

CARRIER APPARATUS OF THIN DISK-SHAPED WORKPIECE, METHOD OF MANUFACTURING THE SAME, AND BOTH-SIDE GRINDING MACHINE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a carrier apparatus of a thin disk-shaped workpiece, a method of manufacturing the same, and a both-side grinding machine, and more particularly to a workpiece rotation supporting technology for positioning the circular outer circumference of a workpiece in a radial direction, and rotating and driving the workpiece, in machining of surface side and/or reverse side of a thin disk-shaped workpiece such as a semiconductor wafer.

Description of the Related Art

For example, a semiconductor wafer is manufactured from a columnar semiconductor ingot made of single crystal silicon and cut into thin slices, and the surface and reverse sides thereof are machined by a grinding machine or polishing machine, and finished to smooth surfaces.

In grinding or polishing work of a thin disk-shaped workpiece such as semiconductor wafer (hereinafter called workpiece), while the workpiece is rotated and supported, the surface side and/or reverse side is machined, and a both-side

grinding machine of grinding the surface and reverse sides of a semiconductor wafer is disclosed, for example, in Japanese Patent Laid-Open Publication No. 2003-71704.

In the both-side grinding machine disclosed in Japanese Patent Laid-Open Publication No. 2003-71704, an annular carrier ring b of a carrier apparatus a is rotationally disposed on a frame not shown. At one inner circumferential side of this carrier ring b, a pair of fixed carrier bodies c are disposed, and other inner circumferential side, a pair of movable carrier bodies d are rotationally disposed in a horizontal plane around a support shaft e, and by these pairs of fixed and movable carrier bodies c, d,..., the workpiece (wafer) W is positioned in a radial direction, and a carrier main body for rotating and supporting is constituted. The workpiece W is detachably held in an inner circumferential area of the carrier bodies c, d, ... The workpiece W is accommodated and supported in the carrier ring b in a state being lifted by the air from an air-bearing device not shown.

A spring f is hooked between the both movable carrier bodies d, d, and by this spring f, the both movable carrier bodies d, d are rotationally forced to the workpiece W side, and the workpiece W is held loosely in a state approaching to the workpiece W. On the carrier ring b, an actuator not shown is disposed, and when the workpiece W is carried in or out, this actuator works to rotate the both movable carrier bodies

d, d in an outer circumferential direction of the carrier ring b by resisting the thrusting force of the spring f, and the workpiece W is released from the held state.

Incidentally, the workpiece W is held with a slight gap between the inner circumferential positions of the carrier bodies c, d, that is, between the inner peripheral edges of the fixed carrier bodies c, c and movable carrier bodies d, d.

So as to be positioned between the pair of fixed carrier bodies c, c, a notch trigger g is mounted and fixed at one inner circumferential side of the carrier ring b, and at the leading end part, a pointed end engaging part h forming a plane triangular pointed edge is formed. When the workpiece W is held between the fixed carrier body c and the movable carrier body d, the pointed end engaging part h of the notch trigger g is engaged with a notch Wn as a cut portion on the outer circumference of the workpiece W. In this state, the carrier ring b is rotated by a motor not shown, and the workpiece W is rotated integrally by way of the notch trigger g.

At the upper and lower sides of the carrier apparatus a, a pair of cup-shaped grinding wheels i, i, and motors j, j for rotating them are disposed so as to be movable in the infeed direction against the carrier apparatus a.

In a state of the workpiece W held in the carrier apparatus a, by rotation of the carrier ring b, the workpiece

W is rotated by way of the notch trigger g, and the pair of grinding wheels i, i are rotated, and are cut deep and moved toward the surface and reverse sides of the workpiece W. By this infeed movement, the grinding wheels i, i grind the surface and reverse sides of the workpiece W simultaneously.

Further, as disclosed in Japanese Patent Laid-Open Publication No. H11-333707, in the processing technology of smoothly polishing or lapping the surface of a semiconductor wafer, the carrier bodies c, d, ... and the notch trigger g may be formed as one piece.

However, in such conventional configuration of the carrier apparatus, the following problems have been known, and further improvements have been desired.

(1) The carrier bodies c, d, ... and the notch trigger g contacting with the workpiece W are worn in a time course, and should be regularly replaced as consumable parts, but the number of parts is great and the structure is complicated, and it was hard to reduce the cost.

In particular, since the plurality of fixed and movable carrier bodies c, d, ... for constituting the carrier main body have the function of positioning the workpiece W in a radial direction, and, in principle, the parts are replaced in batch, but it was costly.

(2) The notch trigger g functioning as a rotating and driving plate of the workpiece W is worn more heavily than the

carrier bodies c, d,..., and is replaced very frequently, and generally it is formed as a separate part from the carrier main body, and its base end part is mounted and fixed on the carrier ring b, and projects inward in the radial direction between the pair of fixed carrier bodies c, c, and is engaged with the notch Wn of the workpiece W. In such configuration, however, the notch trigger g projects inward in the radial direction from the carrier ring b as the mounting part, and is supported like a cantilever, and may be deflected significantly when a load is applied to the notch trigger g, and as a result, the workpiece W may be deflected together with the notch trigger g, or the engagement state of the workpiece W and the notch trigger g may be loosened, and the workpiece W may be broken, and defective parts may be formed, or the grinding wheels i, i may be broken, and other problems have been known.

