WAFER CARRYING APPARATUS AND SEMICONDUCTOR PROCESSING DEVICE HAVING THE SAME

Field of the Invention

The present invention relates to the technical field of microelectronics, in particular to a wafer carrying apparatus and a semiconductor processing device having the wafer carrying apparatus.

Background of the Invention

Plasma etching apparatus is generally used in manufacturing semiconductor, LED, MEMS (microelectromechanical systems) and the like. The etching apparatus is generally composed of a process module and a transmission module. The process module includes a process chamber, the etching process is usually carried out in the process chamber so as to etch required graphics on the wafer. The transmission module is responsible for delivering a wafer to be processed into the process chamber, and delivering the processed wafer out of the process chamber. As for the etching apparatus used in the LED field, since a single wafer usually has a diameter of 2-inch, 4-inch or 6-inch, and the size of the process chamber is usually much larger than the diameter of the wafer, a tray are usually used in the LED etching device in order to increase capacity. Specifically, a plurality of wafers are placed onto the tray, and then the tray is delivered into the process chamber for performing wafer batch process.

Figure 1A illustrates a traditional tray for carrying a wafer, and Figure 1B shows a wafer carrying apparatus having the traditional tray. As shown in Figures 1A and 1B, an electrostatic chuck 200' is provided inside the process chamber 100'. A mechanical arm delivers a tray 300' into the process chamber 100' and put the tray 300' on the electrostatic chuck 200', wherein the wafer 400' is disposed in the groove of the tray 300'. The electrostatic chuck 200' fixes the tray 300' and also controls the temperature of the tray 300', the tray 300' in turn adjust the temperature of the wafer 400'. For better temperature control, Helium may be filled between the electrostatic chuck 200' and the tray 300', in particular, Helium can be filled in the gaps of the contact surfaces of between the electrostatic chuck 200' and the tray 300', so as to increase the heat exchange area therebetween.

In the above wafer carrying apparatus, although the temperature of the

tray 300' and the wafer 400' can be controlled by feeding Helium into the gaps between the contact surfaces of the electrostatic chuck 200' and the tray 300', however, since the temperature of the wafer 400' is controlled indirectly, the efficiency and effectiveness of the temperature control of the wafer 400' shall be further improved. In fact, if heat conduction gas such as Helium is feed into gaps between the contact surfaces of the tray 300' and the wafer 400', similar to the previously described heat exchange method, new problems will be introduced: specifically, if a hole is directly punched at the position where the wafer 400' is placed on the tray 300' and Helium is filled, the punched hole shall has proper diameter. If the diameter of the hole is too small, the heat exchange effect cannot be achieved; and if the diameter of the hole is too large, an upward thrust on the wafer 400' will be produced when Helium is feed in, since the distance between the wafer 400' and the electrostatic chuck 200' is large, the attraction force therebetween which is not large will be further reduced after canceling out the upward thrust on the wafer 400', which will affect the contact between the wafer 400' and the tray 300', thus causing leakage of Helium. If a large amount of Helium is leaked into the process chamber, a good temperature adjustment and control requirements may not be reached.

In summary, how to provide a wafer carrying apparatus which enable quick and efficient temperature control for the carried wafer, has become a technical problem to be solved by those skilled in the art.

Summary of the Invention

An object of the present invention is to overcome at least one of above technical defects, in particular to provide quick and efficient temperature adjustment for the wafer.

To this end, the present invention provide a wafer carrying apparatus which can control the temperature of the wafer quickly and efficiently, such that the temperature of the wafer can be better controlled, the temperature uniformity of the wafer can be enhanced and the process effect of the wafer is improved.

Another object of the present invention is to provide a semiconductor processing device having the wafer carrying apparatus.

In order to achieve the above object, a wafer carrying apparatus according

to the first aspect of the present invention comprises: a chuck and a lifting assembly, said chuck comprising: a chuck body having a hollow cavity therein, and having at least one first through holes at the top wall thereof; and a movable member, which is accommodated in the hollow cavity, the upper surface of the said movable member is provided with projections corresponding to said first through hole; a tray provided on said chuck body, said tray is provided with second through holes aligned with said first through hole for accommodating the wafers, wherein the diameter of the upper end of the second through hole is larger than the diameter of the wafer, and the diameter of the lower end of the second through hole is smaller than the diameter of the wafer; said lifting assembly is connected with the movable member for driving said movable member up and down in the hollow cavity, so that the projections can contact or detach from the wafer.

