

SEMICONDUCTOR PROCESS DEVICE, PROCESS CHAMBER THEREOF, AND TRAY DETECTION METHOD

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TECHNICAL FIELD

[0001] The present disclosure relates to the field of semiconductor manufacturing technology, and in particular, to a semiconductor process device, a process chamber, and a tray detection method.

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BACKGROUND

[0002] In a manufacturing process of a semiconductor wafer, an epitaxial growth process is an important step. The epitaxial growth process refers to growing a single crystal layer on a surface of the wafer to extend crystals on the surface of the wafer, the single crystal layer meeting a certain requirement and having the same crystal orientation as the wafer.

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[0003] In an existing art, an epitaxial growth device includes a tray, an upper heating body, and a lower heating body. The tray is disposed between the upper heating body and the lower heating body, and is heated by the upper heating body and the lower heating body together, and the tray has a rotation function, so that the wafer placed on the tray can be uniformly heated through rotation of the tray. Since the upper heating body and the lower

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heating body are wrapped in the heat insulation felt, an infrared pyrometer cannot be directly installed above the tray to detect a temperature of the tray. Since the temperature and a rotational speed of the tray are closely related to uniformity of an epitaxial film of the wafer, the epitaxial growth device is further provided with a temperature measuring device for detecting the temperature of the tray and a speed measuring device for detecting the rotational speed of the tray. However, the temperature measuring device and the speed measuring device may cause a complicated structure of the epitaxial growth device.

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SUMMARY

[0004] The present disclosure provides a semiconductor process device, a process chamber, and a tray detection method, which can achieve detection of a temperature and a rotational speed of a tray at the same time and simplify structural layout of the device.

5 [0005] In order to solve the above problems, the following technical solutions are adopted in the present disclosure.

[0006] In a first aspect, the present disclosure provides a process chamber of a semiconductor process device, including a process cavity, a tray disposed in the process cavity, a first heating body, a rotating shaft assembly, and an infrared thermometer
10 disposed outside the process cavity, wherein:

the first heating body includes a first heating plate;

the tray is rotatably disposed on a top surface of the first heating plate;

the rotating shaft assembly includes a rotating shaft and a temperature marker, the rotating shaft penetrates through the first heating plate, and is in rotation fit with the first
15 heating plate, a first end of the rotating shaft is connected to the tray to enable the rotating shaft to rotate along with the tray, and a second end of the rotating shaft extends to protrude from a bottom surface of the first heating plate; and

the temperature marker is disposed at the second end of the rotating shaft, and is capable of rotating along with the rotating shaft; and the infrared thermometer is configured to
20 detect a temperature of the temperature marker which rotates to a preset temperature detection position, so as to periodically obtain the temperature of the temperature marker.

[0007] In a second aspect, the present disclosure provides a semiconductor process device, including the process chamber described in the first aspect of the present disclosure.

[0008] In a third aspect, the present disclosure provides a tray detection method applied
25 to the process chamber described in the first aspect of the present disclosure, including:

starting the infrared thermometer, and periodically receiving the temperature of the temperature marker, which is detected by the infrared thermometer when the temperature marker rotates to the preset temperature detection position, as a temperature of the tray;

comparing all temperatures of the temperature marker obtained during a detection time,
30 and determining stability of the temperature of the tray according to all the temperatures of the temperature marker; and

calculating a rotational speed of the tray according to a number of acquisition times of the temperature of the tray in a unit time.

[0009] The technical solutions adopted in the present disclosure can produce the following beneficial effects.

5 [0010] In the semiconductor process device and the process chamber thereof disclosed in the present disclosure, with the configuration that the first end of the rotating shaft is connected to the tray and the second end of the rotating shaft extends to protrude from the bottom surface of the first heating plate, it can be ensured that the tray is in rotation fit with the first heating plate through the rotating shaft. Since the temperature marker is
10 disposed at the second end of the rotating shaft, the temperature marker can perform circumferential rotation along with the rotating shaft.

[0011] When the temperature of the tray is detected, along with the rotation of the temperature marker, the infrared thermometer can periodically detect the temperature of the temperature marker at the preset temperature detection position, so as to periodically
15 obtain the temperature of the tray. Then, the stability of the temperature of the tray is determined according to all the temperatures of the temperature marker obtained within the detection time, so as to achieve accurate temperature measurement of the tray and perform detection of a heating environment simultaneously.

[0012] Meanwhile, when the rotational speed of the tray is detected, the rotational speed
20 of the tray can be calculated based on the number of acquisition times of the temperature of the tray in the unit time.

[0013] Compared with the existing art, the infrared thermometer provided in the present disclosure can not only be configured to detect the temperature of the tray, but also be used as a detection device for detecting the rotational speed of the tray, so that an
25 additional speed measuring device is not needed, which effectively simplifies the structural layout of the device.