In particular, when using the grinding wheels i, i of larger diameter in order to enhance the grinding efficiency and the grinding precision, in order to prevent mutual interference of the grinding wheels i, i, the carrier ring b is also increased in diameter, and the length of the notch trigger g is extremely extended, and these problems become more prominent.

(3) The notch trigger g is thinner than the workpiece W, and a rigid material is demanded, but at the present, a special laminated structure is formed as disclosed in patent

document 1, or a required thickness is created by cutting out from engineering plastics such as PEEK (polyetheretherketone) resin, and the material cost and manufacturing cost are high, and it was an expensive part as a consumable part.

(4) The carrier main body surrounding the outer circumference of the workpiece W is a split structure consisting of a plurality of fixed and movable carrier bodies c, d, ..., and each plate is likely to be distorted, deflected, or deformed, which caused adverse effects on the workpiece W in the grinding process, and it was hard to enhance the grinding precision.

(5) Or, as disclosed in Japanese Patent Laid-Open Publication No. H11-333707, in the structure forming the carrier bodies c, d, ... and the notch trigger g as an integral piece, if the notch trigger portion heavy in abrasion is worn first, all of the integrally formed carrier main body and the notch trigger must be replaced in batch, or in order extend the life of the integral piece, the constituent material must be changed to a material suited to the notch trigger, and it adds to the material cost.

BRIEF SUMMARY OF THE INVENTION

Embodiments of the present invention

present a novel carrier apparatus of a thin disk-shaped workpiece capable of successfully solving these conventional

problems.

Embodiments of the present invention present
a carrier apparatus simple and inexpensive in structure, and capable of processing at high efficiency and high precision, in machining of surface side and/or reverse side of a thin disk-shaped workpiece such as semiconductor wafer.

Embodiments of the present invention present
a method of manufacturing a carrier apparatus capable of manufacturing the carrier apparatus at low cost.

Embodiments of the present invention present
a both-side grinding machine having such carrier apparatus as a constituent device, and capable of grinding the surface and reverse sides of a thin disk-shaped workpiece such as a semiconductor wafer at high efficiency and high precision.

According to an aspect of the invention, there is provided a carrier apparatus of a thin disk-shaped workpiece for constituting a rotation supporting device for rotating and driving a workpiece while supporting the circular outer circumference of the workpiece, including an annular carrier main body having a circular inner peripheral edge surrounding closely the whole circumference of the workpiece, and a notch trigger having a pointed end engaging part to be engaged with a cut portion

provided in the circular outer peripheral edge of the workpiece, being formed as an integral piece, in which the notch trigger is a separate part from the carrier main body, so as to be exchangeable and joined and fixed integrally, and the pointed end engaging part has a mounting structure of projecting inward in a radial direction from a part of the circular inner peripheral edge of the carrier main body.

In an embodiment, thickness of the carrier main body and the notch trigger is set thinner than the finishing thickness of the workpiece, and joining and fixing of the notch trigger and the carrier main body is realized by an adhesive that can be fixed and released.

In an embodiment, notch trigger mounting part on the carrier main body is cut and formed in a shape corresponding to the outer contour shape of the junction part of the notch trigger, and the adhesive is applied on the junction surface of the notch trigger mounting part.

In an embodiment, notch trigger is composed of thin plate members having a triangular contour having one peak formed as the pointed end engaging part to be engaged with the cut part of the workpiece, and in the notch trigger mounting part of the carrier main body, circular grooves for avoiding concentration of stress are formed at positions corresponding to remaining

two peaks of the triangular contour of the notch trigger.

In an embodiment, pointed end engaging part of the notch trigger has an arc contour shape, and its section is set corresponding to the sectional shape of the cut part of the workpiece.

According to a second aspect, there is provided a method of manufacturing a carrier apparatus of a thin disk-shaped workpiece, and includes the following steps (a) to (c).

(a) A cleaning step of cleaning and degreasing junction surfaces of notch trigger mounting part of the carrier main body and junction surfaces of junction parts of the notch trigger;

(b) A joining step of positioning and holding the parallelism of the carrier main body and the notch trigger, and adhering and joining the junction surfaces of notch trigger mounting part of the carrier main body and junction surfaces of junction parts of the notch trigger while applying the adhesive; and

(c) A finishing step of removing the excess adhesive coming out from the junction parts of the carrier main body and the notch trigger integrally joined at the joining step.

