

**METHODS FOR ATTACHING AND DETACHING
CUTTING BLADE, AND BLADE GRIPPING TOOL**

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a technique for attaching or detaching a cutting blade that cuts a workpiece such as a semiconductor wafer.

Description of the Related Art

As disclosed in Japanese Patent Laid-open No. 2009-241177, for example, there are conventionally known cutting machines that cut or machine a workpiece such as a semiconductor wafer to dice the same. A cutting machine of this type includes cutting means for rotating at high speed a cutting blade fixed on a blade mount. When the cutting blade is worn out, a need arises for appropriate replacement work of the cutting blade.

Japanese Patent Laid-open No. 2009-241177 discloses a technique that, with a view to simply and efficiently perform replacement work of a cutting blade with an attribute code applied thereto, also ensures acquisition of information of the attribute code without a need for a separate dedicated

operation, by simply gripping the cutting blade as a replacement object with a grip portion for replacement work.

SUMMARY OF THE INVENTION

In a configuration that a boss portion of a blade mount is inserted in a through-hole of a cutting blade as disclosed in Japanese Patent Laid-open No. 2009-241177, there is a need to design fitting between the through-hole and the boss portion. The use of a clearance fit as the fitting between both of them facilitates the attachment/detachment work of the cutting blade, but there is a concern for a potential increase in the amount of an offset between an axis of the blade mount, in other words, an axis of a spindle on which the blade mount is fixed, and an axis of the cutting blade, thereby raising a problem that the cutting blade may be eccentrically positioned and high-precision machining may become no longer possible.

On the other hand, the use of an interference fit that both of them are tightly fitted together alleviates the problem of eccentricity, but leads to a greater difficulty in performing attachment/detachment

work. In particular, a cutting blade has a very thin cutting edge so that the cutting edge may be broken by an impact when an external force is applied.

The present invention thus has as an object thereof the provision of a novel technique that enables performance of easy attachment/detachment work of a cutting blade to/from a blade mount.

In accordance with an aspect of the present invention, there is provided a method for attaching a cutting blade to a blade mount fixed on a distal end of a spindle. The attaching method includes a gripping step of gripping a hub base of the cutting blade by a blade gripping tool, the hub base defining therethrough a hole to be fitted, a heating step of heating the hub base by a heater disposed in the blade gripping tool, so that the hole is enlarged in inner diameter, and a mounting step of moving the blade gripping tool with the cutting blade gripped and inserting a boss portion of the blade mount into the hole.

Preferably, the hole of the cutting blade may have an inner diameter smaller than an outer diameter of the boss portion when at room temperature.

Preferably, the method further includes, after

the mounting step, a fitting and fixing step of fitting and fixing the cutting blade on the boss portion through natural cooling by allowing the cutting blade to stand at room temperature.

In accordance with another aspect of the present invention, there is provided a blade gripping tool for use in the above-described attaching method. The blade gripping tool includes a grip portion that is formed from a cylindrical member with a gap portion, which is formed extending in a direction of an axis of the cylindrical member, and has a substantially C-shape in a cross-section perpendicular to the axis of the cylindrical member, and a heater disposed inside the grip portion and configured to be brought into contact with the hub base when the hub base is held by an inner peripheral surface of the grip portion. The grip portion is configured so that, when the grip portion is grasped at an outer peripheral surface thereof, the grip portion flexes to narrow the gap portion and surrounds and holds a gripped portion of the hub base by the inner peripheral surface.

In accordance with a further aspect of the present invention, there is provided a method for

detaching a cutting blade attached to a blade mount fixed on a distal end of a spindle. The detaching method includes a gripping step of gripping a hub base of the cutting blade by a blade gripping tool, the hub base defining therethrough a hole to be fitted, a heating step of heating the hub base by a heater disposed in the blade gripping tool, so that the hole is enlarged in inner diameter, and a detaching step of moving the blade gripping tool with the cutting blade gripped and pulling the cutting blade from a boss portion of the blade mount.

Preferably, the hole of the cutting blade may have an inner diameter smaller than an outer diameter of the boss portion when at room temperature.

