

INSPECTION TABLE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an inspection table for use in inspecting a processing apparatus for processing a workpiece held on a chuck table.

Description of the Related Art

There are various kinds of processing apparatuses for processing a workpiece held on a chuck table, such as a cutting apparatus, a laser processing apparatus, and a grinding apparatus for processing a semiconductor wafer or a package substrate as the workpiece. In the case of a cutting apparatus, for example, there occurs a problem such that if the chuck table is inclined by an amount greater than a prescribed amount, a depth of cut in the workpiece by a cutting blade may vary to cause the generation of an uncut area. Further, if a cutting water nozzle is not properly positioned with respect to the cutting blade, more contaminants (cutting dust) may adhere to the workpiece, so that a desired processing result cannot be obtained. It is therefore necessary to periodically inspect the condition of the processing apparatus.

SUMMARY OF THE INVENTION

In the case of inspecting the condition of the processing apparatus, an operator is required to look into a narrow space in the processing apparatus or set various measuring instruments in the processing apparatus, so as to check whether or not the processing apparatus is in a desired condition. That is, effort and skill are required in the inspection of the processing apparatus. For example, in checking whether or not the cutting water nozzle is properly positioned in parallel to the cutting blade in a cutting apparatus, there is a case that an operator sets a mirror below the cutting blade and then looks at the mirror. However, this working is performed in a dark and narrow space and thus very difficult to perform.

It is therefore an object of the present invention to provide an inspection table which allows an operator to recognize the condition of a processing apparatus without the need for effort and skill.

In accordance with an aspect of the present invention, there is provided an inspection table for use in a processing apparatus including a chuck table having a holding surface for holding a workpiece, a processing

unit adapted to be opposed to the holding surface for processing the workpiece held on the chuck table, a table base for detachably supporting the chuck table, a moving unit for moving the table base, and a camera unit for imaging the workpiece held on the chuck table, the inspection table including a base portion adapted to be detachably supported on the holding surface of the chuck table or on the table base; a sensor fixed to the base portion and adapted to be driven by electric power; an information transmitting portion for transmitting information detected by the sensor; and a battery for supplying electric power to the sensor and the information transmitting portion, in which the sensor is selected from a group consisting of a pressure sensor, an inclination sensor, a temperature sensor, a light quantity sensor, and an image sensor, and the sensor is used to measure or record a pressure, inclination, temperature, light quantity, or outward appearance image related to the chuck table, the processing unit, the table base, or the moving unit.

With this configuration, by simply fixing the inspection table on the chuck table (on the holding surface) or on the table base in place of the chuck table, the condition that various sensors are mounted on the

chuck table or on the table base can be realized. Accordingly, a peripheral condition of a cutting unit or a cutting blade (e.g., the inclination of nozzles or a positional relation between the nozzles and the cutting blade) or a peripheral condition of a laser applying unit (e.g., a positional relation between a vacuum unit and a focusing lens) can be imaged and recognized by using the inspection table. Further, with the configuration of the present invention, the inspection table includes the information transmitting portion, so that the inclination of the upper surface of the chuck table or the table base, the yawing or pitching of the moving unit, or the intensity or deviation of illumination by the camera unit, for example, can be recognized from a place remote from the chuck table or the table base.

Preferably, the inspection table further includes a memory for recording the information detected by the sensor. With this configuration, an operator can obtain and use the information detected by the sensor as required.

According to the present invention, it is possible to exhibit an effect that the condition of the processing apparatus can be recognized without the need for effort and skill.

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 a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view illustrating a processing apparatus according to a preferred embodiment of the present invention;

FIG. 2 is a partially sectional side view illustrating an essential part of the processing apparatus illustrated in FIG. 1;

FIG. 3 is a perspective view of a processing unit included in the processing apparatus illustrated in FIG. 1;

FIG. 4 is a partially sectional side view for illustrating an operation of cutting a workpiece held on a chuck table included in the processing apparatus illustrated in FIG. 1;

FIG. 5 is a perspective view similar to FIG. 1, illustrating the case that an inspection table according

to the preferred embodiment is used;

FIG. 6 is a partially sectional side view illustrating an essential part of the processing apparatus illustrated in FIG. 5 in the condition where the inspection table is mounted on the chuck table;

FIG. 7 is a perspective view of the inspection table;

FIG. 8 is a block diagram illustrating the configuration of the inspection table;

FIG. 9 is a schematic side view illustrating an example of the inspection by the inspection table;

FIG. 10 is a schematic side view illustrating another example of the inspection by the inspection table;

FIG. 11 is a schematic side view illustrating another example of the inspection by the inspection table;

FIG. 12 is a schematic side view illustrating another example of the inspection by the inspection table;

FIG. 13 is a schematic plan view of an image obtained by an image sensor provided in the inspection table;

FIG. 14 is a block diagram illustrating an example

of detected information;

FIG. 15 is a flowchart illustrating an example of the processing by the inspection table; and

FIG. 16 is a plan view illustrating a data selection screen transmitted from the inspection table to a terminal equipment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention will now be described in detail with reference to the drawings. The present invention is not limited to the preferred embodiment. Further, the components used in the preferred embodiment may include those that can be easily assumed by persons skilled in the art or substantially the same elements as those known in the art. Further, the configurations described below may be suitably combined. Further, the configurations may be variously omitted, replaced, or changed without departing from the scope of the present invention.