According to a third aspect, there is provided a both-side grinding machine of a thin disk-shaped workpiece of the present invention is a machine for rotating and supporting a thin disk-shaped workpiece, feeding a pair of grinding wheels rotating at high speed in the grinding wheel

axial direction, and grinding the surface and reverse sides of the workpiece simultaneously by the grinding surfaces of these two grinding wheels, including a pair of grinding wheels disposed so that the grinding surfaces may be opposite to each other, and workpiece rotation supporting means for supporting and rotating the workpiece, in a state of the surface and reverse sides of the workpiece opposite to these two grinding surfaces between the grinding surfaces of the pair of grinding wheels, in which the workpiece rotation supporting means has axial direction supporting means for positioning and supporting the workpiece in an axial direction, and radial direction supporting means for positioning, rotating and supporting the workpiece in a radial direction, and this radial direction supporting means has the above carrier apparatus.

The carrier apparatus as per embodiments of the present invention is an apparatus for supporting and rotating a thin disk-shaped workpiece, and grinding or polishing at least one side of the workpiece, and is more specifically a carrier apparatus constituting a workpiece rotation supporting apparatus for rotating and driving while positioning and supporting the circular outer circumference of the workpiece, including an annular carrier main body having a circular inner peripheral edge surrounding closely the whole circumference of the workpiece, and a notch trigger having a pointed end engaging part to be engaged with a cut part provided in the circular

outer peripheral edge of the workpiece, being formed as an integral piece, in which the notch trigger is integrally joined and fixed to the carrier main body as a separate part so as to be exchanged, and the pointed end engaging part has a mounting structure projecting inward in a radial direction from one part of the circular inner peripheral edge of the carrier main body, and therefore the following effects are obtained, and the carrier apparatus assuring machining at high efficiency and high precision can be presented in a simple and inexpensive structure.

(i) The annular carrier main body surrounding closely the whole circumference of the workpiece, and the notch trigger engaged with a cut part of the workpiece are formed as an integral piece, and therefore the number of parts is little and the structure is simple, and the cost can be reduced structurally.

(ii) The carrier main body for positioning the outer circumference of the workpiece in the radial direction is formed in a continuous annular shape having a circular inner peripheral edge closely surrounding the whole circumference of the workpiece, and therefore as compared with the conventional carrier main body of split structure (see FIG. 8), the rigidity is higher, and surface processing of high precision is realized without giving adverse effect on the processing precision of the workpiece.

(iii) Similarly, since the carrier main body is annular and consecutive, as compared with the conventional carrier main body of split structure (see FIG. 8), the processing distortion in manufacture of the carrier main body is smaller, and occurrence of distortion when mounting on the carrier ring can be effectively prevented, and further distortion, deflection or deformation when processing the workpiece may hardly take place, and from this aspect, too, adverse effect is not given to the processing precision of the workpiece, and surface processing of high precision is realized.

(iv) The notch trigger is a separate part from the carrier main body and is exchangeable and is integrally joined and fixed, and therefore optimum component materials may be used for both the notch trigger and the carrier main body, and the material cost of the structure may be reduced on the whole.

In particular, a material high in strength and excellent in abrasion resistance can be used only for the notch trigger functioning as the rotating and driving member of the workpiece, heavily worn and replaced frequently, and therefore the use of the expensive material can be suppressed to a minimum limit, and the material cost can be reduced on the whole.

(v) In addition, the notch trigger is a separate part from the carrier main body and is exchangeable and is integrally joined and fixed, therefore when the notch trigger is worn out earlier, only the notch trigger may be replaced, while the

carrier main body can be used continuously until the end of its service life, and in this respect, the material cost can be suppressed on the whole.

(vi) Since the notch trigger is integrally joined and fixed to the carrier main body, the protruding dimension from the mounting part of the notch trigger inward in the radial direction is very small, and unlike the conventional cantilever type supporting structure, if a load is applied to the notch trigger, it is not deflected significantly. As a result, the workpiece is not distorted together with the notch trigger, and the engagement state of the workpiece and the notch trigger is not loosened, and conventional problems of cracking of workpiece, occurrence of defective parts, or breakage of grinding wheels or other tools may be mostly avoided.

For example, in the grinding process, when grinding wheels of large diameter are used in order to enhance the grinding efficiency or grinding precision, since there is no interference between the mounting part of the notch trigger and the grinding wheels, it is not required to extend the length of the trigger notch.

(vii) Similarly, by such mounting structure of the notch trigger as mentioned above, it is not necessary to use expensive material (for example, PEEK) as countermeasure of lowering of rigidity by the conventional cantilever type structure, and the cost can be reduced by using inexpensive

materials.

(viii) Moreover, since the notch trigger is joined and fixed to the carrier main body, its shape can be simplified, so that the processing cost of the notch trigger can be saved, and further as compared with the conventional notch trigger, the material consumption is saved, and the cost is lowered also in this respect.

According to the manufacturing method of the carrier apparatus of embodiments of the present invention, the carrier apparatus performing these effects effectively can be manufactured easily and at low cost.

According to the both-side grinding machine of embodiments of the present invention, since such carrier apparatus is provided, the above effects can be effectively displayed, and the surface and reverse sides of a thin disk-shaped workpiece can be ground simultaneously at high efficiency and high precision.

These and other embodiments and features of the present invention will be more clearly appreciated and understood by reading the detailed description based on the accompanying drawings and novel facts disclosed in the claims thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view showing a configuration of principal parts of a horizontal both-side grinding machine in an exemplary embodiment of the present invention.

