

CAP DEVICE AND PROCESS APPARATUS

TECHNICAL FIELD

The present invention relates to the field of semiconductor processing technology, and particularly relates to a cap device applicable to a process apparatus, and a process apparatus including the cap device.

BACKGROUND

Chemical vapor deposition (CVD) method is a method in which an epitaxial thin film layer is prepared through interaction of different gases under high temperature. For a CVD apparatus, reaction temperature is generally high, for example, growth temperature of GaN film is 1200°C, and growth temperature of monocrystalline silicon film is 1100°C. In general, methods adopted for high temperature heating include heating wire heating, lamp heating and induction heating, and induction heating is adopted in most of CVD apparatuses with reaction temperature higher than 1000°C. Due to high temperature, and quartz's characteristics of good stability and resistance to sudden cold and hot temperatures under high temperature, a quartz chamber is generally used in CVD technology, but in the meanwhile, quartz also has a characteristic of high possibility of breakage.

In a current structure, a quartz chamber is placed on a pedestal, below which an induction heating coil is located, and the induction heating coil is dipped in a water sink of a plastic chamber to ensure the cooling of the induction heating coil during heating. A graphite disk is placed inside the quartz chamber, the induction heating coil heats the graphite disk by electromagnetic induction. Due to the high reaction temperature, a water cooling area is provided at an upper portion of the quartz chamber, temperature of outer wall of the quartz chamber is reduced by spraying water from the upper cover. A water spraying and cooling mechanism is fixed to the upper cover by screws. In practical applications, since the upper cover goes up and down under the control of a motor, the motor stops moving when a lower limit position sensor detects that the upper cover reaches the lower limit position.

However, in the case that there is a fault in the lower limit position sensor, even when the upper cover reaches the lower limit position, the lower limit position sensor cannot operate normally, that is, cannot send out an instruction that can make the motor stop moving. In this case, the water spraying and cooling mechanism fixed onto the upper cover may contact the outer wall of the quartz chamber and thus damage the quartz chamber when continuously going down along with the upper cover.

In view of the above defect, the inventor finally proposes the present invention after a long period of research and practice.

SUMMARY

In view of the above, it is necessary to provide a cap device and a process apparatus including the above cap device to address the problem that the water spraying and cooling area is likely to contact the outer wall of the quartz chamber and thus damage the quartz chamber, and the like. The above object is realized through the following technical solutions.

There is provided a cap device, comprising a water spraying and cooling part and an upper cover, the water spraying and cooling part and the upper cover are structures separated from each other, and the water spraying and cooling part is able to move in a vertical direction along with the upper cover.

The above object can be further realized through the following technical solutions.

Optionally, the water spraying and cooling part includes a water inlet pipe, a spray head and a baffle plate, the spray head has a shower head structure, the water inlet pipe is connected to an inner cavity of the spray head and is fixed to the baffle plate, and the baffle plate is located above the spray head.

Optionally, the upper cover is provided with a channel, orthographic projection of the baffle plate on an upper surface of the upper cover completely covers orthographic projection of the channel on the upper surface of the upper cover, the orthographic projection of the channel on the upper surface of the upper cover completely covers orthographic projection of the spray head on the upper surface of

the upper cover, a minimum diameter of the channel is larger than a maximum diameter of the spray head, and a maximum diameter of the channel is smaller than a maximum diameter of the baffle plate; and the upper cover is provided below the baffle plate, and the baffle plate is able to be supported by the upper surface of the upper cover, so that the baffle plate, the water inlet pipe and the spray head are able to move in the vertical direction along with the upper cover.

Optionally, the water spraying and cooling part further includes a pillar provided on a water outlet end surface of the spray head.

Optionally, there are a plurality of pillars, the water outlet end surface of the spray head is provided thereon with a plurality of mounting holes for mounting the plurality of pillars, and the plurality of pillars are movably mounted in the plurality of mounting holes.

Optionally, there are a plurality of pillars, which are fixedly mounted on the spray head. Alternatively, there are a plurality of pillars, the water outlet end surface of the spray head is provided thereon with a plurality of mounting holes for mounting the plurality of pillars, and the plurality of pillars are fixedly mounted in the plurality of mounting holes.

As another technical aspect, the present invention further provides a process apparatus, comprising a quartz chamber, a driving mechanism, and the cap device according to any one of the above solutions, and the cap device is mounted above the quartz chamber. The driving mechanism is connected to the upper cover in the cap device, and is used for driving the upper cover to move in the vertical direction; and moving distance of the upper cover in the vertical direction is greater than or equal to movable distance of the water spraying and cooling part in the vertical direction.

