Description

Title of Invention: DOUBLE SIDE GRINDING APPARATUS HAVING CONVEX POLYGON-SHAPED ABRASIVE MEMBERS

Technical Field

[1] This application claims the benefit of U.S. Provisional Patent Application No. 63/180,481, filed 27 April 2021, which is incorporated herein by reference it its entirety.

[2] The field of the disclosure relates generally to simultaneous double side grinding of semiconductor wafers and more particularly to double side grinding apparatus and methods for double side grinding.

Background Art

[3] Semiconductor wafers are commonly used in the production of integrated circuit (IC) chips on which circuitry is printed. The circuitry is first printed in miniaturized form onto surfaces of the wafers, then the wafers are broken into circuit chips. But this smaller circuitry requires that wafer surfaces be extremely flat and parallel to ensure that the circuitry can be properly printed over the entire surface of the wafer. To accomplish this, a grinding process is commonly used to improve certain features of the wafers (e.g., flatness and parallelism) after they are cut from an ingot.

[4] Simultaneous double side grinding operates on both sides of the wafer at the same time and produces wafers with highly planarized surfaces. It is therefore a desirable grinding process. While this grinding process significantly improves flatness and parallelism of the ground wafer surfaces, it can also cause degradation of the topology and nanotopography (NT) of the wafer surfaces.

[5] Poor nanotopography leads to non-uniform oxide layer removal in a later polishing (CMP) process. This can lead to substantial yield losses for the wafer users such as IC manufacturers. As the IC manufacturers move towards smaller process technology, the tolerances for nanotopography are projected to become tighter.

[6] A need exists for methods for simultaneous double side grinding semiconductor structures that improve wafer nanotopography.

[7] This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the disclosure, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present disclosure. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

Disclosure of Invention

Technical Problem

[8] One aspect of the present disclosure is directed to a method for double side grinding a semiconductor structure.

Solution to Problem

[9] The semiconductor structure is positioned between first and second grinding wheels. Each grinding wheel includes a support wheel and a plurality of abrasive members that extend axially outward from the support wheel. Each abrasive member has a wafer-engaging surface. The wafer-engaging surface is shaped as a convex polygon with at least five sides. The semiconductor structure is ground by contacting the first and second grinding wheels with the semiconductor structure and rotating the first and second grinding wheels relative to each other.

[10] Another aspect of the present disclosure is directed to a method for double side grinding a semiconductor structure. The semiconductor structure is positioned between first and second grinding wheels. Each grinding wheel includes a support wheel and a plurality of abrasive members that extend axially outward from the support wheel. Each abrasive member has a wafer-engaging surface. The wafer-engaging surface includes a base. The base is a first side of the wafer-engaging surface. The wafer-engaging surface includes a second side having a first end and a second end. The second side is connected to the base at its first end. The second side and base form an obtuse angle. The wafer-engaging surface includes a third side having a first end and a second end. The third side is connected to the base at its first end. The third side and base form an obtuse angle. The semiconductor structure is ground by contacting the first and second grinding wheels with the semiconductor structure and rotating the first and second grinding wheels relative to each other.

[11] A further aspect of the present disclosure is directed to a double side grinding apparatus. The apparatus includes first and second grinding wheels. Each grinding wheel has a rotational axis and includes a support wheel and a plurality of abrasive members that extend axially outward from the support wheel. Each abrasive member has a wafer-engaging surface. The wafer-engaging surface includes a base. The base is a first side of the wafer-engaging surface. The wafer-engaging surface includes a second side having a first end and a second end. The second side is connected to the base at its first end. The second side and base form an obtuse angle. The wafer-engaging surface includes a third side having a first end and a second end. The third side is connected to the base at its first end. The third side and base form an obtuse angle. Each side of the wafer-engaging surface has an average distance from the rotational axis. The average distance of the base from the rotational axis is less than the average distance of each of the other sides from the rotational axis.

Advantageous Effects of Invention

[12] Various refinements exist of the features noted in relation to the above-mentioned aspects of the present disclosure. Further features may also be incorporated in the above-mentioned aspects of the present disclosure as well. These refinements and additional features may exist individually or in any combination. For instance, various features discussed below in relation to any of the illustrated embodiments of the present disclosure may be incorporated into any of the above-described aspects of the present disclosure, alone or in any combination.

