

ENERGY BEAM IRRADIATION APPARATUS AND WORK TRANSFER MECHANISM

TECHNICAL FIELD

[0001]

The present invention relates to an energy beam irradiation system such as an ion implanter and an electron beam irradiation apparatus for irradiating an energy beam, and a work transfer mechanism for the energy beam irradiation system.

RELATED ART

[0002]

A kind of ion implanters according to the related art includes a platen for transferring wafers to an irradiation area of an ion beam, a load lock chamber, and an intermediate transfer mechanism for transferring wafers between the platen and the load lock chamber. For example, an intermediate transfer mechanism of Patent document 1 is configured to move left and right transfer arms at the same time such that it is possible to arrange wafers in two rows on one platen, thereby improving throughput.

Wafers which these transfer arms handle have only one size.

[Related Art Documents]

[Patent Documents]

[0003]

[Patent document 1] JP-B-4766156

SUMMARY

[0004]

However, the wafer sizes are not limited. There are wafers having diameters of 4 inches, 6 inches, 12 inches, and 18 inches. In order to handle wafers having different sizes,

simply, the above-mentioned configuration needs to be doubled. In this case, the size of the ion implanter remarkably increases.

This matter is not limited to ion implanters, but is common to all of energy beam irradiation systems for irradiating at least one work with an energy beam.

[0005]

The present invention was made in view of that matter, and an object of the present invention is to enable this kind of energy beam irradiation systems to efficiently irradiate works having different sizes with an energy beam while having a reduced size and cost.

[0006]

An energy beam irradiation system of this invention includes an energy beam emission mechanism, first and second work holders, a moving mechanism, first and second work accommodating units, and first and second transfer arms. The energy beam emission mechanism emits an energy beam toward a predetermined irradiation area. The first and second work holders mount at least one first work and at least one second work, respectively. The at least one first work and the at least one second work are objects to be irradiated with the energy beam. The moving mechanism moves forward and backward at least one of the first and second work holders at least between the irradiation area and a work receiving area for work deliveries. The first and second work accommodating units are provided at different positions from each other and accommodate the at least one first work and the at least one second work, respectively. The at least one first work has a different size than the at least one second work. The first transfer arm is provided to be able to reciprocate between the work receiving area and the first work accommodating unit and transfers the at least one first work between the first work accommodating unit and the first work holder when the first work holder locates in the work receiving area. The second transfer arm is provided to be able to reciprocate between the work receiving area and the second work accommodating unit and transfers the at least one second work

between the second work accommodating unit and the second work holder when the second work holder locates in the work receiving area.

[0007]

According to this configuration, it is possible to efficiently irradiate works having different sizes with an energy beam while maintaining almost the same system size as those of ion implanters and the like having two transfer arms according to the related art.

[0008]

As a specific embodiment, the first work accommodating unit and the second work accommodating unit may be provided in opposite sides of the work receiving area each other centering around the work receiving area.

[0009]

In order to make the work holders hold a plurality of or a plurality of row of works by one transfer arm, each of the first and second work holders receives a work from a corresponding transfer arm in the work receiving area, moves by a predetermined distance in a moving direction, and receives another work from the corresponding transfer arm, so as to mount a plurality of works in the moving direction.

As an aspect according to which the effects of the present invention become remarkable, the energy beam may be an ion beam and may implant ions in the at least one first work and the at least one second work.

Further, each of the first and second work accommodating unit may be a load lock mechanism.

[Effect of Invention]

[0010]

According to the present invention configured as described above, it is possible to efficiently irradiate works having different sizes with an energy beam, to make the system size smaller than a normally expectable size, and to promote cost reduction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is a schematic plan view illustrating an entire ion implanter according to an embodiment of the present invention.

FIG. 2 is a partial perspective view illustrating a wafer transfer mechanism according to the embodiment.

FIGS. 3A to 3D are sequence diagrams illustrating an example of wafer transfer according to the embodiment.

FIG. 4A and 4B are operation explaining views illustrating movement of a platen according to the embodiment.

FIG. 5 is a schematic plan view illustrating wafer holding aspects of platens according to another embodiment of the present invention.

FIG. 6 is a schematic plan view illustrating rail members according to a further embodiment of the present invention.

