



US 20070077867A1

(19) **United States**(12) **Patent Application Publication**
NAKAHATA(10) **Pub. No.: US 2007/0077867 A1**(43) **Pub. Date: Apr. 5, 2007**(54) **POLISHING PAD AND POLISHING
APPARATUS****Publication Classification**(76) Inventor: **Masaomi NAKAHATA**, Yokohama-shi
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ALEXANDRIA, VA 22314 (US)(51) **Int. Cl.****B24B 7/30** (2006.01)**B24D 11/00** (2006.01)(52) **U.S. Cl.** **451/41; 451/527**

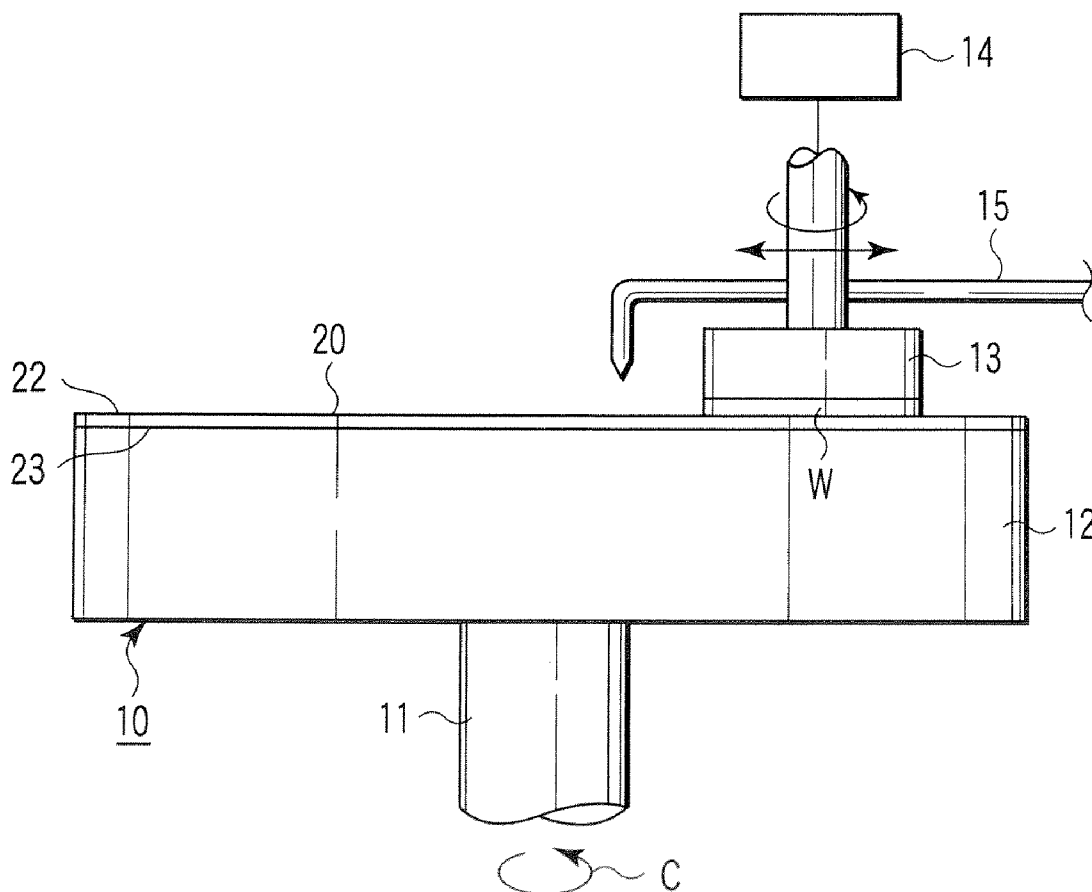
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ABSTRACT

A polishing pad according to the invention includes a plate-like pad body having one surface serving as a polishing surface and the other surface serving as a support surface, and a plurality of hole parts which extend from the polishing surface to the support surface, the each hole part containing a plurality of elongated holes that extend in different directions on a plane of the polishing surface.

(21) Appl. No.: **11/537,162**(22) Filed: **Sep. 29, 2006**(30) **Foreign Application Priority Data**