In the wafer carrying apparatus according to an embodiment of the present invention, the movable member of the chuck is controlled to lift by the lifting assembly, so that the projection can contact or detach from the wafer. When the projection contacts the wafer, the heat exchange can be conducted between the movable member and the wafer, so that the temperature of the wafer is controlled through the chuck, the temperature control of the wafer will be performed quickly and efficiently, the temperature uniformity of the wafer can be enhanced and the process effect is improved. When the projection detaches from the wafer, since the diameter of the upper end of the second through hole is larger than the diameter of the wafer, and the diameter of the lower end of the second through hole of the tray is smaller than the diameter of the wafer, the wafer can be supported at the upper end of the second through hole of the tray with predefined distance from the lower end of the second through hole. Therefore the wafer can be fetched quickly and the process efficiency is improved.

In one embodiment of the present invention, each of the second through holes is stepped, said second through hole comprises a first hole section and a second hole section located below said first hole section, wherein the diameter of the first hole section is larger than the diameter of the wafer and the diameter of the second hole section is smaller than the diameter of the wafer.

When the movable member moves down and the projections detach from the wafers, the wafers will be supported by the steps in the second through holes.

In one embodiment of the present invention, the wafer carrying apparatus

further comprises an electrode for producing electrostatic attraction force to said wafers, one end of the electrode is provided in the movable member and the other end of the electrode extends out of the movable member.

In one embodiment of the present invention, the electrode comprises an electrode body, an electrode branch and a lead segment, one end of said electrode branch is connected with the electrode body and the other end thereof extends into the projection, one end of the lead segment is connected with the electrode body and the other end thereof extends out of the movable member.

Since one end of the electrode branch extends into the projection, the attraction force of the wafer carrying apparatus to the wafer can be enhanced.

In one embodiment of the present invention, a first gas passage and first air holes are provided inside the movable member for supplying the temperature control gas, one end of each of the first air holes communicates with the first gas passage, and the other end thereof exposes from the upper surface of the projection.

Thus, during processing the wafer, the temperature of the wafer can be controlled by the temperature control gas supplied through the first gas passage and the first air hole, so as to further improve the temperature uniformity of the wafer.

In one embodiment of the present invention, a second gas passage and second air holes are provided in the chuck body for supplying the temperature control gas, one end of each of the second air hole communicates with the second gas passage, and the other end thereof exposes from the surface of the chuck body in contact with the tray.

Thus, during processing the wafer, the temperature of the tray can be controlled by the temperature control gas supplied through the second gas passage and the second air hole.

In one embodiment of the present invention, the temperature control gas is Helium.

In one embodiment of the present invention, the amounts of the first through holes, the second through holes and the projections are identical and more than one, and said first through holes, second through holes and the projections correspond to each other.

In one embodiment of the present invention, said lifting assembly may be one of cylinder, hydraulic cylinder, electric cylinder and screw driving means.

According to a second aspect of the present invention, a semiconductor processing device comprises a wafer carrying apparatus, said wafer carrying apparatus may be the wafer carrying apparatus according to the embodiment of the first aspect of the present invention.

In one embodiment of the present invention, the semiconductor processing device is a LED (light emitting diode) or MEMS (microelectromechanical systems) etching machine.

In one embodiment of the present invention, said LED or MEMS etching machine is an inductively coupled plasma etching machine.

Additional features and advantages of the present invention will be given in part in the following description, and in part become apparent from the following description, or be learned by practice of the present invention.