Brief Description of Drawings

[13] Figure 1 is a perspective exploded view of a double side grinding apparatus;

[14] Figure 2 is a cross-section view of a grinding wheel of the double side grinding apparatus;

[15] Figure 3 is a top view of a support wheel of the grinding wheel;

[16] Figure 4 is a top view of the grinding wheel;

[17] Figure 5 is a detailed top view of the grinding wheel showing abrasive members;

[18] Figure 6 is a top view of an abrasive member of the grinding wheel;

[19] Figure 7 is a top view of another embodiment of a grinding wheel;

[20] Figure 8 is a detailed top view of the grinding wheel showing abrasive members;

[21] Figure 9 is a top view of an abrasive member of the grinding wheel;

[22] Figure 10 illustrates box plots of peak to valley nanotopography for semiconductor structures simultaneous double side ground by convex polygon-shaped abrasive members and by conventional abrasive members;

[23] Figure 11 illustrates box plots of peak to valley nanotopography in a 10 mm x 10 mm window for semiconductor structures simultaneous double side ground by convex polygon-shaped abrasive members and by conventional abrasive members;

[24] Figure 12 shows wafer images for semiconductor structures simultaneous double side ground by convex polygon-shaped abrasive members and by conventional abrasive members;

[25] Figure 13 illustrates box plots of bow for semiconductor structures after being simultaneous double side ground by convex polygon-shaped abrasive members and by conventional abrasive members;

[26] Figure 14 illustrates box plots of the change in bow before and after the simultaneous double side grind (delta) for semiconductor structures simultaneous double side ground by convex polygon-shaped abrasive members and by conventional abrasive members;

[27] Figure 15 is a time series plot of the current of the left grinding wheel for semiconductor structures simultaneous double side ground by convex polygon-shaped abrasive members and by conventional abrasive members;

[28] Figure 16 is a time series plot of the current of the right grinding wheel for semi-conductor structures simultaneous double side ground by convex polygon-shaped abrasive members and by conventional abrasive members;

[29] Figure 17 shows the accumulated percentage of particle count (DIC mode) for count 0 for semiconductor structures simultaneous double side ground by convex polygon-shaped abrasive members and by conventional abrasive members;

[30] Figure 18 illustrates images of a convex polygon-shaped abrasive member along its height showing porosity thereof; and

[31] Figure 19 is a time series plot of the CRING value for convex polygon-shaped abrasive members and conventional abrasive members.

[32] Corresponding reference characters indicate corresponding parts throughout the drawings.

Mode for the Invention

[33] An example double side grinding apparatus 100 for use in embodiments of the present disclosure is shown in Figure 1. The double side grinding apparatus 100 (which may also be referred to herein as a "simultaneous double side grinding apparatus") includes a pair of hydrostatic pads 105, 110 that generate water cushions or "pockets" 113 through a source of water 111. The semiconductor structure W is guided between the water cushions 113, thereby "clamping" the wafer W in a generally vertical alignment. The wafer is secured in a carrier ring 122. The carrier ring 122 (and wafer W secured therein) rotates within a hydrostatic guide roller 136. A pair of first and second grinding wheels 133, 135 ("left" and "right" grinding wheels) extend through the hydrostatic pads 105, 110. The pair of grinding wheels 133, 135 rotate in opposite directions relative to each other. The grinding wheels 133, 135 may be connected with air spindles 141, 142 and an electric motor rotates the grinding wheels 133, 135. The grinding wheels 133, 135 may include full peripheral contact with the semiconductor structure as they rotate.

[34] Generally, the double side grinding apparatus 100 may be adapted to process any size semiconductor structure such as structures having a diameter of 200 mm or more, 300 mm or more, or 450 mm or more. The semiconductor structure may be a single crystal silicon wafer. In other embodiments, the semiconductor structure is made of silicon carbide, sapphire, or Al_2O_3. The semiconductor structure may be a layered structure or may be a bulk wafer.

[35] An example grinding wheel 200 of the apparatus is shown in Figure 2. The grinding wheel 200 may be used as the first and second grinding wheels of the apparatus 100 because the first and second grinding wheels are typically identical. The grinding wheel 200 has a rotational axis A about which the grinding wheel rotates. The grinding

wheel 200 include a support wheel 208 and a plurality of abrasive members 212 that extend axially outward from the support wheel 208. The plurality of abrasive members 212 extend circumferentially about the support wheel 208 (about the circumference C (Figure 3)).