In the following preferred embodiment, an XYZ orthogonal coordinate system is set to describe a positional relation between the components with reference to the XYZ orthogonal coordinate system. A predetermined direction in a horizontal plane is defined as an X

direction illustrated by an arrow X in the drawings, and a direction perpendicular to the X direction in this horizontal plane is defined as a Y direction illustrated by an arrow Y in the drawings. Further, a direction perpendicular to both the X direction and the Y direction is defined as a Z direction illustrated by an arrow Z in the drawings. An XY plane defined by the X direction and the Y direction is parallel to a horizontal plane. The Z direction perpendicular to the XY plane is a vertical direction.

The configuration of a processing apparatus 2 according to the preferred embodiment will now be described with reference to FIGS. 1 to 4. FIG. 1 is a perspective view of the processing apparatus 2. FIG. 2 is a partially sectional side view illustrating an essential part of the processing apparatus 2. FIG. 3 is a perspective view of a processing unit included in the processing apparatus 2. FIG. 4 is a partially sectional side view for illustrating an operation of cutting a workpiece held on a chuck table included in the processing apparatus 2.

Reference numeral 100 denotes a workpiece to be processed by the processing apparatus 2 (see FIG. 1, for example). The workpiece 100 is a disk-shaped

semiconductor wafer or optical device wafer including a circular substrate 101 formed of silicon, sapphire, or gallium arsenide, for example. The substrate 101 has a front side 102 and a back side 105 opposite to the front side 102. A plurality of crossing division lines 103 are formed on the front side 102 of the substrate 101 to thereby define a plurality of separate regions where a plurality of devices 104 are respectively formed.

A circular dicing tape 106 as an adhesive tape is attached to the back side 105 of the substrate 101. The circular dicing tape 106 has a diameter larger than that of the substrate 101, and a central circular portion of the dicing tape 106 is attached to the back side 105 of the substrate 101. A ring frame 107 is attached to a peripheral portion of the dicing tape 106. The ring frame 107 has a circular inside opening, in which the workpiece 100 is disposed so as to be supported by the dicing tape 106. Thus, the workpiece 100 is supported through the dicing tape 106 to the ring frame 107 to thereby form a frame unit 108. In other words, the frame unit 108 is composed of the workpiece 100, the dicing tape 106, and the ring frame 107 united together. Further, an annular area 106A of the dicing tape 106 is formed between the workpiece 100 and the ring frame 107.

The substrate 101 of the workpiece 100 is not limited in material, shape, structure, size, etc. For example, the substrate 101 of the workpiece 100 may be formed of ceramic, resin, or metal, for example, and may have any shape. Further, the devices 104 are not limited in kind, number, shape, structure, size, layout, etc.

As illustrated in FIG. 1, the processing apparatus 2 includes a base 4 on which various components are mounted. An X moving mechanism 6 as a work feeding unit is provided on the upper surface of the base 4. The X moving mechanism 6 includes a pair of X guide rails 8 substantially parallel to the X direction as a work feeding direction. An X movable table 10 is slidably mounted on the pair of X guide rails 8.

A nut portion (not illustrated) is formed on the lower surface of the X movable table 10, and an X ball screw 12 parallel to the X guide rails 8 is threadedly engaged with this nut portion. An X pulse motor 14 for rotating the X ball screw 12 is connected to one end of the X ball screw 12. Accordingly, when the X ball screw 12 is rotated by the X pulse motor 14, the X movable table 10 is moved in the X direction along the X guide rails 8. The X moving mechanism 6 is provided with an X position measuring unit (not illustrated) for measuring

the X position of the X movable table 10 as the position in the X direction.

By operating the X moving mechanism 6 to move the X movable table 10 in the X direction, a chuck table 30 is fed in the X direction through a θ table 16 and a chuck table base 20, in which the θ table 16 is provided on the upper surface of the X movable table 10, and the chuck table base 20 is provided on the upper surface of the θ table 16. The upper side of the X moving mechanism 6 including the X movable table 10 is covered with a table cover 18 and a bellows-shaped cover (not illustrated).

The θ table 16 is provided on the upper surface of the X movable table 10 as the front side thereof. The θ table 16 includes a rotational drive source (not illustrated) such as a motor for rotating the chuck table base 20 and the chuck table 30. That is, when this rotational drive source is operated, the chuck table base 20 provided on the upper surface of the θ table 16 and the chuck table 30 provided on the upper surface of the chuck table base 20 are rotated together about a vertical axis substantially parallel to the Z direction as a cutter feeding direction.

As illustrated in FIG. 1, the chuck table base 20 is provided through the θ table 16 on the upper surface

of the X movable table 10. The chuck table base 20 is formed of a conductor such as metal. As illustrated in FIG. 2, the chuck table base 20 includes a cylindrical body portion 21 for supporting and fixing the chuck table 30 and four clamps 22 as frame holding portions provided on the outer circumference of the body portion 21 for holding and fixing the ring frame 107 of the frame unit 108. The body portion 21 of the chuck table base 20 has an upper surface as a flat mounting surface 23 for mounting and supporting the chuck table 30 thereon.

Each clamp 22 is movable in the radial direction of the body portion 21. Accordingly, in operating each clamp 22, each clamp 22 is moved in the radial direction of the body portion 21 according to the diameter of the chuck table 30 to be suitably selected according to the diameter of the workpiece 100 and the diameter of the frame unit 108.

