US 20090042494A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2009/0042494 A1

(43) Pub. Date: Feb. 12, 2009

Moon et al.

(54) **PAD CONDITIONER OF SEMICONDUCTOR WAFER POLISHING APPARATUS AND MANUFACTURING METHOD THEREOF**

(75) Inventors: **Sung-Taek Moon**, Gyeonggi-do (KR); **Kyoung-Moon Kang**, Gyeonggi-do (KR); **Bong-Su Ahn**, Seoul (KR); **Nam-Soo Kim**, Gyeonggi-do (KR); **Gi-Sik Hong**, Gyeonggi-do (KR)

Correspondence Address:
MYERS BIGEL SIBLEY & SAJOVEC
PO BOX 37428
RALEIGH, NC 27627 (US)

(73) Assignee: **Samsung Electronics Co., Ltd.**

(21) Appl. No.: **12/187,007**

(22) Filed: **Aug. 6, 2008**

(30) **Foreign Application Priority Data**

Aug. 6, 2007 (KR) 10-2007-0078560

Publication Classification

(51) **Int. Cl.**

B24B 53/02	(2006.01)
B24D 18/00	(2006.01)
C25D 9/04	(2006.01)
B24B 53/00	(2006.01)

(52) **U.S. Cl.** **451/443**; 51/307; 205/110

(57) **ABSTRACT**

A pad conditioner of semiconductor wafer polishing apparatus and a pad conditioner manufacturing method thereof are provided with a uniform conditioning for a polishing pad of a polishing apparatus, the polishing apparatus being for evenly planarizing a metal layer formed on the surface of wafer in a semiconductor device manufacturing processor. The pad conditioner may include a substrate constructed of a flat plate of disk shape, a coating part formed with a given thickness on the substrate, and a plurality of protrusion parts formed on the coating part, the plurality of protrusion parts having a plurality of polishing members based on the same size in a predetermined grouping or pattern.

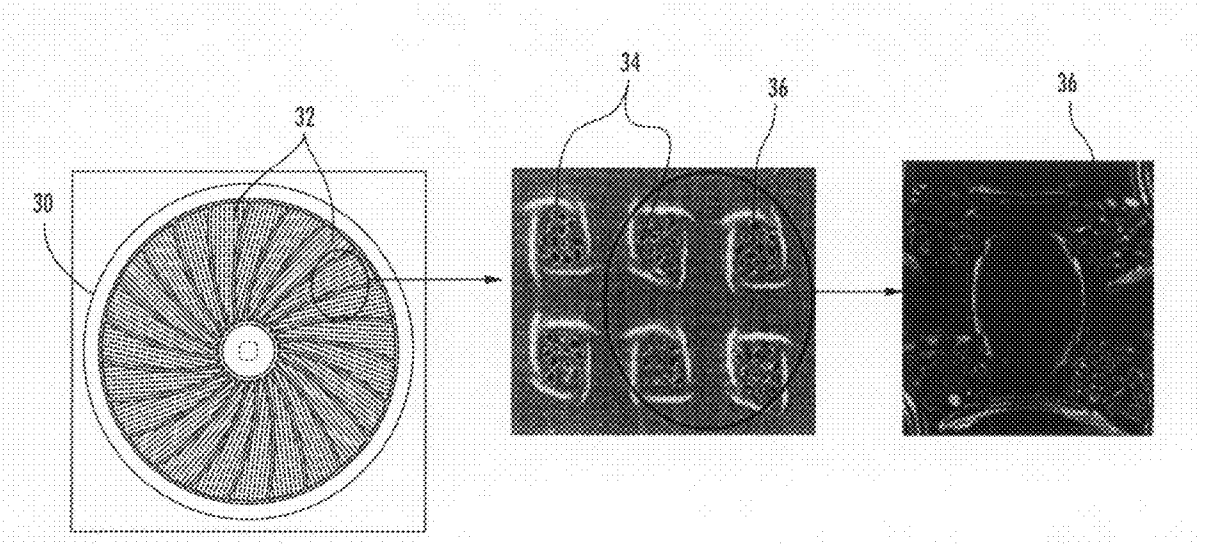


FIG. 1 (CONVENTIONAL ART)

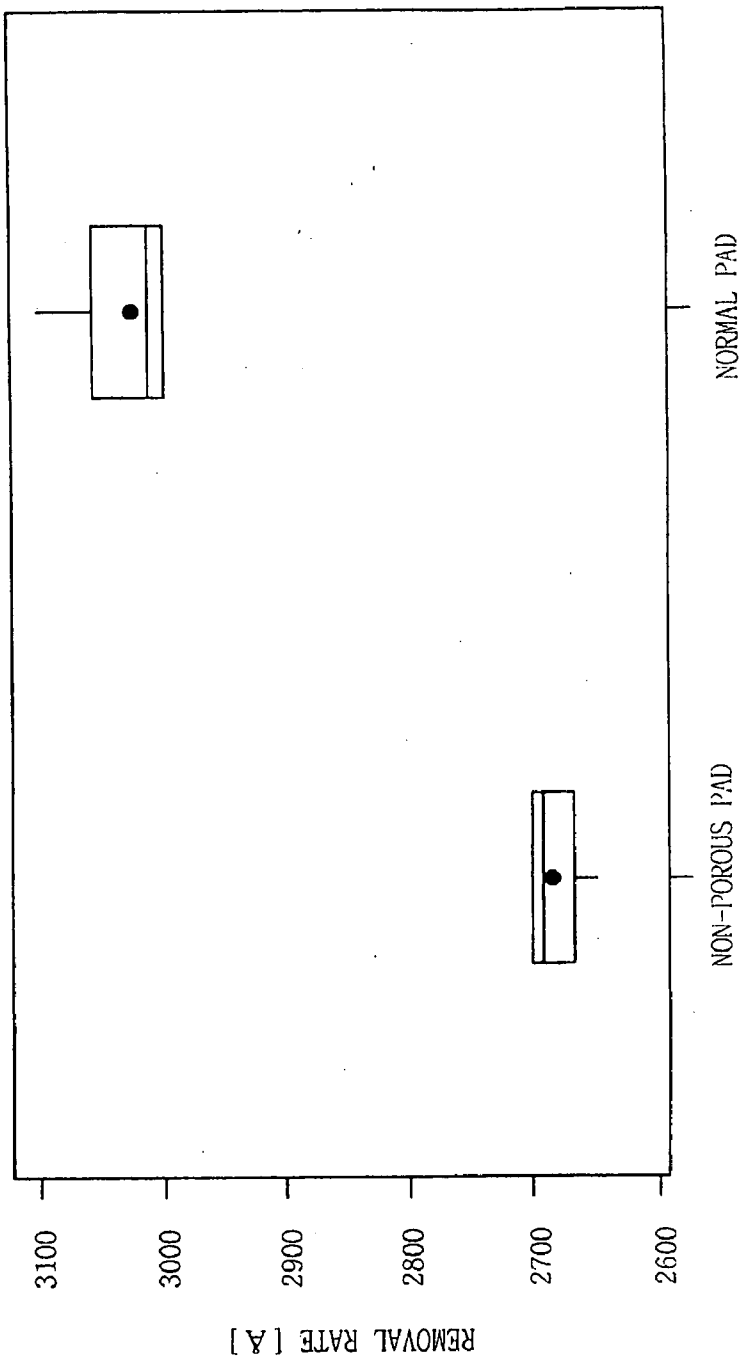


FIG. 2(CONVENTIONAL ART)

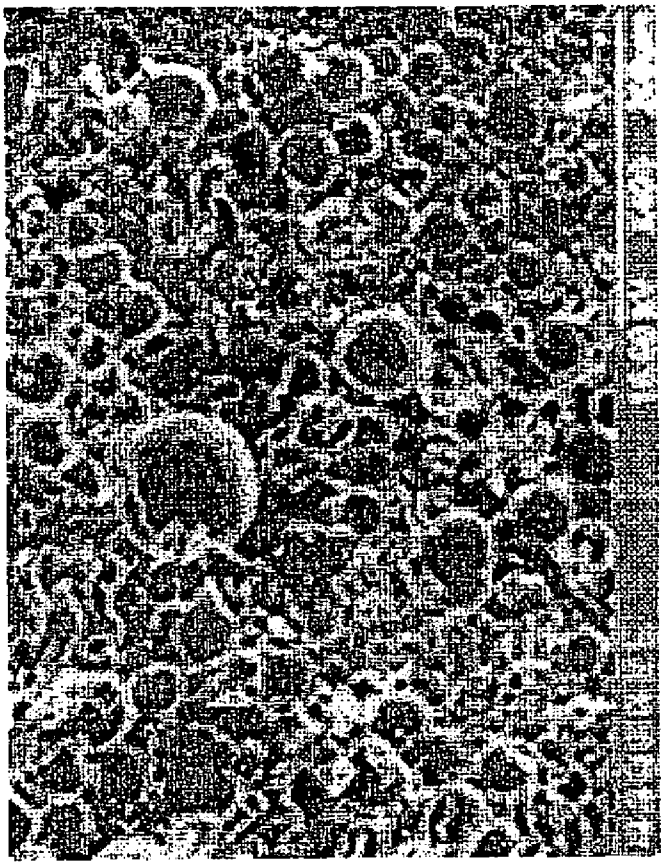


FIG. 3(CONVENTIONAL ART)