BRIEF DESCRIPTION OF DRAWINGS

[0014] The drawings described here are intended to provide a further understanding of the
30 present disclosure and constitutes a part of the present disclosure. The exemplary embodiments of the present disclosure and the description thereof are intended to explain

the present disclosure, but do not constitute improper limitation to the present disclosure.
In the drawings:

[0015] FIG. 1 is a sectional view of a process chamber according to an embodiment of the present disclosure;

5 [0016] FIG. 2 is a schematic diagram illustrating a matching relationship between a tray and a rotating shaft according to an embodiment of the present disclosure;

[0017] FIG. 3 is a schematic structural diagram of a first heating plate according to an embodiment of the present disclosure;

10 [0018] FIG. 4 and FIG. 5 are schematic diagrams illustrating operation principles of a process chamber in different operation states according to an embodiment of the present disclosure;

[0019] FIG. 6 is a schematic diagram illustrating a relationship between a temperature detected by an infrared thermometer and time according to an embodiment of the present disclosure;

15 [0020] FIG. 7 is a sectional view of a first heating plate according to an embodiment of the present disclosure;

[0021] FIG. 8 is a top view of a first heating plate according to an embodiment of the present disclosure;

[0022] FIG. 9 is a sectional view taken along line A-A of FIG. 8;

20 [0023] FIG. 10 is a schematic structural diagram of a tray according to an embodiment of the present disclosure; and

[0024] FIG. 11 is a partially enlarged view of FIG. 1.

[0025] Description of the reference numerals:

100-process cavity,

25 200-tray, 210-driving part, 220-annular fitting part,

300-first heating plate, 310-inlet sub-flow channel, 320-distribution sub-flow channel, 330-first conveyance sub-flow channel, 340-second conveyance sub-flow channel, 350-gas outlet flow channel, 360-through hole, 361-first annular step groove, 362-second annular step groove, 370-accommodating groove, 301-gas inlet, 302-gas outlet, 303-through hole, 304-sealing member, 305-first gas outlet sub-flow channel, 306-second gas outlet sub-flow channel, 307-third gas outlet sub-flow channel,

400-rotating shaft assembly, 410-rotating shaft, 420-temperature marker, 421-blade, 422-impeller, 401-fastener,

500-infrared thermometer, 600-shaft sleeve, 700-second heating body,
S-process space.

DETAIL DESCRIPTION OF EMBODIMENTS

5 [0026] In order to make the objectives, technical solutions and advantages of the present disclosure clearer, the technical solutions of the present disclosure are clearly and thoroughly described below with reference to the drawings and the embodiments of the present disclosure. Apparently, the embodiments described herein are some embodiments of the present disclosure, and do not cover all embodiments. All other embodiments
10 derived by those of ordinary skill in the art from the embodiments described herein without any inventive work belongs to the scope of the present disclosure.

[0027] In the related art, a temperature measurement hole which points to an axial direction of the heating body is formed in the upper heating body, and an infrared thermometer indirectly obtains the temperature of the tray by detecting a temperature of
15 the temperature measurement hole, but since the tray is heated by the upper heating body and the lower heating body together, stability of an ambient temperature of the lower heating body also needs to be monitored to indirectly obtain the temperature of the tray.

[0028] The technical solutions provided in the embodiments of the present disclosure are described in detail below with reference to the drawings.

20 [0029] In order to solve the technical problem in the related art that the complicated structure is caused due to separate configuration of the temperature measuring device and the speed measuring device in the epitaxial growth device, an embodiment of the present disclosure provides a process chamber of a semiconductor process device.

[0030] Referring to FIG. 1 to FIG. 11, the process chamber disclosed in the embodiment
25 of the present disclosure includes a process cavity 100, a tray 200, a first heating body, a rotating shaft assembly 400, and an infrared thermometer 500.

[0031] The process cavity 100 is a basic component of the process chamber and may provide a mounting base. The tray 200, the first heating body, and the rotating shaft assembly 400 are disposed in the process cavity 100. A process space S is formed in the
30 process cavity 100, and provides a process environment for a wafer to be processed. Meanwhile, in order to maintain a high-temperature process environment inside the process cavity 100, the process chamber may further include heat insulation felt disposed

outside the process cavity 100, an induction coil is disposed around and outside the heat insulation felt, and performs induction heating on the first heating body, so that the first heating body may provide the high-temperature process environment for the tray 200 and an interior of the process cavity 100.

5 [0032] The tray 200 is used for placement of the wafer to be processed, that is, the tray 200 bears the wafer during a process. During the process, the wafer needs to be kept in a high temperature state, for example, a temperature of the process environment can reach 1500°C to 1800°C in a silicon epitaxial growth process. In order to guarantee the stable high-temperature process environment, the process space S is heated by the heating body.

10 [0033] In the embodiment of the present disclosure, the tray 200 is rotatably disposed on a top surface of a first heating plate 300, that is, the tray 200 and the first heating plate 300 may perform relative rotation.

[0034] The rotating shaft assembly 400 includes a rotating shaft 410 and a temperature marker 420, the rotating shaft 410 penetrates through the first heating plate 300, and is in rotation fit with the first heating plate 300; a first end of the rotating shaft 410 is connected to the tray 200, so that the rotating shaft 410 may rotate along with the tray 200; and a second end of the rotating shaft 410 extends to protrude from a bottom surface of the first heating plate 300.

20 [0035] The first heating plate 300 may bear the tray 200, the tray 200 and the rotating shaft 410 may move synchronously, and the tray 200 may rotate relative to the first heating plate 300 through the rotating shaft 410. Since the rotating shaft 410 penetrates through the first heating plate 300, the rotating shaft 410 and the first heating plate 300 have a mutual limiting relationship, which optimizes installation reliability between the tray 200 and the first heating plate 300. Further, the top surface of the first heating plate 300 may be provided with an accommodating groove 370 for placement of the tray 200, which may further optimize the installation reliability of the tray 200; and the accommodating groove 370 may be a circular groove.