Oct. 3, 2005 (JP) 2005-290313



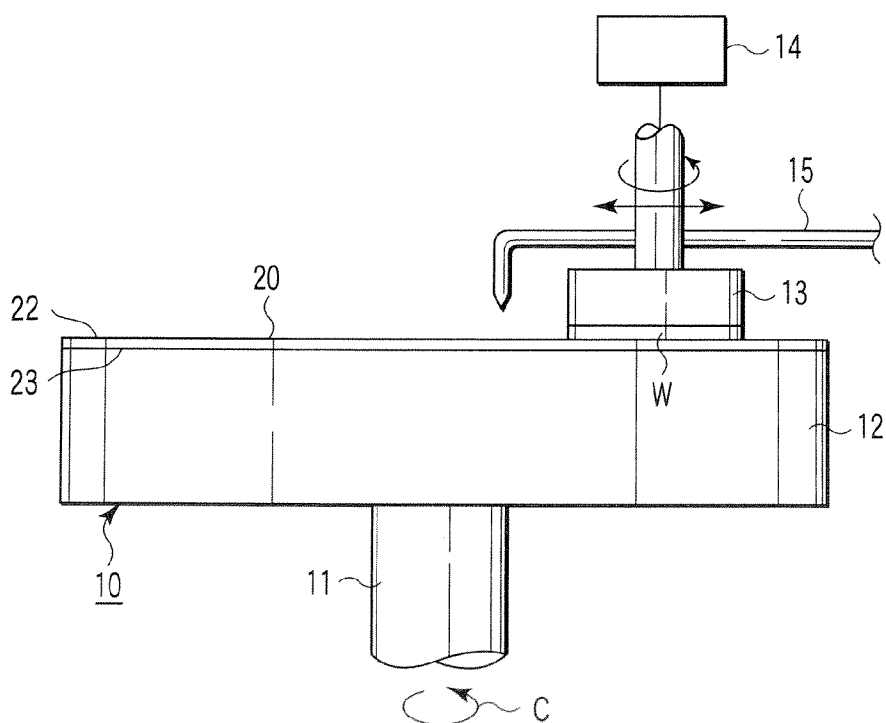


FIG. 1

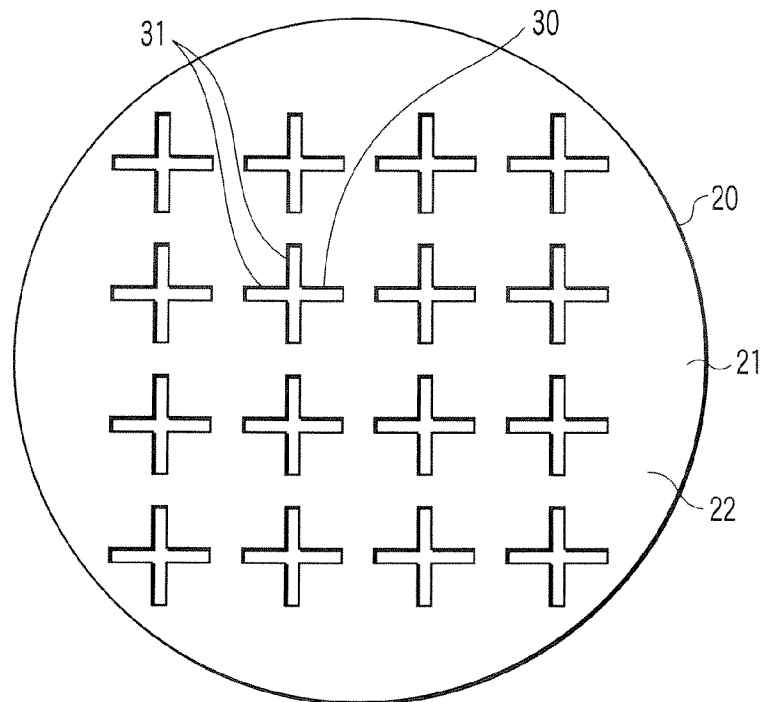


FIG. 2

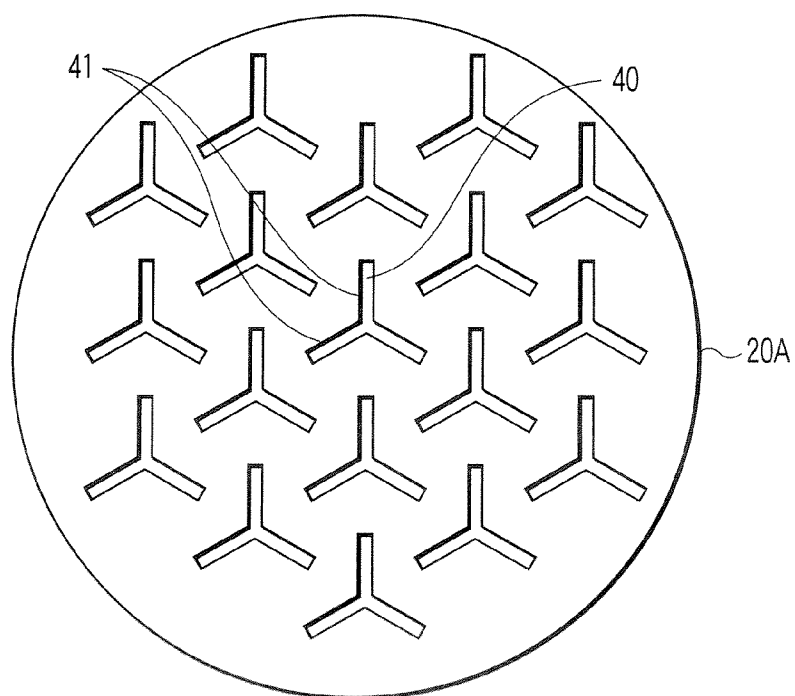


FIG. 3

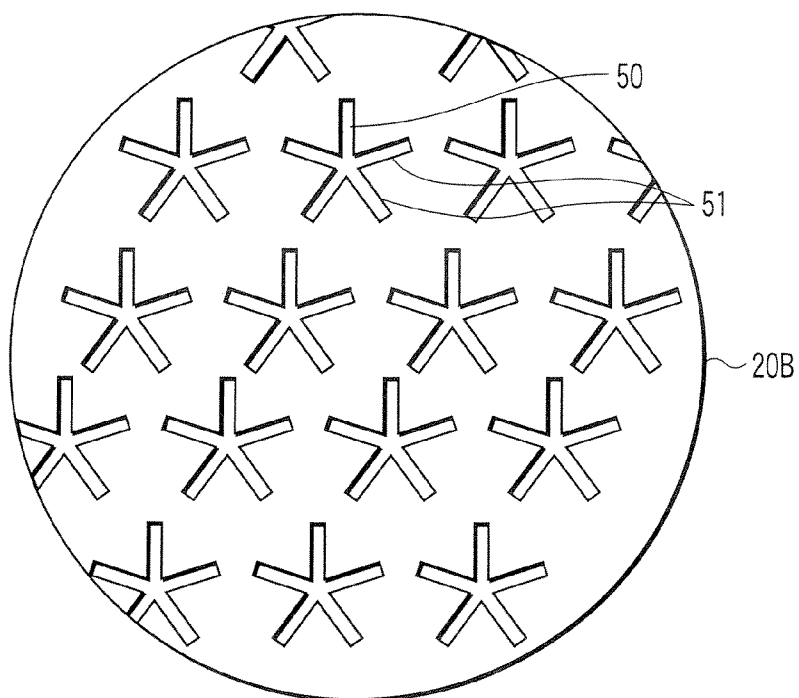


FIG. 4

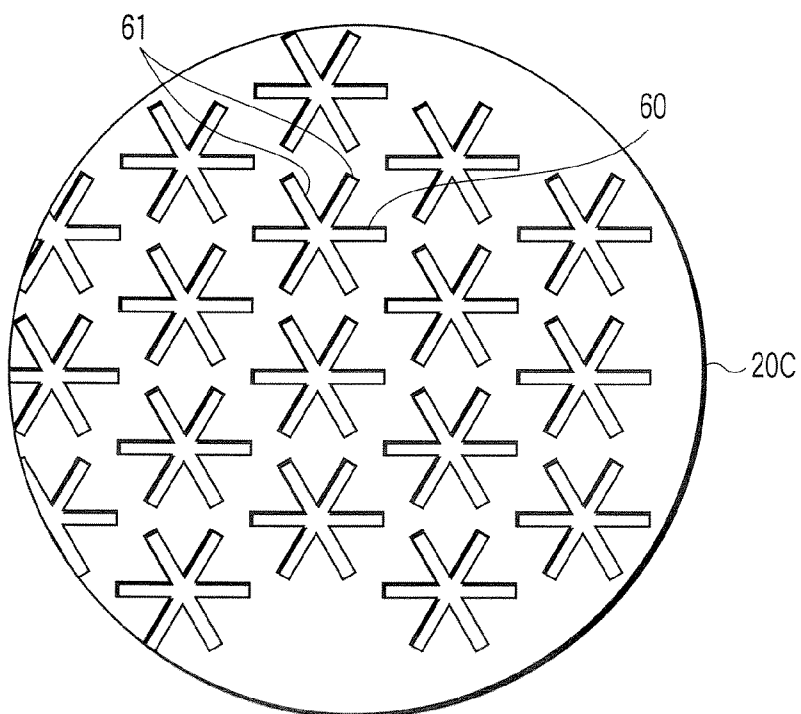


FIG. 5

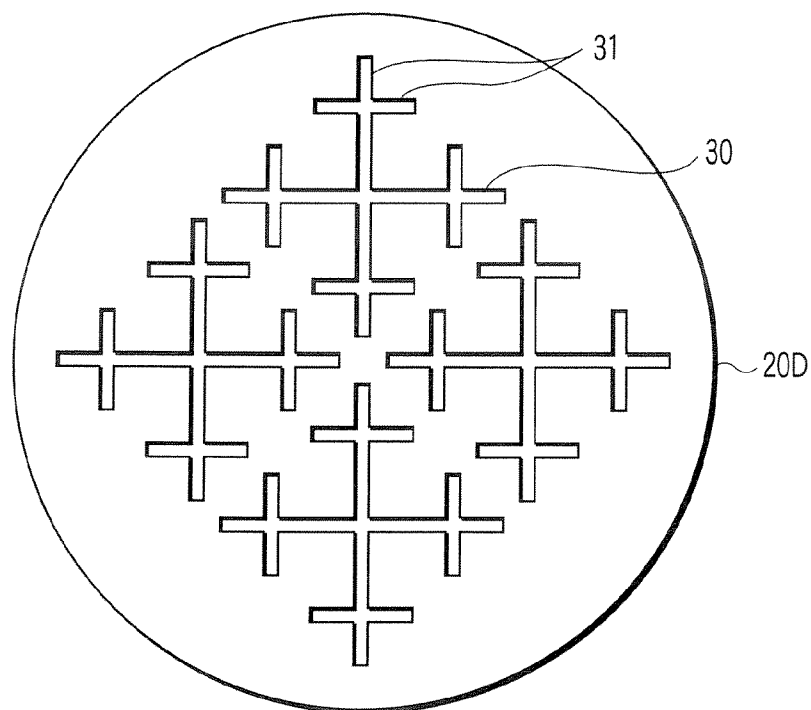


FIG. 6

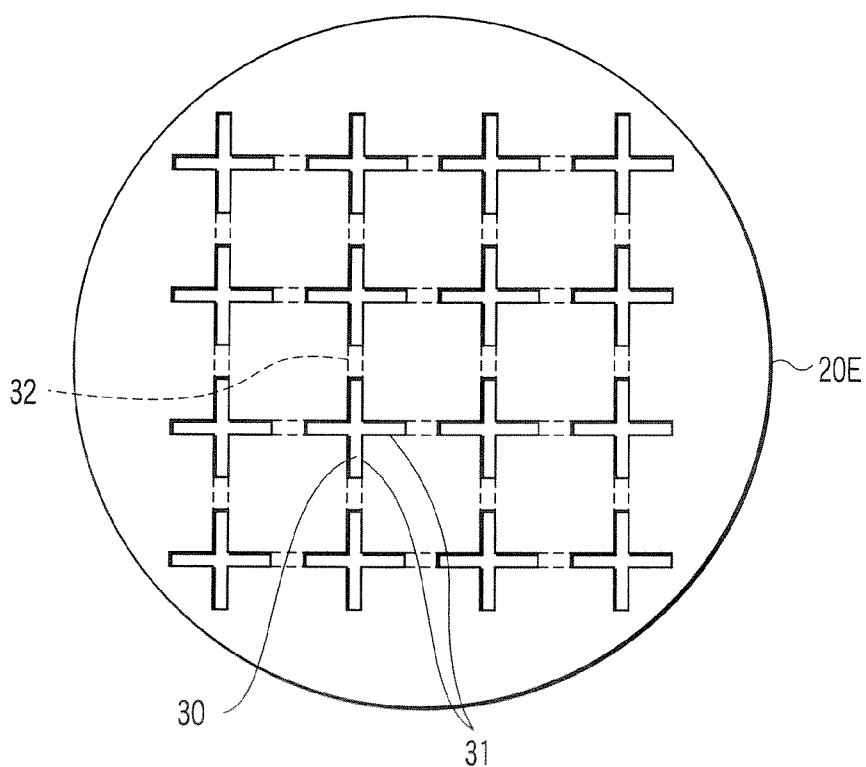


FIG. 7

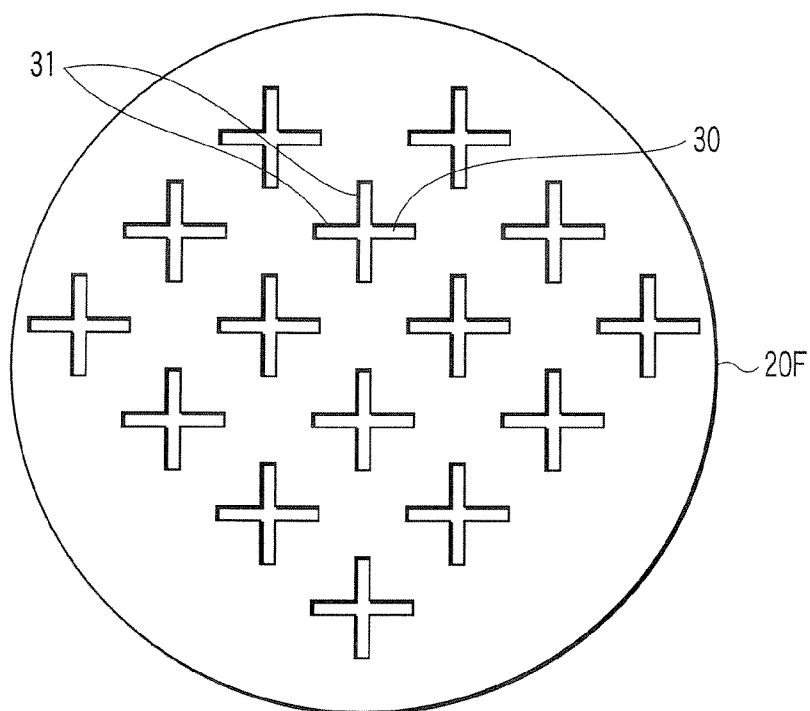


FIG. 8

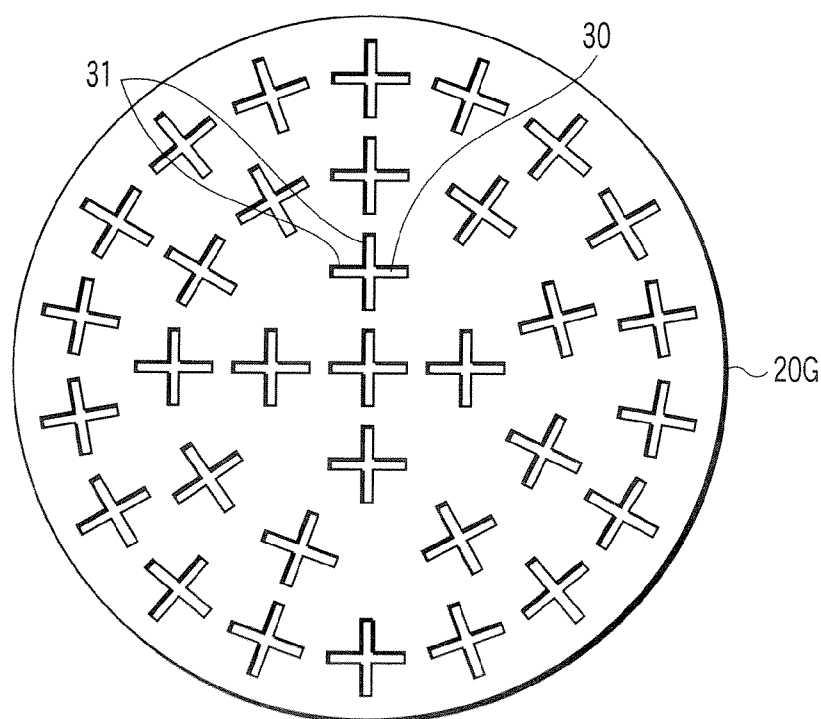


FIG. 9

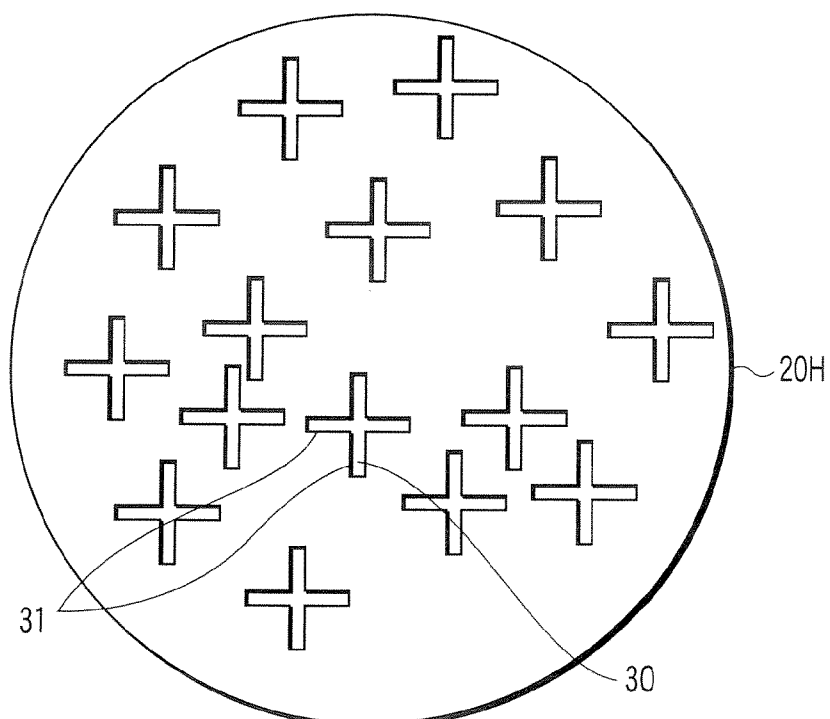


FIG. 10

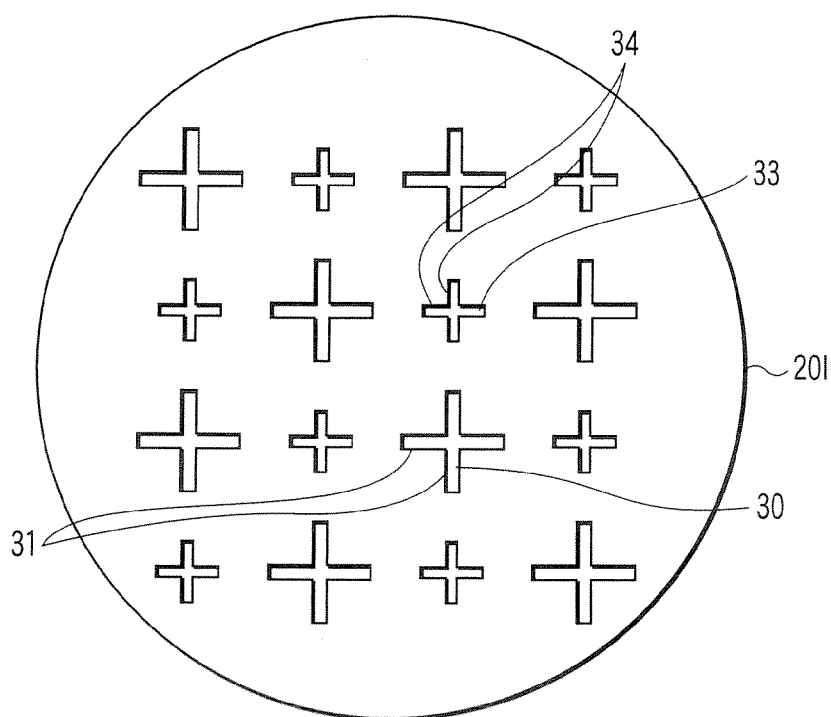


FIG. 11

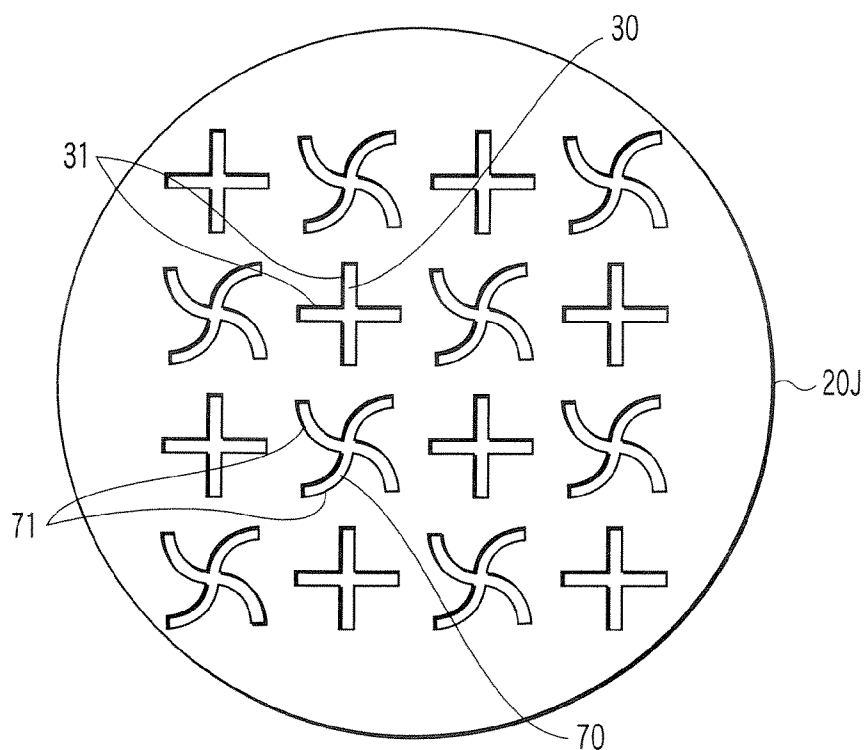


FIG. 12

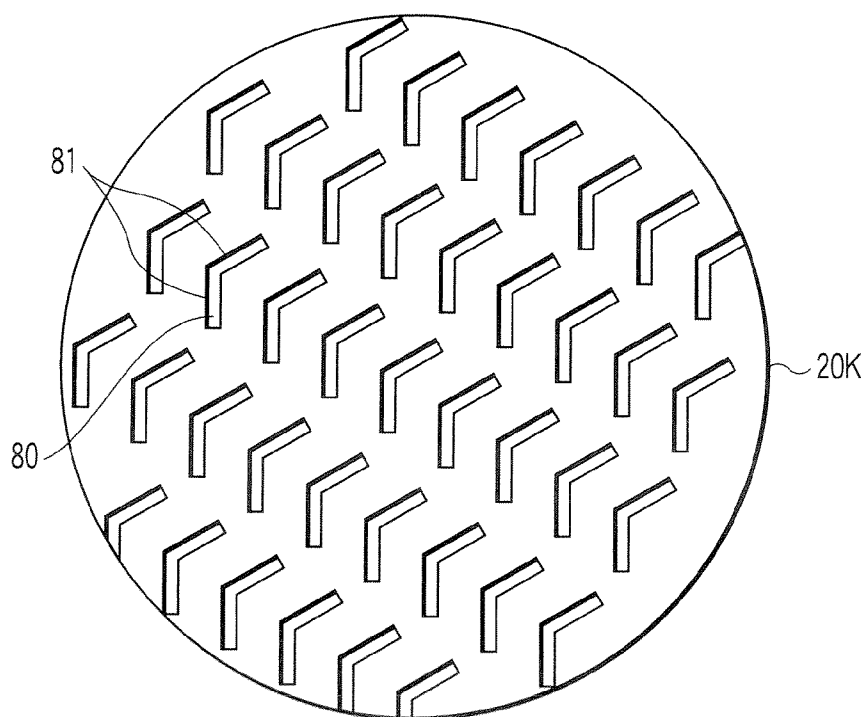


FIG. 13

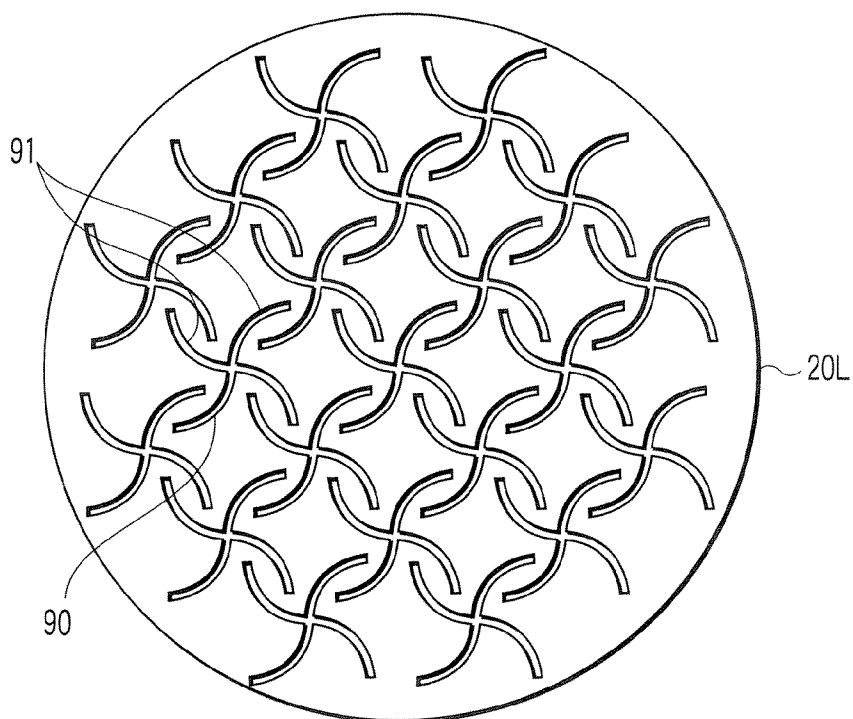


FIG. 14

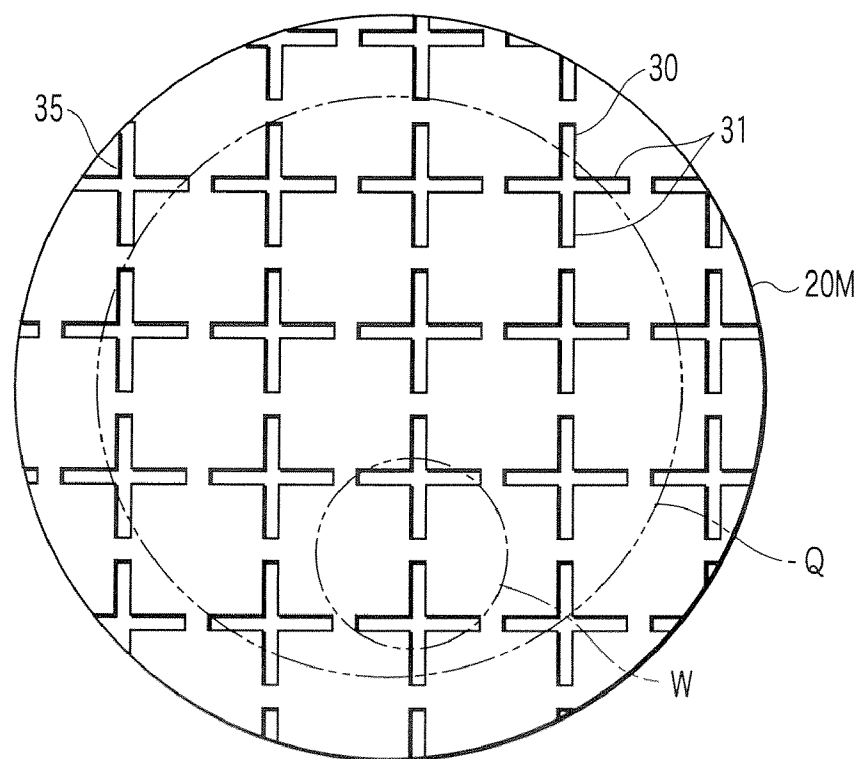


FIG. 15

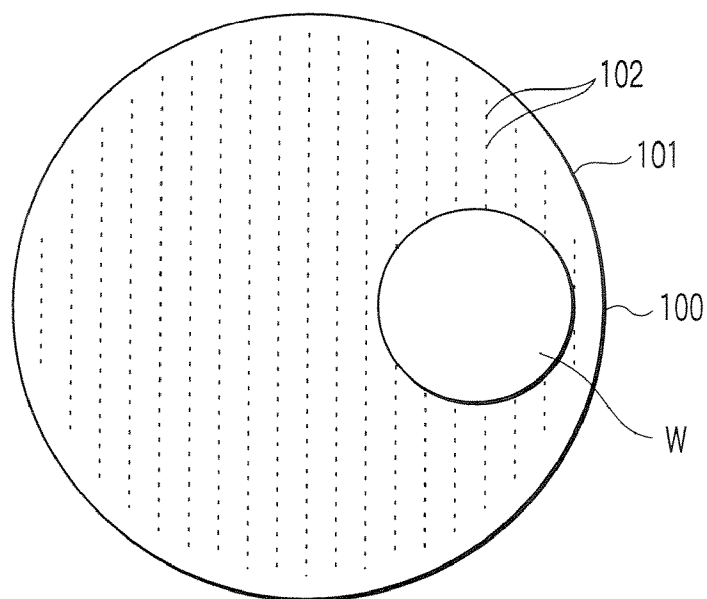


FIG. 16

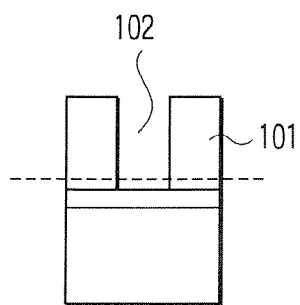


FIG. 17

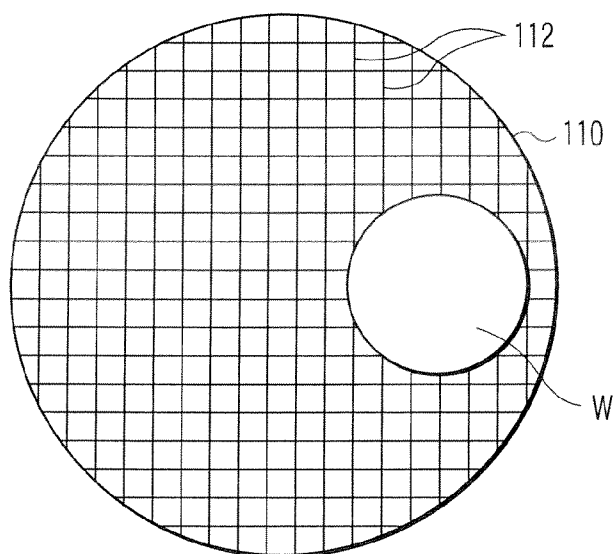


FIG. 18

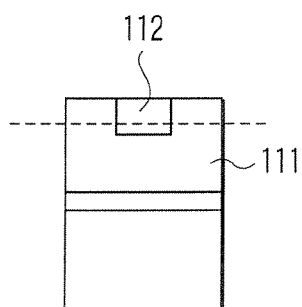


FIG. 19

POLISHING PAD AND POLISHING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from prior Japanese Patent Application No. 2005-290313, filed Oct. 3, 2005, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a polishing pad and a polishing apparatus for polishing a semiconductor wafer, which are used for a chemical and mechanical polishing work in a process of manufacturing semiconductor devices. More particularly, the invention relates to a polishing pad and a polishing apparatus which enable the polishing pad to be elongated and are capable of polishing a semiconductor wafer precisely flat.