[36] The abrasive members 212 include an abrasive grit material such as diamond grit or cubic boron nitride (CBN) grit. In some embodiments, the abrasive members include vitrified diamond.

[37] The support wheel 208 includes a circumferential recess 215 (e.g., formed from a single shoulder or two shoulders formed in the support wheel 208). The plurality of abrasive members 212 are disposed within the circumferential recess 215. The abrasive members 212 may connect to the support wheel 208 by any method that allows the grinding wheel to function as described herein. In some embodiments, the abrasive members 212 are connected to the support wheel 208 by an adhesive. In other embodiments, the abrasive members 212 are connected to the support wheel 208 by a mold. In other embodiments, the abrasive members are connected to a collar (not shown) that is disposed within the circumferential recess.

[38] Referring now to Figures 4-5, a grinding wheel 200 of embodiments of the present disclosure is shown. The grinding wheel 200 includes abrasive members 212 each having a wafer-engaging surface 225 (Figure 6) that contacts the semiconductor structure during grinding. Gaps 219 (Figure 4) may be formed between the abrasive members 212. In other embodiments, gaps are not formed between the abrasive members 212 (i.e., the wafer-engaging surfaces 225 are congruent).

[39] In the illustrated embodiment, the wafer-engaging surface 225 is shaped as a convex polygon having at least five sides. For example, the convex polygon may be a pentagon as shown in the illustrated embodiment or, as in other embodiments, may be a hexagon, heptagon, octagon or other convex polygon. The convex polygon may be a regular polygon or an irregular polygon.

[40] In some embodiments and as shown in Figure 6, the wafer-engaging surface 225 includes a base 235 (e.g., a side from which the height may be measured that may be generally closest or furthest from the rotational axis A (Figure 4) of the grinding wheel 200). Second and third sides 239, 243 extend from the base 235 (which may also be referred to herein as a "first side" of the wafer-engaging surface 225). The second side 239 includes a first end 241 and a second end 242. The second side 239 is connected to the base 235 at its first end 241. The second side 239 and base 235 form an angle λ_1. The third side 243 includes a first end 261 and second end 263. The third side 243 is connected to the base 235 as its first end 261. The third side 243 and base 235 form an angle λ_2. In some embodiments, the first and second angles λ_1, λ_2 are each obtuse angles.

[41] The wafer-engaging surface 225 includes a fourth side 250 that connects to the first side 239 at a first end 267 of the fourth side 250. The wafer-engaging surface 225 includes a fifth side 255 that connects to the second end 243 at a first end 272 of the fifth side 255. In embodiments in which the convex polygon is a pentagon, the fourth and fifth sides 250, 255 connect at second sides 270, 275 of the fourth and fifth sides 250, 255.

[42] The sides 235, 239, 243, 250, 255 of the convex polygon may have any length that allows the abrasive members 212 to function as described herein. In the illustrated embodiment, the second and third sides 239, 243 are each shorter than the base 235 and of each the fourth and fifth sides 250, 255.

[43] As shown in the illustrated embodiment, one or more corners formed between the sides may be rounded corners (e.g., has one or more radii of curvature). For example, the corner 286 formed between the second side 239 and the fourth side 250 is rounded and the corner 288 formed between the third side 243 and the fifth side 255 is rounded. In the illustrated embodiment, the corner 290 formed between the fourth side 250 and fifth side 255 is also rounded (e.g., an apex opposite the base 235 is rounded). The ends of the various sides of the convex polygon that terminate within a rounded corner may generally correspond to the mid-point of the rounded corner unless stated differently herein.

[44] In some embodiments, some or even none of the corners are rounded (i.e., some or all are sharp corners). In the illustrated embodiment, the corner 282 formed between the base 235 and the second side 239 is not rounded and the corner 284 formed between the base 235 and the third side 243 is not rounded. Generally, the choice between round and sharp corners (and the one or more radii of rounded corners) may be made based on the performance of the abrasive member 212.