30 [0036] Meanwhile, since the second end of the rotating shaft 410 extends to protrude from the bottom surface of the first heating plate 300, “to protrude from” here means that the second end of the rotating shaft 410 extends out of the bottom surface of the first heating plate 300, and the bottom surface of the first heating plate 300 is away from the process space S, that is, the second end of the rotating shaft 410 extends out of the process space S, but is still located inside the process cavity 100, as shown in FIG. 1 to FIG. 3.

[0037] In the embodiment of the present disclosure, the temperature marker 420 is disposed at the second end of the rotating shaft 410, and may rotate along with the rotating shaft 410; and the infrared thermometer 500 is configured to detect a temperature of the temperature marker 420, and the temperature marker 420 is configured to rotate to a preset temperature detection position to be detected by the infrared thermometer 500, so that the temperature of the temperature marker 420 may be periodically obtained.

[0038] It should be understood that the infrared thermometer 500 is disposed outside the process chamber, so as to be prevented from being damaged due to a high temperature if disposed inside the process cavity. The infrared thermometer 500 may detect the temperature of the temperature marker 420 which rotates to the preset temperature detection position through, for example, a detection window disposed at the process cavity 100. While measuring a temperature of the tray 200, since the rotating shaft 410 and the tray 200 conduct heat to each other, infrared energy radiated from the second end of the rotating shaft 410 may be directly detected by the infrared thermometer 500, that is, the temperature of the tray 200 may be indirectly detected, which, compared with the solution of the related art that the temperature of the tray is indirectly obtained by detecting the temperature of the heating body, significantly and effectively improves detection accuracy of the temperature of the tray 200. In the embodiment of the present disclosure, since the temperature marker 420 is disposed at the second end of the rotating shaft 410, the infrared thermometer 500 can achieve detection of the temperature of the tray 200 inside the process space S by detecting the temperature of the temperature marker 420 outside the process space S, and can also detect an ambient temperature of the first heating body.

[0039] The temperature marker 420 performs circumferential rotation along with the rotation of the rotating shaft 410 and the tray 200, so that the temperature marker 420 may periodically rotate to a position corresponding to the infrared thermometer 500, that is, the preset temperature detection position, and the infrared thermometer 500 may periodically detect the temperature of the temperature marker 420, thereby periodically obtaining the temperature of the tray. Then, stability of the temperature of the tray 200 is determined according to all the temperatures of the temperature marker 420 obtained within a detection time, so as to realize accurate temperature measurement of the tray 200.

[0040] Meanwhile, when detecting a rotational speed of the tray 200, the rotational speed of the tray 200 may be calculated based on the number of acquisition times of the temperature of the tray 200 in a unit time.

[0041] In a case where the tray 200 rotates, the temperature marker 420 passes the preset temperature detection position during the rotation, and the number of acquisition times may be added by 1 each time the temperature marker 420 passes the preset temperature detection position. It should be noted that the number of acquisition times of the temperature of the temperature marker 420 by the infrared thermometer 500 may be represented by temperature data detected by the infrared thermometer 500. As shown in FIG. 6, in a schematic diagram illustrating a relationship between the temperature detected by the infrared thermometer 500 and time, a sudden temperature change detected by the infrared thermometer 500 may be a sudden change from a peak temperature to a trough temperature, or a sudden change from the trough temperature to the peak temperature, and the number of times of occurrences of the peak temperature during the detection time is recorded as the number of acquisition times.

[0042] With such structural layout, a circumferential region of the second end of the rotating shaft 410 is evenly divided by the temperature marker 420, and in a case where the temperature marker 420 is a single structure, the circumferential region of the second end of the rotating shaft 410 is a 360° integral region. In this way, as long as the number of acquisition times of the temperature of the temperature marker 420 in the unit time is detected, the number of evenly divided portions of the region covered by the rotation of the temperature marker 420 may be obtained, and the number of the evenly divided portions may represent the rotational speed of the rotating shaft 410, thereby representing the rotational speed of the tray 200.

[0043] The process chamber further includes a control system including a reading unit, and the reading unit may read the number of acquisition times of the temperature detected by the infrared thermometer 500 in the unit time, i.e., the number of acquisition times of the tray 200 detected in the unit time. Then, the control system calculates the rotational speed of the tray 200 based on the number of acquisition times. For convenience of calculation, the control system may take a complete peak temperature interval and trough temperature interval as a calculation unit.

[0044] Exemplarily, a rotation angle of the tray 200 in the unit time may be obtained by multiplying a ratio of the number of acquisition times to the number of marking structures (e.g., blades) included in the temperature marker 420 by 2π , so as to obtain the rotational speed of the tray 200. Reference may be made to the formula $\omega = 2n\pi/mT$ for the above calculation process, where ω denotes an angular velocity of the tray 200, n denotes the

number of acquisition times, and m denotes the number of the marking structures (e.g., blades) included in the temperature marker 420.

[0045] Compared with the related art, the infrared thermometer 500 provided in the embodiment of the present disclosure can not only be configured to detect the temperature of the tray 200, but also be used as a detection device for detecting the rotational speed of the tray 200, so that an additional speed measuring device is not needed, which effectively simplifies the structural layout of the device. A type of the temperature marker 420 is not limited in the embodiment of the present disclosure, for example, the temperature marker 420 may include a protrusion provided on a circumferential sidewall of the second end of the rotating shaft 410.