Brief Description of the Drawings

Above and/or additional aspects and advantages of the present invention will become apparent and easy to understand by the following description of the embodiments in conjunction with the accompanying drawings, in which:

Figure 1A is a schematic view of the traditional tray carrying the wafer;

Figure 1B is a cross-sectional view of the wafer carrying apparatus having the traditional tray shown in Figure 1A;

Figure 2 is a schematic view of the wafer carrying device according to the embodiment of the present invention, which shows a lifting assembly driving the projection of the movable member to move downward so that the projection detaching from the wafer; and

Figure 3 is a schematic view of the wafer carrying apparatus according to the embodiment of the present invention, which shows the lifting assembly driving the projection of the movable member to move upward so that the projection contacting the wafer.

Detailed Description of the Embodiments

In the following, the embodiments of the present invention will be described in detail, the examples of embodiment are shown in the drawings, wherein throughout the specification the same or similar reference numerals indicate the same or similar elements or elements with the same or similar functions. The embodiments described with reference to the accompanying drawings are illustrative only for explaining the present invention, and shall not be construed as limiting the present invention.

In the description of the present invention, it is to be understood that the orientations or positional relationships directed by the terms "center", "vertical", "horizontal", "upper", "lower", "front", "rear", "left", "right", " vertical "," horizontal "," top "," bottom "," inner "," outer " are based on the orientation or positional relationship shown in the drawings, only for simplifying the description of the present invention, rather than indicate or imply that the device or element referred to must have a specific orientation or being constructed and operated with specific orientation, and therefore can not be construed as limitations to the present invention. In addition, the terms "first", "second" are used only for the purpose of description, and can not be construed as indicate or imply the relative importance.

In the description of the present invention, unless otherwise defined and limited, the terms "mounted," "connected", "connection" shall be understood broadly, for example, it may be fixedly connected, detachably connected, or integrally connected; it may be mechanical connection or electrical connection; it may be direct connection, or being connected indirectly through media, and may be internal communication of the two components. Ordinary persons skilled in the art can understand the specific meaning of the above terms in the present invention with respect to specific circumstances.

The wafer carrying apparatus 200 according to an embodiment of the present invention will be described below in conjunction with Figures 2 and 3. The wafer carrying apparatus 200 according to the embodiment of the present invention comprises a chuck 210, a tray 220 and a lifting assembly 230.

As shown in Figure 2 and Figure 3, the chuck 210 includes a chuck body 211 and a movable member 212. Specifically, the chuck body 211 has a hollow cavity 213 therein, at least one first through hole 2111 are provided at the top wall of the chuck body 211, the movable member 212 is accommodated in the hollow cavity 213 of the chuck body 211, the upper surface of the movable member 212 is provided with at least one projection 2121 corresponding to the first through holes 2111 (specifically, the amounts are identical, the positions

are aligned and the sizes are matched), such that each projection 2121 can move up and down so as to pass through the corresponding first through hole 2111 in up and down directions.

A tray 220 is provided on the chuck 210, as shown in Figures 2 and 3. Specifically, the tray 220 is provided on the top surface of the chuck body 211 of the chuck 210. The tray 220 is provided with at least one second through holes 2201 aligned with the first through hole 2111 for accommodating the wafer 240, the second through holes 2201 and the first through holes 2111 have identical amount and aligned positions, and the diameter of the second through hole 2201 is larger than the diameter of the projection 2121 so as to allow the projection 2121 moves up and down in the second through hole 2201. The diameter of the upper end of the second through hole 2201 is larger than the diameter of the wafer 240, and the diameter of the lower end of the second through hole 2201 is smaller than the diameter of the wafer 240, so that the wafer 240 can be accommodated (or partially accommodated) in the second through hole 2201 of the tray 220 and the lower surface of the wafer 240 has predefined distance from the lower surface of the tray 220. In the present embodiment, the second through hole 2201 is stepped, that is, the second through hole 2201 comprises a first hole section 2202 and a second hole section 2203 located below said first hole section 2202, wherein the diameter of the first hole section 2202 is larger than the diameter of the wafer 240 and the diameter of the second hole section 2203 is smaller than the diameter of the wafer 240, so that a step shape is formed at the connection position of the first hole section 2202 and the second hole section 2203. Thus, the wafer 240 can be ensured to be at least partially accommodated and supported in the first hole section 2202 of the tray 220. Preferably, the thickness of the wafer 240 is larger than the depth of the first hole section 2202 such that the upper surface of the wafer 240 projects from the upper surface of the tray 220.