As illustrated in FIG. 2, the chuck table 30 has an upper surface 33 and a lower surface 34 opposite to the upper surface 33. A chuck table suction passage 24 and a workpiece suction passage 25 are formed in the body portion 21 of the chuck table base 20. The chuck table suction passage 24 functions to apply a vacuum to the lower surface 34 of the chuck table 30 mounted on the

mounting surface 23 of the chuck table base 20, thereby detachably fixing the chuck table 30 on the chuck table base 20. The chuck table 30 has a holding surface suction passage 36 for applying a vacuum to the upper surface 33 as a holding surface for holding the workpiece 100 thereon. The workpiece suction passage 25 of the chuck table base 20 communicates with the holding surface suction passage 36 of the chuck table 30 mounted on the mounting surface 23, thereby applying a vacuum to the holding surface suction passage 36. The chuck table suction passage 24 and the workpiece suction passage 25 open to the mounting surface 23 of the body portion 21 of the chuck table base 20.

As illustrated in FIG. 2, the chuck table suction passage 24 is connected through a first on-off valve 26 to a vacuum source 28 on the lower side opposite to the mounting surface 23 of the body portion 21 of the chuck table base 20. Similarly, the workpiece suction passage 25 is connected through a second on-off valve 27 to the vacuum source 28 on the lower side opposite to the mounting surface 23 of the body portion 21 of the chuck table base 20. The vacuum source 28 functions to supply a vacuum through the chuck table suction passage 24 to the mounting surface 23 of the chuck table base 20. Further,

the vacuum source 28 also functions to supply a vacuum through the workpiece suction passage 25 and the holding surface suction passage 36 to the upper surface 33 of the chuck table 30 as a holding surface for holding the workpiece 100 through the dicing tape 106.

As illustrated in FIG. 2, the chuck table 30 is detachably fixed to the chuck table base 20 in such a manner that the lower surface 34 of the chuck table 30 comes into close contact with the mounting surface 23 of the chuck table base 20. The workpiece 100 is adapted to be held under suction on the holding surface 33 of the chuck table 30. The chuck table 30 includes a suction holding portion 31 having an upper surface forming the flat holding surface 33 and a table body 32 having a lower surface as the flat lower surface 34 of the chuck table 30.

The table body 32 has an upper surface on which a central recess 35 is formed. The suction holding portion 31 is fitted in the central recess 35 of the table body 32. The suction holding portion 31 is formed of porous ceramic having many porous holes, or the like. The frame unit 108 is adapted to be held under suction on the whole of the holding surface 33 of the suction holding portion 31.

The table body 32 is a disk-shaped member formed of a conductor such as metal. The recess 35 is formed on the upper surface of the table body 32 at its central portion. The holding surface suction passage 36 is formed in the table body 32, so as to apply a vacuum through the suction holding portion 31 to the dicing tape 106 of the frame unit 108 mounted on the holding surface 33, thereby detachably holding the workpiece 100 on the chuck table 30. The holding surface suction passage 36 opens to the lower surface 34 and the bottom surface of the recess 35 of the table body 32.

An annular seal member 38 is provided between the mounting surface 23 of the chuck table base 20 and the lower surface 34 of the chuck table 30 so as to make communication between the workpiece suction passage 25 and the holding surface suction passage 36 in a tight sealed condition. More specifically, a recess 25a is formed on the mounting surface 23 of the chuck table base 20 in such a manner that the workpiece suction passage 25 opens to the bottom surface of the recess 25a. On the other hand, a recess 36a is formed on the lower surface 34 of the chuck table 30 in such a manner that the holding surface suction passage 36 opens to the bottom surface of the recess 36a. The annular seal member 38 is

closely fitted both in the recess 25a and in the recess 36a, so that the workpiece suction passage 25 comes into communication with the holding surface suction passage 36 in a tight sealed condition. The chuck table 30 is replaceable according to the sizes or kinds of the workpiece 100 and the frame unit 108.

The chuck table 30 is fixed to the chuck table base 20 in the following manner. First, the lower surface 34 of the chuck table 30 is mounted on the mounting surface 23 of the chuck table base 20 and then suitably positioned with respect to each other. Thereafter, a vacuum produced by the vacuum source 28 is applied to the mounting surface 23 of the chuck table base 20. Accordingly, the flat lower surface 34 comes into close contact with the flat mounting surface 23 under suction, thereby fixing the chuck table 30 to the chuck table base 20 as illustrated in FIG. 2. Similarly, the frame unit 108 is fixed to the chuck table 30 in the following manner. First, the dicing tape 106 of the frame unit 108 is mounted on the holding surface 33 of the chuck table 30. That is, the workpiece 100 attached to the dicing tape 106 is mounted through the dicing tape 106 on the holding surface 33 of the chuck table 30 and then positioned with respect to each other. Thereafter, a

vacuum produced by the vacuum source 28 is applied to the holding surface 33 of the chuck table 30. Accordingly, the flat lower surface of the dicing tape 106 of the frame unit 108 comes into close contact with the flat holding surface 33, thereby fixing the frame unit 108 to the chuck table 30 under suction as illustrated in FIG. 4.

In the preferred embodiment, the chuck table 30 includes the suction holding portion 31 and the table body 32, in which the suction holding portion 31 is formed of porous ceramic having many porous holes, or the like. However, the configuration of the chuck table 30 is not limited to this configuration. For example, a suction groove may be formed so as to apply a vacuum from the vacuum source 28 to the holding surface 33 of the chuck table 30.

As illustrated in FIG. 4, each clamp 22 is operated to fix the frame unit 108 to the chuck table 30 in such a manner that the ring frame 107 is held by each clamp 22 at a level lower than the level of the holding surface 33 of the chuck table 30. Accordingly, the dicing tape 106 comes into close contact with the holding surface 33, so that the workpiece 100 is firmly supported through the dicing tape 106 to the holding surface 33.

