SUBSTRATE CLAMPING APPARATUS AND METHOD

TECHNICAL FIELD

This application relates to the technical field of semiconductor equipment, and specifically relates to a substrate clamping apparatus and a substrate clamping method.

BACKGROUND

Amid the continuous progress and development of sophisticated and state-of-the-art technology, enhanced performance and diversified types of semiconductor chips are being achieved. Wafers are of various types. According to different thicknesses, wafers can be classified into Taiko wafer (wafer with a thick ring around a thin center), thin wafer, standard wafer, thick wafer, thickened wafer, and the like; according to different diameters, wafers are mainly classified into 6-inch wafer, 8-inch wafer, 12-inch wafer, and the like; according to different materials, wafers can be classified into Si wafer, SiC wafer, GaAs wafer, and the like. Wafers of different thicknesses, sizes, and materials can withstand different external forces. Therefore, the clamping force required for different wafers during a process varies, and must be neither too large nor too small.

Existing wafer clamping apparatuses cannot automatically adjust the clamping force on a wafer, and are prone to causing damage to the wafer.

SUMMARY

The technical problem to be solved by the present invention is to overcome the defect in the prior art that the clamping force of a substrate clamping apparatus on a substrate cannot be automatically adjusted, and the present invention provides a substrate clamping apparatus and a substrate clamping method.

The present invention solves the technical problem described above through the following technical solution:

a substrate clamping apparatus, comprising:

a detection module, for acquiring the type data of a substrate;

a chuck, for placing the substrate;

an execution module, including:

a pneumatic unit, provided on the chuck, for clamping the substrate;

a main line, one end of the main line being connected to a gas source, and the other end being connected to the pneumatic unit;

a pressure regulating unit, provided on the main line, for regulating the gas pressure in the main line;

a processing module, for receiving the type data, and controlling the pressure regulating unit to regulate the gas pressure in the main line based on the type data, allowing the gas pressure to correspond to the type data.

By acquiring the type data of the substrate via the detection module, the processing module can control the pressure regulating unit of the execution module to regulate the corresponding gas pressure according to the type data of the substrate. Different gas pressures correspond to different clamping forces. In this way, the substrate clamping apparatus can automatically output a corresponding clamping force according to the substrate type. Therefore, there is no need to manually change the control parameter of the execution module according to the substrate type, thereby improving the production efficiency of the substrate. In addition, by clamping the substrate in a pneumatic manner, the clamping force of the pneumatic unit can be changed by changing the gas pressure. The control method is simple, and high-precision control of the output force of the pneumatic unit can be achieved.

A substrate clamping method, comprising:

pre-storing the correspondence between substrate type data and substrate clamping force;

acquiring the type data of a substrate;

applying a clamping force corresponding to the substrate type to the substrate according to the correspondence.

Through the method, the substrate clamping apparatus can automatically output corresponding clamping forces for different substrates, with no manual adjustment required, thereby improving the production efficiency and accuracy, and contributing to higher substrate yield.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. 1 is a system structure schematic diagram of the substrate clamping apparatus according to embodiment 1 of the present invention;

FIG. 2 is a structural schematic diagram of the chuck according to embodiment 1 of the present invention;

FIG. 3 is a structural schematic diagram of the pneumatic unit according to embodiment 1 of the present invention;

FIG. 4 is a system structure schematic diagram of the substrate clamping apparatus according to embodiment 2 of the present invention;

FIG. 5 is a system structure schematic diagram of the substrate clamping apparatus according to embodiment 3 of the present invention;

FIG. 6 is a system structure schematic diagram of the substrate clamping apparatus according to embodiment 4 of the present invention;

FIG. 7 is a system structure schematic diagram of the substrate clamping apparatus according to embodiment 5 of the present invention;

FIG. 8 is a process flow diagram of the substrate clamping method according to embodiment 6 of the present invention.

EMBODIMENTS OF THE PRESENT APPLICATION

The present invention is further described below by way of embodiments, but the present invention is not limited to the scope of the embodiments.