Optionally, the moving distance of the upper cover in the vertical direction includes a first distance, and at a terminal point of the first distance, the water spraying and cooling part in the cap device reaches a stop position of the water spraying and cooling part and is supported by the outer wall of the quartz chamber; and at time points of the first distance other than the terminal point, the water spraying and cooling part is supported by the upper cover, and motion states of the water

spraying and cooling part and the upper cover are consistent; wherein the first distance refers to the movable distance of the water spraying and cooling part in the vertical direction.

Optionally, the moving distance of the upper cover in the vertical direction further includes a second distance, in which the water spraying and cooling part and the upper cover are separated from each other in the vertical direction; and at a terminal point of the second distance, the upper cover reaches a lower limit position of the upper cover ; at time points of the second distance other than the terminal point, the water spraying and cooling part is at static state, and the upper cover is at moving state; wherein the second distance refers to a distance between the stop position of the water spraying and cooling part and the lower limit position of the upper cover.

Optionally, the driving mechanism includes a motor.

Optionally, the process apparatus provided by the present invention further comprises: an upper limit position sensor, used for detecting whether or not the upper cover reaches an upper limit position, and outputting a signal capable of stopping operation of the driving mechanism when detecting that the upper cover reaches the upper limit position; and/or a lower limit position sensor, used for detecting whether or not the upper cover reaches a lower limit position, and outputting the signal capable of stopping operation of the driving mechanism when detecting that the upper cover reaches the lower limit position.

The present invention has the following beneficial effects.

In the cap device and the process apparatus provided by the present invention, the upper cover and the water spraying and cooling part are configured to separate from each other, and in the first distance of the upper cover, the upper surface of the upper cover contacts the lower surface of the baffle plate of the water spraying and cooling part, the water spraying and cooling part is supported by the upper cover and driven by the upper cover to move in the vertical direction; in the second distance of the upper cover, the spray head of the water spraying and cooling part is supported by the upper surface of the outer wall of the quartz chamber, the upper surface of the upper cover is separated from the lower surface of the baffle plate of the water

spraying and cooling part, and at this time, the water spraying and cooling part remains at static state and does not move with the movement of the upper cover in the vertical direction. In this way, when the spray head of the water spraying and cooling part has contacted the upper surface of the outer wall of the quartz chamber (i.e., when the pillars have contacted the upper surface of the outer wall of the quartz chamber, in the case that the spray head is provided with the pillars), and the upper cover has not reached the lower limit position yet and is driven by the motor to continue moving down, or the upper cover has reached the lower limit position but the motor continues rotating and drives the upper cover to continue moving down due to the failure of the lower limit position sensor, because the upper surface of the upper cover has separated from the lower surface of the baffle plate of the water spraying and cooling part, and the water spraying and cooling part is supported by the upper surface of the outer wall of the quartz chamber instead of the upper surface of the upper cover, the water spraying and cooling part does not generate power for continuously moving down, and thus will not exert a pressure greater than its own weight onto the quartz chamber. Therefore, the quartz chamber will not be damaged as being subjected to a large pressure, and the service life of the quartz chamber cooperating with the cap device is thus prolonged. In addition, the cap device and the process apparatus provided by the present invention also have advantages such as simple structure, reasonable design, and the like.

BRIEF DESCRIPTION OF THE FIGURES

Fig. 1 is a schematic cross-sectional view of a process apparatus into which a cap device according to an embodiment of the present invention is fitted;

Fig. 2 is a schematic perspective view of the cap device shown in Fig. 1; and

Fig. 3 is a schematic cross-sectional view of the cap device shown in Fig. 1.

In the drawings:

100 – cap device; 110 – water spraying and cooling part; 111 – spray head; 112 – water inlet pipe; 113 – baffle plate; 114 – pillar; 120 – upper cover; 200 – plastic chamber; 210 – pedestal; 220 – water tank; 300 – induction heating coil; 400 – quartz

chamber; 410 – graphite disk.

DETAILED DESCRIPTION

To make the object, technical solutions and advantages of the present invention clearer, a cap device and a process apparatus of the present invention will be further described, by way of embodiments, in detail below in conjunction with the accompanying drawings. It should be understood that the specific embodiments described herein are merely used for explaining the present invention, rather than limiting the present invention.