The lifting assembly 230 and the movable member 212 are connected for driving the movable member 212 up and down in the hollow cavity 213, so that the projection 2121 can contact or detach from the wafer 240.

Specifically, as shown in Figure 2, the lifting assembly 230 drives the movable member 212 down, the projection 2121 moves downwards and its upper surface detaches from the wafer 240, till its upper surface flushes with the upper surface of the chuck body 211. The tray 220 and therefore the carried wafer 240 can be easily delivered, thus the processing efficiency is improved.

As shown in Figure 3, the lifting assembly 230 drives the movable member 212 up, the projection 2121 moves upwards in the first through hole 2111 and the second through hole 2201, so that the upper surface of the projection 2121 projects over the upper surface of the chuck body 211 and contacts the wafer 240.

Although the relationship among the diameters of the first hole section 2202 and the second hole section 2203 and the wafer 240, it is understood that the shapes of the first hole section 2202 and the second hole section 2203 are not limited to a circular hole, but may be a square hole, as long as the wafer 240 can be supported and accommodated within the first hole section 2202 and does not fall into the second hole section 2203.

Similarly, the cross sectional shapes of the first through hole 2111 and the projection 2121 are not limited to circle. In the description of the present invention, unless particularly specified, the first through hole 2111 and the second through hole 2201 and the projection 2121 are exemplified as circular shape.

Preferably, there are plurality of first through hole 2111, a plurality of second through holes 2201 and a plurality of projection 2121, and they correspond to each other, so that the plurality of wafers 240 can be processed simultaneously.

There is no particular limitation in the position of the lifting assembly 230. In a particular embodiment of the present invention, the lifting assembly 230 is located below the chuck 210 and connected to the movable member 212. The implementing form of the lifting assembly 230 is not particularly limited, for example the lifting assembly 230 may be a cylinder, hydraulic cylinder, electric cylinder or screw driving means.

During processing the wafer 240, the lifting assembly 230 pushes the movable member 212 up, so that the projection 2121 of the movable member 212 passes through the first through hole 2111 and a part of the second through hole 2201 so as to contact the wafer 240 and pop up the wafer 240 to detach from the tray 220. At this time, as shown in Figure 3, the projection 2121 of the movable member 212 contacts the wafer 240 directly, the movable member 212 can exchange heat with the wafer 240 directly, such that the temperature of the wafer 240 is controlled by the chuck 210 directly, the temperature of the wafer 240 can be adjusted quickly and efficiently, the temperature uniformity of the wafer 240 and thus the process efficiency can be

improved.

After the process to the wafer 240 is finished, the lifting assembly 230 moves the movable member 212 down so that the projection 2121 of the movable member 212 detaches from the wafer 240. At least a portion of the wafer 240 is accommodated and supported within the second through hole 2201, such that the processed wafer 240 can be delivered out of the process chamber by delivering the transfer tray 220, a rapid fetching of the wafer 240 can be achieved and the processing efficiency is improved.

As shown in Figures 2 and 3, the wafer carrying apparatus 200 according to an embodiment of the present invention further comprises an electrode 250 for generating an electrostatic attraction force to the wafer 240, one end of the electrode 250 is located in the movable member 212, and the other end thereof extends out of the movable member 212 and is connected to a power supply (not shown).

When the electrodes 250 is energized, an electrostatic attraction force to the wafer 240 is generated, so that the contact between the projection 2121 of the movable member 212 and the wafer 240 becomes more stable, thus preventing the wafer 240 from dropping and the temperature control gas which will be described below from leaking into the processing chamber, thereby improving the utilization of Helium, the temperature uniformity of the wafer 240 is improved and a better cooling effect to the wafer 240 is achieved.

Preferably, the electrode 250 includes an electrode body 2502, an electrode branch 2501 and a lead segment 2503. One end of the electrode branch 2501 is connected with the electrode body 2502 and the other end of the electrode branch 2501 extends into the projection 2121. One end of the lead segment 2503 is connected with the electrode body 2502, the other end of the lead segment 2503 extends downwards out of the movable member 212 and may be connected with for example the power supply.