DETAILED DESCRIPTION

[0012]

Hereinafter, an energy beam irradiation system according to the present invention will be described with reference to the accompanying drawings.

[0013]

An example of the energy beam irradiation system is an ion implanter 100. As shown in FIGS. 1 and 2, the ion implanter 100 irradiates works, which are wafers W1 and W2, having different sizes, with an ion beam IB which is an energy beam, thereby implanting ions into the wafers W1 and W2. The ion implanter 100 includes an ion beam emission mechanism (not shown) and the wafer transfer mechanism 20 in an ion

implantation chamber 10. The ion implantation chamber 10 is provided inside a vacuum chamber. The ion beam emission mechanism emits the ion beam IB, and the wafer transfer mechanism 20 transfers the wafers W1 and W2 to a position capable of being irradiated with the ion beam IB.

[0014]

The ion beam emission mechanism emits the ion beam IB, for example, in a ribbon shape toward an irradiation area AR1 which is set inside the ion implantation chamber 10. However, the present invention is not limited thereto. For example, the beam emission mechanism may emit the ion beam IB having a square shape.

[0015]

The wafer transfer mechanism 20 includes wafer loading and unloading mechanisms 21 and 22, wafer transfer mechanisms 31 and 32 and intermediate mechanisms 41 and 42. The wafer loading and unloading mechanisms 21 and 22 load and unload the wafers W1 and W2 between the ion implantation chamber 10 and load lock chambers 11 and 12. The load lock chambers 11 and 12 are provided spaced apart from each other and are provided in the upper side of the ion implantation chamber 10. The wafer transfer mechanisms 31 and 32 hold the wafers W1 and W2 which are subject to ion implantation and transfer the wafers W1 and W2 to the beam irradiation area AR1. The intermediate mechanisms 41 and 42 deliver the wafers W1 and W2 between the wafer loading and unloading mechanisms 21 and 22 and the wafer transfer mechanisms 31 and 32.

[0016]

The wafer loading and unloading mechanisms 21 and 22 include wafer mounting tables 21a and 22a serving as work accommodating units, and actuators (not shown) for moving the wafer mounting tables 21a and 22a upward and downward. The wafer mounting tables 21a and 22a are for mounting the wafers W1 and W2 having different sizes, respectively. When the wafer mounting tables 21a and 22a are at an upper position, they

serve also as partitions (bottom walls in this embodiment) which air-tightly separate the load lock chambers 11 and 12 and the ion implantation chamber 10 from each other. Meanwhile, when the wafer mounting tables 21a and 22a are at a lower position, they are located in the ion implantation chamber 10. And, they can give the wafers W1 and W2 to the intermediate mechanisms 41 and 42 (to be described below) and they can receive the wafers W1 and W2 from the intermediate mechanisms 41 and 42. In the present embodiment, as shown in FIG. 1, along a linear moving direction of the wafers W1 and W2 (to be described below), the two load lock chambers 11 and 12 are provided spaced apart from each other, and the wafer loading and unloading mechanisms 21 and 22 are provided for the load lock chambers 11 and 12, respectively.

[0017]

The wafer transfer mechanisms 31 and 32 may include wafer supporting members 31a and 32a, bases 31b and 32b for supporting the platens 31a and 32a, and a linear moving mechanism 33. The wafer supporting members 31a and 32a are work holders and are also referred to as platens 31a and 32a. The linear moving mechanism 33 linearly moves the bases 31b and 32b forward and backward.

[0018]

The platens 31a and 32a have chucking plates (not shown) which are flat and circular, for instance, and can attract and hold a plurality of rows (two rows in this embodiment) of wafers W1 and W2 on one side surfaces of them by electrostatic chucks. If the sizes of the chucking plates are larger than the sizes of wafers, it is possible to reliably attract and hold the wafers, but there is the fear that the chucking plates might be charged up. Meanwhile, if the sizes of the chucking plates are smaller than the sizes of wafers, it is possible to prevent the chucking plates from being charged up, but there is the fear that the wafers might not be sufficiently attracted and held. Therefore, it is necessary to appropriately set the sizes of the chucking plates.