In the description of the present invention, it should be understood that, orientation or position relation denoted by a term such as ‘above’, ‘below’, ‘inner’, ‘outer’, or the like, is an orientation or position relation as shown in the drawings, is merely for the purpose of facilitating and simplifying the description of the present invention, does not indicate or suggest that the related device or component must have a particular orientation, or be configured and operate at a particular orientation, and thus should not be construed as limiting the present invention.

As shown in Fig. 1, the cap device 100 of the present invention is used in a process apparatus of a CVD apparatus, and cools a quartz chamber 400. The process apparatus includes the cap device 100, a plastic chamber 200, a pedestal 210, a water tank 220, an induction heating coil 300, the quartz chamber 400, a graphite disk 410, and a motor (not shown).

The cap device 100 is located above the plastic chamber 200, the pedestal 210 is placed within the plastic chamber 200, the quartz chamber 400 is placed on the pedestal 210, and the induction heating coil 300 is provided below the pedestal 210 and dipped in the water tank 220 in the plastic chamber 200 to ensure the cooling of the induction heating coil 300 during heating.

The graphite disk 410 is placed within the quartz chamber 400, and the induction heating coil 300 heats the graphite disk 410 by electromagnetic induction. Because the temperature of the quartz chamber 400 rises as a result of the relatively high temperature of the graphite disk 410, the cap device 100 provided by embodiments of

the present invention is provided with a cooling mechanism for cooling the quartz chamber 400, in order to reduce the temperature of the quartz chamber 400.

The cap device 100 provided by the embodiments of the present invention include a water spraying and cooling part 110 and an upper cover 120. The water spraying and cooling part 110 and the upper cover 120 are structures separated from each other, that is, the two are not formed as a whole or fixedly connected together, and the water spraying and cooling part 110 can move up and down in a vertical direction along with the upper cover 120.

In the cap device 100 provided by the embodiments of the present invention, by adopting the upper cover 120 and the water spraying and cooling part 110 separated from each other, it is ensured that the water spraying and cooling part 110 is no longer subjected to a driving force of moving down continuously, but remains at static state, after reaching a stop position of the water spraying and cooling part. Here, the stop position of the water spraying and cooling part is the upper surface of the outer wall of the quartz chamber 400. For example, during the descent of the cap device 100, the water spraying and cooling part 110 stops moving down and stays on the upper surface of the outer wall of the quartz chamber 400, upon reaching the upper surface of the outer wall of the quartz chamber 400. In this way, the water spraying and cooling part 110 is no longer supported by the cap device 100 but supported by the upper surface of the outer wall of the quartz chamber 400. In this case, if the upper cover 120 has not reached its lower limit position, the lower limit position sensor will not send out a signal capable of stopping operation of the motor, and the upper cover 120 goes on moving down; or, if the upper cover 120 has reached its lower limit position, but the lower limit position sensor is not provided or the lower limit position sensor has an error therein and thus cannot send out the signal capable of stopping operation of the motor, the upper cover 120 is still subjected to the driving force of moving down. In this case, since the upper cover 120 and the water spraying and cooling part 110 are structures separated from each other, the upper cover 120 goes on moving down or is subjected to the driving force of moving down continuously, and since the upper cover 120 and the water spraying and cooling part 110 no longer

contact each other, the upper cover 120 will not drive the water spraying and cooling part 110 to move down continuously or transfer the driving force of moving down to the water spraying and cooling part 110. In this way, the quartz chamber 400 will not be subjected to an impact force caused by continuous moving down of the water spraying and cooling part 110 or the driving force transferred to the water spraying and cooling part 110, and it is thus ensured that the quartz chamber 400 will not be damaged easily.

As one optional implementation, the water spraying and cooling part 110 includes a spray head 111, a water inlet pipe 112, a baffle plate 113, and pillars 114. The spray head 111 has a shower head structure and has a cavity structure therein, the water inlet pipe 112 is connected to the interior cavity (hereinafter simply referred to as inner cavity) of the spray head 111 via an upper end surface of the spray head 111, a lower end surface of the spray head 111 is a water outlet end surface, deionized water flows into the inner cavity of the spray head 111 via the water inlet pipe 112, and is sprayed onto the outer wall of the quartz chamber 400 via the water outlet end surface, so as to cool the quartz chamber 400. The pillars 114 are mounted on the water outlet end surface of the spray head 111, mounting holes whose number corresponds to the number of the pillars 114 are provided on the water outlet end surface of the spray head 111, and the pillars 114 are mounted in the mounting holes and used for supporting the spray head 111. Further, the pillars 114 should protrude from the water outlet end surface of the spray head 111, that is, the pillars 114 should extend downwards from the water outlet end surface of the spray head 111 to ensure that the pillars 114 can land on the outer wall of the quartz chamber 400 during the descent of the spray head 111. Furthermore, the mounting holes on the spray head 111 may be through holes, and may also be blind holes.