As illustrated in FIG. 1, a water case 19 is

provided in the vicinity of the X movable table 10. The water case 19 functions to temporarily store cutting water such as pure water used in cutting the workpiece 100 as a waste liquid or the like. The waste liquid stored in the water case 19 is discharged through a drain (not illustrated) or the like to the outside of the processing apparatus 2. Further, a transfer mechanism (not illustrated) for transferring the workpiece 100 to the chuck table 30 is provided at a position close to the chuck table 30.

As illustrated in FIG. 1, a double column type support structure 40 is provided on the upper surface of the base 4 so as to straddle the X moving mechanism 6. Two sets of processing unit moving mechanisms 42 (an example of the moving unit in the present invention) are provided on the front surface of the support structure 40 at an upper portion thereof, in which each set of processing unit moving mechanism 42 functions as an indexing unit and a cutter feeding unit. The two sets of processing unit moving mechanisms 42 commonly include a pair of Y guide rails 44 substantially parallel to the Y direction as an indexing direction, or a lateral direction as viewed in FIG. 1. The pair of Y guide rails 44 is provided on the front surface of the support

structure 40. Each processing unit moving mechanism 42 includes a Y movable plate 46 slidably mounted on the Y guide rails 44.

A nut portion (not illustrated) is formed on the back side (rear surface) of the Y movable plate 46 in each processing unit moving mechanism 42, and a Y ball screw 48 substantially parallel to the Y guide rails 44 is threadedly engaged with this nut portion. A Y pulse motor 50 for rotating the Y ball screw 48 is connected to one end of the Y ball screw 48. Accordingly, when the Y ball screw 48 is rotated by the Y pulse motor 50, the Y movable plate 46 is moved in the Y direction along the Y guide rails 44.

A pair of Z guide rails 52 substantially parallel to the Z direction is provided on the front side (front surface) of the Y movable plate 46 in each processing unit moving mechanism 42. A Z movable plate 54 is slidably mounted on the Z guide rails 52. A nut portion (not illustrated) is formed on the back side (rear surface) of the Z movable plate 54, and a Z ball screw 56 substantially parallel to the Z guide rails 52 is threadedly engaged with this nut portion. A Z pulse motor 58 for rotating the Z ball screw 56 is connected to one end of the Z ball screw 56. Accordingly, when the Z ball

screw 56 is rotated by the Z pulse motor 58, the Z movable plate 54 is moved in the Z direction along the Z guide rails 52.

Each processing unit moving mechanism 42 is provided with a Y position measuring unit (not illustrated) for measuring the Y position of the Y movable plate 46 as the position in the Y direction. Further, each processing unit moving mechanism 42 is provided with a Z position measuring unit (not illustrated) for measuring the Z position of the Z movable plate 54 as the position in the Z direction.

A processing unit 60 for cutting the workpiece 100 held on the chuck table 30 is fixed to the lower portion of the Z movable plate 54 in each processing unit moving mechanism 42. Further, a camera unit 62 as an imaging unit for imaging the workpiece 100 is provided adjacent to the processing unit 60. In each processing unit moving mechanism 42, the processing unit 60 and the camera unit 62 are moved together in the Y direction (indexing direction) by moving the Y movable plate 46 in the Y direction, and the processing unit 60 and the camera unit 62 are moved together in the Z direction (cutter feeding direction) by moving the Z movable plate 54 in the Z direction.

The X position of the chuck table 30 with respect to the processing unit 60 and the camera unit 62 is measured by the X position measuring unit mentioned above. The Y position of the processing unit 60 and the camera unit 62 with respect to the chuck table 30 is measured by the Y position measuring unit mentioned above. The Z position of the processing unit 60 and the camera unit 62 with respect to the chuck table 30 is measured by the Z position measuring unit mentioned above.

As illustrated in FIG. 3, the processing unit 60 is a cutting unit including a spindle 64 having a rotation axis substantially parallel to the holding surface 33 of the chuck table 30 and a cutting blade 66 mounted on the spindle 64. The cutting blade 66 has an annular cutting edge along the outer circumference. The processing unit 60 functions to cut the workpiece 100 held on the chuck table 30. The rotation axis of the spindle 64 is substantially perpendicular to the X direction and the Z direction and substantially parallel to the Y direction. The cutting blade 66 is mounted on the spindle 64 at one end portion thereof so as to be held between a fixing nut (not illustrated) and a mount flange 65. A rotational drive source (not illustrated) such as a motor for rotating the spindle 64 is connected to the other end of

the spindle 64. As illustrated in FIG. 4, the cutting blade 66 is rotated by the torque output from the rotational drive source and transmitted through the spindle 64. By rotating the cutting blade 66 to cut the workpiece 100 along the division lines 103, a cut groove is formed along each division line 103 to thereby obtain individual device chips respectively including the devices 104.

As illustrated in FIG. 3, there are provided in the vicinity of the cutting blade 66 a first cutting water nozzle 63 for supplying cutting water such as pure water to the workpiece 100, a second cutting water nozzle 67 for supplying cutting water such as pure water to the workpiece 100 and the cutting blade 66, and a pair of cooling water nozzles 68 (one of which being illustrated) for spraying cooling water to the opposite side surfaces of the cutting blade 66. As illustrated in FIG. 1, a blade position detecting unit 69 for detecting the vertical position of the cutting blade 66 is provided below the cutting blade 66. The blade position detecting unit 69 functions to detect the height of the lower end of the cutting blade 66, that is, the Z position of the lower end of the cutting blade 66. The above components of the processing unit 60 are controlled by a control

unit 39 according to processing conditions in cutting the workpiece 100.

