

LASER PROCESSING APPARATUS AND METHOD OF OBSERVING LASER BEAM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a laser processing apparatus and a method of observing a laser beam.

Description of the Related Art

In order to divide a workpiece such as a semiconductor wafer into chips, a laser processing apparatus is used which includes a laser beam irradiating unit that condenses and applies a laser beam to the workpiece (see Japanese Patent Laid-Open No. 2007-275912, for example). The laser beam irradiating unit is generally configured to guide the laser beam emitted from a laser oscillator to the workpiece and condense the laser beam to the top surface or the inside of the workpiece by using various optical parts for controlling the size, shape, and the like of the beam, and thereby process the workpiece. Hence, adjustment of an optical part group of the laser beam irradiating unit is essential to obtain a desired processing result when the workpiece is processed.

SUMMARY OF THE INVENTION

Whether or not the desired processing result is obtained is not known until the processing is performed. Thus, a method of adjusting optical parts while processing the workpiece is mainstream. However, this method necessitates actually preparing the workpiece and performing the processing, and therefore has a problem of involving the cost of preparing the workpiece and the labor of the processing. In addition, in the laser beam irradiating unit, while the optical part group is usually disposed in a sealed (shielded) space, the optical part group is in an open state during the adjustment. Thus, debris (processing waste) produced from the workpiece during the processing may adhere to optical parts during the adjustment.

It is accordingly an object of the present invention to provide a laser processing apparatus and a method of observing a laser beam that make it possible to adjust optical parts easily while preventing contamination of the optical parts.

In accordance with an aspect of the present invention, there is provided a laser processing apparatus including a chuck table having a holding surface configured to hold a workpiece, a laser oscillator

configured to oscillate a laser, a first condenser configured to condense a laser beam emitted from the laser oscillator, and irradiate the workpiece held on the chuck table with the laser beam, and an observing unit configured to observe a state of a condensing point of the laser beam applied to the workpiece in a pseudo manner, the observing unit including a second condenser configured to condense the laser beam in a direction different from a direction of the holding surface of the chuck table, a microscope configured to magnify the laser beam condensed by the second condenser, and an imaging element configured to observe the condensing point of the laser beam magnified by the microscope.

Preferably, the observing unit is configured to be detachable.

In accordance with another aspect of the present invention, there is provided an observing method of observing a state of a laser beam applied to a workpiece in a pseudo manner in a laser processing apparatus including a chuck table having a holding surface configured to hold the workpiece, a laser oscillator configured to oscillate a laser, and a first condenser configured to condense the laser beam emitted from the laser oscillator, and irradiate the workpiece held on the

chuck table with the laser beam, the observing method including a preparing step of preparing an observing unit including a second condenser configured to condense the laser beam in a direction different from a direction of the holding surface of the chuck table, a microscope configured to magnify the laser beam condensed by the second condenser, and an imaging element configured to observe a condensing point of the laser beam magnified by the microscope, a disposing step of disposing the observing unit in a position capable of receiving the laser beam emitted from the laser oscillator, and an observing step of observing a state of the condensing point of the laser beam emitted from the laser oscillator and incident on the imaging element.

Preferably, the method of observing the laser beam further includes a determining step of determining whether the state of the condensing point of the laser beam observed in the observing step is acceptable or not.

The present invention makes it possible to adjust optical parts easily while preventing contamination of the optical parts.

The above and other objects, features and advantages of the present invention and the manner of realizing them will become more apparent, and the

invention itself will best be understood from a study of the following description and appended claims with reference to the attached drawings showing some preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view illustrating an example of a configuration of a laser processing apparatus according to an embodiment;

FIG. 2 is a schematic diagram schematically illustrating configurations of a laser beam irradiating unit and an observing unit of the laser processing apparatus described in FIG. 1;

FIG. 3 is a perspective view describing an example of configurations of the laser beam irradiating unit and the observing unit in FIG. 2;

FIG. 4 is a flowchart describing a flow of a method of observing a laser beam according to the embodiment; and

FIG. 5 is a schematic diagram schematically describing configurations of a laser beam irradiating unit and an observing unit of a laser processing apparatus according to a modification.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will hereinafter be described in detail with reference to the drawings. The present invention is not limited by contents described in the following embodiments. In addition, constituent elements described in the following include constituent elements readily conceivable by those skilled in the art and essentially identical constituent elements. Further, configurations described in the following can be combined with each other as appropriate. In addition, various omissions, replacements, or modifications of configurations can be performed without departing from the spirit of the present invention.