[0046] In another embodiment, as shown in FIG. 1 to FIG. 5, the temperature marker 420 may include a plurality of blades 421, which are evenly arranged along a circumferential direction of the rotating shaft 200.

[0047] With such structural layout, a detection path of the infrared thermometer 500 and the rotating shaft 410 are arranged in a staggered manner. The preset temperature detection position is on the detection path of the infrared thermometer 500, the blades 421 may be sequentially rotated to the preset temperature detection position and have the temperatures thereof detected by the infrared thermometer 500, and the obtained temperatures are the peak temperature, as shown in FIG. 5; and when the blades 421 deviate from the detection path of the infrared thermometer 500, the temperatures detected by the infrared thermometer 500 is the trough temperature, as shown in FIG. 4.

[0048] As shown in FIG. 2 and FIG. 11, the temperature marker 420 includes an impeller 422 disposed at the second end of the rotating shaft 410, the impeller 422 is sleeved on the rotating shaft 410, the blades 421 are connected to the impeller 422 and distributed along a circumferential direction, and the second end of the rotating shaft 410 may be provided with a fastener 401 for limiting the impeller 422.

[0049] In an alternative embodiment, as shown in FIG. 8 to FIG. 10, the first heating plate 300 is provided therein with a gas flow channel, which includes a gas outlet flow channel 350 configured to convey a driving gas, the first heating plate 300 includes a gas outlet 302 disposed at the top surface thereof, and the gas outlet 302 is communicated with the gas outlet flow channel 350 and disposed correspondingly with the tray 200; and the tray 200 includes a driving part 210 disposed at a bottom surface thereof, and the driving gas

output through the gas outlet 302 may drive the tray 200 to rotate by pushing the driving part 210.

[0050] With such structural layout, the driving gas input into the gas flow channel may be output through the gas outlet flow channel 350 and the gas outlet 302, and may apply a driving action on the bottom surface of the tray 200; and due to the existence of the driving part 210, the driving gas may drive the tray 200 to rotate by driving the driving part 210. As can be seen, the tray 200 provided in the embodiment of the present disclosure adopts a gas-driven solution, which can avoid a disadvantage of a conventional solution of driving the tray 200 by a motor that a high temperature is hardly withstood. In addition, in the structural layout between the tray 200 and the first heating plate 300, the driving action of the driving gas on the tray 200 has a vertical component which may drive the tray 200 to float by a distance, so that the tray 200 is separated from the first heating plate 300, which facilitates the rotation of the tray 200. The driving action of the driving gas on the tray 200 has a horizontal component which may drive the tray 200 to rotate.

[0051] A configuration of the driving part 210 is not limited in the embodiment of the present disclosure, and the driving part 210 may be a groove or a protrusion. In a case where the driving part 210 is the groove, the driving gas applies the driving action by pushing a wall of the groove; and in a case where the driving part 210 is the protrusion, the driving gas applies the driving action by pushing a sidewall of the protrusion.

[0052] In an alternative embodiment, as shown in FIG. 10, the driving part 210 is a strip-shaped groove with a relatively large extension length, so that an action area of the driving gas on the wall of the strip-shaped groove can be increased, thereby improving driving efficiency. In order to further optimize a driving effect of the driving gas on the strip-shaped groove, a plurality of driving parts 210 may be provided, which can further increase the action area of the driving gas; all the strip-shaped grooves may be obliquely disposed around the rotating shaft 410, which can increase a driving action of the driving gas applied along a circumferential direction of the tray 200; and moreover, the plurality of strip-shaped grooves may be configured to have the same inclination direction, which can avoid interference caused by reverse arrangement of the strip-shaped grooves, and enable the driving gas to apply a co-directional driving action more easily.

[0053] Further, the plurality of strip-shaped grooves are symmetrically arranged around a center of the tray 200.

[0054] In a case where that the driving part 210 is the groove, the driving part 210 may be a spiral groove. In a case where the driving part 210 is the protrusion, the driving part 210 may be a convex strip, a spiral protrusion, or the like.

[0055] In an alternative embodiment, as shown in FIG. 8, the first heating plate 300 includes at least three gas outlets 302, and the at least three gas outlets 302 are evenly distributed along a circumferential direction of a central axis of the tray 200. With such layout, based on the principle that three points create a surface, the driving gas output from the at least three gas outlets 302 may form at least three action zones on the bottom surface of the tray 200, which, compared with the solutions of one or two action zones, can effectively improve driving stability and reliability of the tray 200.

[0056] The number of the gas outlets 302 is not particularly limited in the embodiment of the present disclosure; and in addition to the case illustrated by FIG. 8 where the number of the gas outlets 302 is three, the number of the gas outlets 302 may be one, two, four, five or more.

[0057] In an alternative embodiment, as shown in FIG. 7 to FIG. 9, the gas flow channel further includes a gas inlet flow channel, one end of the gas inlet flow channel is configured to be communicated with an external gas source, and the other end of the gas inlet flow channel is communicated with the gas outlet flow channel, so as to convey the driving gas into the gas outlet flow channel. The gas inlet flow channel is arranged on a horizontal plane, and the gas outlet flow channel 350 is obliquely disposed relative to a vertical direction. With such structural layout, through the oblique arrangement relative to the vertical direction, the gas outlet flow channel 350 may convey the driving gas, which is conveyed in the gas inlet flow channel on the horizontal plane, upwards to be output through the gas outlet 302, and a gas outgoing direction is arranged to form a preset included angle with the tray 200, so as to drive the tray 200 to rotate. Certainly, a matching relationship between the gas outlet flow channel 350 and the gas inlet flow channel is not limited in the embodiment of the present disclosure; and the gas outlet flow channel 350 may be an arc-shaped flow channel, which may also convey the driving gas conveyed on the horizontal plane upwards to be output through the gas outlet 302, with a gas outgoing direction arranged to form a preset included angle with the tray 200.