[0019]

The bases 31b and 32b have block shapes. In a state where surface plate portions of the platens 31a and 32a are parallel with the moving direction, the bases 31b and 32b pivotably support base end portions of the platens 31a and 32a by rotary shafts parallel with the moving direction. Further, inside the bases 31b and 32b, toggle actuators (not shown) such as motors are provided to rotate the platens 31a and 32a such that the surface plate portions toggle between a receiving posture in which the surface plate portions of the platens 31a and 32a are horizontal and a beam irradiation posture in which the surface plate portions are vertical.

[0020]

The linear moving mechanism 33 includes a rail member 33a and slide actuators (not shown). The rail member 33a is configured to arrange horizontally and linearly and allow the bases 31b and 32b to be fit thereinto such that the bases 31b and 32b can slide on the rail member 33a. The slide actuators (not shown) moves the base bases 31b and 32b forward and backward along the rail member 33a. The slide actuators may include belts provided in the rail member 33a and motors for rotating the belts, such that the bases 31b and 32b are arranged to be moved forward and backward on the rail member 33a by the belts.

[0021]

In the present embodiment, the two platens 31a and 32a and the bases 31b and 32b for respectively supporting the platens 31a and 32a are provided to be independently slidable on the common rail member 33a. The linear moving mechanism 33 may use not only the above-mentioned configuration but also a screw feeding mechanism, for instance. Hereinafter, the linear moving direction is also referred to as an x direction.

[0022]

The intermediate mechanisms 41 and 42 include transfer arms 41a and 42a and

pivoting actuators (not shown) such as motors. The transfer arms 41a and 42a have base end portions to be pivotably supported such that the transfer arms 41a and 42a can horizontally turn. The pivoting actuators rotate the transfer arms 41a and 42a forwardly and reversely.

[0023]

The transfer arms 41a and 42a include main arm bodies having a long plate shape, and grasping claws (not shown) provided to lower surface plate portions of the main arm bodies. The grasping claws hook corresponding positions of the peripheral portions of the lower surfaces of the wafers W1 and W2 by the grasping claws such that the wafers W1 and W2 are held below the main arm bodies. In this example, the transfer arm 41a or 42a is configured to be able to hold a plurality of wafers W1 or W2 in one row along its extension direction. However, each of the transfer arms 41a and 42a may hold one wafer W1 or W2.

[0024]

More specifically, as shown in FIG. 1, one pair of transfer arms 41a and 42a is provided to be symmetrical with respect to a horizontal virtual center line C drawn to the right middle between the load lock chambers 11 and 12 and perpendicular to the x direction. Hereinafter, the virtual center line direction will also be referred to as a y direction. If it is necessary to distinguish between the transfer arms, one of them will also be referred to as a first transfer arm 41a and the other one will also be referred to as a second transfer arm 41b. Further, in the present embodiment, one pair of transfer arms 41a and 42a comprises one set. And, each of the transfer arms 41a and 42a has upper and lower sets of two transfer arms which are provided to share common pivots. Hereinafter, the vertical direction will also be referred to as a z direction.

[0025]

In the present embodiment, the wafers W1 and W2 having different sizes are mounted in one row along the x direction on the wafer mounting tables 21a and 22a.

An operation of the present embodiment configured as described above will be described with reference to FIG. 3.

[0026]

First, the wafers W1 and W2 are mounted on the wafer mounting tables 21a and 22a in the load lock chambers 11 and 12. Here, four wafers W1 (also referred to as first wafers W1 hereafter if they need to be distinguished) are mounted in series on one wafer mounting table 21a (also referred to as a first wafer mounting table 21a hereafter if it needs to be distinguished), and 6 smaller wafers W2 (also referred to as second wafers W2 hereafter if they need to be distinguished) are mounted in series on the other wafer mounting table 22a (also referred to as a second wafer mounting table 21a hereafter if it needs to be distinguished).

Next, the load lock chambers 11 and 12 are evacuated, and then the wafer mounting tables 21a and 22a lower into the ion implantation chamber 10.

[0027]

Next, the upper first transfer arm 41a turns above the first wafer mounting table 21a to be positioned, and grasps each first wafer W1. Subsequently, as shown in FIG. 3A, the upper first transfer arm 41a returns toward the rail member 33a up to an angle perpendicular to the x direction. At this position, a work receiving area S1 is set. In this work receiving area S1, a first platen 31a waits in the receiving posture (horizontal posture) in advance. The work receiving area indicates an occupation area (area as seen from the z direction) necessary for delivering wafers between the platens and the transfer arms.