FIG. 2 is a front view showing the configuration of the same both-side grinding machine in a partial sectional view along line II-II of FIG. 1.

FIG. 3 is a magnified front view of a configuration of a carrier main body and a trigger notch as essential parts of a carrier apparatus of the both-side grinding machine.

FIG. 4 is a magnified sectional view of the configuration of the carrier main body and the trigger notch of the carrier apparatus along line IV-IV of FIG. 1.

FIG. 5 is a magnified exploded perspective view of carrier main body and the trigger notch of the carrier apparatus.

FIG. 6A is a magnified front view of the notch trigger.

FIG. 6B is a magnified plan view of the notch trigger.

FIG. 7 is a front view showing a semiconductor wafer as a workpiece to be ground by the both-side grinding machine.

FIG. 8A is a front view showing a partial section of principal parts of a conventional both-side grinding machine for grinding the semiconductor wafer.

FIG. 8B is a side view showing a partial section of principal parts of the both-side grinding machine.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention is specifically described below according to the accompanying

drawings. Throughout the drawings, same reference numerals refer to same components or elements.

The both-side grinding machine of the present invention is shown in FIG. 1 and FIG. 2, and this grinding machine is specifically to grind the surface and reverse sides of a thin disk-shaped workpiece W simultaneously, such as a semiconductor wafer shown in FIG. 7, and is more specifically a horizontal both-side grinding machine having grinding wheel axes 3, 4 of a pair of grinding wheels 1, 2 rotated and supported oppositely in the horizontal direction.

The semiconductor wafer W as the object of grinding in the present preferred embodiment is a thin disk-shaped piece of thickness of 1 mm or less, and in order to align the crystal direction of the wafer in the manufacturing process, a notch Wn is provided as a cut part in the circular outer peripheral edge. In the present preferred embodiment, the notch Wn is utilized effectively so as to achieve grinding.

This grinding machine basically comprises, as shown in FIG. 1 and FIG. 2, a pair of right and left grinding wheels 1, 2 and a workpiece rotation supporting device 5 as principal components of the grinding section, and the workpiece rotation supporting device 5 mainly includes a carrier apparatus 6 which is another feature of the present invention.

The grinding wheels 1, 2 are specifically cup-shaped grinding wheels, and their peripheral edge leading ends 1a,

2a are annular grinding surfaces. These grinding wheels 1, 2 are disposed so that the grinding surfaces 1a, 2a may be opposite to each other in a nearly horizontal state, and at the grinding position between the two grinding surfaces 1a, 2a, as described below, the workpiece W is rotated and supported by the workpiece rotation supporting device 5.

More specifically, the grinding wheels 1, 2 are detachably mounted and fixed at the leading ends of the grinding wheel axes 3, 4. The grinding wheel axes 3, 4 are driven and coupled by drive motors 7, 8 installed inside of the grinding wheel stand not shown, and are operated in axial directions, that is, are moved in the infeed directions X, Y by grinding wheel infeed devices (not shown) similarly installed inside of the grinding wheel stand.

The workpiece rotation supporting device 5 functions as workpiece rotation supporting means for supporting and rotating the workpiece W, and is designed to support and rotate the workpiece W between the grinding surfaces 1a, 2a of the pair of grinding wheels 1, 2 so that its surface and reverse sides Wa, Wb may remain in a perpendicular state opposite to the both grinding surfaces 1a, 2a.

Further, the workpiece rotation supporting device 5 includes axial direction supporting means 10 for positioning and supporting the workpiece W in the axial direction, and radial direction supporting means 11 for positioning the

workpiece W in the radial direction and rotating and supporting, and this radial direction supporting means 11 has the carrier apparatus 6 as the principal component.

The axial direction supporting means 10 is formed as a static pressure supporting device for positioning and supporting the surface and reverse sides Wa, Wb of the workpiece W without making contact by way of a static pressure fluid, and its principal components are a pair of right and left static pressure pads 15, 16 disposed oppositely to each other. These static pressure pads 15, 16 are connected to a fluid supply source not shown, and a pressure fluid such as water supplied from the fluid supply source is ejected from a static pressure groove (not shown), and the surface and reverse sides Wa, Wb of the workpiece W are statically held in a contact-free state nearly in a axial direction central position between the grinding surfaces 1a, 2a of the both grinding wheels 1, 2.

The radial direction supporting means 11 formed as a rotation driving device for positioning the workpiece W in the radial direction and rotating and driving, and its principal components include the carrier apparatus 6 for fitting and supporting the workpiece W, and a rotating device 17 as a rotation drive unit for supporting and rotating this carrier apparatus 6.

The rotating device 17 is composed as shown in FIG. 1, in which a plurality of (four in the preferred embodiment)

support rollers 20, 20, ... are rotationally supporting an outer circumference 30a of a carrier ring 30 of the carrier apparatus 6, and a ring drive gear 21 is engaged with inner teeth 33a of a carrier presser 33 integrally fitted and fixed to the carrier ring 30, and the ring drive gear 21 is driven and coupled to a rotation driving source not shown.