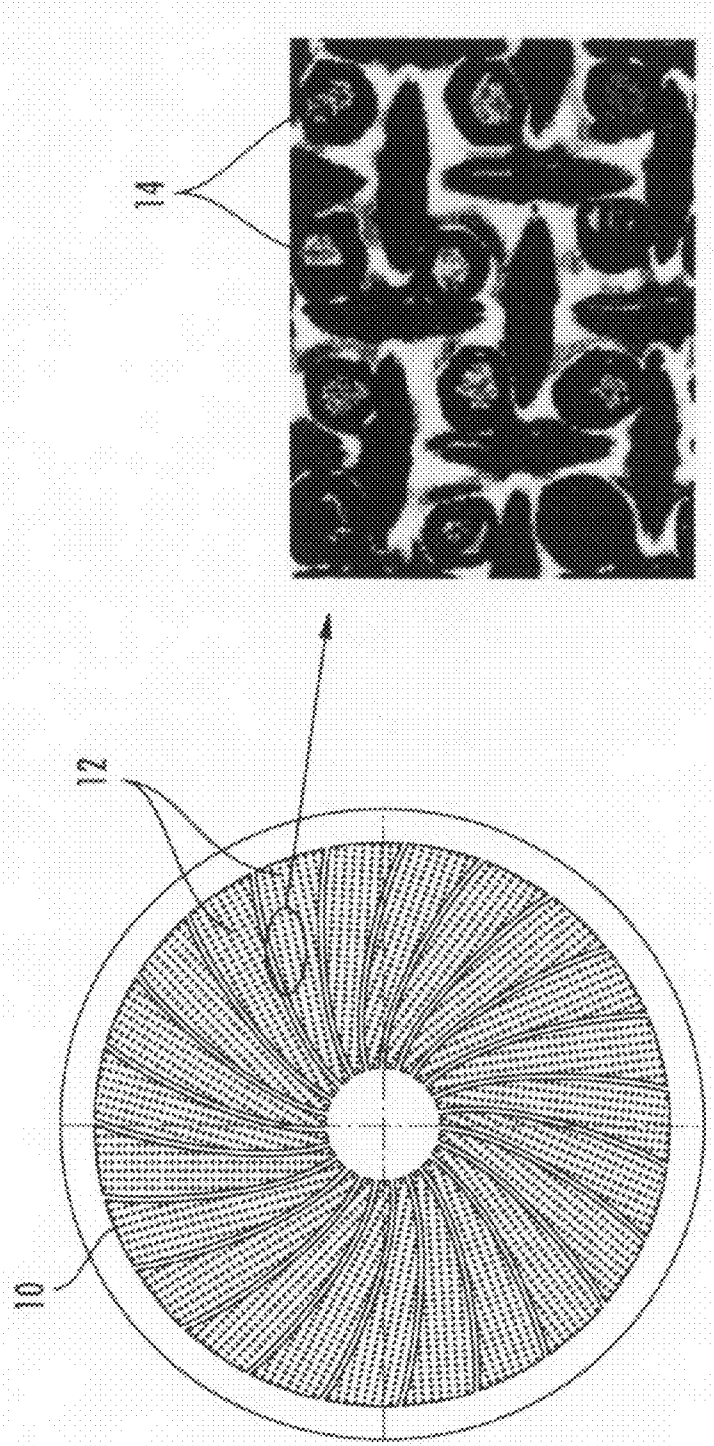
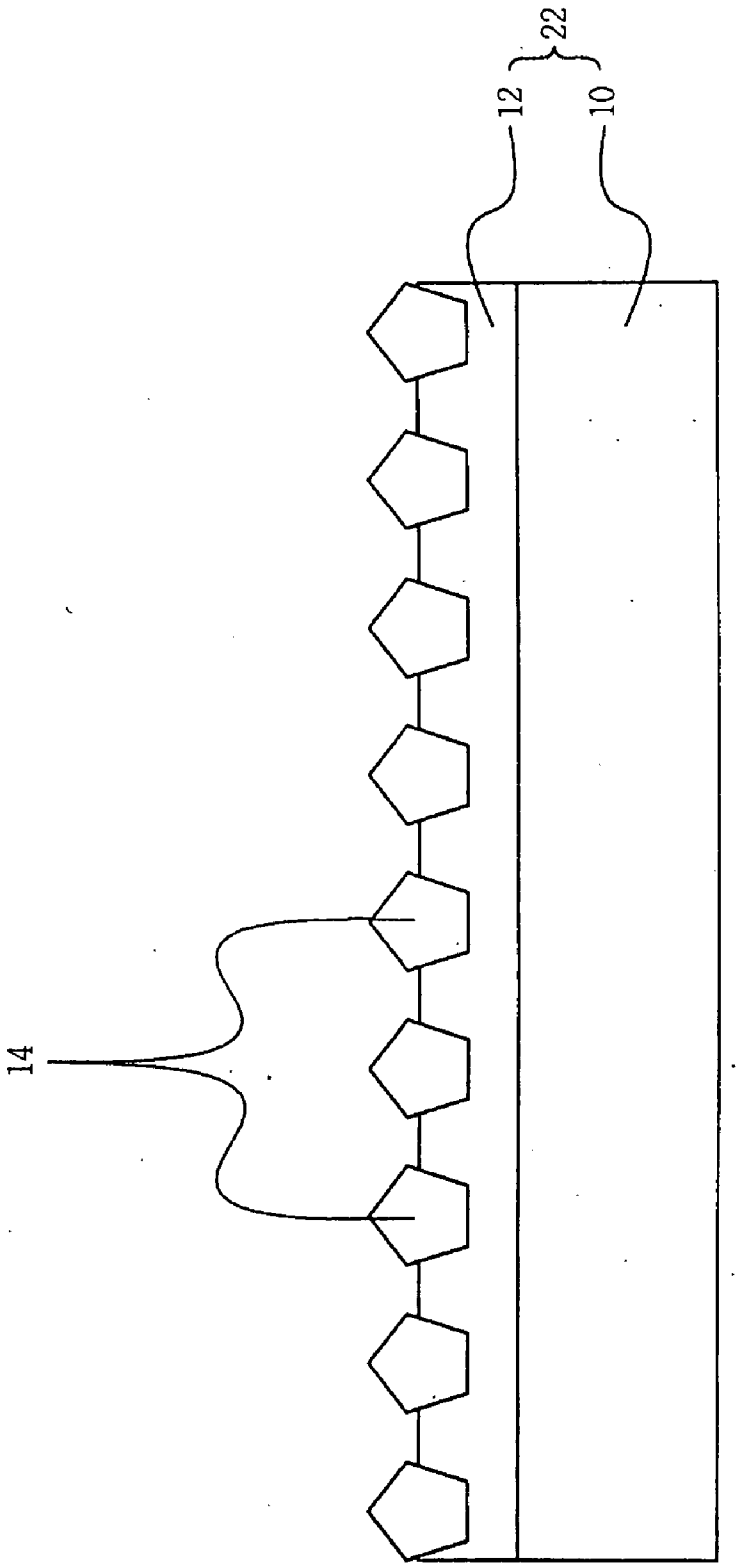


FIG. 4
CONVENTIONAL ART

FIG. 5 (CONVENTIONAL ART)



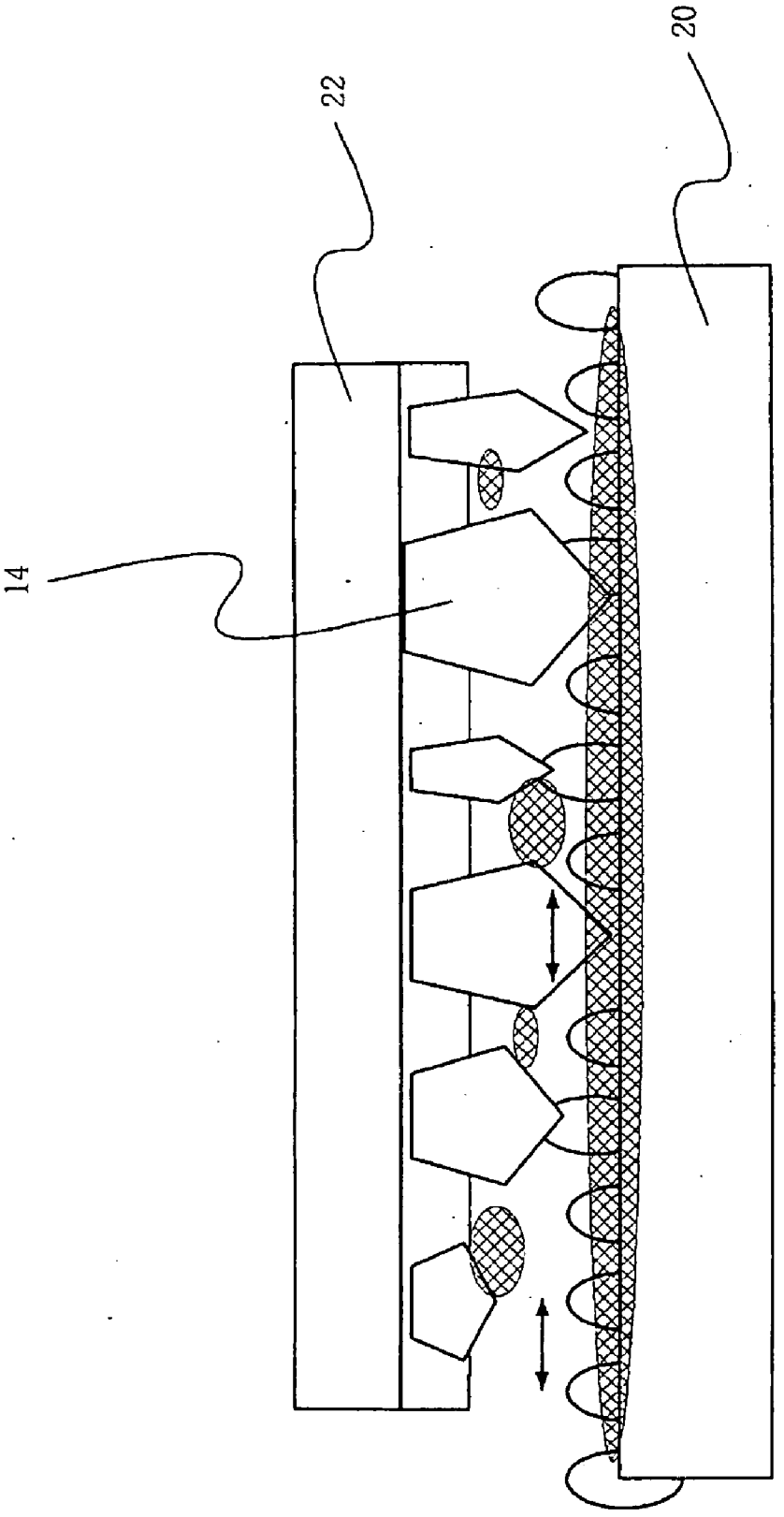


FIG. 6 (CONVENTIONAL ART)