[0058] With such structural layout, since the gas outlet flow channel 350 is a linear flow channel, an axis of the gas outlet flow channel 350 is collinear with an axis of the gas outlet 302; and the linear flow channel facilitates direct processing and molding, so that

an inclination angle of the axis of the gas outlet flow channel relative to the central axis of the tray 200 can be easily set for cooperation with the driving part 210 at the bottom surface of the tray 200 to optimize the driving effect of the driving gas.

[0059] An included angle between the axis of the gas outlet flow channel 350 and the central axis of the tray 200 is α , and the included angle is an obtuse angle, and directly affects the inclination of the gas outlet flow channel 350. The included angle may be 120° , 130° , 140° , or the like.

[0060] Further, the gas inlet flow channel includes an inlet sub-flow channel, a distribution sub-flow channel, and a plurality of conveyance sub-flow channels. A first end of the inlet sub-flow channel is configured to be communicated with the external gas source, a second end of the inlet sub-flow channel is communicated with a gas inlet end of the distribution sub-flow channel, and the distribution sub-flow channel is provided with a plurality of gas outlet ends; gas inlet ends of the plurality of conveyance sub-flow channels are communicated with the plurality of gas outlet ends of the distribution sub-flow channel in a one-to-one correspondence manner; the top surface of the first heating plate is provided with at least three gas outlets 302, and the gas outlet flow channel 350 includes at least three gas outlet sub-flow channels, which are communicated with the gas outlets 302 in a one-to-one correspondence manner; and a gas outlet end of each conveyance sub-flow channel is communicated with one of the gas outlet sub-flow channels. With such structural layout, the external gas source may supply the driving gas into the inlet sub-flow channel, the driving gas may be evenly distributed through the distribution sub-flow channel, the driving gas may be then respectively conveyed to the plurality of conveyance sub-flow channels, then conveyed through each conveyance sub-flow channel to the gas outlet sub-flow channel communicated therewith, and finally output through the gas outlet 302 communicated with the gas outlet sub-flow channel. Such structural layout can prevent the different gas outlets 302 from outputting the driving gas varying in amount, so as to optimize uniformity of the drive action applied by the driving gas on the tray 200.

[0061] In an exemplary embodiment, as shown in FIG. 7 to FIG. 9, the gas inlet flow channel includes an inlet sub-flow channel 310, a distribution sub-flow channel 320, a first conveyance sub-flow channel 330, and a second conveyance sub-flow channel 340. The inlet sub-flow channel 310 extends along a first horizontal direction (i.e., a vertical direction in FIG. 7), an extension direction of the distribution sub-flow channel 320 is

perpendicular to the first horizontal direction (that is, perpendicular to the vertical direction in FIG. 7), a first end of the inlet sub-flow channel 310 is communicated with an external gas source through a gas inlet 301, a second end of the inlet sub-flow channel 310 is communicated with the distribution sub-flow channel 320, for example, the second
5 end of the inlet sub-flow channel 310 is communicated with a gas inlet end located in the middle of the distribution sub-flow channel 320, so as to enable the driving air entering the distribution sub-flow channel 320 to reach two gas outlet ends of the distribution sub-flow channel 320 by the same distance after being divided. Two conveyance sub-flow channels are provided and are respectively the first conveyance sub-flow channel 330 and
10 the second conveyance sub-flow channel 340, which are respectively communicated with the two gas outlet ends of the distribution sub-flow channel 320, and the first conveyance sub-flow channel 330 and the second conveyance sub-flow channel 340 are symmetrically arranged relative to the inlet sub-flow channel 310; one end of each of the distribution sub-flow channel 320, the first conveyance sub-flow channel 330, and the second
15 conveyance sub-flow channel 340 is provided with a through hole 303 at an outer surface of the first heating plate 300, and each through hole 303 is provided with a sealing member 304; and three gas outlets 302 are provided and are evenly distributed along the circumferential direction of the central axis of the tray 200. Three gas outlet sub-flow channels are provided and are respectively a first gas outlet sub-flow channel 305, a
20 second gas outlet sub-flow channel 306, and a third gas outlet sub-flow channel 307, the first gas outlet sub-flow channel 305 is communicated with the inlet sub-flow channel 310, the second gas outlet sub-flow channel 306 is communicated with the first conveyance sub-flow channel 330, the third gas outlet sub-flow channel 307 is communicated with the second conveyance sub-flow channel 340, and the first gas outlet sub-flow channel 305,
25 the second gas outlet sub-flow channel 306, and the third gas outlet sub-flow channel 307 are respectively communicated with the three gas outlets 302 in a one-to-one correspondence manner.