Embodiment 1

As shown in FIG. 1 and FIG. 2, this embodiment provides a substrate clamping apparatus, comprising a detection module 100, a chuck 400, an execution module, and a processing module 200. The detection module 100 is used for acquiring the type data of a substrate. The chuck 400 is used for placing the substrate. The execution module includes pneumatic units 310, a main line 320, and a pressure regulating unit 330. The pneumatic units 310 are provided on the chuck 400, and are used for clamping the substrate. One end of the main line 320 is connected to a gas source 700, and the other end is connected to the pneumatic units 310. The pressure regulating unit 330 is provided on the main line 320, and is used for regulating the gas pressure in the main line 320. The processing module 200 receives the type data of the substrate, and controls the pressure regulating unit 330 to regulate the gas pressure in the main line 320 according to the type data of the substrate, allowing the gas pressure to correspond to the type data of the substrate, thereby causing the pneumatic units 310 to output clamping forces corresponding to the type data of the substrate.

Specifically, the type data of the substrate includes parameters such as thickness, size, and material of the substrate. By acquiring the type data of the substrate via the detection module 100, the processing module 200 can control the pressure regulating unit 330 of the execution module to regulate the gas pressure in the main line 320 according to the type data of the substrate. Different gas pressures correspond to different clamping forces. In this way, the substrate clamping apparatus can automatically output a corresponding clamping force according to the substrate type. Therefore, there is no need to manually change the control parameter of the execution module according to the substrate type, thereby improving the production efficiency and yield of the substrate. In addition, by clamping the substrate in a pneumatic manner, the clamping forces of the pneumatic units 310 can be changed by changing the gas

pressure. The control method is simple, and high-precision control of the output force of the pneumatic units 310 can be achieved.

As an example, the substrate is placed in a substrate carrying device for transportation. The substrate carrying device is marked with the type data of the substrate currently carried. The detection module 100 acquires the type data of the substrate by reading the mark on the substrate carrying device. The mark may specifically be a barcode or an RFID tag containing the type data of the substrate. The type data of different substrates corresponds to different clamping forces, and the clamping force has a one-to-one correspondence with the gas pressure in the main line 320, so the correspondence between the type data of the substrate and the gas pressure can be obtained. The correspondence between substrate type data and gas pressure is pre-stored in the database of the processing module 200. When the processing module 200 receives the type data of the substrate, the processing module 200 can call the database to obtain the corresponding gas pressure.

Further, as shown in FIG. 3, the pneumatic unit 310 includes a cylinder 311 and an execution member 312. The cylinder 311 drives the execution member 312 to move. The execution member 312 contacts the outer edge of the substrate to clamp the substrate in the chuck 400. The pneumatic unit 310 has a simple and compact structure, thereby occupying a small space, facilitating layout in limited space, and providing simpler and more precise output force control. Wherein, as shown in FIG. 2, three pneumatic units 310 are provided, spaced apart on one side of the chuck 400. In addition, three fixing members 500 are correspondingly provided on the other side of the chuck 400. The cylinders 311 drive the execution members 312 to move, and can therefore clamp the substrate between the execution members 312 and the fixing members 500, so as to fix the substrate in the chuck 400.

In this embodiment, three pneumatic units 310 are provided, as shown in FIG. 1. Each pneumatic unit 310 is respectively connected to the main line 320 via a branch line 350. The pneumatic units 310 are arranged in a parallel structure. The plurality of pneumatic units 310 are more stable in the process of clamping the substrate. The pneumatic units 310 are arranged in a parallel structure, the gas pressures of all

pneumatic units 310 are the same, the clamping forces output by all pneumatic units 310 to the substrate are the same, and the control is more precise.

In other embodiments, the number of the pneumatic units 310 is not limited thereto, and may be only one or other numbers, provided that usage requirements are met.

In some embodiments, the pipe diameter of the branch line 350 is smaller than the pipe diameter of the main line 320, which can ensure sufficient gas flow supply and prevent pressure instability in the branch lines 350 caused by insufficient gas flow, contributing to improved output stability of the pneumatic unit 310.

In this embodiment, the execution module further includes a first valve 341. The first valve 341 is provided on the main line 320 between the pressure regulating unit 330 and the pneumatic units 310. The processing module 200 is further used for controlling the open/closed state of the first valve 341. By adding the first valve 341, the first valve 341 can be closed during the pressure regulation process of the pressure regulating unit 330 in the main line 320. When the pressure regulation is completed, the first valve 341 is opened, thereby making the clamping forces output by the pneumatic units 310 more stable.