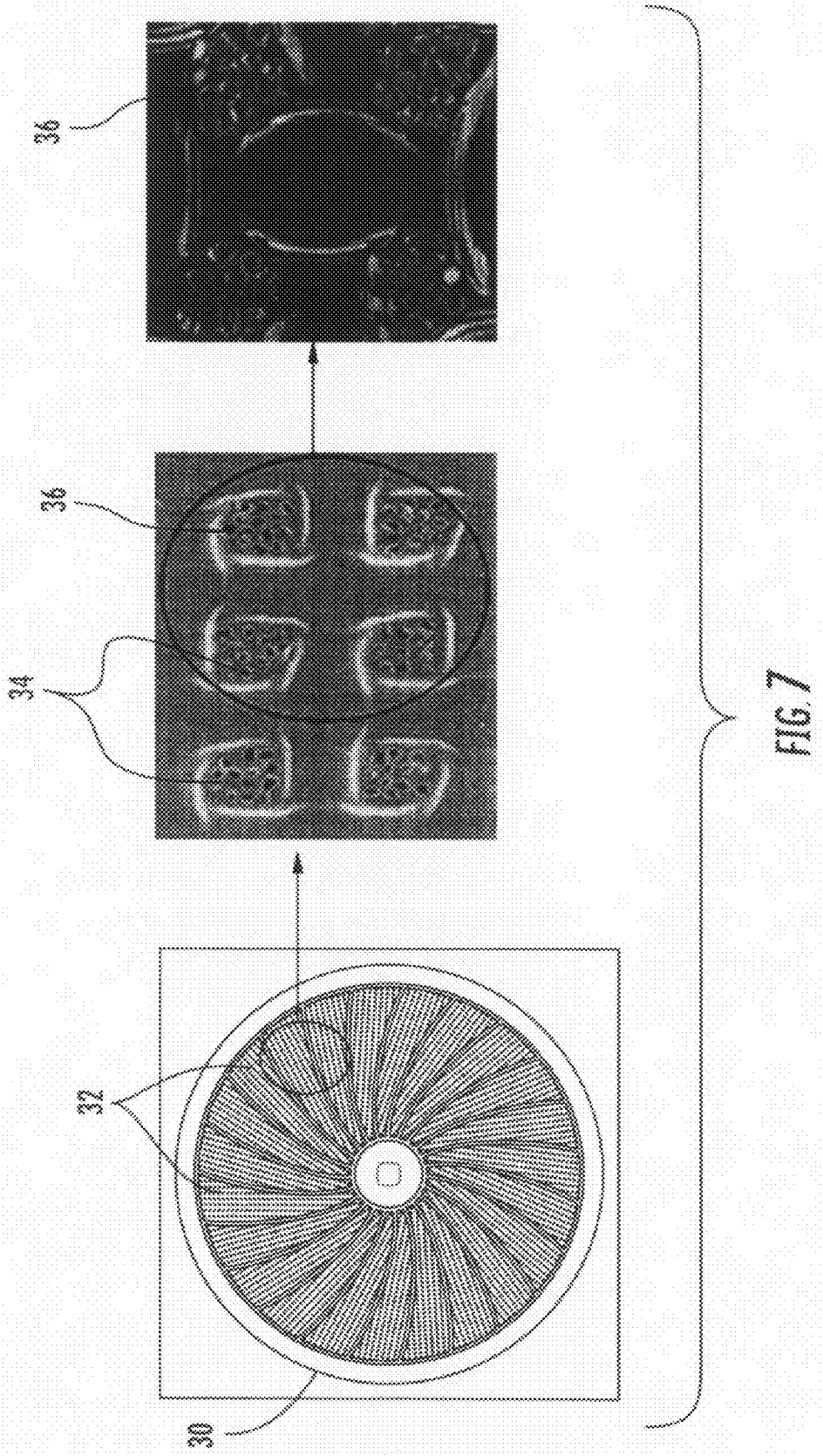


FIG. 7

FIG. 8

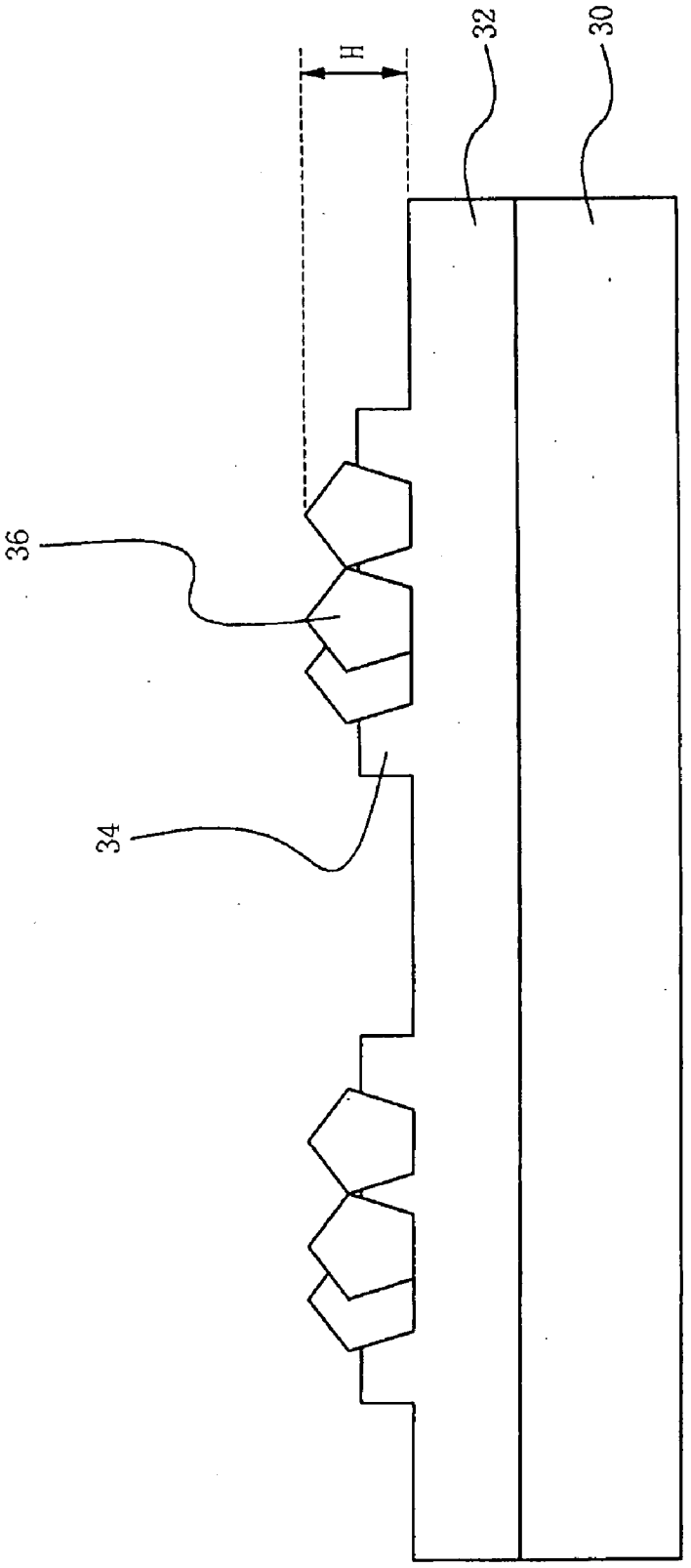
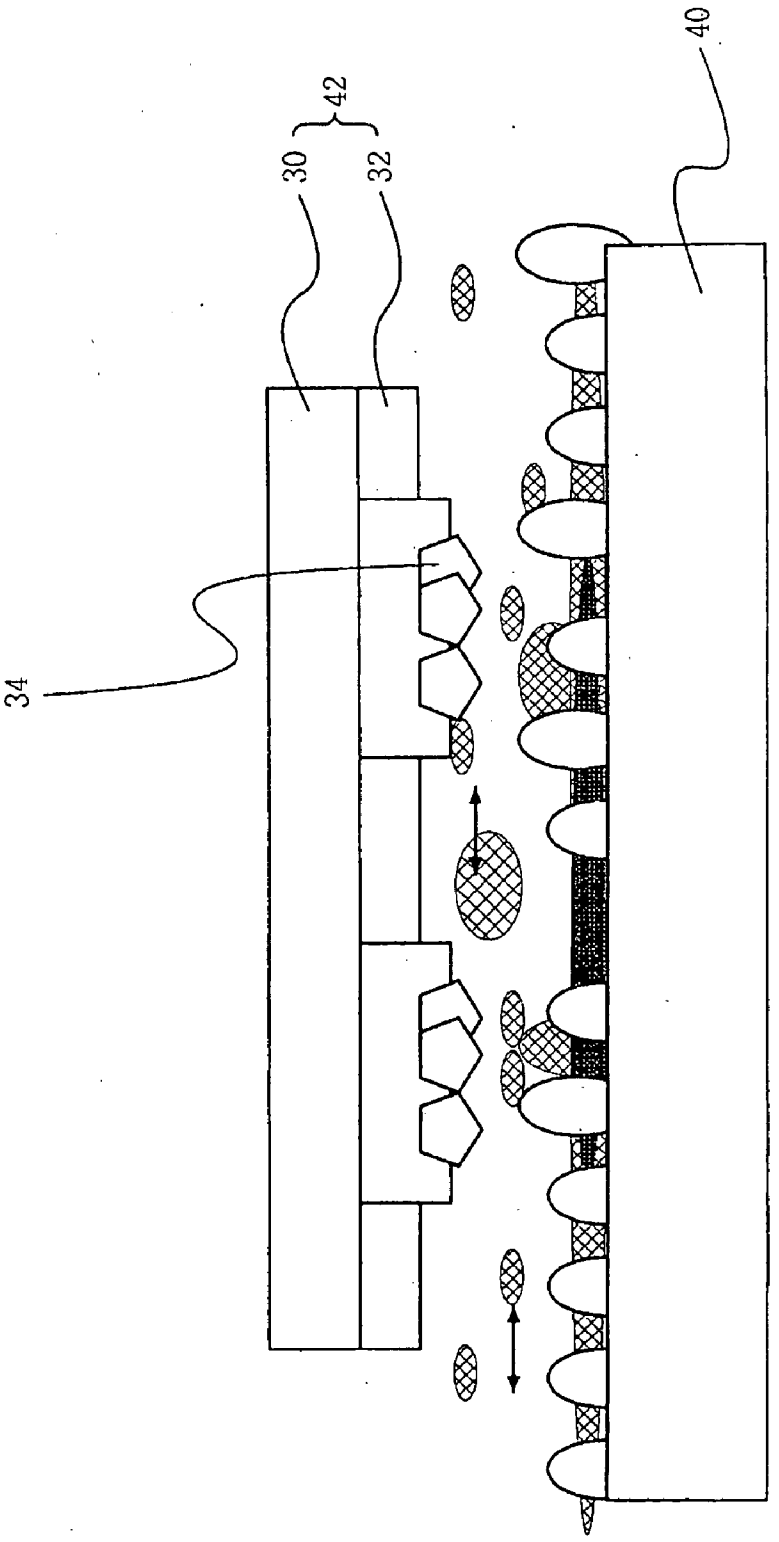