Herein, by driving and rotating of the ring drive gear 21 by this rotation driving source, the carrier apparatus 6 for fitting and supporting the workpiece W is rotated and operated around the center of rotation defined by the support rollers 20, 20, ..., and the workpiece W is supported and rotated in a state positioned in the radial direction.

The carrier apparatus 6 is to fit and support the workpiece W, and as shown in FIG. 1 and FIG. 2, it is mainly composed of the carrier ring 30, carrier main body 31, notch trigger 32, and carrier presser 33.

The carrier ring 30 is a location functioning as the main body ring of the carrier apparatus 6, and is formed of an annular ring member as shown in FIG. 1, and as shown in FIG. 2 and FIG. 4, an outer circumferential surface 30a is formed on a cylindrical surface. The carrier ring 30 has the outer circumferential surface 30a rotationally positioned and supported by the four support rollers 20, 20, ... of the rotating device 17 as the rotation driving part.

At the inner diameter side of the carrier ring 30, an

annular mounting groove 30c is provided continuously around the whole circumference, and the outer peripheral edge position of the carrier main body 31 is fitted in the mounting groove 30c, and is mounted and fixed from both sides exchangeable by an annular carrier presser 33. Fixing the carrier presser 33 on the carrier ring 30 is properly realized by any conventional fixing means, and in the illustrated preferred embodiment, mounting bolts (not shown) are used.

The carrier presser 33 is formed like an inner toothed wheel made of an annular ring member as shown in FIG. 1, and the inner teeth 33a are formed in the inner circumference. Thus, when the carrier presser 33 is integrally fitted and fixed in the mounting groove 30c of the carrier ring 30, as mentioned above, the outer circumference 30a of the carrier ring 30 is rotationally supported by the four support rollers 20, 20, ... of the rotating device 17 as the rotation drive unit, and the ring driving gear 21 of the rotating device 17 is engaged with the inner teeth 33a of the carrier presser 33.

The carrier main body 31 is a location for fitting and supporting the workpiece W in collaboration with the notch trigger 32, and more specifically as shown in FIG. 1, it is formed of a thin annular plate material, and its circular inner peripheral edge 31a is formed to surround closely the circular outer circumference (whole circumference) of the workpiece W. That is, the circular inner peripheral edge 31a has an inside

diameter slightly larger than the outside diameter of the workpiece W to be ground, and a specified gap is formed against the outer periphery of the workpiece W, and hence the workpiece W is freely fitted and supported on the carrier main body 31.

The notch trigger 32 has a pointed end engaging part 32a to be engaged with the notch Wn as a cut part provided in the circular outer peripheral edge of the workpiece W, and is composed as an integral piece with the carrier main body 31.

More specifically, the notch trigger 32 is integrally joined and fixed to the carrier main body 31 as an exchangeable separate part, and the pointed end engaging part 32a has a mounting structure of projecting inward in a radial direction from a part of the circumferential direction of the circular inner peripheral edge 31a of the carrier main body 31. The pointed end engaging part 32a of the notch trigger 32 is engaged with the notch Wn of the workpiece W in a rotating direction of the carrier apparatus 6, in a state of the workpiece W being freely engaged and supported in the circular inner peripheral edge 31a of the carrier main body 31.

The carrier main body 31 and the notch trigger 32 are designed to be rotated integrally in the rotating direction while positioning the workpiece W in the radial direction while engaging and supporting freely, and in the grinding process, they contact heavily with the workpiece W, and the gap to the workpiece W may be excessive due to abrasion, or uneven abrasion

may cause adverse effects on the grinding precision.

Accordingly, the carrier main body 31 and the notch trigger 32 are formed as consumable parts to be exchanged regularly or irregularly, and have the following characteristic structure.

The thickness of the carrier main body 31 and the notch trigger 32 is set smaller than the finishing thickness of the workpiece W, and joining and fixing of the notch trigger 32 on the carrier main body 31 is achieved by an adhesive that can be fixed and released.

The notch trigger mounting part 35 in the carrier main body 31 is cut and formed in a shape corresponding to the outer peripheral contour shape of the base end side junction part 32b of the notch trigger 32, and the adhesive is applied to the junction surface of the notch trigger mounting part 35.

In the illustrated preferred embodiment, the notch trigger 32 is specifically formed as shown in FIG. 5 and FIG. 6, and it is made of a thin plate material having a triangular contour, having one peak formed as the pointed end engaging part 32a to be engaged with the notch Wn in the workpiece W, and in the notch trigger mounting part 35 of the carrier main body 31, circular grooves 35a, 35a for avoiding stress concentration are formed in the positions (corner positions) corresponding to the remaining two peaks of the triangular contour of the notch trigger 32. These circular grooves 35a,

35a bring down secondary effects of facilitating the manufacture of the notch trigger mounting part 35.