A configuration of a laser processing apparatus 1 according to an embodiment of the present invention will first be described with reference to the drawings. FIG. 1 is a perspective view describing an example of a configuration of the laser processing apparatus 1 according to the embodiment. FIG. 2 is a schematic diagram schematically describing configurations of a laser beam irradiating unit 20 and an observing unit 30 of the laser processing apparatus 1 described in FIG. 1. FIG. 3 is a perspective view describing an example of configurations of the laser beam irradiating unit 20 and

the observing unit 30 in FIG. 2. In the following description, an X-axis direction is one direction in a horizontal plane. A Y-axis direction is a direction orthogonal to the X-axis direction in the horizontal plane. A Z-axis direction is a direction orthogonal to the X-axis direction and the Y-axis direction. The Z-axis direction is a direction orthogonal to the X-axis direction and the Y-axis direction. In the laser processing apparatus 1 according to the embodiment, a processing feed direction is the X-axis direction, and an indexing feed direction is the Y-axis direction.

As described in FIG. 1 and FIG. 2, the laser processing apparatus 1 includes a chuck table 10, the laser beam irradiating unit 20, the observing unit 30, an X-axis direction moving unit 40, a Y-axis direction moving unit 50, a Z-axis direction moving unit 60, an imaging unit 70, and a display unit 80. The laser processing apparatus 1 according to the embodiment is an apparatus that processes a workpiece 100 by irradiating a workpiece 100 held on the chuck table 10 with a laser beam 21 by the laser beam irradiating unit 20. The processing of the workpiece 100 by the laser processing apparatus 1 is, for example, modified layer formation processing of forming a modified layer within the

workpiece 100 by stealth dicing, groove processing of forming a groove in the top surface of the workpiece 100, cutting processing of cutting the workpiece 100 along a planned dividing line, or the like.

The workpiece 100 is a wafer such as a semiconductor device wafer, or an optical device wafer in a disk shape which wafer has silicon (Si), sapphire (Al_2O_3), gallium arsenide (GaAs), silicon carbide (SiC), or the like as a substrate. It is to be noted that the workpiece 100 is not limited to the embodiment. The workpiece 100 in the present invention may not be in a disk shape. The workpiece 100 is, for example, supported within the opening of an annular frame 110 while a tape 111 to which an annular frame 110 is affixed and which has a larger diameter than the outside diameter of the workpiece 100 is affixed to the undersurface of the workpiece 100.

The chuck table 10 holds the workpiece 100 by a holding surface 11. The holding surface 11 has a disk shape formed of a porous ceramic or the like. The holding surface 11 in the embodiment is a flat surface parallel with a horizontal direction. The holding surface 11 is, for example, connected to a vacuum suction source via a vacuum suction path. The chuck table 10 sucks and holds

the workpiece 100 mounted on the holding surface 11. A plurality of clamp units 12 that sandwich the annular frame 110 supporting the workpiece 100 are arranged on the periphery of the chuck table 10.

A rotating unit 13 rotates the chuck table 10 about an axis parallel with the Z-axis direction. The rotating unit 13 is supported by an X-axis direction moving plate 14. The rotating unit 13 and the chuck table 10 are moved in the X-axis direction by the X-axis direction moving unit 40 via the X-axis direction moving plate 14. The rotating unit 13 and the chuck table 10 are moved in the Y-axis direction by the Y-axis direction moving unit 50 via the X-axis direction moving plate 14, the X-axis direction moving unit 40, and a Y-axis direction moving plate 15.

The laser beam irradiating unit 20 is a unit that irradiates the workpiece 100 held on the chuck table 10 with a pulsed laser beam 21. As described in FIG. 2 and FIG. 3, the laser beam irradiating unit 20 includes a laser oscillator 22, mirrors 23 and 24, an adjustment target lens 25, an attachment plate 26, a first condenser 29, and a direction changing mirror 31.