[0004] 2. Description of the Related Art

[0005] In a process of manufacturing semiconductor devices, a chemical and mechanical polishing work is carried out when an insulating film surface of a wafer is flattened. A polishing pad is used for flattening of the insulating film surface. A polishing surface of the polishing pad for use in the chemical/mechanical polishing work is plane-shaped. A to-be-polished surface of the wafer and the polishing surface of the polishing pad are arranged in parallel to each other. To polish, the wafer surface and the polishing surface thus arranged are in contact with each other, while being both rotated. Various types of polishing apparatuses are used.

[0006] For example, in a polishing pad **100** as shown in FIGS. **16** and **17**, a number of through holes, which pass through the polishing pad, are arrayed on a polishing pad surface **101** made of foamed urethane or the like. In a polishing pad **110** as shown in FIGS. **18** and **19**, lattice like polishing grooves **112** are formed on a polishing pad surface **111**. The grooves function to feed and exhaust an abrasive liquid and to effectively eject polishing waste (refer to, for example, Jpn. Pat. Appln. KOKOKU Publication No. 62-34509 and Jpn. Pat. Appln. KOKAI Publication No. 2003-300149). In those figures, W designates a wafer. Concentric circle- and spiral-shaped polishing grooves are also known. Further, a polishing pad having a combination of polishing grooves and through holes is also known. A polishing pad having polishing grooves formed therein has a high ability to feed and exhausting the abrasive liquid. Therefore, such a pad is advantageous in that polishing amount variations in the central part and the peripheral end part of the wafer are small. The polishing pad is advantageous in that it is easy to peel the wafer from the polishing pad since air enters the wafer center through the grooves.

[0007] However, this type of polishing pad suffers from the following problems. When the foamed urethane is abraded and the polishing grooves wear away, the polishing grooves lose their function of feeding and exhausting the abrasive liquid and of ejecting the polishing waste. A depth of the polishing groove is generally about the half of a thickness of the polishing pad. If the depth of the polishing

groove reaches the back side of the polishing pad, the polishing pad is separated from the surface plate and unable to exhibit its function.

[0008] In the case of the polishing pad having the through holes, on the other hand, the polishing pad can exhibit its function just before the polishing pad wears away. In this respect, its service life is long. However, this type of polishing pad is low in its ability to feed and exhaust the abrasive liquid. Because of this, the polishing amount variations