In accordance with a still further aspect of the present invention, there is provided a blade gripping tool for use in the above-described detaching method. The blade gripping tool includes a grip portion formed from a cylindrical member with a gap portion, which is formed extending in a direction of an axis of the cylindrical member, and having a substantially C-shape in a cross-section perpendicular to the axis of the cylindrical member; and a heater disposed inside the grip portion and configured to be

brought into contact with the hub base when the hub base is held by an inner peripheral surface of the grip portion. The grip portion is configured so that, when the grip portion is grasped at an outer peripheral surface thereof, the grip portion flexes to narrow the gap portion and surrounds and holds a gripped portion of the hub base by the inner peripheral surface.

According to the present invention, the boss portion of the blade mount can be smoothly inserted into the hole as the inner diameter of the hole has been enlarged by heating. Especially, in a design that fixes the cutting blade by an interference fit, excellent attachability can be realized and an offset hardly occurs between the axis of the cutting blade so mounted and the axis of the spindle, thereby enabling high-precision machining.

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 depicting an example of a cutting machine, to which an embodiment of the present invention is applied;

FIG. 2 is an exploded perspective view depicting a configuration example of cutting means;

FIG. 3A is a front view of a blade gripping tool;

FIG. 3B is a rear view of the blade gripping tool;

FIG. 4 is a perspective view depicting how a cutting blade is to be gripped by the blade gripping tool;

FIG. 5A is a partially cross-sectional side view depicting the cutting blade gripped by the blade gripping tool and heated at a hub base thereof by a heater disposed in the blade gripping tool, and a blade mount having a boss portion; and

FIG. 5B is a partially cross-sectional side view depicting the cutting blade gripped by the blade gripping tool and fitted and fixed on the boss portion through natural cooling by allowing the cutting blade to stand at room temperature.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the attached drawings as needed, a description will hereinafter be made about an embodiment of the present invention. A cutting machine 1 depicted in FIG. 1 is an example of a machine to or from which a cutting blade 20 is attached or detached using a blade gripping tool 60 depicted in FIG. 2.

As depicted in FIG. 1, the cutting machine 1 is configured including a chuck table 2, moving means 3, imaging means 4, and cutting means 5. Examples of a workpiece may include, but are not particularly limited to, plate-shaped various materials to be machined, such as plate-shaped semiconductor wafers and optical device wafers, plate-shaped inorganic material substrates, and plate-shaped ductile materials.

The chuck table 2 holds the workpiece under suction. The chuck table 2 is formed in a disc shape, and has an upper surface formed as a flat surface that is parallel to a horizontal direction. The chuck table 2 has a holding portion which is formed of a porous ceramic and is connected to an undepicted

vacuum suction source.

The moving means 3 serves to move the chuck table 2 and the cutting means 5 relative to each other in an X-axis direction, a Y-axis direction, and a Z-axis direction. The moving means 3 is configured including X-axis moving means 3a, Y-axis moving means 3b, and Z-axis moving means 3c. The X-axis moving means 3a supports the chuck table 2 movably in the X-axis direction (equivalent to a cutting feed direction) relative to a bed 6. The Y-axis moving means 3b supports the cutting means 5 movably in the Y-axis direction (equivalent to an indexing feed direction) relative to the bed 6. The Z-axis moving means 3c supports the cutting means 5 movably in the Z-axis direction (equivalent to a cutting-in feed direction) relative to the bed 6. The moving means 3a, the moving means 3b, and the moving means 3c each include, for example, an electric motor, a ball screw, nuts, and the like.

Before cutting or machining a workpiece along each scheduled division line (hereinafter called "street"), the imaging means 4 images the street to perform an alignment adjustment of the cutting means 5 with the street. The imaging means 4 is, for example,

a camera using a charge coupled device (CCD) image sensor, or the like.

The cutting means 5 serves to apply cutting or machining to the workpiece. As depicted in FIG. 2, the cutting means 5 is configured including rotary drive means 10, the cutting blade 20, a blade mount 30, and a blade fixture nut 40.

The rotary drive means 10 serves to rotationally drive the cutting blade 20 at high speed. The rotary drive means 10 includes a spindle 11, a spindle housing 12, and an undepicted electric motor. On a distal end of the spindle 11, the blade mount 30 is detachably fixed by a mount fixture nut 50.

The cutting blade 20 is configured as what is generally called a hub blade, and includes an annular hub base 21 formed with a metal such as an aluminum alloy and an annular cutting edge 22 formed so as to surround the hub base 21 along its outer periphery.