The laser oscillator 22 oscillates a laser having a predetermined wavelength for processing the workpiece

100. The laser beam 21 applied by the laser beam irradiating unit 20 has a wavelength transmissible through or absorbable by the workpiece 100.

The mirror 23 reflects the laser beam 21 emitted from the laser oscillator 22, and reflects the laser beam 21 toward the mirror 24. The mirror 24 further reflects the laser beam 21 reflected by the mirror 23 toward the observing unit 30. In a case where the laser beam 21 emitted from the laser oscillator 22 is an ultraviolet ray (UV), a reflective film that reflects UV is formed on the mirrors 23 and 24.

The adjustment target lens 25 is disposed on an optical path of the laser beam 21 between the laser oscillator 22 and the observing unit 30. The adjustment target lens 25 propagates the laser beam 21 emitted from the laser oscillator 22, and propagates the laser beam 21 to the observing unit 30 or a processing point of the workpiece 100. The adjustment target lens 25 in the embodiment is constituted by a plurality of lenses. As described in FIG. 3, the plurality of lenses of the adjustment target lens 25 in the embodiment are attached to the attachment plate 26 in a state of being housed in holders 251, respectively. The holders 251 support outer edge portions of the respective lenses of the adjustment

target lens 25, and expose central portions of the lenses.

The attachment plate 26 includes a plate main body 261 in a flat plate shape and a plurality of fixing portions 262. The fixing portions 262 are provided in the plate main body 261, and the adjustment target lens 25 and the direction changing mirror 31 to be described later are detachably fixed to the fixing portions 262. The fixing portions 262 in the embodiment are screw holes into which screws not described that are passed through through holes 252 penetrating the holder 251 are screwed. However, the fixing portions 262 in the present invention are not limited to this. The fixing portions 262 in the embodiment are plurally arranged at intervals along an optical path of the laser beam 21 between the laser oscillator 22 and the mirror 23, and are plurally arranged at intervals along a vertical direction orthogonal to the optical path.

The first condenser 29 condenses the laser beam 21 reflected by the direction changing mirror 31 to be described later, and condenses and applies the laser beam 21 to the workpiece 100 held on the chuck table 10. That is, the first condenser 29 is a condensing lens for processing. The first condenser 29 in the embodiment is a

biconvex single lens. At least the first condenser 29 of the laser beam irradiating unit 20 is supported by the Z-axis direction moving unit 60 installed on a column 3 erected from an apparatus main body 2 of the laser processing apparatus 1 (see FIG. 1).

The direction changing mirror 31 is detachably disposed on an optical path of the laser beam 21 between the laser oscillator 22 and a second condenser 33 of the observing unit 30 to be described later. The direction changing mirror 31 in the embodiment is detachably disposed on an optical path of the laser beam 21 between the adjustment target lens 25 and the second condenser 33. As described in FIG. 3, an outer edge portion of the direction changing mirror 31 in the embodiment is supported by a holder 311. The holder 311 is attached to the attachment plate 26. The direction changing mirror 31 is thereby attached to the attachment plate 26. In the case where the laser beam 21 emitted from the laser oscillator 22 is UV, a reflective film that reflects UV is formed on the direction changing mirror 31.

The observing unit 30 is a unit for observing the state of a condensing point of the laser beam 21 applied to the workpiece 100 in a pseudo manner. The observing unit 30 in the embodiment includes a casing 32, a second

condenser 33, a microscope 34, and an imaging element 35.

In a case where the direction changing mirror 31 is disposed on an optical path of the laser beam 21 between the laser oscillator 22 and the second condenser 33, the direction changing mirror 31 reflects the laser beam 21 propagated from the adjustment target lens 25, and reflects the laser beam 21 toward the workpiece 100 held on the holding surface 11 of the chuck table 10. In a state in which the direction changing mirror 31 is removed from the optical path of the laser beam 21 between the laser oscillator 22 and the second condenser 33, the laser beam 21 transmitted through the adjustment target lens 25 enters the imaging element 35 via the second condenser 33 and the microscope 34.

The casing 32 has the second condenser 33, the microscope 34, and the imaging element 35 attached to the inside thereof. As described in FIG. 3, the casing 32 is attached to the attachment plate 26. That is, the observing unit 30 in the embodiment is configured to be detachable from the attachment plate 26. The laser beam 21 emitted from the laser oscillator 22 enters the inside of the casing 32 in a state in which the direction changing mirror 31 is removed from the optical path of the laser beam 21 between the laser oscillator 22 and the

second condenser 33.