The pointed end engaging part 32a of the notch trigger 32 is finished in an R-shape as shown in FIG. 5 and FIG. 6A in the illustrated preferred embodiment, having an arc-shaped contour, and the corners in the axial direction are finished in an orthogonal shape, and the section is formed in a rectangular section as shown in FIG. 6B. A specific shape or structure of the pointed end engaging part 32a may be determined appropriately in relation to the shape and structure of the notch Wn of the workpiece W at the engaging partner.

That is, the pointed end engaging part 32a is finished in an R-shape as shown in FIG. 6A, so as not to bite into the notch Wn of the workpiece W.

The section of the pointed end engaging part 32a is finished in a rectangular section as shown in FIG. 6B, because the outer circumference of the workpiece W (including the portion of the notch Wn) may be chamfered so as to avoid breakage, and in such a case when the notch trigger 32 is chamfered similarly as in the workpiece W, the notch Wn of the workpiece W may not be hooked (engaged) on the notch trigger 32, and this is to avoid such inconvenience.

Therefore, when the outer circumference including the notch Wn portion of the workpiece W is finished to a rectangular section free from chamfering opposite to the case above,

correspondently, when the section of the pointed end engaging part 32a of the notch trigger 32 is in reverse configuration to the illustrated preferred embodiment, although not particularly shown in the drawing, instead of the rectangular section shown in FIG. 6B, chamfering or similar finishing is done.

The carrier main body 31 and the notch trigger 32 are made of proper materials in consideration of the material of the workpiece W to be ground, and are not particularly specified. They may be made of same materials or different materials appropriately, but are desired to be selected in consideration of degree of abrasion or others.

For example, if the workpiece W is a silicon wafer as in the present preferred embodiment, the material of the notch trigger 32 is not desired to be metal materials in consideration of metal contamination or other problems.

In the illustrated preferred embodiment, the carrier main body 31 is made of inexpensive GFRP (glass fiber reinforced plastics), and the notch trigger 32 made of engineering plastics having a higher strength than the GFRP used in the carrier main body 31, for example, FRP based on PEEK (polyetheretherketone) resin or the like, so that the material cost can be suppressed.

As mentioned above, the carrier main body 31 and the notch trigger 32 are both consumable parts, but the notch trigger

32 is worn more and replaced more frequently, and preferably only the notch trigger 32 may be made of material of higher strength and higher wear resistance.

The notch trigger 32 is an exchangeable and separate part from the carrier main body 31 as mentioned above, and is joined and fixed integrally, and the process of joining and fixing the notch trigger 32 to the carrier main body 31 to form as an integral piece (manufacturing process) may be achieved in the following steps (a) to (c).

(a) A cleaning step of junction surfaces

A step of cleaning and degreasing junction surfaces of notch trigger mounting part 35 of the carrier main body 31 and junction surfaces of junction parts of the notch trigger 32.

This step is to remove contamination, moisture, oily matter or the like because the adhesive as the joining means used in the next joining step should be free from them, so that the fixing capacity of the adhesive may be exhibited to the full.

(b) A joining step

A step of positioning and holding the parallelism of the carrier main body 31 and the notch trigger 32, and adhering and joining the junction surfaces of notch trigger mounting part 35 of the carrier main body 31 and junction surfaces of junction parts of the notch trigger 32 while applying the adhesive.

The applying position of the adhesive is the entire surface of the plane portion of the notch trigger mounting part 35 in FIG. 5, and the adhesive is a generally available instant adhesive. The selecting conditions of the instant adhesive include sufficient strength as the joining and fixing means of the present preferred embodiment, one-component type, high viscosity, and high working efficiency.

When joining the carrier main body 31 and the notch trigger 32, a sufficient caution is needed so that the notch trigger 32 and the carrier main body 31 may be parallel to each other, and by using a surface plate or the like having a guaranteed parallelism, the parallelism of the two parts 31 and 32 may be achieved relatively easily.

(c) A finishing step

A step of removing the excess adhesive coming out from the junction parts of the carrier main body 31 and the notch trigger 32 integrally joined at the joining step thoroughly to be finished cleanly.

If the integrally joined notch trigger 32 and carrier main body 31 are used directly without removing the adhesive oozing out from the junction parts, they may contact with the grinding wheels 1,2 in the grinding process, thereby causing clogging of grinding surfaces 1a, 2a of the grinding wheels 1, 2, or breakage of the workpiece W.

In this way, the notch trigger 32 integrally joined on

the carrier main body 31 is, as shown in FIG. 1, engaged with the notch Wn of the workpiece W, and rotates integrally, and a force is applied in the rotating direction, but the notch trigger 32 in the illustrated preferred embodiment is designed in a junction fixing structure as shown in FIG. 3 (including a triangular contour of the notch trigger 32), so that it is hardly separated in the rotating direction from the carrier main body 31. On the other hand, since the adhesion area of the both parts 31, 32 is small, the bonding force in the rotating axis direction is weak, and hence the notch trigger 32 can be easily detached from the carrier main body 31 and can be replaced.

Therefore, in the both-side grinding machine having such configuration, the workpiece rotation supporting device 5 rotates and supports the workpiece W at the grinding position, and the pair of grinding wheels 1, 2 rotating at high speed are fed in by a specified infeed in the direction of the grinding wheel axes 3, 4, and the surface and reverse sides Wa, Wb of the workpiece W are ground simultaneously by the grinding surfaces 1a, 2a of the both grinding wheels 1, 2.