The hub base 21 includes a hole 24 centrally formed therethrough for mounting the hub base 21 on a boss portion 34 of the blade mount 30. Through the hole 24, the boss portion 34 of the blade mount 30 is internally inserted. The cutting edge 22 is made from abrasive grains of diamond, cubic boron nitride (CBN),

or the like and a bonding material such as a metal or a resin, and is formed to a predetermined thickness.

The blade mount 30 includes a flange portion 32 for holding the cutting edge 22 of the cutting blade 20 between itself and the hub base 21, the boss portion 34 to be inserted into the hole 24 of the hub base 21 (hereinafter called "the hole 24 of the cutting blade 20"), and an externally threaded portion 36 on which the blade fixture nut 40 is to be fastened.

In the configuration depicted in FIG. 2, the hole 24 of the cutting blade 20 has an inner diameter, which is greater than outer diameters of the externally threaded portion 36 and the mount fixture nut 50 but is smaller than an outer diameter of the boss portion 34 of the blade mount 30, to enable an interference fit of the cutting blade 20 on the boss portion 34 as will be described in detail subsequently herein. It is, however, to be noted that the present invention can also be applied even if the inner diameter of the hole 24 of the cutting blade 20 is equal to or greater than the outer diameter of the boss portion 34 of the blade mount 30.

The blade fixture nut 40 is formed in a ring

shape, and on its inner peripheral surface, an internal thread 42 is formed for threaded engagement with the externally threaded portion 36 of the blade mount 30. In an end face of the blade fixture nut 40, four pin insertion holes 44 are arranged angularly offset from one another by 90 degrees, so that the blade fixture nut 40 is configured to enable its rotational operation by engagement pins of an undepicted fastening tool inserted in the pin insertion holes 44.

A description will next be made about the blade gripping tool 60 to be used for a replacement of the cutting blade 20. As depicted in FIGS. 3A through 5B, the blade gripping tool 60 is configured including a grip portion 62, which an operator grasps by fingers to operate, and a heater 64.

The grip portion 62 is configured of a ring-shaped member having a substantially C-shape in a cross-section perpendicular to a direction of an axis of a cylindrical member with a gap portion 62s formed extending in an axial direction in a portion of a cylindrical wall of the cylindrical member. The grip portion 62 can be made, for example, from resin, metal, or rubber, or a combination of two or more of

these materials. The grip portion 62 has an inner peripheral surface 62c formed so that the inner peripheral surface 62c can be brought into contact with an outer peripheral surface 21c of a hub 21a formed on the hub base 21 of the cutting blade 20.

Described specifically, the grip portion 62 is configured so that, when the grip portion 62 is grasped by the fingers at an outer peripheral surface 62d thereof, the grip portion 62 flexes to narrow the gap portion 62s and the inner peripheral surface 62c comes into contact with the outer peripheral surface 21c of the hub 21a, in other words, the grip portion 62 surrounds and holds a gripped portion of the hub base 21 by the inner peripheral surface 62c. As a result, the cutting blade 20 can be held by the blade gripping tool 60. The outer peripheral surface 21c of the hub 21a thus functions as the gripped portion.

On the outer peripheral surface 62d of the grip portion 62, the protection plates 62a are disposed upright in a radial direction and extend in a peripheral direction so that the protection plates 62a prevent the fingers from slipping toward the cutting edge 22 of the cutting blade 20. In this embodiment, the two protection plates 62a are disposed at

positions offset from each other in the peripheral direction so that the fingers are protected over a wide range.

On the outer peripheral surface 62d of the grip portion 62 on one side of the protection plates 62a in the direction of the axis of the cylindrical member, specifically on a side that becomes a side opposite to the cutting blade 20 when the cutting blade 20 is gripped, finger rests 62b are formed to facilitate hooking of the fingers. In this embodiment, the outer peripheral surface 62d is configured to have a continuous waveform on the one side of the protection plates 62a in the direction of the axis of the cylindrical member, thereby facilitating reception of the fingers in valley portions.

The heater 64 is configured of a sheet-shaped member having a heating surface and is fixed on latch claws 62k disposed at plural locations on an inner side of the grip portion 62. In this embodiment, the heater 64 can be configured of a silicon heater that is energized via a power cord 62m (FIG. 3A) to generate heat.