[0028]

Next, if the first transfer arm 41a having grasped the first wafers W1 turns to be positioned above the first platen 31a, for example, lifting pins (not shown) rise from below the first wafers W1 so as to slightly raise the first wafers W1 such that the first wafers W1 are spaced from the grasping claw, and supports the first wafers W1. Next, the first

transfer arm 41a returns toward the first wafer mounting table 21a so as to move from the work receiving area S1.

The lifting pins descend such that the first wafers W1 supported by the lifting pins are mounted on the first platen 31a, and the first wafers W1 are attracted and held by the electrostatic chuck.

[0029]

Meanwhile, the first wafer mounting table 21a from which the first wafers W1 have been transferred enters the load lock chamber 11 again. After other first wafers W1 are newly mounted on the first wafer mounting table 21a, as shown in FIG. 3A, the first wafer mounting table 21a returns into the ion implantation chamber 10 and waits therein.

[0030]

After the first transfer arm 41a returns from above the first platen 31a, it grasps the other first wafers W1, and returns toward the work receiving area S1 as shown in FIG. 3B.

During this time, by the linear moving mechanism 33, the first platen 31a moves in the x direction by almost the interval between the rows of the first platen 31a which hold the first wafers W1, and waits.

[0031]

The first transfer arm 41a turns to arrive there, and the first wafers W1 are mounted on the first platen 31a by the lifting pins and are attracted and held by the electrostatic chuck, as described above. This state is shown in FIG. 3C.

In this way, the first wafers W1 are mounted in two rows on the first platen 31a.

Next, the first platen 31a is raised up so as to become the beam irradiation posture so as to irradiate the ion beam IB perpendicular to the first wafers W1 as shown in FIG. 3D.

Next, through the same procedure as described above, the second wafers W2 transferred from the second wafer mounting table 22a by the second transfer arm 42a are mounted on the second platen 32a.

[0032]

A second work receiving area S2 where the second platen 32a receives the second wafers W2 may overlap the first work receiving area S1, or may be adjacent or close to the first work receiving area S1. In the former case, the receiving of the first wafers W1 by the first platen 31a and the receiving of the second wafers W2 by the second platen 32a cannot be performed at the same time. However, in the later case, they can be performed at the same time.

[0033]

The first platen 31a and the second platen 32a having the wafers W1 and W2 thereon slide in the x direction from the work receiving areas S1 and S2 on the same rail member 33a, thereby moving to the irradiation area AR1 of the ion beam IB.

In the present specification, the irradiation area AR1 of the ion beam IB is defined by an area where at least a part of the wafers W1 and W2 are irradiated with the ion beam IB, when the wafer transfer mechanisms 31 and 32 move along the moving direction of the moving mechanism 33, as shown in Figs. 1, 4A and 4B. A non-irradiation area in the present specification is defined by an area other than the irradiation area AR1, and includes waiting areas AR2 and an area AR3. The waiting areas AR2 are areas where the wafer transfer mechanisms 31 and 32 further moves from the irradiation area AR1, as shown in Figs 4A and 4B. The area AR3 includes the work receiving areas S1 and S2 and an acceleration-and-deceleration area where the moving mechanism 33 accelerates and decelerates the wafer transfer mechanisms 31 and 32 along the moving direction between the irradiation area AR1 and at least one of the work receiving areas S1 and S2. In Figs. 4A and 4B, the wafer transfer mechanisms 31 and 32 are in the non-irradiation area since both of the wafers W1 and W2 are not irradiated with the ion beam IB.

Here, first, the first platen 31a enters the irradiation area AR1 of the ion beam IB as shown in FIG. 4A, and reciprocates so as to pass the irradiation area AR1 one or more times. As

a result, a predetermined dose of ions are implanted in each first wafer W1. During this time, the second platen 32a waits in a waiting area AR2 on the work receiving area (S1 or S2) side as seen from the irradiation area AR1 of the ion beam IB.

[0034]

If the ion irradiation onto each first wafer W1 held by the first platen 31a finishes, the first platen 31a moves to another waiting area AR2 opposite to the work receiving areas S1 and S2 as seen from the irradiation area AR1 of the ion beam IB, as shown in FIG. 4B. Next, the second platen 32a enters the irradiation area AR1 of the ion beam IB, and reciprocates similarly to the first platen 31a such that a predetermined dose of ions is implanted in each second wafer W2.