The water inlet pipe 112 is fixedly connected to the spray head 111, and tightness between the water inlet pipe 112 and the spray head 111 should be ensured so that water leakage will not occur at the junction between the water inlet pipe 112 and the spray head 111 when the deionized water flows into the inner cavity of the spray head 111 through the water inlet pipe 112.

The baffle plate 113 is located above the spray head 111 and the upper cover 120, and fixed to the water inlet pipe 112 so that the baffle plate 113 and the spray head 111 can move synchronously. When the pillars 114 do not contact the upper surface of the outer wall of the quartz chamber 400, an upper surface of the upper cover 120 contacts a lower surface of the baffle plate 113, so as to drive the baffle plate 113 and the spray head 111 to move up or down together. That is to say, when the pillars 114 do not contact the upper surface of the outer wall of the quartz chamber 400, the water spraying and cooling part 110 is supported by the upper cover 120; when the pillars 114 contact the upper surface of the outer wall of the quartz chamber 400, the water spraying and cooling part 110 is supported by the outer wall of the quartz chamber 400.

The cap device 100 is controlled by a driving mechanism such as a motor to move up and down, operation and stop of the motor depend on an output signal of the limit position sensor, and the output signal of the limit position sensor depends on the position of the upper cover 120. Here, the limit position sensor includes: an upper limit position sensor used for detecting whether or not the upper cover 120 reaches the upper limit position, and a lower limit position sensor used for detecting whether or not the upper cover 120 reaches the lower limit position. For example, during descent of the cap device 100, if the lower limit position sensor detects that the upper cover 120 reaches the lower limit position, the lower limit position sensor sends out a signal capable of stopping operation of the motor, then the motor stops operating, and the upper cover 120 stops moving accordingly; on the contrary, if the lower limit position sensor does not detect that the upper cover 120 reaches the lower limit position, the lower limit position sensor will not send out a signal capable of stopping operation of the motor, and then the upper cover 120 is driven by the motor to go on moving down. As another example, during the ascent of the cap device 100, if the upper limit position sensor detects that the upper cover 120 reaches the upper limit position, the upper limit position sensor sends out a signal capable of stopping operation of the motor, then the motor stops operating, and the upper cover 120 stops moving accordingly; on the contrary, if the upper limit position sensor does not detect that the

upper cover 120 reaches the upper limit position, the upper limit position sensor will not send out a signal capable of stopping operation of the motor, and then the upper cover 120 is driven by the motor to go on moving up.

Further, when the upper cover 120 is driven by the motor to move down, if the pillars 114 on the spray head 111 in the cap device 100 lands on the upper surface of the outer wall of the quartz chamber 400, the baffle plate 113 stops moving down, and since the water spraying and cooling part 110 and the upper cover 120 are separated structures, the upper cover 120 will go on moving down without being affected by the water spraying and cooling part 110. At this time, the water spraying and cooling part 110 is supported by the outer wall of the quartz chamber 400 and is no longer supported by the upper cover 120. When the upper cover 120 is driven by the motor to move up, the upper cover 120 moves up first, and after the upper cover 120 moves up to contact the baffle plate 113, the upper cover 120 drives the baffle plate 113 to move up together, and the pillars 114 on the spray head 111 will leave the upper surface of the outer wall of the quartz chamber 400. At this time, the water spraying and cooling part 110 is supported by the upper cover 120 and is no longer supported by the outer wall of the quartz chamber 400.

As one optional implementation, the upper cover 120 is provided with a channel, and the spray head 111 and the upper cover 120 are provided below the baffle plate 113. In order that the upper cover 120 can drive the baffle plate 113 and the spray head 111 to move together by contacting the baffle plate 113, orthographic projections, on the upper surface of the upper cover 120, of the spray head 111, the baffle plate 113 and the channel need to overlap each other. Specifically, the orthographic projection of the baffle plate 113 on the upper surface of the upper cover 120 completely covers that of the channel on the upper surface of the upper cover 120, and the orthographic projection of the channel on the upper surface of the upper cover 120 completely covers that of the spray head 111 on the upper surface of the upper cover 120, that is, the minimum diameter of the channel is larger than the maximum diameter of the spray head 111, and the maximum diameter of the channel is smaller than the maximum diameter of the baffle plate 113. In this way, the spray head 111

can pass through the channel freely, but the baffle plate 113 cannot pass through the channel, and thus the baffle plate 113 can be supported by the upper surface of the upper cover 120, so as to drive the baffle plate 113, the water inlet pipe 112 fixed to the baffle plate 113, and the spray head 111 fixed to the water inlet pipe 112 to move up and down along with the upper cover 120.