[45] Each side 235, 239, 243, 250, 255 of the wafer-engaging surface 225 has an average distance from the rotational axis A (Figure 4). In the illustrated embodiment, the average distance D_{235} of the base 235 from the rotational axis A is less than the average distance from the rotational axis of each of the other sides 239, 243, 250, 255 (i.e., the base 235 is closer to the rotational axis A than the other sides of the convex polygon).

[46] Another embodiment of the grinding wheel 300 is shown in Figures 7-8. The components shown in Figures 7-8 that are analogous to those of Figures 4-5 are designated by the corresponding reference number of Figures 4-5 plus "100" (e.g., part 212 becomes 312). In the embodiment of Figures 7-8, the orientation of the abrasive member 312 is turned 180° from the abrasive member 212 of Figures 4-6 (compare Figure 6 and 9). In this illustrated embodiment, the average distance D_{335} of the base 335 from the rotational axis A is greater than the average distance from the rotational axis A of each of the other sides 239, 243, 250, 255 (i.e., the base 235 is further from

the rotational axis A than the other sides of the convex polygon). Other than the orientation of the abrasive member 312, the abrasive member 312 may be the same as the abrasive member 212 of Figures 4-6.

[47] In accordance with embodiments of the present disclosure, the semiconductor structure may be double side grinded by positioning the semiconductor structure between the first and second grinding wheels (Figure 1). The semiconductor structure is ground by contacting the first and second grinding wheels with the semiconductor structure and rotating the first and second grinding wheels relative to each other (i.e., in opposite directions).

[48] Compared to conventional methods for simultaneously double-side grinding semiconductor structures, the methods of the present disclosure have several advantages. Convex polygonal-shaped abrasive members have more abrasive surface area relative to conventional abrasive members for holding the semiconductor structure. This reduces vibration in the horizontal direction and the slope by the contacted grinding wheel. The rotating semiconductor structure may be ground under more balanced conditions and the nanotopography may be improved. Further, the abrupt step along the edge area of the semiconductor structure may be improved and distorted areas on the ground wafer may be reduced. The convex polygonal-shaped abrasive members may generate less surface damage with less grinding current. Different shapes or orientations of the convex polygonal abrasive member may be used to produce different bow effects in the wafer. The convex polygonal-shaped abrasive members may have a relatively consistent porosity across its length which increases the consistency of the grinding process.

[49] EXAMPLES

[50] The processes of the present disclosure are further illustrated by the following Examples. These Examples should not be viewed in a limiting sense.

[51] **Example 1: Nanotopography Improvement by use of a Convex Polygon-Shaped Abrasive Members**

[52] A first set of semiconductor structures (single crystal silicon wafers) were simultaneously double-side ground by a grinding wheel having abrasive members as shown in Figures 4-7 of U.S. Patent No. 6,692,343. A second set of semiconductor structures (single crystal silicon wafers) were simultaneously double-side ground by a grinding wheel having abrasive members with a convex polygon shape (convex pentagon). Figure 10 shows the peak to valley nanotopograhy and Figure 11 shows peak to valley of a 10 mm x 10 mm window of the wafer. As shown in Figures 10-11, the pentagon-shaped abrasive members have improved nanotopography.

[53] **Example 2: Reduction in Distorted Area by use of a Convex Polygon-Shaped Abrasive Members**

[54] Figure 12 shows wafer images for a wafer ground by a grinding wheel of Figures 4-6 of the application having pentagon-shaped abrasive members "(1)" and grinding wheels having the abrasive members shown in Figures 4-7 of U.S. Patent No. 6,692,343 with "(2)" being a center pattern and "(3)" being an edge pattern. The pentagon-shaped abrasive members were better able to apply holding force toward the rotating wafer surface and sustained generated slope without having to change over the grinding sequence. As shown in Figure 12, the wafer ground with the pentagon-shaped abrasive members prevented generation of distorted area on the ground wafer, thereby improving nanotopography.

[55] **Example 3: Change in Bow by use of a Convex Polygon-Shaped Abrasive Members**

[56] The center profile (BOW best fit, CRING), without tilt adjustment of the grinding wheel, for pentagon-shaped abrasive members having a base closest to the rotational axis of the grinding wheels ("Figs. 4-5 of Application"), for pentagon-shaped abrasive members having a base furthest from the rotational axis ("Figs. 7-8 of Application") and for abrasive members shown in Figures 4-7 of U.S. Patent No. 6,692,343 ("US 6,692,343") is shown in Figures 13-14. Figure 13 shows the measured bow after the double side grind and Figure 14 shows the difference in the bow before and after the double side grind. The pentagon-shaped abrasive members have different removal amounts and the grinding wheels have different BOW capability.