[0035]

After the ion implantation is completed in that way, the platens 31a and 32a having the wafers W1 and W2 mounted thereon return to the work receiving areas S1 and S2, are transferred to the load lock chambers 11 and 12 by the transfer arms 41a and 42a, and are taken out to the outside.

[0036]

Specifically, first, the first platen 31a returns to the first work receiving area S1 and becomes a horizontal posture (the receiving posture). Next, the lifting pins rise such that the first wafers W1 having been subject to the ion implantation are lifted from the first platen 31a. Next, the lower first transfer arm 41a turns and grasps the first row of first wafers W1 and turns toward the first wafer mounting table 21a.

[0037]

Meanwhile, the upper first transfer arm 41a grasps first wafers W1 having not been subject to the ion implantation from the first wafer mounting table 21a, and moves them. Further, alternately with the lower first transfer arm 41a, the upper first transfer arm 41a mounts the first wafers W1 having been subject to the ion implantation, in an empty area on

the first platen 31a.

[0038]

The first wafers W1 having been subject to the ion implantation are mounted on the first wafer mounting table 21a by the lower first transfer arm 41a, are transferred to the load lock chambers 11 and 12, and are exchanged with the first wafers W1 having not been subject to the ion implantation.

The first wafers W1 having not been subject to the ion implantation are mounted on the first wafer mounting table 21a, moves to the ion implantation chamber 10, and are grasped by the upper first transfer arm 41a.

[0039]

During this time, the first platen 31a moves in the x direction by the interval between the rows of the first platen 31a which held the first wafers W1, by the linear moving mechanism 33. The remaining second-row first wafers W1 having been subject to the ion implantation are grasped by the lower first transfer arm 41a, and are transferred toward the first wafer mounting table 21a. Next, alternately with the lower first transfer arm 41a, the upper first transfer arm 41a mounts the first wafers W1 having not been subject to the ion implantation, in an empty area on the first platen 31a.

In this way, the second-row first wafers W1 which have been subject to the ion implantation and which are held on the first platen 31 are exchanged with first wafers W1 having not been subject to the ion implantation.

[0040]

Similarly, the upper and lower second transfer arms 42a and the second wafer mounting table 22a operate, such that, at the second platen 32a, two-row second wafers W2 having been subject to the ion implantation are exchanged with second wafers W2 having not been subject to the ion implantation.

Next, this operation is repeated such that ions are sequentially implemented in the

first wafers W1 and the second wafers W2 having different sizes.

[0041]

According to this configuration, it is possible to efficiently irradiate wafers having different sizes with an energy beam while maintaining almost the same size as that of the ion implanter having the two transfer arms 41a and 42a according to the related art.

[0042]

The present invention is not limited to the above-mentioned embodiment.

One transfer arm may be provided on each of the left and right sides. However, if two transfer arms are provided on each of the left and right sides as in the above-mentioned embodiment, the throughput (processing capability of the apparatus) is improved.

The wafer transfer sequence is also not limited to the above-mentioned embodiment, but various sequences may be considered.

Further, wafers are not necessarily disposed in two rows on the platens, but may be disposed in one row or in three or more rows. If the wafers are disposed in a plurality of rows, and the ion implantation process is performed at a stroke, the throughput is improved.

[0043]

A twist mechanism for adjusting a twist angle of wafers may be provided, and the twist adjustment on wafers may be performed before or after the wafers enter a load lock chamber.

The number of platens may be two or more, and a plurality of platens may be provided for transferring wafers having the same size. For example, one platen for transferring 4-inch wafers and two platens for transferring 6-inch wafers may be provided.

[0044]

The configuration on the ion beam emission mechanism side is not particularly limited. For example, a mass analysis magnet for performing mass analysis on a beam from an ion source may be provided.

The shapes of wafers are not limited to a circular shape, but may be a rectangular shape.

[0045]

On a platen, wafers W may be disposed in zigzags as shown in FIG. 5. In this case, it is possible to reduce a scan stroke B2 as compared to a stroke B1 of the above-mentioned embodiment, and to reduce the size of the apparatus. However, the dimension L2 of the beam in a longitudinal direction (a direction perpendicular to a platen transfer direction) needs to be larger than the dimension L1 in the above-mentioned embodiment. Also, it is necessary to dispose the lifting pins at different places or to provide a mechanism for shifting the platens in the wafer row direction.

