing holes.

7. The process tank temperature-measuring device according to claim 6, further comprising:

a cover plate, partially or completely covering the opening of the process tank, the surface of the cover plate being provided with a plurality of through holes connected to the inside of the process tank, and the fixing bracket being arranged on the surface of the cover plate;

wherein, the temperature-measuring portion is inserted in the through holes, and the extension portion is fixed to the fixing bracket.

8. The process tank temperature-measuring device according to claim 7, wherein, the through holes comprise a first group of through holes and a second group of through holes arranged side by side, the first group of through holes and the first-layer fixing holes are in one-to-one correspondence, and the second group of through holes and the second-layer fixing holes are in one-to-one correspondence.

9. The process tank temperature-measuring device according to claim 5, wherein, when the fixing bracket is equipped with a plurality of protective pipes, at least two of the protective pipes have temperature-measuring portions of different lengths, so that the temperature-measuring probes in the at least two protective pipes are respectively positioned at different heights in the process tank to detect the temperature of the chemical solution at different heights.

10. The process tank temperature-measuring device according to any one of claims 1 to 9, wherein the protective pipe is a quartz pipe, and the connection between

the temperature-measuring portion and the extension portion is provided with an arc transition portion.

11. A substrate processing apparatus, comprising:

a process tank, for containing a chemical solution required for a substrate undergoing liquid processing; and

the process tank temperature-measuring device according to any one of claims 1 to 10.