[57] **Example 4: Reduction in Surface Damage by use of a Convex Polygon-Shaped Abrasive Members**

[58] Figure 17 shows the accumulated percentage of particle count (DIC mode) for grinding wheels having abrasive members as shown in Figures 4-7 of U.S. Patent No. 6,692,343 (left column) and for grinding wheels having pentagon-shaped abrasive members (right column). As shown in Figure 17, the pentagon-shaped abrasive members resulted in less surface damage with less grinding current (Figs. 15-16).

[59] **Example 5: Grinding Stability by use of a Convex Polygon-Shaped Abrasive Members**

[60] The convex polygon-shaped wheel involved stable grinding capability from the top layer of the convex polygon structure to the bottom layer. As shown in Figure 18, the porosity of the convex polygon-shaped wheel was consistent through-out its length. This is evidenced by Figure 19 which shows the CRING value changed (from low to high and back to low) for the abrasive members of Figures 4-7 of U.S. Patent No. 6,692,343 while the pentagon-shaped abrasive members exhibited consistent values.

[61] As used herein, the terms "about," "substantially," "essentially" and "approximately" when used in conjunction with ranges of dimensions, concentrations, temperatures or other physical or chemical properties or characteristics is meant to cover variations that

may exist in the upper and/or lower limits of the ranges of the properties or characteristics, including, for example, variations resulting from rounding, measurement methodology or other statistical variation.

[62] [0001] When introducing elements of the present disclosure or the embodiment(s) thereof, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," "including," "containing," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements. The use of terms indicating a particular orientation (e.g., "top," "bottom," "side," etc.) is for convenience of description and does not require any particular orientation of the item described.

[63] As various changes could be made in the above constructions and methods without departing from the scope of the disclosure, it is intended that all matter contained in the above description and shown in the accompanying drawing[s] shall be interpreted as illustrative and not in a limiting sense.

Claims

[Claim 1] A method for double side grinding a semiconductor structure, the method comprising:
positioning the semiconductor structure between first and second grinding wheels, each grinding wheel comprising:
a support wheel; and
a plurality of abrasive members that extend axially outward from the support wheel, each abrasive member having a wafer-engaging surface, the wafer-engaging surface being shaped as a convex polygon with at least five sides; and
grinding the semiconductor structure by contacting the first and second grinding wheels with the semiconductor structure and rotating the first and second grinding wheels relative to each other.

[Claim 2] The method as set forth in claim 1 wherein the convex polygon has one or more rounded corners.

[Claim 3] The method as set forth in claim 2 wherein one of the sides of the polygon comprise a base and a plurality of sides other than the base, wherein each of the corners formed between two sides of the polygon other than the base are rounded.

[Claim 4] The method as set forth in claim 3 wherein each of the corners formed with the base are sharp corners.

[Claim 5] The method as set forth in any one of claims 1 to 4 wherein the abrasive members comprise diamond grit.

[Claim 6] The method as set forth in claim 5 wherein the abrasive members comprise vitrified diamond.

[Claim 7] The method as set forth in any one of claims 1 to 6 wherein each abrasive member is connected to the support wheel by an adhesive or a mold.

[Claim 8] The method as set forth in any one of claims 1 to 7 wherein the support wheel forms a circumferential recess, the abrasive members being disposed within the circumferential recess.

[Claim 9] The method as set forth in any one of claims 1 to 8 wherein the convex polygon is a convex pentagon.

[Claim 10] The method as set forth in any one of claims 1 to 9 wherein the semi-conductor structure is secured by first and second hydrostatic pads.

[Claim 11] A method for double side grinding a semiconductor structure, the method comprising:

positioning the semiconductor structure between first and second grinding wheels, each grinding wheel comprising:
a support wheel; and
a plurality of abrasive members that extend axially outward from the support wheel, each abrasive member having a wafer-engaging surface, the wafer-engaging surface comprising:
a base, the base being a first side of the wafer-engaging surface;
a second side having a first end and a second end, the second side being connected to the base at its first end, the second side and base forming an obtuse angle; and
a third side having a first end and a second end, the third side being connected to the base at its first end, the third side and base forming an obtuse angle; and
grinding the semiconductor structure by contacting the first and second grinding wheels with the semiconductor structure and rotating the first and second grinding wheels relative to each other.