As illustrated in FIG. 1, the processing apparatus 2 includes the control unit 39 for controlling the components of the processing apparatus 2 according to processing conditions in cutting the workpiece 100. The control unit 39 is a computer capable of executing a computer program, in which the computer includes a computing apparatus having a microprocessor such as a central processing unit (CPU), a storing apparatus having a memory such as a read only memory (ROM) and a random access memory (RAM), and an input/output interface apparatus.

The size and kind of the chuck table 30 are input from an operator through an input unit (not illustrated) to the control unit 39 and then recorded in the control unit 39. The control unit 39 controls the operation of the first on-off valve 26 to select either an open condition where a vacuum from the vacuum source 28 is applied through the chuck table suction passage 24 or a closed condition where the vacuum is not applied through the chuck table suction passage 24, thereby selecting either an operative condition where the chuck table 30 is fixed to the mounting surface 23 of the chuck table base

20 under suction or an inoperative condition where the chuck table 30 is not fixed to the mounting surface 23 of the chuck table base 20 under suction. Similarly, the control unit 39 controls the operation of the second on-off valve 27 to select either an open condition where a vacuum from the vacuum source 28 is applied through the workpiece suction passage 25 or a closed condition where the vacuum is not applied through the workpiece suction passage 25, thereby selecting either an operative condition where the workpiece 100 is held under suction on the holding surface 33 of the chuck table 30 or an inoperative condition where the workpiece 100 is not held under suction on the holding surface 33 of the chuck table 30.

There will now be described an inspection table 200 for use in the processing apparatus 2 according to the preferred embodiment with reference to FIGS. 5 to 9. FIG. 5 is a perspective view illustrating the processing apparatus 2 in using the inspection table 200. FIG. 6 is a partially sectional side view illustrating an essential part of the processing apparatus 2 in the condition where the inspection table 200 is mounted on the chuck table 30. FIG. 7 is a perspective view of the inspection table 200. FIG. 8 is a block diagram illustrating the configuration

of the inspection table 200. FIGS. 9 to 12 are schematic side views illustrating various examples of the inspection by the inspection table 200. FIG. 13 is a schematic plan view of an image obtained by an image sensor provided in the inspection table 200. FIG. 14 is a block diagram illustrating an example of detected information.

As illustrated in FIG. 5, the inspection table 200 is mounted on the holding surface 33 of the chuck table 30 and then positioned by the operator in carrying out the inspection of the processing apparatus 2. Thereafter, a vacuum produced by the vacuum source 28 is applied to the holding surface 33 of the chuck table 30. Accordingly, the lower surface of the inspection table 200 comes into close contact with the flat holding surface 33 of the chuck table 30 under suction, so that the inspection table 200 is fixed to the chuck table 30 as illustrated in FIG. 6.

Thereafter, the control unit 39 is operated through the input unit by the operator to thereby operate the processing apparatus 2 and then carry out the inspection of the processing apparatus 2. In carrying out the inspection of the processing apparatus 2, the processing apparatus 2 may be manually operated by the operator as

mentioned above or may be automatically operated in a predetermined mode previously prepared for the inspection.

The operator can obtain information detected by the inspection table 200 in the inspection of the processing apparatus 2 by using terminal equipment 300. As the terminal equipment 300, a mobile terminal such as a smartphone and a tablet may be used.

The control unit 39 operates the processing apparatus 2 according to an input from the operator. For example, the control unit 39 controls the operation of the second on-off valve 27 to select either an open condition where a vacuum from the vacuum source 28 is applied through the workpiece suction passage 25 or a closed condition where the vacuum is not applied through the workpiece suction passage 25, thereby selecting either an operative condition where the inspection table 200 is held under suction on the holding surface 33 of the chuck table 30 or an inoperative condition where the inspection table 200 is not held under suction on the holding surface 33 of the chuck table 30.

As illustrated in FIG. 7, the inspection table 200 includes a base portion 201 adapted to be detachably supported to the holding surface 33 of the chuck table 30. In the preferred embodiment, the lower surface of the

inspection table 200 is brought into close contact with the flat holding surface 33 of the chuck table 30 under suction, so that the inspection table 200 is detachably supported to the chuck table 30. This configuration is merely illustrative. As a modification, the inspection table 200 may be detachably supported to the chuck table base 20 (an example of the table base in the present invention). In this case, the chuck table 30 is first removed from the chuck table base 20, and the lower surface of the inspection table 200 is next mounted on the mounting surface 23 of the chuck table base 20 and then positioned. Thereafter, a vacuum from the vacuum source 28 is applied to the mounting surface 23 of the chuck table base 20. Accordingly, the lower surface of the inspection table 200 is brought into close contact with the flat mounting surface 23 of the chuck table base 20 under suction, so that the inspection table 200 can be directly fixed to the chuck table base 20.

As illustrated in FIGS. 7 and 8, the inspection table 200 includes a pressure sensor 202, an inclination sensor 203, a temperature sensor 204, a light quantity sensor 205, an image sensor 206, and a light 207. All of the pressure sensor 202, the inclination sensor 203, the temperature sensor 204, the light quantity sensor 205,

the image sensor 206, and the light 207 are fixed to the base portion 201 and adapted to be driven by electric power supplied from a battery 212.