As depicted in FIG. 5A, the heater 64, while

holding the cutting blade 20, comes into contact with an end face 21b of the hub 21a of the hub base 21 of the cutting blade 20, and the heater 64 is formed as a heater surface 64h at a contacting surface thereof.

As depicted in FIG. 5B, the heater 64 includes an insertion hole 64a formed therethrough to enable insertion of the externally threaded portion 36 and mount fixture nut 50 of the blade mount 30 when mounting the cutting blade 20.

A description will next be made about a method of use of the blade gripping tool 60 configured as described above. First, as depicted in FIG. 4, the hub 21a of the hub base 21 of the cutting blade 20 is inserted into an inside of the grip portion 62, and the grip portion 62 is grasped at the finger rests 62b by the fingers to apply a force to the grip portion 62, so that the blade gripping tool 60 holds the cutting blade 20 and is brought into a state depicted in FIG. 5A (gripping step).

As depicted in FIG. 5A, the heater 64 is next energized to heat the hub base 21 of the cutting blade 20 (heating step). ON/OFF operation of the energization of the heater 64 can be configured so that, if the heater 64 is connected to a control unit

for the cutting machine 1 (FIG. 1), for example, it can be performed by operating an interface of the control unit. If the heater 64 is configured as an independent apparatus without connection to the cutting machine, on the other hand, the ON/OFF operation of the energization of the heater 64 can be performed by conducting ON/OFF operation of a power supply from an undepicted power source as desired. The cutting blade 20 is heated by the heater 64 as described above, so that the temperature of the hub base 21 rises and the hole 24 is enlarged in inner diameter accordingly.

As depicted in FIGS. 5A and 5B, with the hole 24 of the cutting blade 20 being placed opposite the position of the boss portion 34 of the blade mount 30, the blade gripping tool 60 is then moved so that the boss portion 34 is inserted into the hole 24 (mounting step). Here, the boss portion 34 can be smoothly inserted because the inner diameter of the hole 24 has been enlarged by the heating. Yet, even if the inner diameter of the hole 24 of the cutting blade 20 is greater than the outer diameter of the boss portion 34 of the blade mount 30, the attachment or detachment of the cutting blade 20 can also be smoothly performed as

the hole 24 is enlarged in inner diameter by heating.

After moving the cutting blade 20 to a position where the cutting edge 22 comes into contact with the flange portion 32 of the blade mount 30 as depicted in FIG. 5B, the force which has been applied to the grip portion 62 by the fingers is loosened to release the holding of the hub base 21, and the blade gripping tool 60 is then retracted off from the cutting blade 20.

In the manner described above, the mounting of the cutting blade 20 by the blade gripping tool 60 is performed. As depicted in FIG. 2, the blade fixture nut 40 is subsequently fastened to the externally threaded portion 36 of the blade mount 30, so that all the steps for the mounting of the cutting blade 20 are completed.

The mounting of the cutting blade 20 by the blade gripping tool 60 is also similarly possible in configurations that do not use the blade fixture nut 40, such as a configuration that the cutting blade 20 is fixed by a large interference fit between the hole 24 of the cutting blade 20 and the boss portion 34 of the blade mount 30 and a configuration that the cutting blade 20 is fixed by a suction holding system

disposed on the side of the blade mount 30.

Description has been made hereinabove about the mounting of the cutting blade 20. When detaching the cutting blade 20, on the other hand, the cutting blade 20 can be smoothly detached from the boss portion 34 (detaching step) in the state of FIG. 5B by gripping the hub base 21 of the cutting blade 20, which is attached to the blade mount 30, with the blade gripping tool 60 in a similar manner as in the gripping step of the attachment method (gripping step), and then heating the hub base 21 with the heater 64 to enlarge the inner diameter of the hole 24 (heating step).

According to the method of the present invention for the attachment of the cutting blade, the boss portion 34 can be smoothly inserted into the hole 24 as the inner diameter of the hole 24 has been enlarged by heating. Especially in a design that fixes the cutting blade by an interference fit, excellent attachability can be realized and an offset hardly occurs between the axis of the cutting blade so mounted and the axis of the spindle, thereby enabling high-precision machining.

Preferably, as depicted in FIG. 5B, the inner

diameter of the hole 24 of the cutting blade 20 may be smaller than the outer diameter of the boss portion 34 when at room temperature. If this is the case, the cutting blade 20 and the blade mount 30 are designed to achieve the fixing of the cutting blade 20 by an interference fit, enabling excellent attachability and high-precision machining.