[Claim 12] The method as set forth in claim 11 wherein the wafer-engaging surface comprises a fourth side and a fifth side.

[Claim 13] The method as set forth in claim 11 or claim 12 wherein each grinding wheel has a rotational axis, each side of the wafer-engaging surface having an average distance from the rotational axis, wherein the average distance of the base from the rotational axis is greater than the average distance from the rotational axis of each of the other sides.

[Claim 14] The method as set forth in claim 11 or claim 12 wherein each grinding wheel has a rotational axis, each side of the wafer-engaging surface having an average distance from the rotational axis, wherein the average distance of the base from the rotational axis is less than the average distance from the rotational axis of each of the other sides.

[Claim 15] The method as set forth in any one of claims 11 to 14 wherein the wafer-engaging surface has one or more rounded corners.

[Claim 16] The method as set forth in claim 15 wherein the corner formed between the base and the second side is not rounded and the corner formed between the base and the third side is not rounded.

[Claim 17] The method as set forth in any one of claims 11 to 16 wherein the wafer-engaging surface is pentagon-shaped and comprises a fourth side and a fifth side.

[Claim 18] The method as set forth in any one of claims 11 to 17 wherein the abrasive members comprise diamond grit.

[Claim 19] The method as set forth in claim 18 wherein the abrasive members comprise vitrified diamond.

[Claim 20] The method as set forth in any one of claims 11 to 19 wherein each abrasive member is connected to the support wheel by an adhesive or a mold.

[Claim 21] The method as set forth in any one of claims 11 to 20 wherein the support wheel forms a circumferential recess, the abrasive members being disposed within the circumferential recess.

[Claim 22] The method as set forth in any one of claims 11 to 21 wherein the semi-conductor structure is secured by first and second hydrostatic pads.

[Claim 23] A double side grinding apparatus comprising:
first and second grinding wheels, each grinding wheel having a rotational axis and comprises:
a support wheel; and
a plurality of abrasive members that extend axially outward from the support wheel, each abrasive member having a wafer-engaging surface, the wafer-engaging surface comprising:
a base, the base being a first side of the wafer-engaging surface;
a second side having a first end and a second end, the second side being connected to the base at its first end, the second side and base forming an obtuse angle; and
a third side having a first end and a second end, the third side being connected to the base at its first end, the third side and base forming an obtuse angle; and
each side of the wafer-engaging surface having an average distance from the rotational axis, wherein the average distance of the base from the rotational axis is less than the average distance of each of the other sides from the rotational axis.

[Claim 24] The double side grinding apparatus as set forth in claim 23 wherein the wafer-engaging surface comprises a fourth side and a fifth side.

[Claim 25] The double side grinding apparatus as set forth in claim 23 or claim 24 wherein the wafer-engaging surface has one or more rounded corners.

[Claim 26] The double side grinding apparatus as set forth in claim 25 wherein the corner formed between the base and the second side is not rounded and the corner formed between the base and the third side is not rounded.

[Claim 27] The double side grinding apparatus as set forth in any one of claims 23 to 26 wherein the wafer-engaging surface is pentagon-shaped and comprises a fourth side and a fifth side.

[Claim 28] The double side grinding apparatus as set forth in any one of claims 23 to 27 wherein the abrasive members comprise diamond grit.

[Claim 29] The double side grinding apparatus as set forth in claim 28 wherein the abrasive members comprise vitrified diamond.

[Claim 30] The double side grinding apparatus as set forth in any one of claims 23 to 29 wherein the support wheel forms a circumferential recess, the abrasive members being disposed within the circumferential recess.

[Claim 31] The double side grinding apparatus as set forth in any one of claims 23 to 30 wherein the support wheel forms a circumferential recess, the collar being disposed within the circumferential recess.

[Claim 32] The double side grinding apparatus as set forth in any one of claims 23 to 31 further comprising first and second hydrostatic pads that secure the semiconductor structure.