As an example, the pressure regulating unit 330 is a pressure regulating valve. The pressure regulating valve is in communication with the processing module 200.

The communication connection may adopt one or a combination of wired communication and wireless communication, and may be specifically selected according to needs. No excessive limitation is made here.

Embodiment 2

This embodiment is basically the same as the solution of embodiment 1. The difference is that, as shown in FIG. 4, the execution module further includes a first pressure sensor 360. The first pressure sensor 360 is in communication with the processing module 200. The first pressure sensor 360 is provided on the main line 320 between the pressure regulating unit 330 and the pneumatic units 310, and is used for

measuring the gas pressure in the main line 320 after pressure regulation by the pressure regulating unit 330.

In this solution, the first pressure sensor 360 is in communication with the processing module 200, and can feed the gas pressure in the main line 320 back to the processing module 200 in real time, facilitating precise control of the pneumatic units 310 to prevent gas pressure runaway, which can otherwise cause damage to the substrate.

In this embodiment, the execution module further includes a manual on/off valve 371 and a manual pressure regulating valve 372. The manual pressure regulating valve 372 is provided on the main line 320 between the pressure regulating unit 330 and the gas source 700. The manual on/off valve 371 is provided on the main line 320 between the manual pressure regulating valve 372 and the gas source 700. The pressure of the main line 320 can be pre-regulated to an appropriate value via the manual pressure regulating valve 372, and the pressure of the main line 320 is more stable, which can prevent the influence of fluctuation of the gas source 700 on the pressure of the main line 320.

Embodiment 3

This embodiment is basically the same as the solution of embodiment 2. The difference is that, as shown in FIG. 5, in this embodiment, the execution module not only includes the first valve 341, but also includes a second valve 342. One passage of the second valve 342 is in communication with the external atmosphere, and the other passage of the second valve 342 is in communication with the main line 320 after the first valve 341. The pneumatic units 310 are connected to the main line 320 between the first valve 341 and the second valve 342. The processing module 200 is further used for controlling the open/closed state of the second valve 342.

In this solution, by opening the first valve 341 and closing the second valve 342, gas in the main line 320 can be controlled to drive the pneumatic units 310 to apply thrust to the substrate to clamp the substrate. By closing the first valve 341 and opening the second valve 342, gas in the pneumatic units 310 can flow to the external

atmosphere through the second valve 342, thereby releasing the substrate. The clamping and releasing of the substrate can be controlled only by controlling the open/closed states of the first valve 341 and the second valve 342.

Specifically, the first valve 341 and the second valve 342 are solenoid valves. The first valve 341 and the second valve 342 are respectively in communication with the processing module 200.

The communication connection may adopt one or a combination of wired communication and wireless communication, and may be specifically selected according to needs. No excessive limitation is made here.

Embodiment 4

As shown in FIG. 6, this embodiment is basically the same as the solution in embodiment 3. The difference is that, in this embodiment, the execution module further includes a control line 344. The first valve 341 and the second valve 342 are pneumatic valves. The first valve 341 and the second valve 342 are connected to the gas source 700 via the control line 344. A solenoid valve 343 is provided on the control line 344, and the solenoid valve 343 is in communication with the processing module 200. The processing module 200 controls the opening and closing of the solenoid valve 343, and can control the communication state of the control line 344, thereby controlling the working states of the first valve 341 and the second valve 342. Specifically, when the solenoid valve 343 is closed, the first valve 341 is in a closed state, the second valve 342 is opened, and gas in the pneumatic units 310 can flow to the external atmosphere through the second valve 342, thereby releasing the substrate; when the solenoid valve 343 is opened, gas in the gas source 700 can reach the first valve 341 and the second valve 342 through the solenoid valve, thereby opening the first valve 341, closing the second valve 342, and controlling gas in the main line 320 to drive the pneumatic units 310 to apply thrust to the substrate to clamp the substrate.