[0062] With such structural layout, the external gas source may supply the driving gas into the inlet sub-flow channel 310, the driving gas may be evenly distributed through the
30 distribution sub-flow channel 320, and the driving gas may be then respectively conveyed to the first conveyance sub-flow channel 330 and the second conveyance sub-flow channel 340. In the inlet sub-flow channel 310, the driving gas may be output through the first gas outlet sub-flow channel 305 and the corresponding gas outlet 302; in the first conveyance

sub-flow channel 330, the driving gas may be output through the second gas outlet sub-flow channel 306 and the corresponding gas outlet 302; and in the second conveyance sub-flow channel 340, the driving gas may be output through the third gas outlet sub-flow channel 307 and the corresponding gas outlet 302. Such structural layout can prevent the different gas outlets 302 from outputting the driving gas varying in amount, so as to optimize the uniformity of the drive action applied by the driving gas on the tray 200.

[0063] The distribution sub-flow channel 320, the first conveyance sub-flow channel 330, and the second conveyance sub-flow channel 340 can be easily processed based on the through holes 303, and the sealing members 304 can guarantee airtightness of the distribution sub-flow channel 320, the first conveyance sub-flow channel 330, and the second conveyance sub-flow channel 340. The sealing member 304 may be a gas-channel blocking wire, sealing rubber, or the like.

[0064] Certainly, a formation mode of the gas inlet flow channel in the first heating plate 300 is not limited in the embodiment of the present disclosure. In another embodiment, the first heating plate 300 may include a first heating sub-plate and a second heating sub-plate, gas inlet grooves are formed on a lower surface of the first heating sub-plate and on an upper surface of the second heating sub-plate, the gas inlet grooves on the lower surface of the first heating sub-plate are opposite to the gas inlet grooves on the upper surface of the second heating sub-plate, and the first heating sub-plate and the second heating sub-plate are assembled, so that the oppositely arranged gas inlet grooves may form the complete inlet sub-flow channel 310, the complete distribution sub-flow channel 320, the complete first conveyance sub-flow channel 330, and the complete second conveyance sub-flow channel 340. With such structural layout, the above through holes 303 are not needed.

[0065] In an alternative embodiment, the axes of the at least three gas outlets 302 are all obliquely arranged around the rotating shaft 410, and have the same inclination direction. With such structural layout, the driving gas output from each gas outlet 302 may form an included angle with the bottom surface of the tray 200 when reaching the bottom surface of the tray 200, so that it can be ensured that the driving action of the driving gas on the tray 200 has a vertical component and a horizontal component, with the vertical component being capable of driving the tray 200 to float and the horizontal component being capable of acting on the driving part 210 and driving the tray 200 to rotate.

[0066] Meanwhile, with the axes of the gas outlets 302 having the same inclination direction, it can be ensured that the axes of the gas outlets 302 have the same inclination characteristic, so that the horizontal components of the driving gas output from the different gas outlets can apply consistent driving action on the tray 200, thereby
5 optimizing the driving effect.

[0067] In an alternative embodiment, as shown in FIG. 2 and FIG. 11, the process chamber further includes a shaft sleeve 600, the first heating plate 300 is provided with a through hole 360 penetrating through the top surface and the bottom surface thereof, and the shaft sleeve 600 is sleeved outside the rotating shaft 410 and between the rotating shaft 410 and
10 a wall of the through hole 360. With such structural layout, the shaft sleeve 600 can support the rotating shaft 410 and the wall of the through hole 360, so as to prevent the rotating shaft 410 from tilting. The rotating shaft 410 is typically made of an abrasion resistant material, so that abrasion of the shaft 410 can be reduced.

[0068] Further, as shown in FIG. 11, a first annular step groove 361 is disposed in the through hole 360, and the shaft sleeve 600 is disposed in the first annular step groove 361.
15 With such structural layout, the first annular step groove 361 provides an accommodating space for the shaft sleeve 600, which can improve structural compactness. Moreover, a step surface of the first annular step groove 361 can support and limit the shaft sleeve 600.

[0069] Further, as shown in FIG. 8, FIG. 10, and FIG. 11, a second annular step groove 362 is further disposed in the through hole 360, and the second annular step groove 362 and the first annular step groove 361 are sequentially arranged from top to bottom along the through hole 360; and the tray 200 includes an annular fitting part 220 disposed at the bottom surface thereof, and the annular fitting part 220 is sleeved outside the shaft sleeve 600 and disposed in the second annular step groove 362.
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[0070] With such structural layout, the through hole 360 is a multi-stage step hole, the second annular step groove 362 provides an accommodating space for the annular fitting part 220, and the annular fitting part 220 is subjected to a radial inward limiting action applied by the shaft sleeve 600, and is also subjected to a radial outward limiting action applied by the second annular step groove 362, so that a positioning effect on the tray 200
25 is optimized.

[0071] In an alternative embodiment, the process chamber further includes a second heating body 700, a first end cap, and a second end cap; the first heating body further includes a first arc-shaped heating member connected to the first heating plate 300, the
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second heating body 700 includes a second heating plate and a second arc-shaped heating member, and the first heating body is disposed opposite to the second heating body; and the first end cap is disposed at a first end of the first heating body and a first end of the second heating body 700, the second end cap is disposed at a second end of the first heating body and a second end of the second heating body 700, and the first heating plate and the second heating plate are disposed opposite to each other, and form the process space S therebetween.