The pressure sensor 202 functions to detect a pressure applied to the inspection table 200. As illustrated in FIG. 9, the pressure sensor 202 is positioned directly below the camera unit 62, and information regarding the pressure of air 62a sprayed from the camera unit 62 is detected by the pressure sensor 202. The air 62a is sprayed in the case of removing the cutting water from the front side of the workpiece 100. Further, the pressure sensor 202 can also detect information regarding the pressure of the cutting water to be supplied to the front side of the workpiece 100.

The inclination sensor 203 functions to detect the inclination of the inspection table 200 with respect to the X direction and the Z direction. For example, the inclination sensor 203 detects information regarding the inclination of the holding surface 33 of the chuck table 30 or information regarding yawing and pitching caused by the movement of the chuck table 30.

The temperature sensor 204 functions to detect the temperature of the upper surface of the inspection table

200. As illustrated in FIG. 10, the temperature sensor 204 is positioned directly below the cutting blade 66 of the processing unit 60, and information regarding the room temperature in a processing room where the workpiece 100 is cut or information regarding the temperature of cooling water 68a to be supplied from the cooling water nozzles 68 to the cutting blade 66 in cutting the workpiece 100 is detected by the temperature sensor 204. Further, the temperature sensor 204 can also detect information regarding the temperature of the cutting water to be supplied from the first cutting water nozzle 63 and the second cutting water nozzle 67 in cutting the workpiece 100.

The light quantity sensor 205 functions to detect the quantity of light applied to the inspection table 200. As illustrated in FIG. 11, the camera unit 62 includes an image sensor unit 621 for imaging a processed condition of the workpiece 100. The light quantity sensor 205 is positioned directly below the image sensor unit 621 to detect information regarding autofocus light quantity and angle recognition light quantity according to episcopic light applied from an episcopic illumination unit 622 through a condenser lens 623 and oblique light applied from an oblique illumination unit 624. Further, by using

the information regarding the light quantity obtained by the light quantity sensor 205, the operator can also check contamination on a camera lens or a light cover in the image sensor unit 621.

The image sensor 206 functions to obtain an image of an object above the inspection table 200. As illustrated in FIG. 12, the image sensor 206 is positioned directly below the processing unit 60, and an image G1 illustrating a positional relation between the cutting blade 66 and the cutting water nozzles 68 as illustrated in FIG. 13 is obtained by the image sensor 206. By referring to the image G1 illustrated in FIG. 13, the operator can recognize that one of the two cooling water nozzles 68 (the lower nozzle 68 as viewed in FIG. 13) is not parallel to the cutting blade 66 as viewed in plan. The light 207 is adapted to emit light in synchronism with the timing of imaging by the image sensor 206.

The inspection table 200 further includes an information communicating portion 208 (an example of the information transmitting portion in the present invention). The information communicating portion 208 functions to transmit the information detected by the pressure sensor 202, the inclination sensor 203, the

temperature sensor 204, the light quantity sensor 205, and the image sensor 206 to the outside of the inspection table 200. For example, the information communicating portion 208 can transmit the detected information to the control unit 39 or the terminal equipment 300. The information communicating portion 208 can transmit the detected information by radio or by wire. The information communicating portion 208 can support a short-range radio communication standard for performing the communication with the control unit 39 or the terminal equipment 300. Examples of the short-range radio communication standard that can be supported by the information communicating portion 208 include worldwide interoperability for microwave access (WiMAX) (registered trademark), IEEE802.11, and Bluetooth (registered trademark). Alternatively, the information communicating portion 208 may include a terminal adapted to be connected through a communication cable to the control unit 39 or the terminal equipment 300, in which the communication cable supports the communication standard for the control unit 39 or the terminal equipment 300. Examples of the terminal that can be included in the information communicating portion 208 include an universal serial bus (USB), high-definition multimedia interface (HDMI)

(registered trademark), mobile high-definition link (MHL), and local area network (LAN) connectors.

The inspection table 200 further includes a storing portion 209 and a computing portion 211. The storing portion 209 functions to store a program for realizing the function for various kinds of processing to be executed by the inspection table 200 and to also store data to be used for the processing by the program. The storing portion 209 includes a nonvolatile or volatile semiconductor memory such as a RAM, a ROM, a flash memory, an erasable programmable read only memory (EPROM), and an electrically erasable programmable read only memory (EEPROM) (registered trademark). The program stored in the storing portion 209 may also be called a program product having a processor readable and non-transitory recording medium including a plurality of commands for performing data processing that can be executed by a processor included in the computing portion 211. The storing portion 209 may also be used as a temporary working area by the processor included in the computing portion 211 in executing the commands described in the program.

The storing portion 209 (an example of the memory in the present invention) includes a detected information

recording area 210. As illustrated in FIG. 14, the information detected by the pressure sensor 202, the inclination sensor 203, the temperature sensor 204, the light quantity sensor 205, and the image sensor 206 included in the inspection table 200 is recorded in the detected information recording area 210.

The computing portion 211 functions to compute according to the program stored in the storing portion 209, thereby executing various kinds of processing by the inspection table 200. The computing portion 211 includes a processor such as a CPU microprocessor, a microcomputer, a digital signal processor (DSP), and a system large scale integration (LSI).