Specifically, both the first valve 341 and the second valve 342 are two-way two-position valves. The initial working position of the first valve 341 is the closed state, and the initial working position of the second valve 342 is an open state. The

open/closed states of the first valve 341 and the second valve 342 are always opposite, wherein the open/closed state includes the open state and the closed state. The open/closed states of the first valve 341 and the second valve 342 are always opposite, thereby enabling the first valve 341 and the second valve 342 to achieve synchronous state change via one control line.

In other embodiments, two control lines may also be respectively provided for the first valve 341 and the second valve 342 for separate control.

Embodiment 5

As shown in FIG. 7, this embodiment is basically the same as the solution in embodiment 3. The difference is that, in this embodiment, the substrate clamping apparatus further comprises second pressure sensors 380. The second pressure sensors 380 are provided on the branch lines 350. The second pressure sensors 380 are used for measuring the gas pressures in the branch lines 350. The gas pressures in the branch lines 350 are the same as the gas pressures of the cylinders 311 in the pneumatic units 310. Therefore, the gas pressures of the pneumatic units 310 can be indirectly measured via the second pressure sensors 380. The second pressure sensors 380 are connected to the processing module 200 in a wireless communication manner. By providing the second pressure sensors 380 to measure the gas pressures of the pneumatic units 310 and feed the gas pressures back to the processing module 200, when gas leakage occurs on the pneumatic unit 310, the second pressure sensors 380 will detect pressure fluctuation and feed the fluctuation back to the processing module 200. When the actual measured values of the second pressure sensors 380 exceed a preset range, a leakage alarm can be triggered.

In other embodiments, the second pressure sensors 380 and the processing module 200 may also be connected in a wired communication manner.

In this embodiment, the substrate clamping apparatus further comprises force sensors 600. The force sensors 600 are provided on the execution members 312 of the pneumatic units 310, and are used for measuring the clamping forces of the execution members 312. The force sensors 600 are connected to the processing module 200 in a

wireless communication manner. The force sensors 600 can feed the clamping forces of the execution members 312 on the substrate back to the processing module 200, thereby detecting whether the actual output clamping forces of the execution members 312 on the substrate are consistent with the theoretical clamping force.

In other embodiments, the force sensors 600 and the processing module 200 may also be connected in a wired communication manner. The arrangement position of the force sensors is not limited thereto, and the force sensors may also be provided on the fixing members on the chuck, and can also measure the actual clamping forces of the execution members on the substrate.

Embodiment 6

As shown in FIG. 8, this embodiment provides a substrate clamping method, comprising:

S10: pre-storing the correspondence between substrate type data and substrate clamping force;

S20: acquiring the type data of a substrate;

S30: applying a clamping force corresponding to the substrate type to the substrate according to the correspondence.

Through the method, a substrate clamping apparatus can automatically output corresponding clamping forces for different types of substrates, with no manual adjustment required, thereby improving the production efficiency and accuracy, and contributing to higher substrate yield.

Specifically, the substrate clamping apparatus is a chuck, and can clamp the substrate in a pneumatic clamping manner.

In this embodiment, step S20 specifically includes:

S21: marking the type data of a substrate in a substrate carrying device;

S22: placing the substrate into the corresponding substrate carrying device;

S23: acquiring the type data of the substrate by acquiring the mark in the substrate carrying device.

Certainly, in other embodiments, the type data of the substrate may also be directly acquired via an optical sensor.

Although the specific embodiments of the present invention have been described above, those skilled in the art should understand that these embodiments are merely examples. The protection scope of the present invention is defined by the appended claims. Those skilled in the art can make various changes or modifications to these embodiments without departing from the principle and essence of the present invention, and these changes and modifications all fall within the protection scope of the present invention.

What is claimed is:

1. A substrate clamping apparatus, comprising:

a detection module, for acquiring the type data of a substrate;

a chuck, for placing the substrate;

an execution module, including:

a pneumatic unit, provided on the chuck, for clamping the substrate;

a main line, one end of the main line being connected to a gas source, and the other end being connected to the pneumatic unit;

a pressure regulating unit, provided on the main line, for regulating the gas pressure in the main line;

a processing module, for receiving the type data, and controlling the pressure regulating unit to regulate the gas pressure in the main line based on the type data, allowing the gas pressure to correspond to the type data, and thereby allowing the pneumatic unit to output a clamping force corresponding to the type data.