Further, shapes of the channel, the baffle plate 113 and the upper cover 120 are not limited in the present invention. In fact, shapes of cross sections (i.e., shapes of the orthographic projections on the upper surface of the upper cover 120) of the channel, the baffle plate 113 and the spray head 111 may be circular, rectangular or other shapes, and preferably, the shape of cross section of the spray head 111 corresponds to that of the channel. In fact, any shapes may be possible as long as it can be ensured that the baffle plate 113 can be supported by the upper cover 120 and the spray head 111 can pass through the channel freely.

As shown in Fig. 2, the channel in the embodiment is a through hole whose cross section is circular, the cross sections of the spray head 111, the baffle plate 113 and the upper cover 120 are circular accordingly, and the diameter of the through hole in the upper cover 120 is larger than that of the spray head 111 but smaller than that of the baffle plate 113.

The upper cover 120 and the water spraying and cooling part 110 are separated structures, the upper cover 120 is mounted below the baffle plate 113, a preset distance is provided between the baffle plate 113 and lower end surfaces of the pillars 114 on the spray head 111, and the preset distance needs to satisfy the following conditions: first, when the upper cover 120 reaches the lower limit position, the lower end surfaces of the pillars 114 contact and are supported by the upper surface of the outer wall of the quartz chamber 400; second, the preset distance is a sum of the thickness and a second descending distance of the upper cover 120 in a vertical direction, wherein, the second descending distance is a descending distance of the upper cover 120 from a time when the lower end surfaces of the pillars 114 come into contact with the outer wall of the quartz chamber 400 to a time when the upper cover 120 descends to the lower limit position. It should be noted that, the second descending distance has

a value greater than or equal to zero; when the second descending distance is zero, the upper surface of the outer wall of the quartz chamber 400 and the lower limit position of the upper cover 120 are at the same level; when the second descending distance is greater than zero, the upper surface of the outer wall of the quartz chamber 400 is lower than the lower limit position of the upper cover 120, that is, when the lower end surfaces of the pillars 114 descend to the upper surface of the outer wall of the quartz chamber 400, the upper cover 120 has not descended to the lower limit position yet. Further, a total descending distance (total ascending distance) of the upper cover 120 is greater than or equal to that of the water spraying and cooling part 110.

That is to say, moving distance of the upper cover 120 in the vertical direction (the total descending distance or total ascending distance of the upper cover 120) includes a first distance, at the terminal point of which, the water spraying and cooling part 110 reaches the stop position of the water spraying and cooling part and is supported by the upper surface of the outer wall of the quartz chamber 400; at the time points in the first distance other than the terminal point, the water spraying and cooling part 110 is supported by the upper cover 120, and the motion states of the two are consistent; here, the so-called first distance refers to a movable distance of the water spraying and cooling part 110 in the vertical direction.

Further, the moving distance of the upper cover 120 in the vertical direction includes a second distance, in which, the water spraying and cooling part 110 and the upper cover 120 are separated from each other in the vertical direction; at the terminal point of the second distance, the upper cover 120 reaches the lower limit position of the upper cover; at the time points in the second distance other than the terminal point, the water spraying and cooling part 110 is at static state, and the upper cover 120 is at moving state; here, the second distance refers to a distance between the stop position of the water spraying and cooling part and the lower limit position of the upper cover. As described above, in practical applications, the moving distance of the upper cover 120 in the vertical direction may include the first distance only.

The working process of the cap device 100 will be described below by taking a case that the upper surface of the outer wall of the quartz chamber 400 is lower than

the lower limit position of the upper cover 120 as shown in Fig. 1 as an example.

During the descent of the upper cover 120, it begins with the first distance, in which the pillars 114 in the water spraying and cooling part 110 do not contact the upper surface of the outer wall of the quartz chamber 400, and at this time, the upper surface of the upper cover 120 contacts the lower surface of the baffle plate 113, and the water spraying and cooling part 110 is supported by the upper cover 120 and moves down along with the upper cover 120. At the terminal point of the first distance, the pillars 114 of the water spraying and cooling part 110 come into contact with the upper surface of the outer wall of the quartz chamber 400, and the water spraying and cooling part 110 is supported by the upper surface of the outer wall of the quartz chamber 400 and is no longer supported by the upper cover 120. Then it comes into the second distance, in which the lower surface of the baffle plate 113 is separated from the upper surface of the upper cover 120, the upper cover 120 can move down continuously before reaching the lower limit position, but the water spraying and cooling part 110 is supported by the upper surface of the outer wall of the quartz chamber 400 and thus no longer moves down. At the terminal point of the second distance, the upper cover 120 stops moving as it reaches the lower limit position.