The processor included in the computing portion 211 functions to execute the program loaded to the RAM included in the storing portion 209. Accordingly, the function for various kinds of processing to be executed by the inspection table 200 is realized. Examples of the function for various kinds of processing to be executed by the inspection table 200 include a function of connecting the inspection table 200 to the control unit 39 or the terminal equipment 300 by radio or by wire so that the communication between the inspection table 200 and the control unit 39 or the terminal equipment 300 can

be made, a function of providing a data selection screen to the control unit 39 or the terminal equipment 300, and a function of providing the detected information to the control unit 39 or the terminal equipment 300.

The computing portion 211 may be realized by a dedicated hardware. In this case, the computing portion 211 may be realized by a single circuit, a composite circuit, a programmed processor, a parallel programmed processor, an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), or the combination thereof.

The inspection table 200 further includes the battery 212. The battery 212 functions to supply electric power to each component of the inspection table 200. The battery 212 may be detachably mounted on the inspection table 200 or may be built in the inspection table 200. In the case that the battery 212 is detachable to the inspection table 200, a primary battery may be used or a secondary battery may also be used. In the case that the battery 212 is built in the inspection table 200, a secondary battery is preferable as compared with a primary battery.

There will now be described an example of the processing by the inspection table 200 with reference to

FIG. 15. FIG. 15 is a flowchart illustrating an example of the processing by the inspection table 200. The processing illustrated in FIG. 15 is performed by the computing portion 211 included in the inspection table 200.

As illustrated in FIG. 15, the computing portion 211 performs connection processing according to a demand or a request from the terminal equipment 300, for example (step S101). After finishing the connection processing, the computing portion 211 transmits a data selection screen to the terminal equipment 300 as a target connected (step S102). FIG. 16 is a plan view illustrating an example of the data selection screen. As illustrated in FIG. 16, reference numeral 310 denotes a display included in the terminal equipment 300. A data selection screen 311 transmitted from the inspection table 200 to the terminal equipment 300 is displayed on the display 310 of the terminal equipment 300. The data selection screen 311 has a pressure data item 312, an inclination data item 313, a light quantity data item 314, an image data item 315, a temperature data item 316, and a data acquisition button 317, all of which are operable by the operator. The data selection screen 311 further has a plurality of check boxes 322 to 326 to be marked by

the operator, in which these check boxes 322 to 326 respectively correspond to the items 313 to 316. In the case of acquiring pressure data from the inspection table 200, the operator marks the check box 322 and then operates the data acquisition button 317. As a result, a demand for acquisition of the pressure data is transmitted to the inspection table 200.

Referring back to FIG. 15, the computing portion 211 determines whether or not a demand for acquisition of data has been received from the terminal equipment 300 (step S103). When the demand for acquisition of data has been received from the terminal equipment 300 (step S103: Yes), the computing portion 211 reads out the detected information corresponding to the item selected in the data acquisition demand, from the detected information recording area 210 (step S104).

Thereafter, the computing portion 211 transmits the detected information read out from the detected information recording area 210 to the terminal equipment 300 (step S105). Thereafter, the computing portion 211 determines whether or not a demand for disconnection has been received from the terminal equipment 300 (step S106).

When the demand for disconnection has been received from the terminal equipment 300 (step S106: Yes), the

computing portion 211 performs disconnection processing (step S107) and then ends the program. On the other hand, when the demand for disconnection has not been received from the terminal equipment 300 (step S106: No), the program returns to step S103 mentioned above.

When the demand for acquisition of data has not been received from the terminal equipment 300 (step S103: No), the program jumps to step S106 mentioned above.

In the example illustrated in FIG. 15, the detected information corresponding to the item selected by the operator is transmitted from the computing portion 211 to the terminal equipment 300. As a modification, the program may be previously set so that the detected information corresponding to all of the items is transmitted. In this case, immediately after finishing the connection with the terminal equipment 300, the computing portion 211 can read out all the items of the detected information recorded in the detected information recording area 210 and then transmit the detected information to the terminal equipment 300.

As described above, the inspection table 200 according to the preferred embodiment is used in the processing apparatus 2 including the chuck table 30 having the holding surface 33 for holding the workpiece

100, the processing unit 60 adapted to be opposed to the holding surface 33 for processing the workpiece 100 held on the chuck table 30, the chuck table base 20 (an example of the table base) for detachably supporting the chuck table 30, the processing unit moving mechanism 42 (an example of the moving unit) for moving the chuck table base 20 (an example of the table base), and the camera unit 62 for imaging the workpiece 100 held on the chuck table 30. The inspection table 200 includes the base portion 201 adapted to be detachably supported to the holding surface 33 of the chuck table 30. The inspection table 200 further includes the sensors (the pressure sensor 202, the inclination sensor 203, the temperature sensor 204, the light quantity sensor 205, and the image sensor 206) fixed to the base portion 201 and adapted to be driven by electric power supplied from the battery 212. The inspection table 200 further includes the information communicating portion 208 (an example of the information transmitting portion) for transmitting information detected by the sensor and the battery 212 for supplying electric power to the sensor and the information communicating portion 208.

According to the inspection table 200 having the above configuration, the pressure sensor 202 can detect

information regarding the pressure of the air 62a to be sprayed from the camera unit 62 and information regarding the pressure of cutting water to be supplied to the front side of the workpiece 100, for example.

Further, according to the inspection table 200 having the above configuration, the inclination sensor 203 can detect information regarding the inclination of the holding surface 33 of the chuck table 30 and information regarding yawing and pitching caused by the movement of the chuck table 30, for example.

Further, according to the inspection table 200 having the above configuration, the temperature sensor 204 can detect information regarding the room temperature in a processing room, information regarding the temperature of the cooling water 68a to be supplied from the cooling water nozzles 68 to the cutting blade 66, and information regarding the temperature of the cutting water to be supplied from the first cutting water nozzle 63 and the second cutting water nozzle 67, for example.