The second condenser 33 condenses the laser beam 21 in a direction different from that of the holding surface 11 of the chuck table 10. The observing unit 30 observes the laser beam 21 condensed in a direction different from that at a time of processing due to the absence of the direction changing mirror 31. That is, the second condenser 33 is a dummy condensing lens. The second condenser 33 in the embodiment is a biconvex single lens. The focal length of the second condenser 33 is the same as the focal length of the first condenser 29. That is, the condensing point of the laser beam 21 condensed by the second condenser 33 is a pseudo processing point. The focal length of the second condenser 33 in the embodiment is 50 mm. The second condenser 33 in the embodiment condenses the laser beam 21 that has entered the inside of the casing 32, and guides the laser beam 21 to the microscope 34.

The microscope 34 magnifies the laser beam 21 condensed by the second condenser 33. The magnification of the microscope 34 is set to be, for example, 10 to 30 times both inclusive. The magnification of the microscope 34 in the embodiment is set to be 20 times. In the case where the laser beam 21 oscillated from the laser

oscillator 22 is UV, the microscope 34 includes a UV compatible microscope lens resistant to UV.

The imaging element 35 observes the condensing point of the laser beam 21 magnified by the microscope 34. The imaging element 35 images a predetermined visual field range, and images the condensing point of the laser beam 21 within the visual field range. The imaging element 35 includes, for example, a charge coupled device (CCD), a complementary metal oxide semiconductor (CMOS), or the like. Because the focal length of the second condenser 33 is the same as the focal length of the first condenser 29, the imaging element 35 can observe the condensing point of the laser beam 21 in a pseudo manner, the condensing point being similar to the condensing point of the laser beam 21 reflected by the direction changing mirror 31 at a time of processing. An operator can adjust optical parts such as the adjustment target lens 25 while observing an image of the pseudo processing point imaged by the imaging element 35.

The observing unit 30 may be removed after an end of the adjustment, or may observe leakage light of the laser beam 21 transmitted through the direction changing mirror 31 without being removed even after the end of the adjustment.

As described in FIG. 1, the X-axis direction moving unit 40 is a unit that moves the chuck table 10 and the laser beam irradiating unit 20 relative to each other in the X-axis direction as a processing feed direction. The X-axis direction moving unit 40 in the embodiment moves the chuck table 10 in the X-axis direction. The X-axis direction moving unit 40 in the embodiment is installed on the apparatus main body 2 of the laser processing apparatus 1.

The X-axis direction moving unit 40 supports the X-axis direction moving plate 14 movably in the X-axis direction. The X-axis direction moving unit 40 includes a well-known ball screw 41, a well-known pulse motor 42, and well-known guide rails 43. The ball screw 41 is provided so as to be rotatable about an axis. The pulse motor 42 rotates the ball screw 41 about the axis. The guide rails 43 support the X-axis direction moving plate 14 movably in the X-axis direction. The guide rails 43 are provided in a state of being fixed to the Y-axis direction moving plate 15.

The Y-axis direction moving unit 50 is a unit that moves the chuck table 10 and the laser beam irradiating unit 20 relative to each other in the Y-axis direction as an indexing feed direction. The Y-axis direction moving

unit 50 in the embodiment moves the chuck table 10 in the Y-axis direction. The Y-axis direction moving unit 50 in the embodiment is installed on the apparatus main body 2 of the laser processing apparatus 1.

The Y-axis direction moving unit 50 supports the Y-axis direction moving plate 15 movably in the Y-axis direction. The Y-axis direction moving unit 50 includes a well-known ball screw 51, a well-known pulse motor 52, and well-known guide rails 53. The ball screw 51 is provided so as to be rotatable about an axis. The pulse motor 52 rotates the ball screw 51 about the axis. The guide rails 53 support the Y-axis direction moving plate 15 movably in the Y-axis direction. The guide rails 53 are provided in a state of being fixed to the apparatus main body 2.