2. The substrate clamping apparatus according to claim 1, wherein the substrate clamping apparatus further comprises a fixing member, the pneumatic unit is provided on one side of the chuck, the fixing member is correspondingly provided on the other side of the chuck, and the pneumatic unit is used for cooperating with the fixing member to clamp the substrate.

3. The substrate clamping apparatus according to claim 2, wherein the pneumatic unit includes a cylinder and an execution member, and the cylinder is used for driving the execution member to move, allowing the execution member to contact the outer edge of the substrate to clamp the substrate in the chuck.

4. The substrate clamping apparatus according to claim 3, wherein the substrate clamping apparatus further comprises a force sensor, the force sensor is in

communication with the processing module, the force sensor is provided on the execution member or the fixing member, and is used for measuring the clamping force of the execution member on the substrate.

5. The substrate clamping apparatus according to claim 1, wherein the detection module acquires the type data of the substrate by detecting the mark on a substrate carrying device, the substrate carrying device is used for carrying the substrate, and the mark on the substrate carrying device stores the type data of the substrate currently carried.

6. The substrate clamping apparatus according to claim 1, wherein the execution module further includes a first pressure sensor, the first pressure sensor is in communication with the processing module, the first pressure sensor is provided on the main line between the pressure regulating unit and the pneumatic unit, and is used for measuring the gas pressure in the main line after pressure regulation by the pressure regulating unit.

7. The substrate clamping apparatus according to claim 1, wherein the substrate clamping apparatus further comprises branch lines, a plurality of pneumatic units are provided, each pneumatic unit is respectively connected to the main line via the branch line, and all pneumatic units are arranged in a parallel structure.

8. The substrate clamping apparatus according to claim 7, wherein the pipe diameter of the branch line is smaller than the pipe diameter of the main line.

9. The substrate clamping apparatus according to claim 7, wherein the substrate clamping apparatus further comprises second pressure sensors, the second pressure sensors are in communication with the processing module, the second pressure sensors are provided on the branch lines, and are used for measuring the gas pressures in the branch lines.

10. The substrate clamping apparatus according to claim 1, wherein the execution module further includes a first valve, the first valve is provided on the main line between the pressure regulating unit and the pneumatic unit, and the processing module is further used for controlling the open/closed state of the first valve.

11. The substrate clamping apparatus according to claim 10, wherein the execution module further includes a second valve, one passage of the second valve is in communication with the external atmosphere, and the other passage of the second valve is in communication with the main line after the first valve, the pneumatic unit is connected to the main line between the first valve and the second valve, and the processing module is further used for controlling the open/closed state of the second valve.

12. The substrate clamping apparatus according to claim 11, wherein the first valve and the second valve are solenoid valves, and the first valve and the second valve are respectively in communication with the processing module.

13. The substrate clamping apparatus according to claim 11, wherein the execution module further includes a control line, the first valve and the second valve are pneumatic valves, the first valve and the second valve are connected to the gas source via the control line, a solenoid valve is provided on the control line, the solenoid valve is in communication with the processing module, and the processing module is further used for controlling the opening/closing of the solenoid valve to control the communication state of the control line.

14. The substrate clamping apparatus according to claim 13, wherein the first valve and the second valve are both two-position two-way valves, the initial working position of the first valve is a closed state, the initial working position of the second valve is an open state, and the open/closed states of the first valve and the second valve are always opposite.

15. A substrate clamping method, comprising:

pre-storing the correspondence between substrate type data and substrate clamping force;

acquiring the type data of a substrate;

applying a clamping force corresponding to the substrate type to the substrate according to the correspondence.

16. The substrate clamping method according to claim 15, wherein the step of acquiring the type data of a substrate includes: marking the type data of the substrate in a substrate carrying device; placing the substrate into the corresponding substrate carrying device; acquiring the type data of the substrate by acquiring the mark in the substrate carrying device.

17. The substrate clamping method according to claim 15, wherein the substrate clamping apparatus clamps the substrate in a pneumatic manner.