Further, according to the inspection table 200 having the above configuration, the light quantity sensor 205 can detect information regarding autofocus light quantity and angle recognition light quantity according to episcopic light and oblique light, for example.

Further, according to the inspection table 200 having the above configuration, the image sensor 206 can image a peripheral condition of the processing unit 60 and the cutting blade 66 (e.g., the inclination of the cooling water nozzles 68 and the positional relation between the cooling water nozzles 68 and the cutting blade 66). By referring to the image obtained by the image sensor 206 of the inspection table 200, the operator can recognize the peripheral condition of the processing unit 60 and the cutting blade 66 (e.g., the inclination of the cooling water nozzles 68 and the positional relation between the cooling water nozzles 68 and the cutting blade 66).

Further, according to the inspection table 200 having the above configuration, the information communicating portion 208 can transmit the information detected by the pressure sensor 202, the inclination sensor 203, the temperature sensor 204, the light quantity sensor 205, and the image sensor 206 to the outside of the inspection table 200. Accordingly, the operator is not required to perform a checking operation in a dark and narrow space and can recognize the condition of the processing apparatus 2 from a remote place.

The inspection table 200 further includes the storing portion 209 (an example of the memory) for recording the detected information from the sensors (the pressure sensor 202, the inclination sensor 203, the temperature sensor 204, the light quantity sensor 205, and the image sensor 206). Accordingly, the operator can obtain and use the information detected by the sensor as required.

[Other preferred embodiments]

The inspection table according to the present invention is not limited to the inspection table 200 according to the above preferred embodiment, and various modifications may be made without departing from the scope of the present invention. For example, the chuck table 30 may include the various sensors and others included in the inspection table 200.

Further, the inspection table 200 may be used for the inspection of a laser applying unit. In this case, the inspection table 200 can image a peripheral condition of the laser applying unit (e.g., a positional relation between a vacuum unit for removing debris and a focusing lens) and then record the image obtained. Accordingly, the operator can save effort for a checking operation and recognize the peripheral condition of the laser applying

unit (the positional relation between the vacuum unit and the focusing lens) from a remote plate.

The present invention is not limited to the details of the above described preferred embodiment. 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. An inspection table detachably disposed in a processing apparatus including a chuck table having a holding surface for holding a workpiece, a processing unit adapted to be opposed to the holding surface for processing the workpiece held on the chuck table, a table base detachably supporting the chuck table, a moving unit for moving the table base, and a camera unit for imaging the workpiece held on the chuck table, the inspection table comprising:

a base portion adapted to be detachably supported on the holding surface of the chuck table or on the table base;

a sensor fixed to the base portion and adapted to be driven by electric power;

an information transmitting portion for transmitting information detected by the sensor to a control unit or a terminal equipment; and

a battery for supplying electric power to the sensor and the information transmitting portion,

wherein the sensor is selected from a group consisting of a pressure sensor, an inclination sensor, a temperature sensor, a light quantity sensor, and an image sensor, and

the sensor is used to measure or record a pressure, inclination, temperature, light quantity, or outward appearance image related to the chuck table, the processing unit, the table base, or the moving unit, and

wherein the inspection table further includes a light fixed on the base portion and adapted to be driven by electric power, and the light adapted to emit light in synchronism with the timing of imaging by the image sensor.

2. The inspection table according to claim 1, further comprising:

a memory for recording the information detected by the sensor.

3. The inspection table according to claim 1, wherein the inspection table includes a pressure sensor fixed to the base portion in such a manner that it is positioned directly below the camera unit when the inspection table is detachably supported on the holding surface of the chuck table or the table base, for detecting the pressure of air sprayed from the camera unit and for detecting the pressure of cutting water to be supplied to the workpiece.

4. The inspection table according to claim 1, wherein inspection table includes an inclination sensor for detecting inclination of the holding surface of the chuck

table or detecting yawing and pitching caused by the movement of the chuck table.

5. The inspection table according to claim 1, wherein the inspection table includes a temperature sensor fixed to the based portion in such a manner that the temperature sensor is positioned directly below a cutting blade of the processing unit when the inspection table is detachably supported on the holding surface of the chuck table or the table base for (i) detecting the temperature in a processing room where the workpiece is cut, (ii) detecting the temperature of cooling water to be supplied from a cooling water nozzle to the cutting blade in cutting the workpiece and (iii) detecting the temperature of cutting water to be supplied from a first cutting water nozzle and a second cutting water nozzle in cutting the workpiece.

6. The inspection table according to claim 1, wherein the inspection table includes a light quantity sensor fixed to the base portion in such a manner that the light quantity sensor is positioned directly below an image sensor unit of the camera unit when the inspection table is detachably supported on the holding surface of the chuck table or the table base for detecting autofocus light quantity and angle recognition light quantity according to episcopic light applied from an episcopic illumination unit

through a condenser lens and oblique light applied from an illumination unit, and thereby allowing an operator to check if there are contamination on a camera lens or a light cover in the image sensor unit.

7. The inspection table according to claim 1, wherein the inspection table includes an image sensor fixed to the base portion in such a manner that the image sensor is positioned directly below the processing unit when the inspection table is detachably supported on the holding surface of the chuck table or the table base so as to allow the operator to obtain an image of an object above the inspection table and an image illustrating a positional relation between the cutting blade and the cutting water nozzles.