During the ascent of the upper cover 120, it begins with the second distance, in which the lower surface of the baffle plate 113 is separated from the upper surface of the upper cover 120, the water spraying and cooling part 110 is supported by the upper surface of the outer wall of the quartz chamber 400, the upper cover 120 is driven by the driving mechanism to move up, and the water spraying and cooling part 110 remains at static state. When the upper cover 120 ascends to such an extent that the upper surface of the upper cover 120 contacts the lower surface of the baffle plate 113, the first distance begins. In the first distance, the water spraying and cooling part 110 is supported by the upper cover 120 and is no longer supported by the upper surface of the outer wall of the quartz chamber 400, so the motion states of the upper cover 120 and the water spraying and cooling part 110 are the same, that is, the upper cover 120 goes on moving up and drives the baffle plate 113 and the spray head 111 to move up together.

By adopting the above separated structures of the upper cover 120 and the water spraying and cooling part 110, in the second distance of the upper cover 120, the motion states of the spray head 111 and the upper cover 120 are out of sync. In this way, during the descent, when the lower end surfaces of the pillars 114 of the spray head 111 contact and are supported by the outer wall of the quartz chamber 400, the upper cover 120 will not drive the water spraying and cooling part 110 to move down continuously even if the upper cover 120 continues moving down. Therefore, the outer wall of the quartz chamber 400 will not be subjected to the impact force caused by continuous moving down of the water spraying and cooling part 110, and it is thus ensured that the quartz chamber 400 will not be damaged easily.

In the embodiment, at least two pillars 114 are provided at edge positions of the water outlet end surface of the spray head 111 to play a good supporting role. Furthermore, the at least two pillars 114 are uniformly distributed on the water outlet end surface of the spray head 111 to ensure that the outer wall of the quartz chamber 400 is subjected to a uniform force when contacting the pillars 114 of the spray head 111. It can be understood that, the at least two pillars 114 may also be arranged at other positions on the water outlet end surface of the spray head 111 according to actual needs, and movably mounted on the spray head 111. Further, heights of the pillars 114 (i.e., lengths of the pillars 114 extending out from the water outlet end surface of the spray head 111) may be set to be adjustable, and by adjusting the heights of the pillars 114, the distance between the spray head 111 and the outer wall of the quartz chamber 400 is adjusted accordingly, so as to meet different cooling requirements.

Further, to ensure stable and accurate supporting of the pillars 114, inner diameters of the mounting holes for the pillars 114 on the water outlet end surface of the spray head 111 should match outer diameters of the pillars 114. After the pillars 114 are engaged with the mounting holes, the heights of the pillars 114 are adjusted by axial movement of the pillars 114 in the mounting holes.

To ensure that the pillars 114 can play a role of supporting, the pillars 114 should protrude from the water outlet end surface of the spray head 111 no matter whether

the mounting holes in the spray head 111 are through holes or blind holes, so as to ensure a distance between the spray head 111 and the outer wall of the quartz chamber 400. In this way, when descending to the upper surface of the outer wall of the quartz chamber 400, the water spraying and cooling part 110 is supported by the outer wall of the quartz chamber 400 through the pillars 114, so as to ensure that the spray head 111 will not contact the outer wall of the quartz chamber 400 to further reduce the damage to the quartz chamber 400.

As one optional implementation, the mounting holes for the pillars 114 on the spray head 111 may be threaded holes, and accordingly, the pillars 114 are cylinders with external thread structure. The threaded holes and the cylinders with external thread structure cooperate with each other to adjust the distance between the spray head 111 and the outer wall of the quartz chamber 400 and thus ensure the cooling effect of the cap device 100. In the embodiment, the pillars 114 are studs, which are mounted onto the threaded holes on the spray head 111 through threaded connection to support the spray head 111 and ensure the distance between the spray head 111 and the outer wall of the quartz chamber 400.

As one optional implementation, there are a plurality of pillars 114, which are fixedly mounted on the spray head 111, that is, the pillars 114 and the spray heads 111 are an integrated structure, and in this way, the distance between the spray head 111 and the outer wall of the quartz chamber 400 is fixed, as long as the heights of the pillars 114 can satisfy the cooling effect of the cap device 100 required by the process. This implementation is easy to operate although limited in flexibility.