FIG. 9



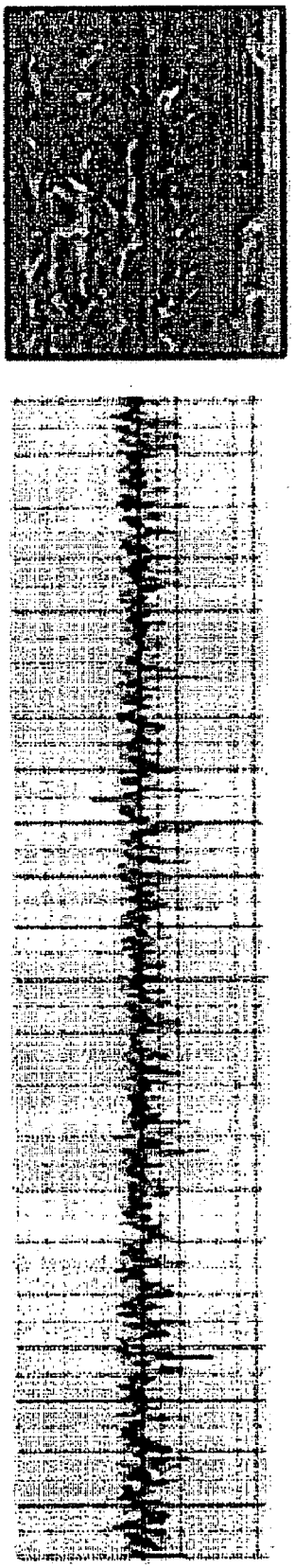


FIG. 10A

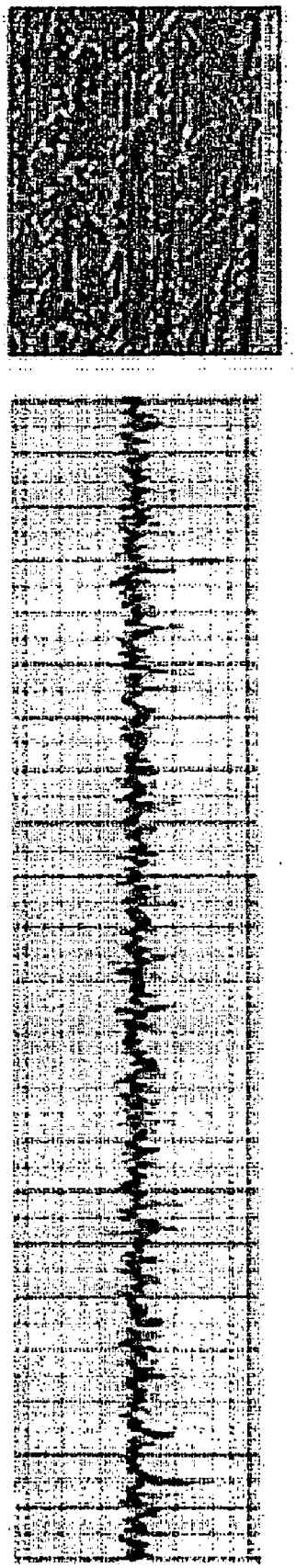


FIG. 10B

FIG. 11A

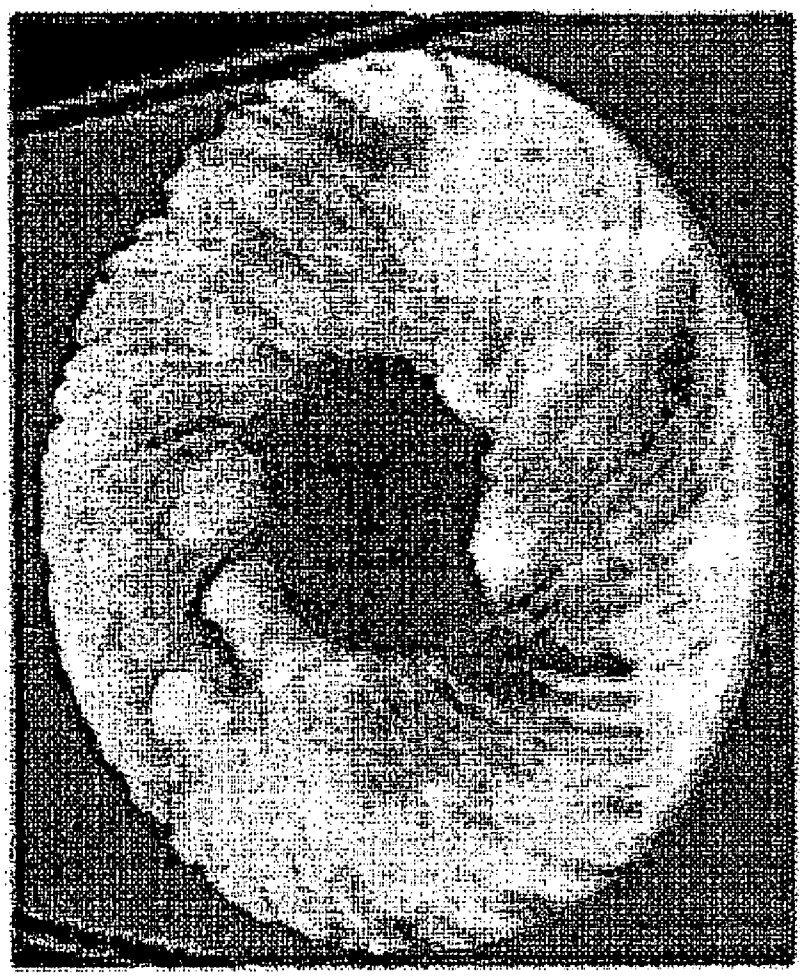


FIG. 11B

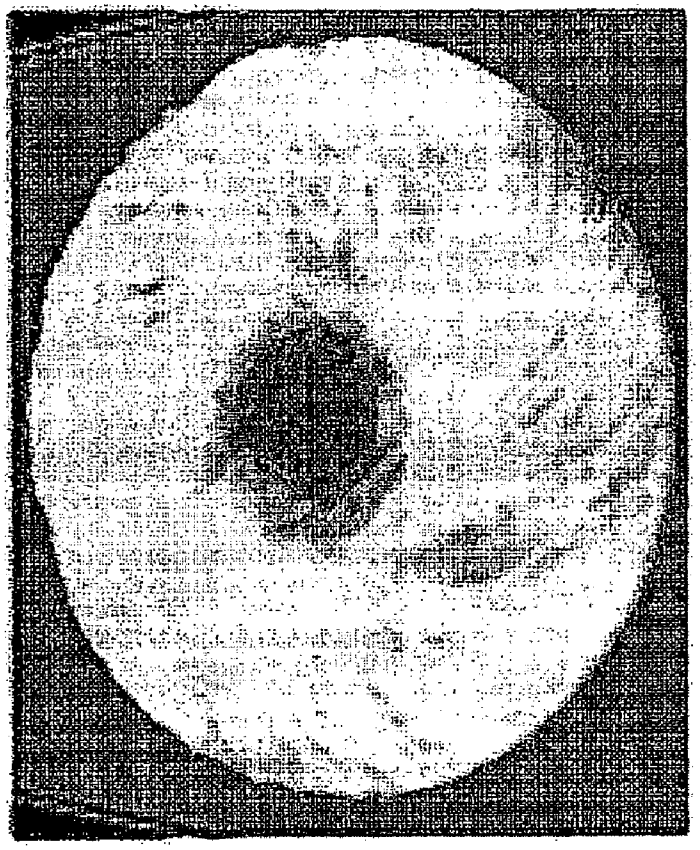


FIG. 12

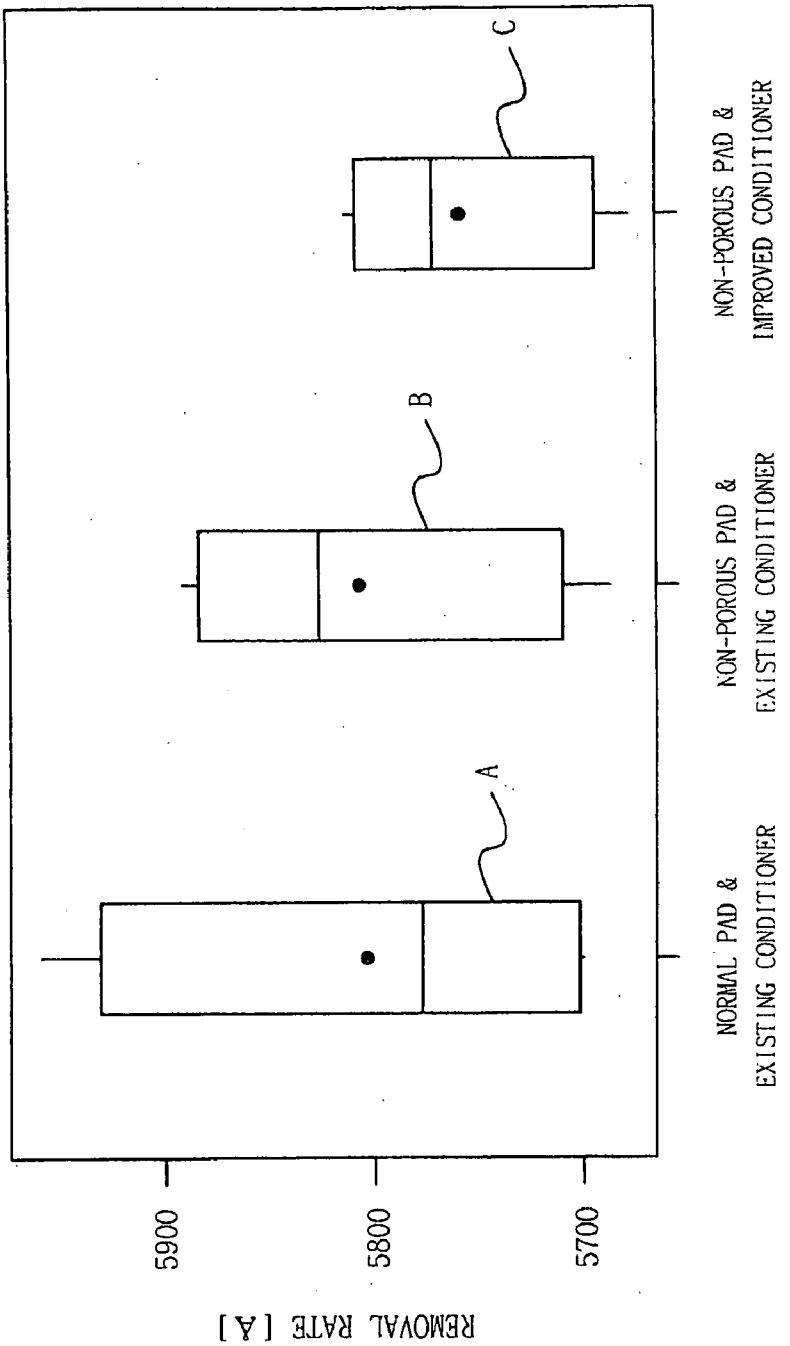

REMOVAL RATE [Å]
5900
5800
5700
A
B
C