in the central part and the peripheral end part are large. Further, it is difficult to peel the wafer from the polishing pad since the polishing pad cannot feed air to the central part of the wafer. Additionally, the wafer sticks to the polishing pad during the polishing operation. The wafer is easily forced out of the wafer carrier.

BRIEF SUMMARY OF THE INVENTION

[0009] To achieve the above object, there are provided a polishing pad and a polishing apparatus.

[0010] According to one embodiment of the present invention, a polishing pad which polishes a to-be-polished object is provided, which includes a plate-like pad body having one surface serving as a polishing surface and the other surface serving as a support surface; and a plurality of hole parts which extend from the polishing surface to the support surface, said each hole part containing a plurality of elongated holes that extend in different directions on a plane of the polishing surface.

[0011] According to another embodiment of the present invention, a polishing apparatus is provided, which includes a polishing pad provided on a surface plate; a holder member arranged to face the polishing pad, the holder member holding a to-be-polished object; and a drive mechanism which polishes the to-be-polished object by relatively and frictionally moving the polishing pad and the to-be-polished object held by the holder member, wherein the polishing pad comprises: a plate-like pad body having one surface serving as a polishing surface and the other surface serving as a support surface attached to the surface plate; and a plurality of hole parts which extend from the polishing surface to the support surface, said each hole part containing a plurality of elongated holes that extend in different directions on a plane of the polishing surface.

[0012] According to another embodiment of the present invention, a method of polishing a to-be-polishing surface of a to-be-polished object, which includes holding a plate-like polishing pad provided on a surface plate, the polishing pad having one surface serving as a polishing surface and the other surface serving as a support surface attached to the surface plate, and the pad body including a plurality of hole parts which extend from the polishing surface to the support surface, said each hole part containing a plurality of elongated holes that extend in different directions on a plane of the polishing surface; holding a to-be-polished object by a holder member such that the to-be-polished object is arranged to face the polishing pad; and moving the polishing pad relative to the to-be-polished object in a friction manner.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0013] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate

embodiments of the invention, and together with the general description given above and the detailed description of the embodiments given below, serve to explain the principles of the invention.