As depicted in FIG. 5B, after the mounting step, the cutting blade 20 is fitted and fixed on the boss portion 34 through natural cooling by allowing the cutting blade 20 to stand at room temperature (fitting and fixing step). If this is the case, it is also possible to realize, for example, a method that fixes the cutting blade 20 without the blade fixture nut 40 (FIG. 2).

According to the method of the present invention for the detachment of the cutting blade, the inner diameter of the hole 24 has been enlarged by heating so that the cutting blade 20 can be smoothly pulled out of the boss portion 34. Excellent detachability can be realized especially in a design that performs fixing by an interference fit.

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. A method for attaching a cutting blade to a blade mount fixed on a distal end of a spindle, comprising:

a gripping step of gripping a hub base of the cutting blade by a blade gripping tool, the hub base defining therethrough a hole to be fitted;

a heating step of heating the hub base by a heater disposed in the blade gripping tool, so that the hole is enlarged in inner diameter; and

a mounting step of moving the blade gripping tool with the cutting blade gripped and inserting a boss portion of the blade mount into the hole.

2. The method according to claim 1, wherein the hole of the cutting blade has an inner diameter smaller than an outer diameter of the boss portion when at room temperature.

3. The method according to claim 2, further comprising:

after the mounting step, a fitting and fixing step of fitting and fixing the cutting blade on the boss portion through natural cooling by allowing the cutting blade to stand at room temperature.

4. A blade gripping tool for use in a method

for attaching a cutting blade to a blade mount fixed on a distal end of a spindle,

the method including

a gripping step of gripping a hub base of the cutting blade by the blade gripping tool, the hub base defining therethrough a hole to be fitted,

a heating step of heating the hub base by a heater disposed in the blade gripping tool, so that the hole is enlarged in inner diameter, and

a mounting step of moving the blade gripping tool with the cutting blade gripped and inserting a boss portion of the blade mount into the hole,

the blade gripping tool comprising:

a grip portion that is formed from a cylindrical member with a gap portion and has a substantially C-shape in a cross-section perpendicular to an axis of the cylindrical member, the gap portion being formed extending in a direction of the axis of the cylindrical member; and

a heater disposed inside the grip portion and configured to be brought into contact with the hub base when the hub base is held by an inner peripheral surface of the grip portion,

wherein the grip portion is configured so that, when the grip portion is grasped at an outer peripheral surface thereof, the grip portion flexes to narrow the gap portion and surrounds and holds a gripped portion of the hub base by the inner peripheral surface.

5. A method for detaching a cutting blade attached to a blade mount fixed on a distal end of a spindle, comprising:

a gripping step of gripping a hub base of the cutting blade by a blade gripping tool, the hub base defining therethrough a hole to be fitted;

a heating step of heating the hub base by a heater disposed in the blade gripping tool, so that the hole is enlarged in inner diameter; and

a detaching step of moving the blade gripping tool with the cutting blade gripped and pulling the cutting blade from a boss portion of the blade mount.

6. The method according to claim 5, wherein the hole of the cutting blade has an inner diameter smaller than an outer diameter of the boss portion when at room temperature.

7. A blade gripping tool for use in a method for detaching a cutting blade attached to a blade

mount fixed on a distal end of a spindle,

the method including

a gripping step of gripping a hub base of the cutting blade by the blade gripping tool, the hub base defining therethrough a hole to be fitted,

a heating step of heating the hub base by a heater disposed in the blade gripping tool, so that the hole is enlarged in inner diameter, and

a detaching step of moving the blade gripping tool with the cutting blade gripped and pulling the cutting blade from a boss portion of the blade mount.

the blade gripping tool comprising:

a grip portion that is formed from a cylindrical member with a gap portion and has a substantially C-shape in a cross-section perpendicular to an axis of the cylindrical member, the gap portion being formed extending in a direction of the axis of the cylindrical member; and

a heater disposed inside the grip portion and configured to be brought into contact with the hub base when the hub base is held by an inner peripheral surface of the grip portion,

wherein the grip portion is configured so

that, when the grip portion is grasped at an outer peripheral surface thereof, the grip portion flexes to narrow the gap portion and surrounds and holds a gripped portion of the hub base by the inner peripheral surface.