By introducing the electrode branch 2501 into the projection 2121, the projection 2121 may attract the wafer 240 better when contacting the wafer 240. If there are more than one projection 2121, the wafers 240 can be attracted via the electrode branch 2501 in each projection 2121, respectively, the attraction force can be enhanced.

With reference to Figure.3, in some examples of the present invention, a first gas passage (not shown) and a first air hole (not shown) are provided inside the movable member 212 for supplying the temperature control gas.

One end of the first air hole communicates with the first gas passage, and the other end of the first air hole extends to the upper surface of the projection 2121 (i.e. the surface on the projection 2121 which can contact the wafer 240), that is, the other end of the first air hole exposes from the surface of the projection 2121 contacting the wafer 240. The first gas passage may communicate with Helium source (not shown).

During processing the wafer, the temperature of the wafer 240 can be controlled by the temperature control gas supplied through the first gas passage and the first air hole. By feeding the temperature control gas at the surface of the projection 2121 contacting the wafer 240, the wafer 240 can be cooled down effectively. Furthermore, the temperature control gas is typically an inert gas which can rapidly cool down the wafer 240. Preferably, the temperature control gas may be helium (He).

In the wafer carrying apparatus 200 according to the embodiment of the present invention, when the lifting assembly 230 drives the movable member 212 of chuck 210 moves upwards for a predefined vertical distance to reach a position shown in Figure 3, the projection 2121 of the movable member 212 contacts the wafer 240. Heat exchange occurs between the movable member 212 of chuck 210 and the wafer 240, so that the temperature of the wafer 240 can be controlled by means of the contact between the movable member 212 of chuck 210 and the wafer 240. The wafer 240 can be cooled down quickly and effectively, the temperature uniformity of the wafer 240 and the process effect can be improved. By feeding Helium into the gaps between the contact surfaces of the movable member 212 of chuck 210 and the wafer 240, the cooling effect on the wafer 240 can be further enhanced. Also, by energizing the electrode 250, the attractive force between the projection 2121 of the movable member 212 and the wafer 240 can be enhanced, which prevent the Helium from leaking into the process chambers and also provide effective cooling to the wafer 240.

In the wafer carrying apparatus 200 according to the embodiment of the present invention, when the lifting assembly 230 drives the movable member 212 of chuck 210 to move downwards for a predefined vertical distance to reach a position shown in Figure 2, the wafer 240 detaches from the projection 2121 of the movable member 212. Since the diameter of the lower end of the second through hole 2201 of the tray 220 is smaller than the diameter of the wafer 240, and the diameter of the upper end of the second through hole 2201 of the tray 220 is larger than the diameter of the wafer 240, the wafer 240 will

be supported at the upper end of the second through hole 2201 of the tray 220, the wafer 240 can be fetched rapidly by moving the tray 220, thereby the efficiency of the wafer carrying apparatus 200 is improved.

Optionally, as shown in Figure.3, a second gas passage (not shown) and a second air hole (not shown) may be provided in the chuck body 211 for supplying the temperature control gas. One end of the second air hole communicates with the second gas passage, and the other end of the second air hole expose from the surface of the chuck body 211 contacting the tray 220. By feeding the temperature control gas into the gaps between the chuck body 211 and the tray 220, the temperature of the tray 220 can be controlled. The second gas passage communicates with Helium source (not shown). As mentioned above, the temperature control gas may be helium (He). Because the tray 220 contacts the wafer 240, the temperature of the wafer 240 may be adjusted indirectly by controlling the temperature of the tray 220, thus the cooling down time of the wafer 240 can be shortened and the process efficiency can be improved.

In the wafer carrying apparatus according to the embodiment of the present invention, the temperature of the wafer is directly controlled by the movable member of the chuck, thus the temperature uniformity of the wafer can be improved, the wafer can be cooled down quickly, thus the process effect on the wafer is improved. The shape of the wafer is not limited to that shown in Figure 1A, but may be any shape available in practice.