[0014] FIG. 1 is a side view showing a polishing apparatus having a polishing pad assembled thereto, which is an embodiment of the present invention;

[0015] FIG. 2 is a plan view showing the polishing pad assembled into the polishing apparatus;

[0016] FIG. 3 is a plan view showing a first modification of the polishing pad;

[0017] FIG. 4 is a plan view showing a second modification of the polishing pad;

[0018] FIG. 5 is a plan view showing a third modification of the polishing pad;

[0019] FIG. 6 is a plan view showing a fourth modification of the polishing pad;

[0020] FIG. 7 is a plan view showing a fifth modification of the polishing pad;

[0021] FIG. 8 is a plan view showing a sixth modification of the polishing pad;

[0022] FIG. 9 is a plan view showing a seventh modification of the polishing pad;

[0023] FIG. 10 is a plan view showing an eighth modification of the polishing pad;

[0024] FIG. 11 is a plan view showing a ninth modification of the polishing pad;

[0025] FIG. 12 is a plan view showing a tenth modification of the polishing pad;

[0026] FIG. 13 is a plan view showing an eleventh modification of the polishing pad;

[0027] FIG. 14 is a plan view showing a twelfth modification of the polishing pad;

[0028] FIG. 15 is an explanatory view showing an operation range in the polishing apparatus;

[0029] FIG. 16 is a plan view showing a polishing pad with through holes formed therein and a semiconductor wafer;

[0030] FIG. 17 is a cross sectional view showing a main portion of the polishing pad;

[0031] FIG. 18 is a plan view showing a polishing pad with polishing grooves formed therein and a semiconductor wafer; and

[0032] FIG. 19 is a cross sectional view showing a main portion of the polishing pad.

DETAILED DESCRIPTION OF THE INVENTION

[0033] FIG. 1 is a side view showing a polishing apparatus 10, which is a first embodiment of the present invention. FIG. 2 is a plan view showing a polishing pad 20 assembled into the polishing apparatus 10.

[0034] The polishing apparatus 10 is comprised of a rotation drive mechanism 11, a surface plate 12 mounted to

the rotation drive mechanism 11, a holder mechanism 13 arranged facing the surface plate 12, a moving mechanism 14 for driving the holder mechanism 13 and moving it along the upper surface of the surface plate 12, and a nozzle 15 for feeding an abrasive liquid onto the surface plate 12.

[0035] A polishing pad 20 is detachably attached to the upper surface of the surface plate 12, and a semiconductor wafer W as a to-be-polished object is attached to the holder mechanism 13.

[0036] The polishing pad 20 is provided with a pad body 21 made of resin such as foamed polyurethane or urethane. The pad body 21 is attached to the surface plate 12 in a state that one surface of the pad body 21 is faced upward as a polishing surface 22, while the other surface serves as a support surface 23.

[0037] Hole parts 30 extend from the support surface 23 to the polishing surface 22, i.e., in the thickness direction of the pad body 21. The hole parts 30 may be formed by, for example, a punching work. The hole parts 30 each take a cross-shape consisting of four elongated holes 31 radially arranged as from the polishing surface 22 side, as shown in FIG. 2. More specifically, a plurality of elongated holes 31, which extend in different directions on a plane (surface) of the polishing surface 22, are combined to form each hole part 30.

[0038] An outer configuration of each hole part 30 has a size ranging from 5 mm to 300 mm, for example. A width of each elongated hole 31 ranges from 1 mm to 8 mm, for example. A distance between the adjacent hole parts 30 is not larger than two times of the outer configuration of the hole part 30.

[0039] It is noted that in the polishing pad 20 thus constructed, the combination of the plurality of elongated holes forms the hole part 30. This feature lowers the sealingness between the to-be-polished surface of the semiconductor wafer W and the surface of the polishing pad 1, and hence, hardly creates negative pressure. Consequently, after the polishing work finishes, it is easy to remove the to-be-polished object from the surface of the polishing pad 1.

[0040] The hole parts 30 are formed so as to pass through the pad body 21 in the thickness direction. For this reason, a time period taken until the pad body 21 wears and the hole parts 30 wear away is long. As a result, the pad life is elongated, and a frequency of replacing the polishing pad 20 with a new one is reduced. Further, the amount of the abrasive liquid flowing through the hole parts 30 is increased, so that the polishing is stable, and the flatness uniformity of the surface is enhanced.

[0041] Unlike the polishing pad having the polishing grooves formed therein, the abrasive liquid never flows through the polishing grooves out of the polishing pad. The hole parts 30 keep the abrasive liquid therein to thereby reduce the amount of the abrasive liquid used.

[0042] The hole parts 30 are through holes. Accordingly, the hole parts may be formed by a punching work, and hence, the manufacturing cost is lower than that of the polishing pad having the polishing grooves.

[0043] As described above, the polishing apparatus 10 using the polishing pad 20 according to the present embodiment increases the service life of the polishing pad 20,

enhances the uniformity of the polishing amount over the surface of the semiconductor wafer, and prevents the wafer from sticking to the polishing pad.

[0044] While the polishing pad 20 uses a single layer pad body of foamed urethane, it may have a multi-layered structure in which a layer formed with soft unwoven fabric and a foamed urethane layer (closer to the surface plate 12) layered on the former. In the case of the multi-layered structure, the hole parts 30 are formed only in the foamed urethane layer.

[0045] FIG. 3 is a plan view showing a polishing pad 20A according to a first modification of the polishing pad 20. In the modification, hole parts 40 are provided in place of the hole parts 30. The hole parts 40 each include three elongated holes 41. This modification also produces useful effects, which are comparable with those of the polishing pad 20.

[0046] FIG. 4 is a plan view showing a polishing pad 20B according to a second modification of the polishing pad 20. In the modification, hole parts 50 are provided in place of the hole parts 30. The hole parts 50 each include five elongated holes 41. This modification also produces useful effects, which are comparable with those of the polishing pad 20.

[0047] FIG. 5 is a plan view showing a polishing pad 20C according to a third modification of the polishing pad 20. In the modification, hole parts 60 are provided in place of the hole parts 30. The hole parts 60 each include six elongated holes 61. The modification also produces useful effects, which are comparable with those of the polishing pad 20.

[0048] FIG. 6 is a plan view showing a polishing pad 20D according to a fourth modification of the polishing pad 20. In the modification, an array of hole parts 30 are different from that of those of the polishing pad 20 within such a range that the pad body 21 is not separated. As shown, the adjacent hole parts 30 are coupled with one another within a spatial range within which the pad body 21 is not separated from the surface plate. The modification also produces useful effects, which are comparable with those of the polishing pad 20.