NORMAL PAD & EXISTING CONDITIONER
NON-POROUS PAD & EXISTING CONDITIONER
NON-POROUS PAD & IMPROVED CONDITIONER

FIG. 13

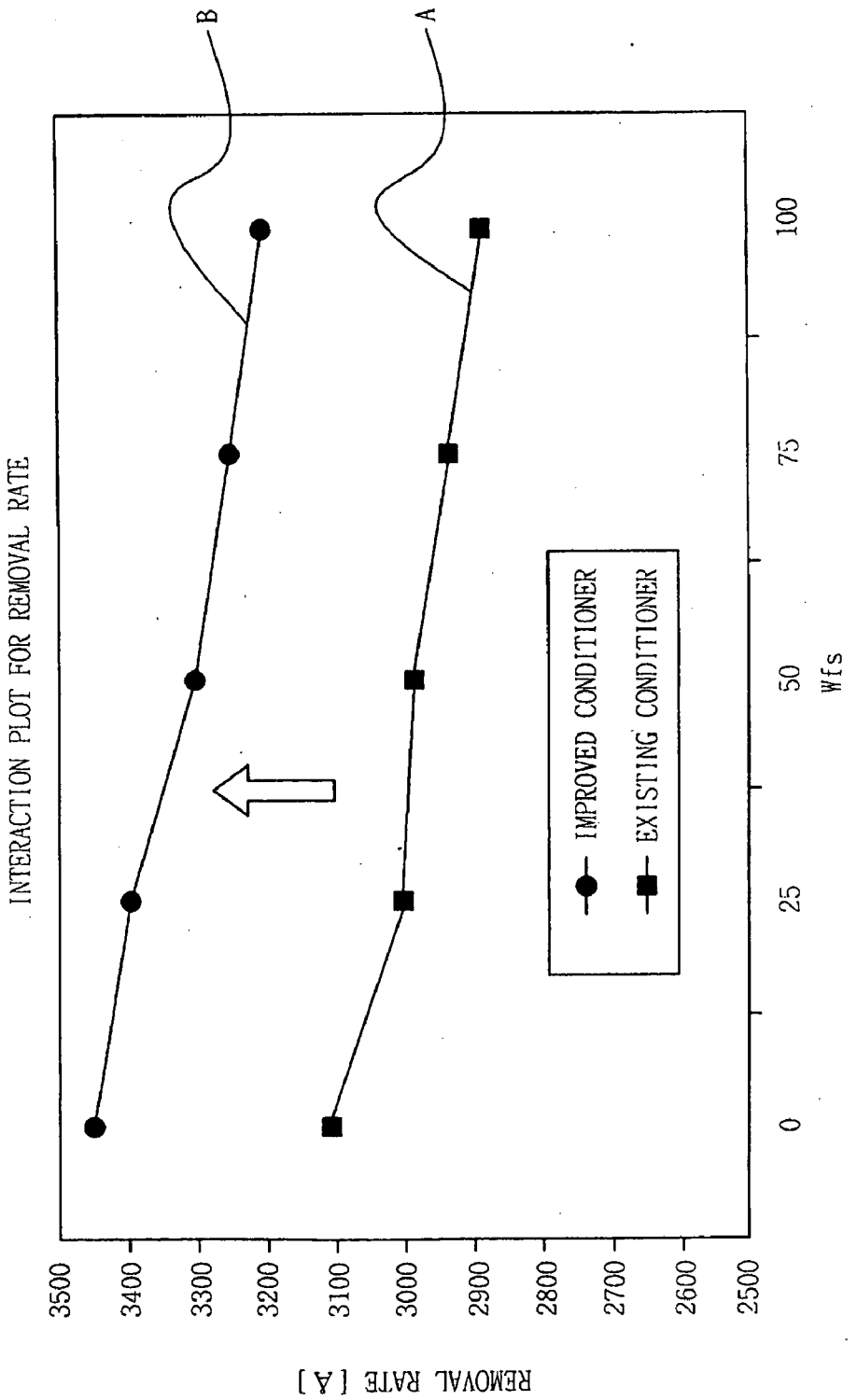

INTERACTION PLOT FOR REMOVAL RATE
B
A
IMPROVED CONDITIONER
EXISTING CONDITIONER
REMOVAL RATE [Å]
3500
3400
3300
3200
3100
3000
2900
2800
2700
2600
2500
0
25
50
75
100
Wfs