Embodiments of the present invention also provide a semiconductor processing device comprises a wafer carrying apparatus according to any one of above embodiments of the present invention. The semiconductor processing device according to the embodiments of the present invention may be an etching device or an epitaxial device. It shall be understood that other configurations and operations of the semiconductor processing device according to the embodiments of the present invention is known to those skilled in the art, and will not be described in detail here.

In one embodiment of the present invention, the semiconductor processing device is a LED or MEMS etching machine. In particular, the LED or MEMS etching machine is an inductively coupled plasma etching machine.

The semiconductor processing device according to the embodiments of the present invention has the advantage and beneficial effects brought by the wafer carrying apparatus, the detailed description is omitted here.

In the description of the present specification, reference to the terms "an embodiment", "some embodiments", "an example", "a specific example", or " some examples" etc., means that a particular feature, structure, material, or characteristic described with reference to the embodiments or the examples are included in at least one embodiment or example of the present invention. In the present specification, the schematic representations of the above term not necessarily refer to the same embodiment or example. Furthermore, the particularly described features, structures, materials, or characteristics may be combined in a suitable manner in any one or more embodiments or examples.

While embodiments of the present invention have been illustrated and described, it can be readily understood to those of ordinary skill in the art that without departing from the principles and spirit of the present invention, various changes, modifications, substitutions and variations may be made to these embodiments, the scope of the invention shall be defined by the appended claims and their equivalents.

Claims

1. A wafer carrying apparatus, comprising:

a chuck comprising:

a chuck body having a hollow cavity therein, and having at least one first through holes at the top wall thereof; and

a movable member, which is accommodated in the hollow cavity, the upper surface of the said movable member is provided with projections corresponding to said first through holes;

a tray provided on said chuck body, said tray is provided with second through holes aligned with said first through holes for accommodating the wafers, wherein the diameter of the upper end of the second through hole is larger than the diameter of the wafer, and the diameter of the lower end of the second through hole is smaller than the diameter of the wafer;

a lifting assembly, which is connected with the movable member for driving said movable member up and down in the hollow cavity such that the projections contact or detach from the wafers.

2. The wafer carrying apparatus of claim 1, wherein each of the second through hole is stepped, said second through hole comprises a first hole section and a second hole section located below said first hole section, wherein the diameter of the first hole section is larger than the diameter of the wafer and the diameter of the second hole section is smaller than the diameter of the wafer.

3. The wafer carrying apparatus of claim 1, further comprising an electrode for producing electrostatic attraction force to said wafers, one end of the electrode is provided in the movable member and the other end of the electrode extends out of the movable member.

4. The wafer carrying apparatus of claim 3, wherein the electrode comprises an electrode body, an electrode branch and a lead segment, one

end of said electrode branch is connected with the electrode body and the other end thereof extends into the projection, one end of the lead segment is connected with the electrode body and the other end thereof extends out of the movable member.

5. The wafer carrying apparatus of claim 1, wherein a first gas passage and first air holes are provided inside the movable member for supplying the temperature control gas, one end of each of the first air holes communicates with the first gas passage, and the other end thereof exposes from the upper surface of the projection.

6. The wafer carrying apparatus of claim 1, wherein a second gas passage and second air holes are provided in the chuck body for supplying the temperature control gas, one end of each of the second air hole communicates with the second gas passage, and the other end thereof exposes from the surface of the chuck body in contact with the tray.

7. The wafer carrying apparatus of claim 5 or 6, wherein the temperature control gas is Helium.

8. The wafer carrying apparatus of any one of claims 1-6, wherein the amounts of the first through holes, the second through holes and the projections are identical and more than one, and said first through holes, second through holes and the projections correspond to each other.

9. The wafer carrying apparatus of claim 1, wherein the lifting assembly is one of cylinder, hydraulic cylinder, electric cylinder and screw driving means.

10. A semiconductor processing device comprising a wafer carrying apparatus of any one of claims 1-9.

11. The semiconductor processing device of claim 10, wherein the

semiconductor processing device is LED or MEMS etching machine.

12. The semiconductor processing device of claim 11, wherein the LED or MEMS etching machine is an inductively coupled plasma etching machine.