The Z-axis direction moving unit 60 is a unit that moves the condensing point of the laser beam 21 condensed by the first condenser 29 of the laser beam irradiating unit 20 in an optical axis direction perpendicular to the holding surface 11 of the chuck table 10. More specifically, the Z-axis direction moving unit 60 moves the chuck table 10 and the laser beam irradiating unit 20 relative to each other in the Z-axis direction as a condensing point position adjustment direction. The Z-

axis direction moving unit 60 in the embodiment moves the laser beam irradiating unit 20 in the Z-axis direction. The Z-axis direction moving unit 60 in the embodiment is installed on the column 3 erected from the apparatus main body 2 of the laser processing apparatus 1.

The Z-axis direction moving unit 60 supports at least the first condenser 29 (see FIG. 2) of the laser beam irradiating unit 20 movably in the Z-axis direction. The Z-axis direction moving unit 60 includes a well-known ball screw 61, a well-known pulse motor 62, and well-known guide rails 63. The ball screw 61 is provided so as to be rotatable about an axis. The pulse motor 62 rotates the ball screw 61 about the axis. The guide rails 63 support the laser beam irradiating unit 20 movably in the Z-axis direction. The guide rails 63 are provided in a state of being fixed to the column 3.

The imaging unit 70 is, for example, disposed so as to image a lower side from directly above the first condenser 29 of the laser beam irradiating unit 20. The imaging unit 70 includes a coaxial camera, a CCD camera, or an infrared camera.

The display unit 80 is a display unit formed by a liquid crystal display apparatus or the like. The display unit 80, for example, displays, on a display surface, a

processing condition setting screen, the state of the workpiece 100 imaged by the imaging unit 70, the state of processing operation, and the like. The display unit 80, for example, displays, on the display surface, an image of the condensing point of the laser beam 21 imaged by the imaging element 35.

In a case where the display surface of the display unit 80 includes a touch panel, the display unit 80 may include an input unit. The input unit can receive various kinds of operations such as registration of processing content information by the operator. The input unit may be an external input apparatus such as a keyboard. The information or the image displayed on the display surface of the display unit 80 is changed by an operation from the input unit or the like. The display unit 80 may include a notifying unit. The notifying unit notifies predetermined notification information to the operator of the laser processing apparatus 1 by emitting at least one of sound and light. The notifying unit may be an external notifying apparatus such as a speaker, or a light emitting apparatus.

A method of observing the laser beam 21 according to the embodiment will next be described. FIG. 4 is a flowchart describing a flow of the method of observing

the laser beam 21 according to the embodiment. The method of observing the laser beam 21 includes a preparing step 201, a disposing step 202, an observing step 203, and a determining step 204.

The preparing step 201 is a step of preparing the observing unit 30. That is, the preparing step 201 prepares the observing unit 30 including the second condenser 33 that condenses the laser beam 21 in a direction different from that of the holding surface 11 of the chuck table 10, the microscope 34 that magnifies the laser beam 21 condensed by the second condenser 33, and the imaging element 35 that observes the condensing point of the laser beam 21 magnified by the microscope 34.

The disposing step 202 is a step of disposing the observing unit 30 prepared in the preparing step 201 in a position capable of receiving the laser beam 21 emitted from the laser oscillator 22. The disposing step 202 in the embodiment disposes the observing unit 30 such that the second condenser 33, the microscope 34, and the imaging element 35 are arranged on the optical path of the laser beam 21 reflected by the mirror 24 and transmitted through the adjustment target lens 25. At this time, the direction changing mirror 31 is removed

from an optical path between the mirror 24 and the second condenser 33.

The observing step 203 is a step of observing the state of the condensing point of the laser beam 21 emitted from the laser oscillator 22 and entering the imaging element 35. In the observing step 203, the observing unit 30 disposed in the disposing step 202 is irradiated with the laser beam 21. The condensing point of the laser beam 21 entering the inside of the casing 32 of the observing unit 30, the condensing point being condensed by the second condenser 33, is magnified by the microscope 34, and is imaged by the imaging element 35. An image of the condensing point of the laser beam 21 imaged by the imaging element 35 is, for example, displayed on the display surface of the display unit 80 so as to be able to be checked by the operator.