FIG. 14

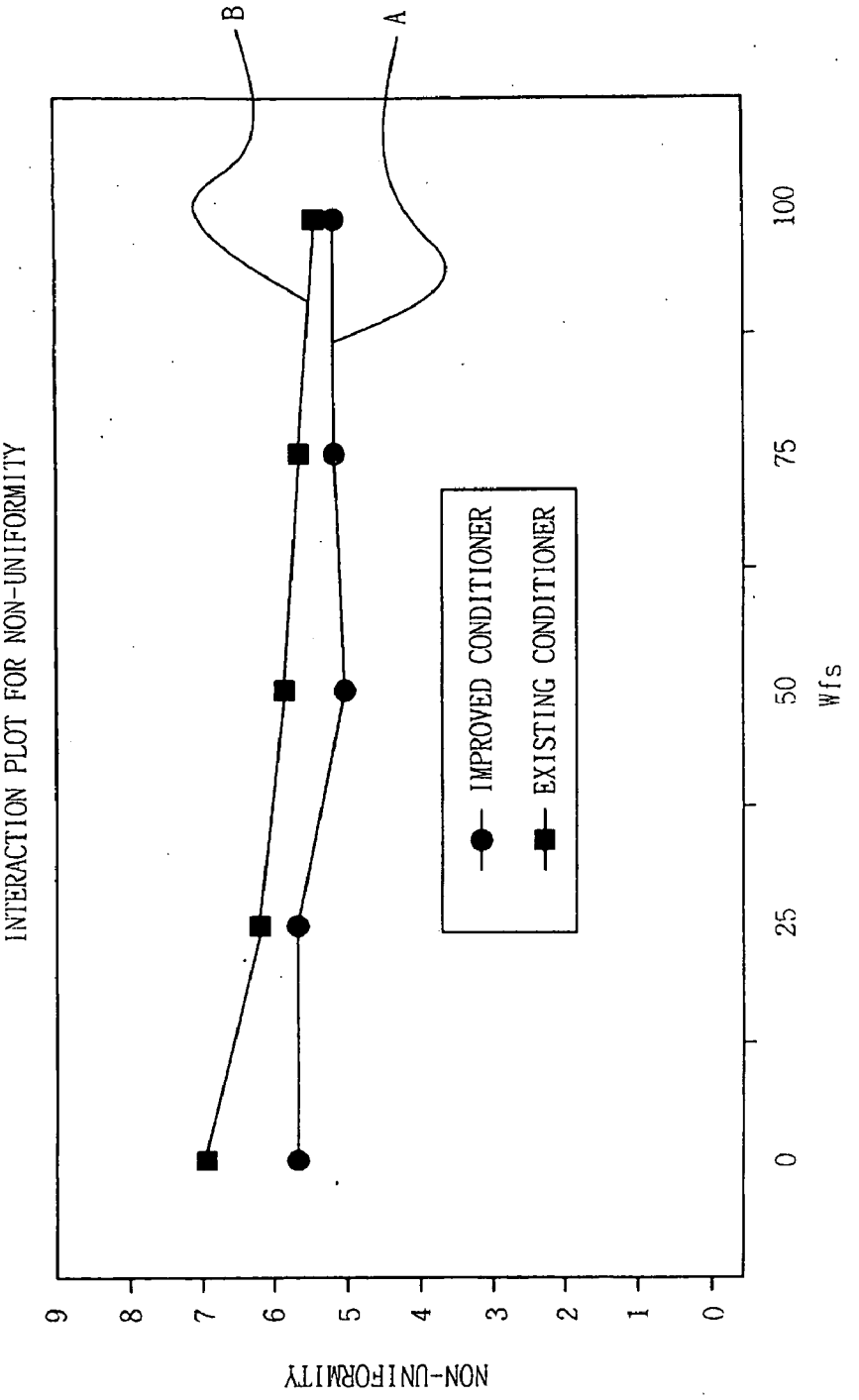

INTERACTION PLOT FOR NON-UNIFORMITY
NON-UNIFORMITY
Wfs
IMPROVED CONDITIONER
EXISTING CONDITIONER
A
B
0
1
2
3
4
5
6
7
8
9
0
25
50
75
100

FIG. 15

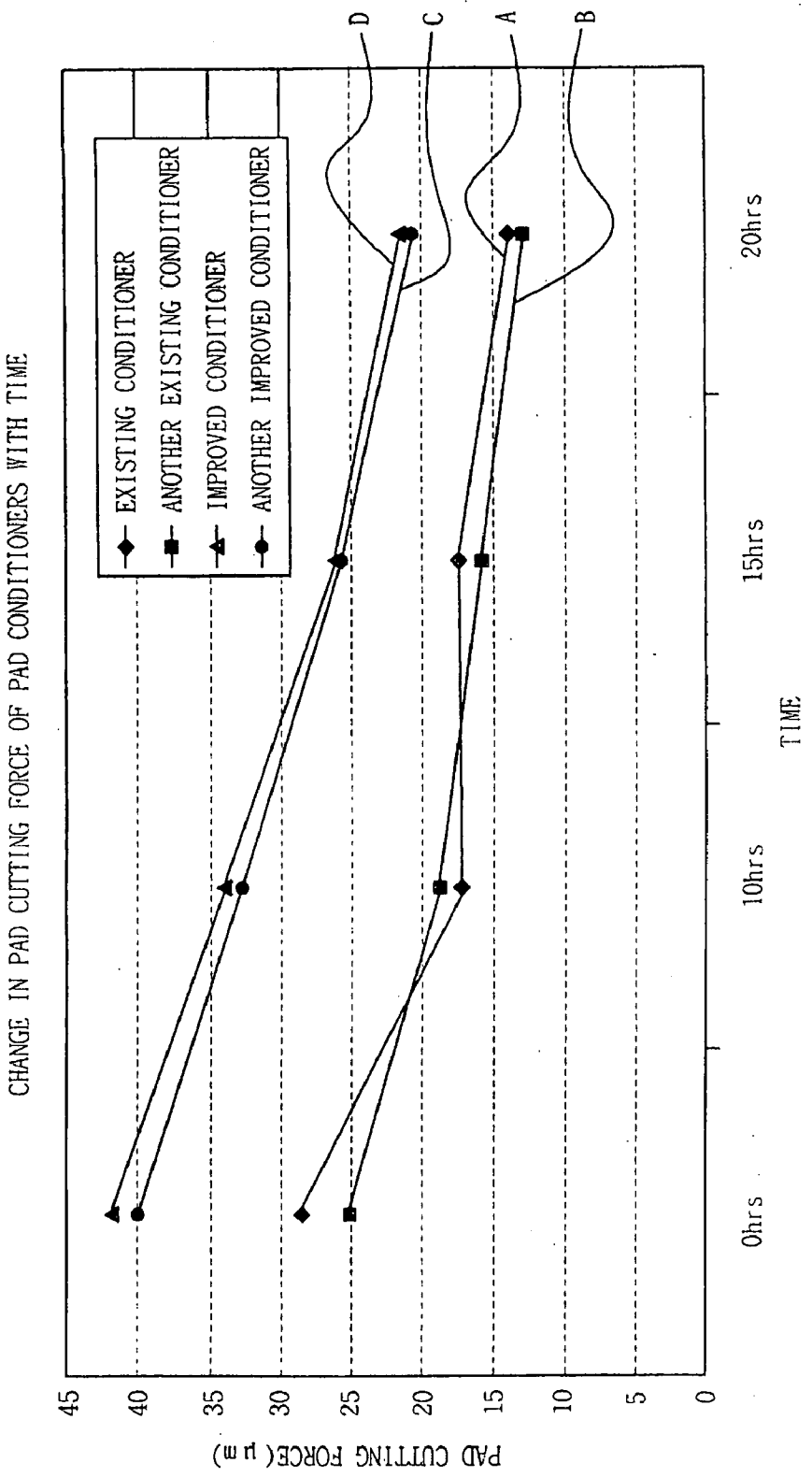

CHANGE IN PAD CUTTING FORCE OF PAD CONDITIONERS WITH TIME
EXISTING CONDITIONER
ANOTHER EXISTING CONDITIONER
IMPROVED CONDITIONER
ANOTHER IMPROVED CONDITIONER
D
C
A
B
PAD CUTTING FORCE(μm)
45
40
35
30
25
20
15
10
5
0
0hrs
10hrs
15hrs
20hrs
TIME

FIG. 16

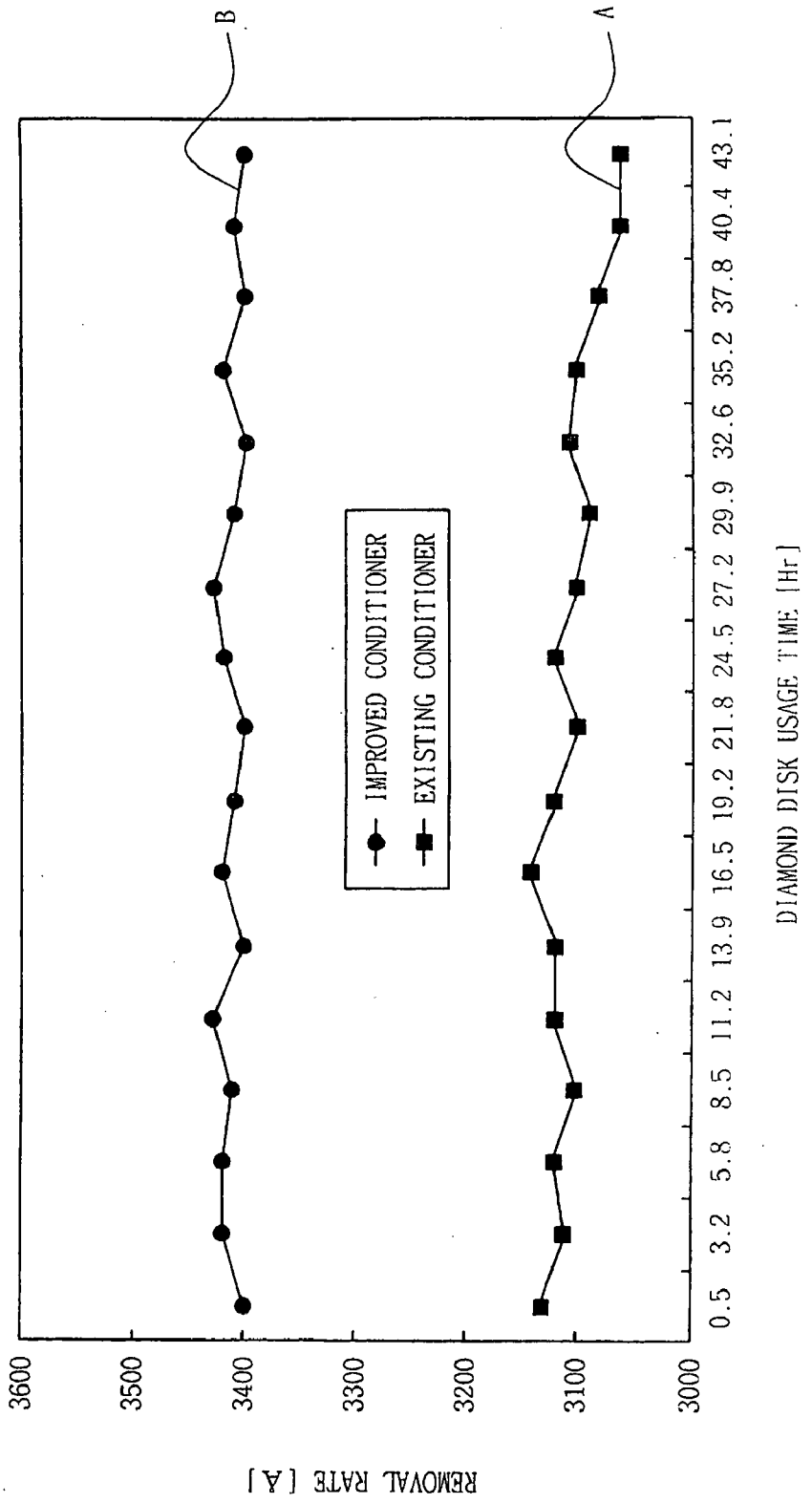

B
A
IMPROVED CONDITIONER
EXISTING CONDITIONER
3600
3500
3400
3300
3200
3100
3000
REMOVAL RATE [Å]
0.5 3.2 5.8 8.5 11.2 13.9 16.5 19.2 21.8 24.5 27.2 29.9 32.6 35.2 37.8 40.4 43.1
DIAMOND DISK USAGE TIME [Hr]