The cap device 100 of the present invention operates as follows.

When the upper cover 120 moves down, the lower surface of the baffle plate 113 contacts the upper surface of the upper cover 120, and the baffle plate 113 and the spray head 111 move down along with the upper cover 120.

When the pillars 114 on the spray head 111 move down to contact the upper surface of the outer wall of the quartz chamber 400, the upper surface of the outer wall of the quartz chamber 400 supports the spray head 111 and the water inlet pipe 112 and the baffle plate 113 connected thereto, and thus the water spraying and

cooling part 110 stops moving down. At this time, if the upper cover 120 does not reach the lower limit position, the lower limit position sensor will not send out the signal capable of stopping rotation of the motor, the motor will continue rotating and drive the upper cover 120 to go on moving down, and thus the upper surface of the upper cover 120 is separated from the lower surface of the baffle plate 113.

The upper cover 120 continues moving down, and the distance between the upper surface of the upper cover 120 and the lower surface of the baffle plate 113 continues increasing. When the lower limit position sensor detects that the upper cover 120 reaches the lower limit position, the lower limit position sensor sends out the signal capable of stopping rotation of the motor, the motor stops rotating, and thus the upper cover 120 stops moving.

When the upper cover 120 moves up from the lower limit position, since there is a certain distance (i.e., the second distance) between the upper surface of the upper cover 120 and the lower surface of the baffle plate 113, the upper cover 120 moves up first, and at this time, the baffle plate 113 and the spray head 111 do not move along with the upper cover 120.

During the ascent of the upper cover 120, when the upper cover 120 ascends by the second distance, the upper surface of the upper cover 120 contacts the lower surface of the baffle plate 113. Afterwards, if the upper cover 120 continues moving up, it will drive the baffle plate 113 and the spray head 111 to move up together, so that the pillars 114 on the spray head 111 leave the upper surface of the outer wall of the quartz chamber 400, and as the upper cover 120 continues moving up, the distance between the pillars 114 and the upper surface of the outer wall of the quartz chamber 400 increases gradually.

Subsequently, the upper cover 120 continues moving up to reach the upper limit position. The upper limit position sensor detects that the upper cover 120 reaches the upper limit position, and sends out the signal capable of stopping rotation of the motor, the motor stops rotating, and the upper cover 120 stops moving accordingly.

The deionized water flows into the inner cavity of the spray head 111 via the water inlet pipe 112, and is sprayed onto the outer wall of the quartz chamber 400

from the water outlet end surface of the spray head 111 to reduce the temperature of the quartz chamber 400.

As another technical aspect, the present invention further provides a process apparatus including a quartz chamber and a cap device, the cap device is mounted above the quartz chamber and may be implemented as the cap device provided by any of the above embodiments of the present invention. The structure and the working process of the cap device are similar to those described in the forgoing embodiments, and are thus not repeatedly described here.

In summary, in the cap device and the process apparatus provided by the embodiments of the present invention, the upper cover and the water spraying and cooling part are configured to separate from each other, and in the first distance of the upper cover, the upper surface of the upper cover contacts the lower surface of the baffle plate of the water spraying and cooling part, and the water spraying and cooling part is supported by the upper cover and driven by the upper cover to move in the vertical direction; in the second distance of the upper cover, the spray head of the water spraying and cooling part is supported by the upper surface of the outer wall of the quartz chamber, the upper surface of the upper cover is separated from the lower surface of the baffle plate of the water spraying and cooling part, and at this time, the water spraying and cooling part remains at static state and does not move with the movement of the upper cover in the vertical direction. In this way, when the spray head of the water spraying and cooling part has contacted the upper surface of the outer wall of the quartz chamber (i.e., when the pillars have contacted the upper surface of the outer wall of the quartz chamber, in the case that the spray head is provided with the pillars), and the upper cover has not reached the lower limit position yet and is driven by the motor to continue moving down, or the upper cover has reached the lower limit position but the motor continues rotating and drives the upper cover to continue moving down due to the failure of the lower limit position sensor, because the upper surface of the upper cover has separated from the lower surface of the baffle plate of the water spraying and cooling part, and the water spraying and cooling part is supported by the upper surface of the outer wall of the quartz chamber

instead of the upper surface of the upper cover, the water spraying and cooling part does not generate power for continuously moving down, and thus will not exert a pressure greater than its own weight onto the quartz chamber. Therefore, the quartz chamber will not be damaged as being subjected to a large pressure, and the service life of the quartz chamber cooperating with the cap device is thus prolonged.