In this workpiece rotation supporting device 5, the surface and reverse sides Wa, Wb of the workpiece W fitted and supported by the carrier apparatus 6 of the radial direction supporting means 11 are held with a static pressure in a state free from contact by the static pressure pads 15, 16 of the

axial direction supporting means 10, and the grinding surfaces 1a, 2a of the grinding wheels 1, 2 are positioned and supported nearly at central positions in the axial direction, and the carrier apparatus 6 is rotated and operated around the center of rotation defined by the support rollers 20, 20, ..., so that the workpiece W is supported and rotated in a state positioned in the radial direction.

As described specifically above, the carrier apparatus 6 of the present preferred embodiment brings about the following effects.

(1) Since the annular carrier main body 31 closely surrounding the whole circumference of the workpiece W, and the notch trigger 32 to be engaged with the notch Wn of the workpiece W are formed as an integral piece, the number of parts is saved and the structure is simple, and the cost can be lowered structurally.

(2) Since the carrier main body 31 for positioning the outer circumference of the workpiece W in the radial direction is formed in a continuous annular shape having a circular inner peripheral edge 31a surrounding closely the whole circumference of the workpiece W, as compared with the conventional carrier bodies c, d, ... of split structure as shown in FIG. 8, the rigidity is higher, and surface machining of high precision is realized without giving adverse effects on the machining precision of the workpiece W in the grinding

process.

(3) Similarly, since the carrier main body 31 is annular and continuous, as compared with the conventional carrier bodies c, d, ... of split structure as shown in FIG. 8, it is almost free from machining distortion during manufacture of the carrier main body 31, and occurrence of distortion when mounting on the carrier ring 30 may be effectively prevented, and further it is almost free from distortion, deflection or deformation in the grinding process of the workpiece W, and from this respect, too, surface machining of high precision is realized without giving adverse effects on the machining precision of the workpiece W in the grinding process.

(4) Since the notch trigger 32 is an exchangeable and separate part from the carrier main body 31 and is integrally joined and fixed, optimum materials can be used for both the notch trigger 32 and the carrier main body 31 individually, and the material cost of the carrier apparatus 6 can be lowered on the whole.

In particular, an excellent material of high strength and high wear resistance can be used only for the notch trigger 32 which functions as the rotation driving member of the workpiece W, and is heavy in abrasion and high in frequency of exchange, and the consumption of expensive materials can be suppressed, and the material cost of the carrier apparatus 6 can be suppressed on the whole.

(5) In addition, since the notch trigger 32 is an exchangeable and separate part from the carrier main body 31 and is integrally joined and fixed, if the notch trigger 32 is worn out first because it is more easily worn, only the notch trigger 32 can be replaced, and the carrier main body 31 can be used continuously until the end of service life, and in this respect, too, the material cost of the carrier apparatus 6 can be suppressed on the whole.

(6) Since the notch trigger 32 is integrally joined and fixed to the carrier main body 31, the dimension of protruding inward in the radial direction from the mounting part of the notch trigger 32 is very small, and unlike the conventional cantilever-like supporting structure, the notch trigger 32 is not deflected largely if a heavy load is applied. As a result, the workpiece W does not follow up the notch trigger 32 to disconnect the engagement state of the workpiece W and the notch trigger 32, and unlike the prior art, it is almost free from occurrence of defective parts due to breakage of the workpiece W, breakage of grinding wheel, and other problems.

For example, when the grinding wheels 1, 2 of large diameter are used in order to enhance the grinding efficiency or grinding precision, since there is no interference between the mounting part of the notch trigger 32 and the grinding wheels 1, 2, it is not required to extend the length of the notch trigger 32.

(7) Similarly, because of such mounting structure of the notch trigger 32, it is not required to use expensive materials (such as PEEK) as the measure against lowering of rigidity of the conventional cantilever-like structure, and the cost can be lowered by using inexpensive materials.

(8) Structurally, since the notch trigger 32 is joined and fixed to the carrier main body 31, the shape can be simplified, and the processing cost of the notch trigger 32 can be saved, and as compared with the conventional notch trigger 32, the material consumption can be saved, and the cost is lowered also in this respect.

Moreover, according to the manufacturing method of the carrier apparatus 6 of the present invention, the carrier apparatus 6 displaying these effects effectively can be manufactured easily and at low cost.

Further, according to the both-side grinding machine of the present invention, since such carrier apparatus 6 is provided, these effects are exhibited effectively, and the surface and reverse sides W_a , W_b of the thin disk-shaped workpiece W can be ground simultaneously at high efficiency and high precision.

Incidentally, in the preferred embodiment of the present invention described herein, various design changes and modifications are possible as mentioned below.