FIG. 17

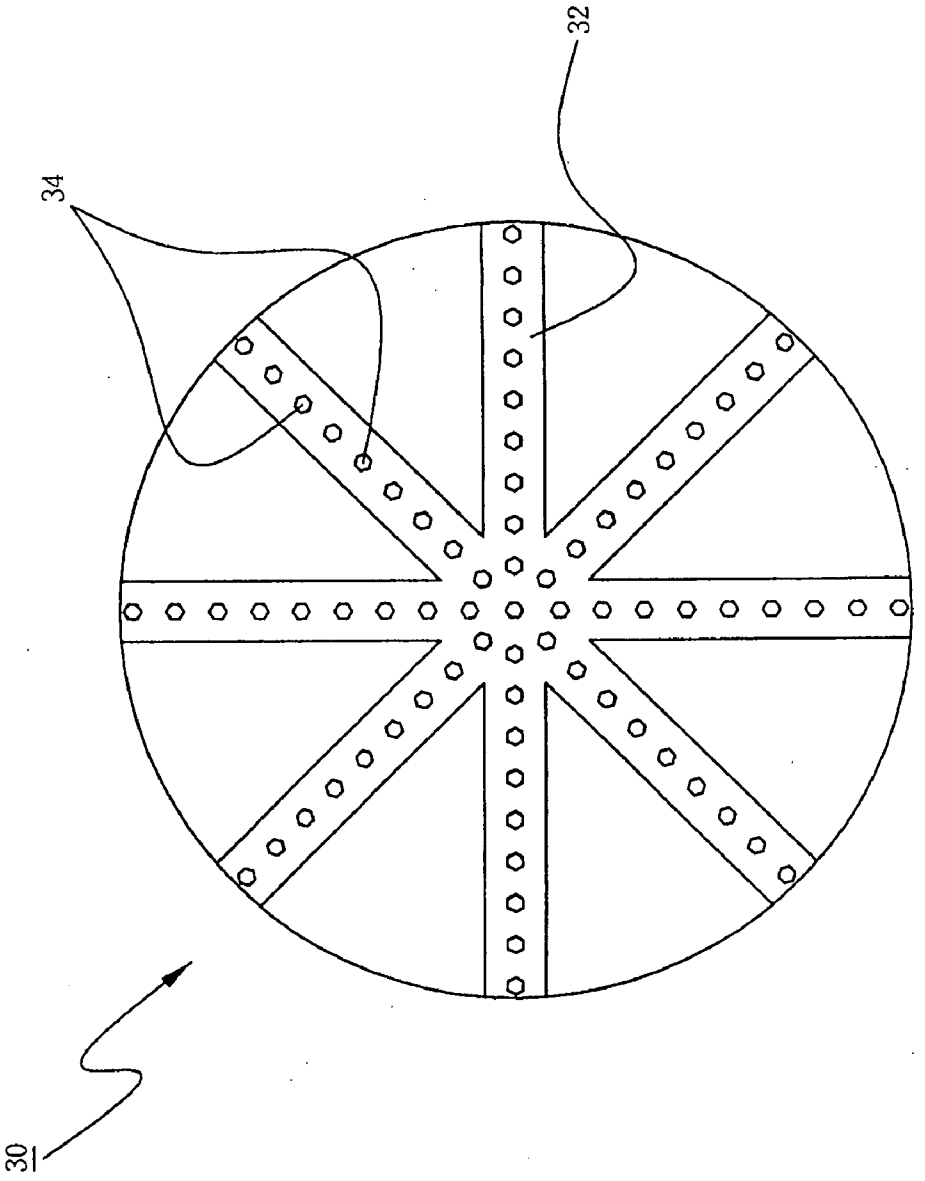


FIG. 18

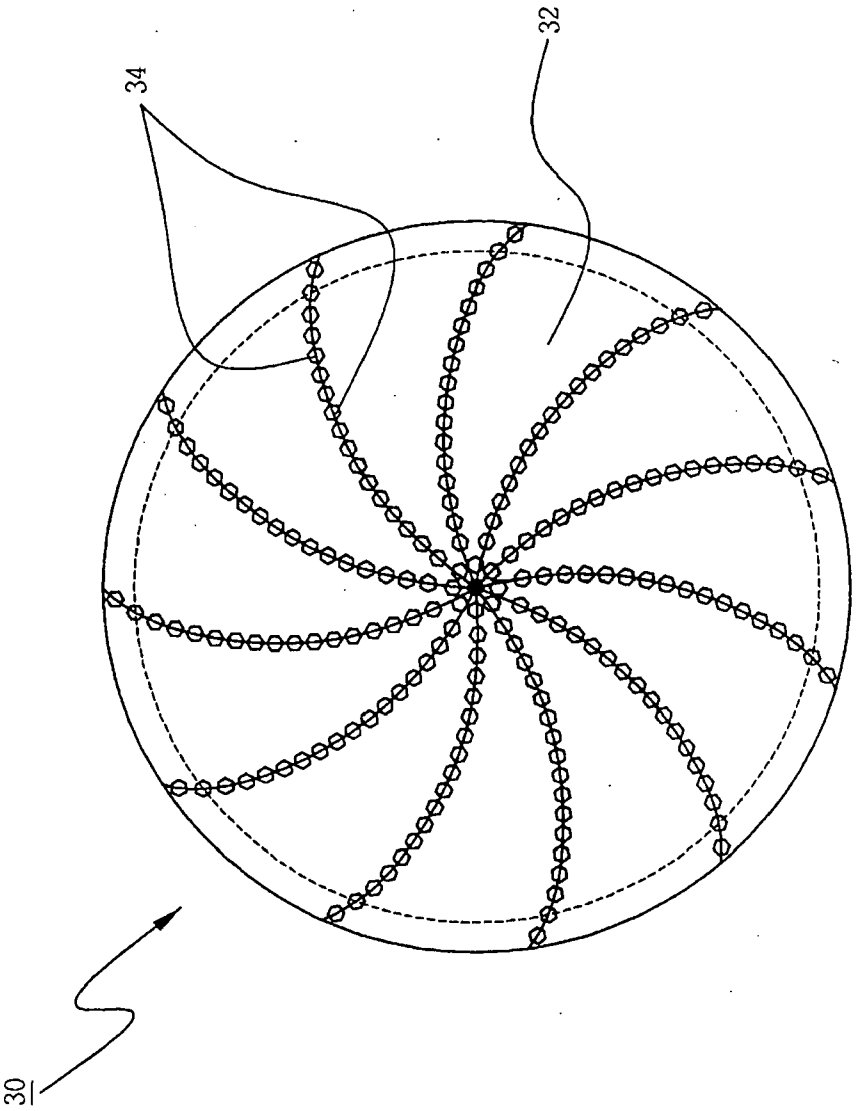
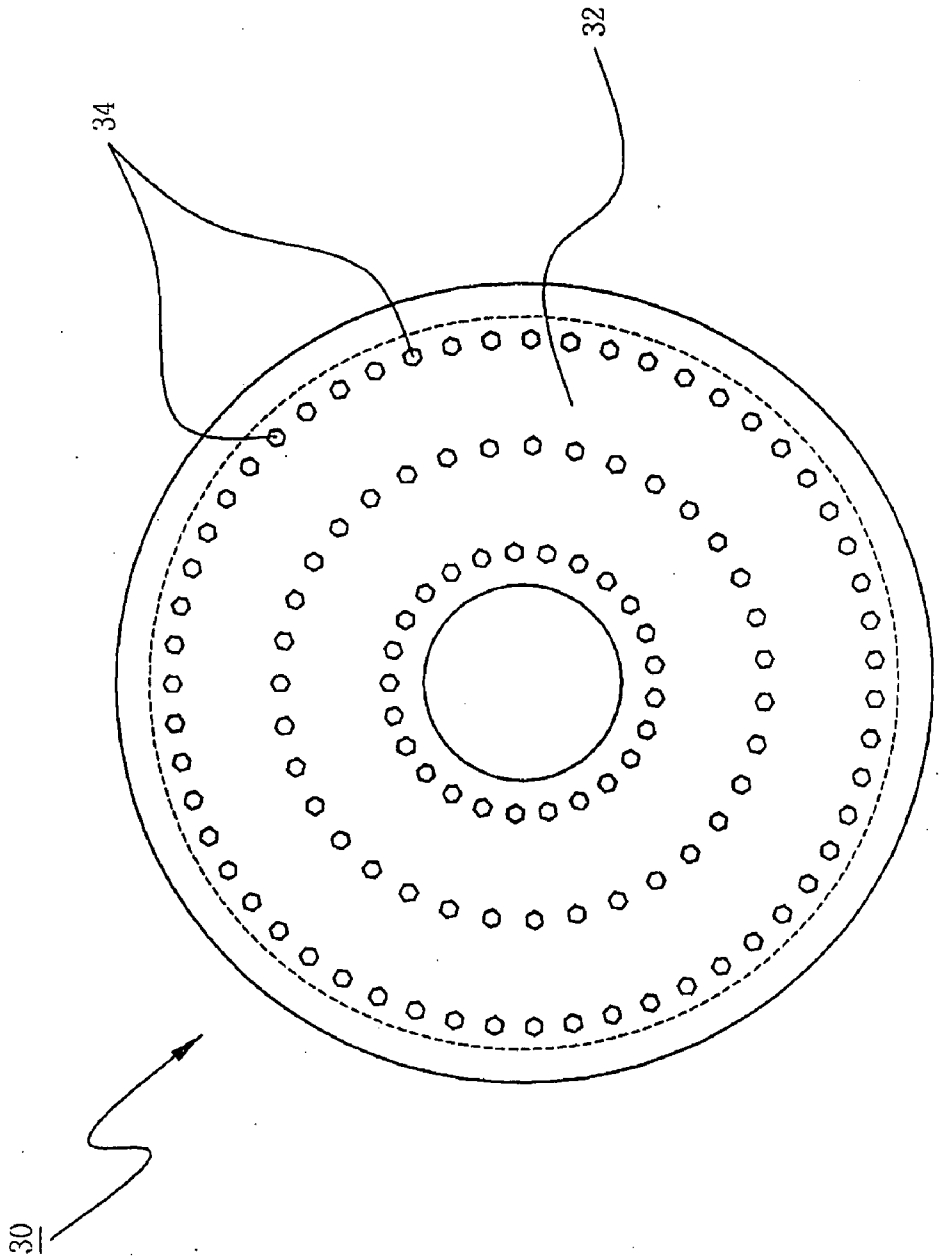