[0072] The first heating plate 300 is connected to the first arc-shaped heating member to form the semi-circular first heating body running through along an axial direction, and a first heating cavity is formed between the first heating plate and the first arc-shaped heating member; and the second heating plate is connected to the second arc-shaped heating member to form the semi-circular second heating body 700 running through along the axial direction, and a second heating cavity is formed between the second heating plate and the second arc-shaped heating member. The temperature marker 420 is disposed in the first heating cavity, and the infrared thermometer 500 may detect infrared radiation energy produced by the temperature marker 420 in the first heating cavity, so as to detect the temperature of the temperature marker 420. In this way, detection of the temperature of the tray 200 can be realized, and detection of the ambient temperature of the first heating body in the first heating cavity can also be realized.

[0073] In the embodiment of the present disclosure, the process chamber may be provided with the first heating plate 300 and the second heating plate disposed opposite to each other, the tray 200 is located in the process space S between the first heating plate 300 and the second heating plate, and the induction coil is disposed around and outside the first heating body and the second heating body 700 for performing induction heating on the first heating body and the second heating body 700. In this way, temperature uniformity of the environment where the tray 200 is located can be improved, which can facilitate improvement in epitaxial growth quality of a wafer.

[0074] An embodiment of the present disclosure further provides a semiconductor process device, including the process chamber described in any of the above embodiments. Therefore, the semiconductor process device has the beneficial effects of any of the above embodiments, which will not be described in detail here. Optionally, the semiconductor process device provided in the embodiment of the present disclosure is an epitaxial growth device. Certainly, the semiconductor process device may be a semiconductor heat

treatment device which needs detection of the temperature and the rotational speed of the tray.

[0075] An embodiment of the present disclosure further provides a detection method for the tray 200, which is applied to the process chamber described in any of the above
5 embodiments, and is used for detection of the temperature and the rotational speed of the tray 200. The detection method includes:

step S100, starting the infrared thermometer 500, and periodically receiving the temperature of the temperature marker 420, which is detected by the infrared thermometer 500 when the temperature marker 420 rotates to the preset temperature detection position,
10 as the temperature of the tray 200;

step S200, comparing all the temperatures of the temperature marker 420 obtained during the detection time, and determining the stability of the temperature of the tray 200 according to a comparison result; and

step S300, calculating the rotational speed of the tray 200 according to the number of
15 acquisition times of the temperature of the tray 200 in the unit time.

[0076] In the embodiment of the present disclosure, since the temperature marker 420 is disposed at the second end of the rotating shaft 410, the temperature marker 420 performs circumferential rotation along with the rotation of the rotating shaft 410 and the tray 200 while the rotating shaft 410 is rotating along with the tray 200, and the infrared
20 thermometer 500 may periodically detect the temperature of the temperature marker 420 at the preset temperature detection position, thereby periodically obtaining the temperature of the tray 200. Then, the stability of the temperature of the tray 200 is determined according to all the temperatures of the temperature marker 420 obtained within the detection time, so as to realize accurate temperature measurement of the tray
25 200.

[0077] Meanwhile, when detecting the rotational speed of the tray 200, the rotational speed of the tray 200 may be calculated based on the number of acquisition times of the temperature of the tray 200 in the unit time.

[0078] Exemplarily, in a case where the tray 200 rotates, the temperature marker 420
30 passes the preset temperature detection position during the rotation, and the number of acquisition times may be added by 1 each time the temperature marker 420 passes the preset temperature detection position. It should be noted that the number of acquisition times of the temperature of the temperature marker 420 by the infrared thermometer 500

may be represented by the temperature data detected by the infrared thermometer 500. Exemplarily, as shown in FIG. 6, in the schematic diagram illustrating the relationship between the temperature detected by the infrared thermometer 500 and the time, a sudden temperature change detected by the infrared thermometer 500 may be a sudden change from the peak temperature to the trough temperature, or a sudden change from the trough temperature to the peak temperature, and the number of times of occurrences of the peak temperature during the detection time is recorded as the number of acquisition times.

[0079] The rotation angle of the tray 200 in the unit time may be obtained by multiplying the ratio of the number of acquisition times to the number of the marking structures (e.g., blades) included in the temperature marker 420 by 2π , so as to obtain the rotational speed of the tray 200. Reference may be made to the formula $\omega = 2n\pi/mT$ for the above calculation process, where ω denotes the angular velocity of the tray 200, n denotes the number of acquisition times, and m denotes the number of the marking structures (e.g., blades) included in the temperature marker 420.

[0080] Compared with the related art, the infrared thermometer 500 provided in the embodiment of the present disclosure can not only be configured to detect the temperature of the tray 200, but also be used as a detection device for detecting the rotational speed of the tray 200, so that an additional speed measuring device is not needed, which effectively simplifies the structural layout of the device.

[0081] The above embodiments of the present disclosure focus on the differences between the embodiments, and different optimization features of the embodiments can be combined to form better embodiments as long as the different optimization features are not contradictory, which will not be described in detail here for conciseness of the description.

[0082] The description above is merely of the embodiments of the present disclosure, but is not intended to limit the present disclosure. Various modifications and changes may be made to the present disclosure by those of ordinary skill in the art. Any modification, equivalent replacement and improvement made within the spirit and principle of the present disclosure should be included in the scope of the appended claims of the present disclosure.