The platen transfer direction does not need to be perpendicular to the beam irradiation direction.

[0046]

As shown in FIG. 6, a dedicated rail member for transfer may be provided for each of the first platen 31a and the second platen 32a. In this case, since any waiting areas are not necessary, it is possible to reduce the dimension of the apparatus in the platen transfer direction (the x direction).

[0047]

When the first wafers W1 are mounted on the first platen 31a, if the first platen 31a is leveled, it interferes with a transfer rail member 33a2 for the second platen 32a. For this reason, for example, the position of one transfer rail member 33a1 is shifted toward the back side in the paper plane of the drawing (in the z direction), as compared to the other transfer rail member 33a2. In this case, the work receiving areas for platens 31a and 32a are deviated from each other in the z direction. In anticipation of the deviation, it is necessary to expand the driving range of the lifting pins.

The erection angles (lying) of the platens may be controlled such that the tilt angles

of the wafers are adjusted.

[0048]

The present invention can be applied for purposes other than ion implanters. In this case, it is possible to achieve the same effects as those described above. For example, the present invention can be applied to electron beam irradiation apparatuses, sputtering apparatuses, plasma doping apparatuses, etc. The works may be substrates other than wafers.

The present invention is not limited to the above-mentioned embodiment, but can be modified in various ways within the scope of the present invention.

WHAT IS CLAIMED IS:

1. An energy beam irradiation system comprising:

an energy beam emission mechanism that emits an energy beam toward a predetermined irradiation area;

first and second work holders that mount at least one first work and at least one second work, respectively;

wherein the at least one first work and the at least one second work are objects to be irradiated with the energy beam;

a moving mechanism that moves forward and backward at least one of the first and second work holders at least between the irradiation area and a work receiving area for work deliveries;

first and second work accommodating units that are provided at different positions from each other and that accommodate the at least one first work and the at least one second work, respectively,

wherein the at least one first work has a different size than the at least one second work;

a first transfer arm that is provided to be able to reciprocate between the work receiving area and the first work accommodating unit and that transfers the at least one first work between the first work accommodating unit and the first work holder when the first work holder locates in the work receiving area; and

a second transfer arm that is provided to be able to reciprocate between the work receiving area and the second work accommodating unit and that transfers the at least one second work between the second work accommodating unit and the second work holder when the second work holder locates in the work receiving area.

2. The energy beam irradiation system according to claim 1, wherein:

the first work accommodating unit and the second work accommodating unit are provided in opposite sides of the work receiving area each other centering around the work receiving area.

3. The energy beam irradiation system according to claim 1 or 2, wherein:

each of the first and second work holders receives a work from a corresponding transfer arm in the work receiving area, moves by a predetermined distance in a moving direction, and receives another work from the corresponding transfer arm, so as to mount a plurality of works in the moving direction.

4. The energy beam irradiation system according to any one of claims 1 to 3, wherein:

the energy beam is an ion beam and implants ions in the at least one first work and the at least one second work.

5. The energy beam irradiation system according to any one of claims 1 to 4, wherein:

each of the first and second work accommodating unit is a load lock mechanism.

6. A work transfer mechanism comprising:

first and second work holders that mount at least one first work and at least one second work, respectively;

wherein the at least one first work and the at least one second work are objects to be irradiated with an energy beam;

a moving mechanism that moves forward and backward at least one of the first and second work holders at least between a predetermined irradiation area which is irradiated

with the energy beam and a work receiving area for work deliveries;

first and second work accommodating units that are provided at different positions from each other and that accommodate the at least one first work and the at least one second work, respectively,

wherein the at least one first work has a different size than the at least one second work;

a first transfer arm that is provided to be able to reciprocate between the work receiving area and the first work accommodating unit and that transfers the at least one first work between the first work accommodating unit and the first work holder when the first work holder locates in the work receiving area; and

a second transfer arm that is provided to be able to reciprocate between the work receiving area and the second work accommodating unit and that transfers the at least one second work between the second work accommodating unit and the second work holder when the second work holder locates in the work receiving area.