The determining step 204 is a step of determining whether the state of the condensing point of the laser beam 21 observed in the observing step 203 is acceptable or not. In the determining step 204, for example, a beam shape and a luminous intensity distribution at the processing point of the laser beam 21 are determined on the basis of the shape, luminance distribution, or the like of the condensing point of the imaged image. The

determination in the determining step 204 may be made by a control unit of the laser processing apparatus 1, for example. The control unit may determine whether the state of the condensing point of the laser beam 21 is acceptable or not by, for example, determining whether or not the shape and luminance distribution of the condensing point of the imaged image are within a preset range.

When it is determined in the determining step 204 that the state of the condensing point of the laser beam 21 is not acceptable, optical parts such as the adjustment target lens 25 are adjusted while the imaged image of the condensing point of the laser beam 21 imaged by the imaging element 35 is checked. When it is determined in the determining step 204 that the state of the condensing point of the laser beam 21 is acceptable, the adjustment is ended.

[Modification]

A configuration of a laser processing apparatus 1-2 according to a modification will next be described with reference to the drawings. FIG. 5 is a schematic diagram schematically describing configurations of a laser beam irradiating unit 20-2 and an observing unit 30-2 of the laser processing apparatus 1-2 according to the

modification. The laser processing apparatus 1-2 according to the modification is different as compared with the laser processing apparatus 1 according to the embodiment in that the laser processing apparatus 1-2 according to the modification includes the laser beam irradiating unit 20-2 and the observing unit 30-2 in place of the laser beam irradiating unit 20 and the observing unit 30.

The laser beam irradiating unit 20-2 in the modification is different as compared with the laser beam irradiating unit 20 in the embodiment in that the laser beam irradiating unit 20-2 in the modification does not include the direction changing mirror 31 but further includes a mirror 28. In addition, the observing unit 30-2 in the modification is different as compared with the observing unit 30 in the embodiment in that the observing unit 30-2 in the modification further includes a direction changing mirror 31-2.

The direction changing mirror 31-2 is detachably disposed on an optical path of the laser beam 21 between the laser oscillator 22 and the mirror 28. The direction changing mirror 31-2 in the modification is detachably disposed on an optical path of the laser beam 21 between the adjustment target lens 25 and the mirror 28. The

direction changing mirror 31-2 in the modification is attached to the inside of the casing 32.

In a case where the direction changing mirror 31-2 is disposed on the optical path of the laser beam 21 between the laser oscillator 22 and the mirror 28, the direction changing mirror 31-2 reflects the laser beam 21 transmitted through the adjustment target lens 25, and makes the laser beam 21 enter the imaging element 35 via the second condenser 33 and the microscope 34. In a case where the direction changing mirror 31-2 is removed from the optical path of the laser beam 21 between the laser oscillator 22 and the mirror 28, the laser beam 21 transmitted through the adjustment target lens 25 falls on the mirror 28.

The mirror 28 reflects the laser beam 21 reflected by the mirror 24 and transmitted through the adjustment target lens 25 toward the workpiece 100 held on the holding surface 11 of the chuck table 10. Incidentally, the laser beam 21 falls on the mirror 28 when the direction changing mirror 31-2 is removed from the optical path of the laser beam 21 between the laser oscillator 22 and the mirror 28.

As described above, the laser processing apparatuses 1 and 1-2 according to the embodiment and the

modification can observe the laser beam 21 in the same state as at the processing point without performing processing, by a dummy condenser (second condenser 33) and an optical system that magnifies and observes the laser beam 21 condensed by this dummy condenser. Hence, labor and the number of processing man-hours for preparing the workpiece 100 for adjustment can be reduced. In addition, debris produced from the workpiece 100 at a time of processing can be prevented from adhering to optical parts during the adjustment. Further, because the adjustment is made while the laser beam 21 is observed, an abnormality in the laser beam 21 can be noticed in an adjustment stage. Thus, an effect of being able to prevent rework is produced.

The present invention is not limited to the details of the above described preferred embodiments. The scope of the invention is defined by the appended claims and all changes and modifications as fall within the equivalence of the scope of the claims are therefore to be embraced by the invention.