What is claimed is:

1. A process chamber of a semiconductor process device, comprising a process cavity, a tray disposed in the process cavity, a first heating body, a rotating shaft assembly, and an infrared thermometer disposed outside the process cavity, wherein:

the first heating body comprises a first heating plate;

the tray is rotatably disposed on a top surface of the first heating plate;

the rotating shaft assembly comprises a rotating shaft and a temperature marker, the rotating shaft penetrates through the first heating plate, and is in rotation fit with the first heating plate, a first end of the rotating shaft is connected to the tray to enable the rotating shaft to rotate along with the tray, and a second end of the rotating shaft extends to protrude from a bottom surface of the first heating plate; and

the temperature marker is disposed at the second end of the rotating shaft, and is capable of rotating along with the rotating shaft; and the infrared thermometer is configured to detect a temperature of the temperature marker, the infrared thermometer is configured to detect the temperature marker, which rotates to a preset temperature detection position, so as to periodically obtain the temperature of the temperature marker, and the infrared thermometer calculates a rotational speed of the tray according to a number of acquisition times of the temperature of the temperature marker in a unit time.

2. The process chamber of claim 1, wherein the temperature marker comprises a plurality of blades, which are evenly arranged along a circumferential direction of the rotating shaft.

3. The process chamber of claim 1, wherein the first heating plate is provided therein with a gas flow channel, the gas flow channel comprises a gas outlet flow channel configured to convey a driving gas, the top surface of the first heating plate is provided with a gas outlet, and the gas outlet is communicated with the gas outlet flow channel and disposed correspondingly with the tray; and the tray comprises a driving part disposed at a bottom surface of the tray, and the driving gas output through the gas outlet drives the tray to rotate by pushing the driving part.

4. The process chamber of claim 3, wherein the top surface of the first heating plate is provided with at least three gas outlets, and the at least three gas outlets are evenly distributed along a circumferential direction of a central axis of the tray.

5. The process chamber of claim 4, wherein the gas flow channel further comprises a gas inlet flow channel, the gas inlet flow channel is configured to be communicated with an external gas source, so as to convey the driving gas into the gas outlet flow channel, the gas inlet flow channel is arranged on a horizontal plane, and the gas outlet flow channel is obliquely disposed relative to a vertical direction.

6. The process chamber of claim 5, wherein the gas inlet flow channel comprises an inlet sub-flow channel, a distribution sub-flow channel, and a first conveyance sub-flow channel and a second conveyance sub-flow channel, a first end of the inlet sub-flow channel is configured to be communicated with the external gas source, a second end of the inlet sub-flow channel is communicated with the distribution sub-flow channel, and the first conveyance sub-flow channel and the second conveyance sub-flow channel are respectively communicated with two ends of the distribution sub-flow channel, and are symmetrically arranged relative to the inlet sub-flow channel; and one end of each of the distribution sub-flow channel, the first conveyance sub-flow channel, and the second conveyance sub-flow channel is provided with a through hole, and the through hole is provided with a sealing member; and

the gas outlet flow channel comprises a first gas outlet sub-flow channel, a second gas outlet sub-flow channel, and a third gas outlet sub-flow channel, the first gas outlet sub-flow channel is communicated with the inlet sub-flow channel, the second gas outlet sub-flow channel is communicated with the first conveyance sub-flow channel, the third gas outlet sub-flow channel is communicated with the second conveyance sub-flow channel, and the first gas outlet sub-flow channel, the second gas outlet sub-flow channel, and the third gas outlet sub-flow channel are respectively communicated with the gas outlets in a one-to-one correspondence manner.

7. The process chamber of claim 1, further comprising a shaft sleeve, wherein the first heating plate is provided with a through hole penetrating through the top surface and the bottom surface of the first heating plate, and the shaft sleeve is sleeved

outside the rotating shaft and located between the rotating shaft and a wall of the through hole; and

a first annular step groove is disposed in the through hole, and the shaft sleeve is located in the first annular step groove.

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8. The process chamber of claim 7, wherein a second annular step groove is further disposed in the through hole, and the first annular step groove and the second annular step groove are sequentially arranged from bottom to top along the through hole; and the tray comprises an annular fitting part disposed at a bottom surface of the tray, and the annular fitting part is sleeved outside the shaft sleeve and disposed in the second annular step groove.

9. The process chamber of claim 1, further comprising a second heating body, a first end cap, and a second end cap; wherein the first heating body further comprises a first arc-shaped heating member connected to the first heating plate, and a first heating cavity is formed between the first heating plate and the first arc-shaped heating member; the second heating body comprises a second heating plate and a second arc-shaped heating member, and a second heating cavity is formed between the second heating plate and the second arc-shaped heating member; and the first heating body is disposed opposite to the second heating body; and

the first end cap is disposed at a first end of the first heating body and a first end of the second heating body, the second end cap is disposed at a second end of the first heating body and a second end of the second heating body, the first heating plate and the second heating plate are disposed opposite to each other, and a process space is formed between the first heating plate and the second heating plate.

10. A semiconductor process device, comprising the process chamber of any one of claims 1 to 9.

11. A tray detection method applied to the process chamber of any one of claims 1 to 9, comprising:

starting the infrared thermometer, detecting by the infrared thermometer the temperature of the temperature marker when the temperature marker rotates to the

preset temperature detection position, periodically obtaining by the infrared thermometer the temperature of the temperature marker to periodically obtain a temperature of the tray;

5 comparing all temperatures of the temperature marker obtained during a detection time to determine stability of the temperature of the tray; and

calculating a rotational speed of the tray according to a number of acquisition times of the temperature of the tray in a unit time.