The above embodiments merely represent some of the embodiments of the present invention. They are described in detail, but cannot therefore be construed as limiting the patent scope of the present invention. It should be noted that, for a person of ordinary skill in the art, various modifications and improvements may be made without departing from the concept of the present invention, and these modifications and improvements also belong to the protection scope of the present invention. Therefore, the protection scope of the present invention should be defined by the appended claims.

CLAIMS:

1. A cap device, comprising a water spraying and cooling part and an upper cover, characterized in that:

the water spraying and cooling part and the upper cover are structures separated from each other, and the water spraying and cooling part is able to move in a vertical direction along with the upper cover.

2. The cap device according to claim 1, characterized in that:

the water spraying and cooling part includes a water inlet pipe, a spray head and a baffle plate, the spray head has a shower head structure, the water inlet pipe is connected to an inner cavity of the spray head and fixed to the baffle plate, and the baffle plate is located above the spray head.

3. The cap device according to claim 2, characterized in that:

the upper cover is provided with a channel, orthographic projection of the baffle plate on an upper surface of the upper cover completely covers orthographic projection of the channel on the upper surface of the upper cover, the orthographic projection of the channel on the upper surface of the upper cover completely covers orthographic projection of the spray head on the upper surface of the upper cover, a minimum diameter of the channel is larger than a maximum diameter of the spray head, and a maximum diameter of the channel is smaller than a maximum diameter of the baffle plate; and

the upper cover is provided below the baffle plate, and the baffle plate is able to be supported by the upper surface of the upper cover, so that the baffle plate, the water inlet pipe and the spray head are able to move in the vertical direction along with the upper cover.

4. The cap device according to claim 2, characterized in that:

the water spraying and cooling part further includes a pillar provided on a water

outlet end surface of the spray head.

5. The cap device according to claim 4, characterized in that:

there are a plurality of pillars, the water outlet end surface of the spray head is provided thereon with a plurality of mounting holes for mounting the plurality of pillars, and the plurality of pillars are movably mounted in the plurality of mounting holes.

6. The cap device according to claim 4, characterized in that:

there are a plurality of pillars, which are fixedly mounted on the spray head; or

there are a plurality of pillars, the water outlet end surface of the spray head is provided thereon with a plurality of mounting holes for mounting the plurality of pillars, and the plurality of pillars are fixedly mounted in the plurality of mounting holes.

7. A process apparatus, comprising a quartz chamber and a driving mechanism, characterized in that: the process apparatus further comprises the cap device according to any one of claims 1 to 6, and the cap device is mounted above the quartz chamber;

the driving mechanism is connected to the upper cover in the cap device, and is used for driving the upper cover to move in the vertical direction; and

moving distance of the upper cover in the vertical direction is greater than or equal to movable distance of the water spraying and cooling part in the vertical direction.

8. The process apparatus according to claim 7, characterized in that:

the moving distance of the upper cover in the vertical direction includes a first distance, and at a terminal point of the first distance, the water spraying and cooling part in the cap device reaches a stop position of the water spraying and cooling part and is supported by the outer wall of the quartz chamber; and

at time points of the first distance other than the terminal point, the water

spraying and cooling part is supported by the upper cover, and motion states of the water spraying and cooling part and the upper cover are consistent; wherein

the first distance refers to the movable distance of the water spraying and cooling part in the vertical direction.

9. The process apparatus according to claim 8, characterized in that: the moving distance of the upper cover in the vertical direction further includes a second distance, in which the water spraying and cooling part and the upper cover are separated from each other in the vertical direction; and

at a terminal point of the second distance, the upper cover reaches a lower limit position of the upper cover; at time points of the second distance other than the terminal point, the water spraying and cooling part is at static state, and the upper cover is at moving state; wherein

the second distance refers to a distance between the stop position of the water spraying and cooling part and the lower limit position of the upper cover.

10. The process apparatus according to claim 7, characterized in that: the driving mechanism includes a motor.

11. The process apparatus according to claim 7, characterized in that: the process apparatus further comprises:

an upper limit position sensor, used for detecting whether or not the upper cover reaches an upper limit position, and outputting a signal capable of stopping operation of the driving mechanism when detecting that the upper cover reaches the upper limit position; and

a lower limit position sensor, used for detecting whether or not the upper cover reaches a lower limit position, and outputting the signal capable of stopping operation of the driving mechanism when detecting that the upper cover reaches the lower limit position.