WHAT IS CLAIMED IS:

1. A laser processing apparatus (1) comprising:
a chuck table (10) having a holding surface (11) configured to hold a workpiece (100);
a laser oscillator (22) configured to oscillate a laser;
a direction changing mirror (31);
a first condenser (29) configured to condense a laser beam (21) emitted from the laser oscillator (22) and reflected by the direction changing mirror (31), and irradiate the workpiece (100) held on the chuck table (10) with the laser beam (21);
an observing unit (30) configured to observe a state of a condensing point of the laser beam (21) applied to the workpiece (100) in a pseudo manner, the observing unit (30) including
a second condenser (33) configured to condense the laser beam (21) in a direction parallel to the holding surface (11) of the chuck table (10),
a microscope (34) configured to magnify the laser beam (21) condensed by the second condenser (33),
an imaging element (35) configured to observe and image the condensing point of the laser beam (21) magnified by the microscope (34); and

a control unit configured to determine whether the state of the condensing point of the laser beam (21) observed by the imaging element (35) is acceptable or not,

wherein

when the direction changing mirror (31) is detachably disposed on an optical path of the laser beam (21) between the laser oscillator (22) and the second condenser (33), the direction changing mirror (31) reflects the laser beam (21) towards the workpiece (100), and when the direction changing mirror (31) is removed from the optical path of the laser beam (21) between the laser oscillator (22) and the second condenser (33), the laser beam (21) enters the imaging element (35) via the second condenser (33) and the microscope (34), and

wherein

when it is determined that the state of the condensing point of the laser beam (21) is not acceptable,

optical parts of the laser processing apparatus (1) are adjusted while the image of the condensing point of the laser beam (21) imaged by the imaging element (35) is checked; and

when it is determined that the state of the condensing point of the laser beam (21) is acceptable, the

adjustment of the optical parts is ended.

2. A laser processing apparatus (1-2) comprising:
a chuck table (10) having a holding surface (11)
configured to hold a workpiece (100);

a laser oscillator (22) configured to oscillate a
laser;

a mirror (28);

a first condenser (29) configured to condense a
laser beam (21) emitted from the laser oscillator (22)
and reflected by the mirror (28), and irradiate the
workpiece (100) held on the chuck table (10) with the
laser beam (21);

an observing unit (30-2) configured to observe a
state of a condensing point of the laser beam (21)
applied to the workpiece (100) in a pseudo manner, the
observing unit (30-2) including

a second condenser (33) configured to
condense the laser beam (21) in a direction perpendicular
to the holding surface (11) of the chuck table (10),

a microscope (34) configured to magnify the
laser beam (21) condensed by the second condenser (33),

an imaging element (35) configured to
observe and image the condensing point of the laser beam
(21) magnified by the microscope (34),

a direction changing mirror (31-2); and
a control unit configured to determine whether the
state of the condensing point of the laser beam (21)
observed by the imaging element (35) is acceptable or
not,

wherein

when the direction changing mirror (31-2) is
detachably disposed on an optical path of the laser beam
(21) between the laser oscillator (22) and the mirror (28),
the direction changing mirror (31-2) reflects the laser
beam (21) and makes the laser beam (21) enter the imaging
element (35) via the second condenser (33) and the
microscope (34); and when the direction changing mirror
(31-2) is removed from the optical path of the laser beam
(21) between the laser oscillator (22) and the mirror (28),
the laser beam (21) falls on the mirror (28), and

wherein

when it is determined that the state of the
condensing point of the laser beam (21) is not acceptable,
optical parts of the laser processing apparatus (1-
2) are adjusted while the image of the condensing point of
the laser beam (21) imaged by the imaging element (35) is
checked; and

when it is determined that the state of the

condensing point of the laser beam (21) is acceptable, the adjustment of the optical parts is ended.

3. The laser processing apparatus (1; 1-2) according to claim 1 or claim 2, wherein

the observing unit (30; 30-2) is configured to be detachable.

4. The laser processing apparatus (1; 1-2) according to claim 1 or claim 2, wherein

the control unit is configured to determine whether the state of the condensing point of the laser beam (21) observed by the imaging element (35) is acceptable or not by determining whether or not a shape and luminance distribution of the condensing point of the image imaged by the imaging element (35) are within a preset range.