[0049] FIG. 7 is a plan view showing a polishing pad 20E according to a fifth modification of the polishing pad 20. In the modification, a communication hole 32 interconnects the adjacent hole parts 30. With provision of the communication holes 32, the abrasive liquid is movable among the hole parts 30 to thereby spread to the whole polishing pad 20E. This modification also produces useful effects, which are comparable with those of the polishing pad 20.

[0050] FIG. 8 is a plan view showing a polishing pad 20F according to a sixth modification of the polishing pad 20. In the modification, an array of hole parts 30 is different from that of the hole parts of the polishing pad 20. That is, elongated holes 31, which are located closest to each other, are not aligned with each other. The modification also produces useful effects, which are comparable with those of the polishing pad 20.

[0051] FIG. 9 is a plan view showing a polishing pad 20G according to a seventh modification of the polishing pad 20. In the modification, an array of hole parts 30 is different from that of the hole parts of the polishing pad 20. The hole parts 30 are concentrically arrayed on the pad body 21. The

modification also produces useful effects, which are comparable with those of the polishing pad 20.

[0052] FIG. 10 is a plan view showing a polishing pad 20H according to an eighth modification of the polishing pad 20. In the modification, an array of hole parts 30 is different from that of the hole parts of the polishing pad 20. That is, hole parts 30 are randomly arrayed. The modification also produces useful effects, which are comparable with those of the polishing pad 20.

[0053] FIG. 10 is a plan view showing a polishing pad 20I according to a ninth modification of the polishing pad 20. In the embodiment, hole parts 30 and small hole parts 33, which are smaller than the former, but similar to the former, are formed in the polishing pad. The smaller hole parts 33 each include four elongated holes 34. The hole parts 30 and the smaller hole parts 33 are alternately arrayed. This modification also produces useful effects, which are comparable with those of the polishing pad 20.

[0054] FIG. 12 is a plan view showing a polishing pad 20J according to a tenth modification of the polishing pad 20. In the embodiment, hole parts 30 and hole parts 70, which are different in shape from the hole parts 30, are formed in the polishing pad. The hole parts 70 each include four arcuate elongated holes 71. The hole parts 30 and the hole parts 70 are alternately arrayed. The modification also produces useful effects, which are comparable with those of the polishing pad 20.

[0055] FIG. 13 is a plan view showing a polishing pad 20K according to an eleventh modification of the polishing pad 20. In the modification, hole parts 80 are provided in place of the hole parts 30. The hole parts 80 each include two elongated holes 81, which are radial but unequal. The modification also produces useful effects, which are comparable with those of the polishing pad 20.

[0056] FIG. 14 is a plan view showing a polishing pad 20L according to a twelfth modification of the polishing pad 20. In the modification, hole parts 90 are provided in place of the hole parts 30. The hole parts 90 also include four arcuate elongated holes 91. The modification also produces useful effects, which are comparable with those of the polishing pad 20.

[0057] FIG. 15 is an explanatory view showing a polishing pad 20M according to a twelfth modification of the polishing pad 20 and an operation range in the polishing apparatus 10. In the modification, hole parts 30 are provided as in the polishing pad 20. The modification also produces useful effects as in the already described pads even when the hole parts 30 contain a hole part 30 with a chipped part 35, which is located on the peripheral part of the pad body 21.

[0058] In this case, the moving range of the wafer W is restricted as indicated by a two-dot chain line Q. This is because, if the wafer W moves out of the area enclosed by the two-dot chain line Q, it rubs the chipped part 50 to possibly be scratched. This modification also produces useful effects, which are comparable with those of the polishing pad 20.

[0059] It should be understood that the present invention is not limited to the embodiments described above, but the invention may be modified, altered and changed within the true spirits and the scope of the invention. It is evident that

a plurality of components described in the embodiments may be appropriately combined. If required, some components may be removed from all the components described in the embodiments. Further, the components used in the different embodiments may also be combined.

[0060] Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

What is claimed is:

1. A polishing pad which polishes a to-be-polished object, comprising:

a plate-like pad body having one surface serving as a polishing surface and the other surface serving as a support surface; and

a plurality of hole parts configure to extend from the polishing surface to the support surface, said each hole part containing a plurality of elongated holes that extend in different directions on a plane of the polishing surface.

2. The polishing pad according to claim 1, wherein the elongated holes of said each hole part radially extend from a predetermined position.

3. The polishing pad according to claim 2, wherein the elongated hole is plural in number.

4. The polishing pad according to claim 2, wherein the elongated hole takes a cross-shape.

5. The polishing pad according to claim 2, wherein a shape of the elongated hole includes a linear shape.

6. The polishing pad according to claim 2, wherein a shape of the elongated hole includes a curve shape.

7. The polishing pad according to claim 1, wherein the hole parts are arrayed at equal intervals.

8. The polishing pad according to claim 1, wherein the support surface of the pad body is provided with a communicating hole which communicates the adjacent hole parts with each other.

9. A polishing apparatus comprising:

a plate-like polishing pad provided on a surface plate, the polishing pad having one surface serving as a polishing surface and the other surface serving as a support surface attached to the surface plate, and the pad body including a plurality of hole parts configure to extend from the polishing surface to the support surface, said each hole part containing a plurality of elongated holes that extend in different directions on a plane of the polishing surface;

a holder member arranged to face the polishing pad, the holder member holding a to-be-polished object; and

a drive mechanism configure to polish the to-be-polished object by relatively and frictionally moving the polishing pad and the to-be-polished object held by the holder member.

10. The polishing apparatus according to claim 9, wherein the drive mechanism relatively moves the to-be-polished object and the holder member in a friction manner such that they are separated from a part on the peripheral part of the polishing surface where some of the hole parts are exposed.

11. The polishing apparatus according to claim 9, wherein the elongated holes of said each hole part radially extend from a predetermined position.

12. The polishing apparatus according to claim 9, wherein the support surface of the pad body is provided with a communicating means which communicates the adjacent hole parts with each other.

13. A method of polishing a to-be-polishing surface of a to-be-polished object, comprising:

holding a plate-like polishing pad provided on a surface plate, the polishing pad having one surface serving as a polishing surface and the other surface serving as a support surface attached to the surface plate, and the pad body including a plurality of hole parts which extend from the polishing surface to the support surface, said each hole part containing a plurality of elongated holes that extend in different directions on a plane of the polishing surface;

holding a to-be-polished object by a holder member such that the to-be-polished object is arranged to face the polishing pad; and

moving the polishing pad relative to the to-be-polished object in a friction manner.

14. The polishing method according to claim 13, wherein the to-be-polished object and the holder member are relatively moved in a friction manner such that, while being separated from a part on the peripheral part of the polishing surface where some of the hole parts are exposed.

15. The polishing method according to claim 13, wherein the elongated holes of said each hole part radially extend from a predetermined position.

16. The polishing method according to claim 13, wherein the support surface of the pad body is provided with a communicating hole which communicates the adjacent hole parts with each other.

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