For example, the illustrated preferred embodiment shows

the present invention is applied in the carrier apparatus 6 in the horizontal both-side grinding machine, but it can be also applied in the carrier apparatus of the vertical both-side grinding machine as disclosed in Japanese Patent Laid-Open Publication No. 2003-71704, or may be applied as the carrier apparatus of the grinding machine of one-side grinding. Further, the present invention may be applied as the carrier apparatus of other machining tool for machining thin disk-shaped workpieces, for example, as the carrier apparatus of the grinding machine disclosed in Japanese Patent Laid-Open Publication No. H11-333707.

The workpiece W to be ground is not limited to the semiconductor wafer as shown in FIG. 7, but includes other thin disk-shaped workpieces.

The specific structure of the carrier apparatus 6 is not limited to the structure specified in the drawings as far as the same or similar effects are obtained, and for example the constituent materials of the carrier main body 31 and the notch trigger 32 may be properly selected depending on the material of the workpiece W to be processed, and are not limited to those shown in the illustrated preferred embodiment. For example, in the case of workpiece W made of iron materials, it is preferred to use iron materials in the aspect of both rigidity and cost.

The specific exemplary embodiment disclosed in the

detailed description above is intended to disclose the technical detail of the present invention, and it must be noted that the present invention is not interpreted in a limited narrow scope of the embodiment, but should be appreciated in a wider scope in various changes and modifications possible within the scope of the spirit and the claims of the present invention mentioned below.

What is claimed is:

1. A carrier apparatus of a thin disk-shaped workpiece for constituting a workpiece rotation supporting device for rotating and driving while positioning and supporting the circular outer circumference of the workpiece, in an apparatus for grinding or polishing at least one side of the workpiece while supporting and rotating the thin disk-shaped workpiece, comprising:

an annular carrier main body having a circular inner peripheral edge surrounding closely the whole circumference of the workpiece, and a notch trigger having a pointed end engaging part to be engaged with a cut portion provided in the circular outer peripheral edge of the workpiece, being formed as an integral piece,

wherein the notch trigger is a separate part from the carrier main body, so as to be exchangeable and joined and fixed integrally, and the pointed end engaging part has a mounting structure of projecting inward in a radial direction from a part of the circular inner peripheral edge of the carrier main body.

2. The carrier apparatus of a thin disk-shaped workpiece according to claim 1,

wherein the thickness of the carrier main body and the notch trigger is set thinner than the finishing thickness of

the workpiece, and joining and fixing of the notch trigger and the carrier main body is realized by an adhesive that can be fixed and released.

3. The carrier apparatus of a thin disk-shaped workpiece according to claim 2,

wherein the notch trigger mounting part on the carrier main body is cut and formed in a shape corresponding to the outer contour shape of the junction part of the notch trigger, and

the adhesive is applied on the junction surface of the notch trigger mounting part.

4. The carrier apparatus of a thin disk-shaped workpiece according to claim 3,

wherein the notch trigger is composed of thin plate members having a triangular contour having one peak formed as the pointed end engaging part to be engaged with the cut part of the workpiece, and

in the notch trigger mounting part of the carrier main body, circular grooves for avoiding concentration of stress are formed at positions corresponding to remaining two peaks of the triangular contour of the notch trigger.

5. The carrier apparatus of a thin disk-shaped workpiece according to any one of claims 1 to 4,

wherein the pointed end engaging part of the notch trigger has an arc contour shape, and its section is set

corresponding to the sectional shape of the cut part of the workpiece.

6. A method of manufacturing a carrier apparatus of a thin disk-shaped workpiece for constituting a workpiece rotation supporting device for rotating and driving while positioning and supporting the circular outer circumference of the workpiece, in an apparatus for grinding or polishing at least one side of the workpiece while supporting and rotating the thin disk-shaped workpiece, comprising following steps (1) to (3):

(1) A cleaning step of cleaning and degreasing junction surfaces of notch trigger mounting part of the carrier main body and junction surfaces of junction parts of the notch trigger;

(2) A joining step of positioning and holding the parallelism of the carrier main body and the notch trigger, and adhering and joining the junction surfaces of notch trigger mounting part of the carrier main body and junction surfaces of junction parts of the notch trigger while applying the adhesive; and

(3) A finishing step of removing the excess adhesive coming out from the junction parts of the carrier main body and the notch trigger integrally joined at the joining step.

7. A both-side grinding machine of a thin disk-shaped workpiece for rotating and supporting a thin disk-shaped

workpiece, feeding a pair of grinding wheels rotating at high speed in the grinding wheel axial direction, and grinding the surface and reverse sides of the workpiece simultaneously by the grinding surfaces of these two grinding wheels, comprising:

a pair of grinding wheels disposed so that the grinding surfaces may be opposite to each other, and

workpiece rotation supporting means for supporting and rotating the workpiece, in a state of the surface and reverse sides of the workpiece opposite to these two grinding surfaces between the grinding surfaces of the pair of grinding wheels,

wherein the workpiece rotation supporting means has axial direction supporting means for positioning and supporting the workpiece in an axial direction, and radial direction supporting means for positioning, rotating and supporting the workpiece in a radial direction, and

this radial direction supporting means has the carrier apparatus as set forth in any one of claims 1 to 5.