5. An observing method of observing a state of a laser beam (21) applied to a workpiece (100) in a pseudo manner in a laser processing apparatus (1) including

a chuck table (10) having a holding surface (11) configured to hold the workpiece (100), a laser oscillator (22) configured to oscillate a laser, a direction changing mirror (31), and a first condenser (29) configured to condense the laser beam (21) emitted from the laser oscillator (22) and reflected by the direction changing mirror (31), and irradiate the

workpiece (100) held on the chuck table (10) with the laser beam (21), the observing method comprising:

a preparing step of preparing an observing unit (30) including a second condenser (33) configured to condense the laser beam (21) in a direction parallel to the holding surface (11) of the chuck table (10), a microscope (34) configured to magnify the laser beam (21) condensed by the second condenser (33), and an imaging element (35) configured to observe and image a condensing point of the laser beam (21) magnified by the microscope (34);

a disposing step of disposing the observing unit (30) in a position capable of receiving the laser beam (21) emitted from the laser oscillator (22);

an observing step of observing a state of the condensing point of the laser beam (21) emitted from the laser oscillator (22) and incident on the imaging element (35); and

a determining step of determining whether the state of the condensing point of the laser beam (21) observed in the observing step is acceptable or not,

wherein

when the direction changing mirror (31) is detachably disposed on an optical path of the laser beam

(21) between the laser oscillator (22) and the second condenser (33), the direction changing mirror (31) reflects the laser beam (21) towards the workpiece (100) and when the direction changing mirror (31) is removed from the optical path of the laser beam (21) between the laser oscillator (22) and the second condenser (33), the laser beam (21) enters the imaging element (35) via the second condenser (33) and the microscope (34), and

wherein

in the determining step, when it is determined that the state of the condensing point of the laser beam (21) is not acceptable,

optical parts of the laser processing apparatus (1) are adjusted while the image of the condensing point of the laser beam (21) imaged by the imaging element (35) is checked, and

when it is determined in the determining step that the state of the condensing point of the laser beam (21) is acceptable, the adjustment of the optical parts is ended.

6. An observing method of observing a state of a laser beam (21) applied to a workpiece (100) in a pseudo manner in a laser processing apparatus (1-2) including a chuck table (10) having a holding surface (11)

configured to hold the workpiece (100), a laser oscillator (22) configured to oscillate a laser, a mirror (28), and a first condenser (29) configured to condense a laser beam (21) emitted from the laser oscillator (22) and reflected by the mirror (28), and irradiate the workpiece (100) held on the chuck table (10) with the laser beam (21), the observing method comprising:

 a preparing step of preparing an observing unit (30-2) including a second condenser (33) configured to condense the laser beam (21) in a direction perpendicular to the holding surface (11) of the chuck table (10), a microscope (34) configured to magnify the laser beam (21) condensed by the second condenser (33), a direction changing mirror (31-2), and an imaging element (35) configured to observe and image a condensing point of the laser beam (21) magnified by the microscope (34);

 a disposing step of disposing the observing unit (30-2) in a position capable of receiving the laser beam (21) emitted from the laser oscillator (22);

 an observing step of observing a state of the condensing point of the laser beam (21) emitted from the laser oscillator (22) and incident on the imaging element (35); and

 a determining step of determining whether the state

of the condensing point of the laser beam (21) observed in the observing step is acceptable or not,

wherein

when the direction changing mirror (31-2) is detachably disposed on an optical path of the laser beam (21) between the laser oscillator (22) and the mirror (28), the direction changing mirror (31-2) reflects the laser beam (21) and makes the laser beam (21) enter the imaging element (35) via the second condenser (33) and the microscope (34), and when the direction changing mirror (31-2) is removed from the optical path of the laser beam (21) between the laser oscillator (22) and the mirror (28), the laser beam (21) falls on the mirror (28), and

wherein

in the determining step, when it is determined that the state of the condensing point of the laser beam (21) is not acceptable,

optical parts of the laser processing apparatus (1-2) are adjusted while the image of the condensing point of the laser beam (21) imaged by the imaging element (35) is checked, and

when it is determined in the determining step that the state of the condensing point of the laser beam (21)

is acceptable, the adjustment of the optical parts is ended.

7. The laser beam observing method according to claim 5 or claim 6, wherein

in the determining step, a beam shape and a luminous intensity distribution at a processing point of the laser beam (21) are determined on a basis of a shape and luminance distribution of the condensing point of the image imaged by the imaging element (35).