FIG. 19



PAD CONDITIONER OF SEMICONDUCTOR WAFER POLISHING APPARATUS AND MANUFACTURING METHOD THEREOF

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority under 35 U.S.C. §119 from Korean Patent Application 10-2007-0078560, filed on Aug. 6, 2007, the disclosure of which is incorporated herein by reference in its entirety.

FIELD AND BACKGROUND

[0002] The present invention relates to semiconductor wafer polishing apparatus, and more particularly, to a pad conditioner for use with a semiconductor wafer polishing apparatus and a pad conditioner manufacturing method, for uniformly conditioning a polishing pad of the polishing apparatus.

[0003] Semiconductor devices typically may be a multi-layered structure including conductive, semiconductive or insulative layers. After each layer is deposited, the layers may be etched to create circuitry features. These layers, however, may become non-planar which may be problematic. Thus there is a need to planarize the outer surface of the layer to provide a planar (i.e., relatively flat) smooth surface. Several planarization methods such as a Spin on Glass ("SOG"), etch back, reflow etc. have been developed and applied to a planarization process of a semiconductor device such as a wafer.

[0004] Chemical Mechanical Polishing ("CMP") is one technique. The mechanical polishing may generate an alteration layer and may result in a defect on a semiconductor device. The chemical polishing avoids the generation of alteration layer, but chemical polishing alone may not result in the precise desired planarization. In the CMP process, a polishing table, may be provided with a polishing pad, has a rotary motion, and a polishing head simultaneously performs a rotary motion and a shaking motion, providing a pressurizing force at a given pressure. A semiconductor device (e.g., a wafer) may be mounted on a polishing head part via surface tension or vacuum. The surface of wafer and the polishing pad may be contacted with each other by using the weight of the polishing head and an applied pressurization. The chemical aspect of CMP relates to using a reactive chemical slurry applied to the surface of the wafer to remove conductive materials on the wafer. In performing the polishing process of the CMP method, an irregular wear of the polishing pad may be generated, thus the conditioning of the polishing pad may be required and may be performed during the polishing or after the polishing. Examples of such polishing pad conditioner are disclosed in U.S. Pat. No. 6,042,457 to Wilson et al. and U.S. Pat. No. 5,938,507 to Ko et al., the disclosures of which are incorporated herein by reference in their entireties.

[0005] A pad conditioner may be largely constructed of three elements, namely a head, body and bearing. The element in contact with the surface of the polishing pad may be the head; the head may be provided by installing a diamond disk onto the head. Such a pad conditioner may be manufactured by using an electroplating method. The polishing pad conditioner may be made by spraying diamond particles onto the body part formed of stainless steel, thus providing an electroplated diamond disk. The diamond particles may be fixed using metal fusing. In such electroplating or brazing method, diamond particles, however, may be irregularly distributed thereon, and furthermore, the sizes of diamond particles may be irregular, too, and the height of surface for a cutting part may not be uniform. In other words, the diameters of diamond particles may be about 150 μm-250 μm and their sizes may not be uniform, which cause a rough surface-roughness on the conditioned-polishing pad.

[0006] In a conditioning work with such structure, not only the process through partial point-contact of diamond particle may be provided, but also a cutting performance may be dropped since a cutting angle of a diamond particle is generally an obtuse angle. To compensate for the dropped-cutting force, a high pressure may be required in conditioning the polishing pad using a conventional conditioner. The polishing pad may be made from a polymeric material such as polyurethane, and may have a top/bottom double-layer pad construction. The CMP may be performed through a top pad, and a bottom pad may provide compressibility. When the conditioner performs a conditioning while applying a large pressure onto polishing pad, the conditioning may not become smooth due to the compressibility of the bottom pad of polishing pad, and furthermore it may be very difficult to keep the flatness of the polishing pad.

[0007] Additionally, the conventional conditioner does not have a groove or ditch for an exit of a device because it is not easy to form a planned-exit ditch in view of manufacturing characteristic of electroplating or brazing. As a result, residual particles accumulate on the conditioner surface, which may result in a decrease in the conditioning efficiency.

[0008] The conditioning work may be performed in situ, i.e., simultaneous to the CMP work to increase productivity. Here, polishing solution used in the CMP contains polishing particles such as silica, alumina or ceria, etc. The polishing process may be classified as an oxide CMP or as a metal CMP according to the kind of polishing solution used. The polishing solution for the oxide CMP may have a pH value of pH10 to pH12, and the polishing solution for the metal CMP may have a pH value of pH4. The CMP process may be performed at the same time as the in-situ conditioning, thus not only a polishing pad, also metal such as nickel for bonding diamond particles onto the substrate, may be polished together by the polishing particles. This may cause a detach effect of diamond particles from the substrate. Moreover, in a metal CMP, polishing solution therefor may have a strong acidity bringing about a corrosion of metal. In other words, a bonding force is weakened, resulting in a detach effect of diamond particles.

[0009] The detached diamond particles may be generally stuck to the polishing pad in the polishing step. The diamond particle stuck to the polishing pad may produce a serious scratch on the surface of a device, increasing a process error and the polishing pad may need to be replaced. Meanwhile, a conventional conditioner does not have a groove/ditch for an exit of a device since it is not easy to form a planned-exit passage by a manufacturing characteristic such as an electroplating or brazing.

[0010] According to a conventional art, a CMP conditioner may be provided. Typically a CMP conditioner may include a plating layer with relief protrusions formed on the surface of diamond-ore base, and respective ones of polishing diamond particles may be fixed on the relief protrusions. The polishing diamond particles performs CMP conditioning. Keen tips of all the diamond particles may be adapted vertically to the flat surface of the plating layer, thus a prominent keenness may be kept initially with a high performance, but the keen tips may become blunt too early, shortening the life of the conditioner.

[0011] Polishing pad used in an oxide CMP process of semiconductor manufacturing processes may have pores and grooves through which slurry flows smoothly. Here, slurry flows through the grooves of polishing pad and flows into the pores, thereby maintaining the amount of slurry necessary for the oxide CMP and providing a retaining and stabilized oxide CMP process. However, such pore and groove type may heighten a cutting force of polishing pad in a polishing of the wafer and conditioning of diamond disk, and so this may relatively shorten a life of the polishing pad. Furthermore, an irregular pore size of the polishing pad may increase an oxide CMP performance distribution. Also the groove may become a cause of problem for a residue of slurry and scratch occurrence.

[0012] To rectify such problem, a non-porous polishing pad has been developed, but in performing an oxide CMP through use of a general diamond disk conditioner, the amount of slurry necessary for the surface of polishing pad may be insufficient and thus a drop effect of CMP removal rate by 10% or more may be caused (see, FIG. **1**).

[0013] That is, in performing the oxide CMP through use of a general diamond disk conditioner, in a case of a normal polishing pad having pores, a surface roughness necessary for slurry can be gotten (see, FIG. **2**), but in a case of a non-porous polishing pad, a surface roughness necessary for slurry cannot be gotten as shown in FIG. **3**.

SUMMARY

[0014] Accordingly, some embodiments of the invention may provide a pad conditioner for use in a semiconductor wafer polishing apparatus capable of improving a surface roughness of a non-porous polishing pad in an oxide CMP of the non-porous polishing pad. In a polishing of wafer and conditioning of polishing diamond pad, a cutting force of the polishing pad may be reduced, thus prolonging life of the polishing pad.

[0015] According to an embodiment of the invention, a pad conditioner for use in a semiconductor wafer polishing apparatus may comprise a substrate constructed of a flat plate of disk shape, a coating part formed with a given thickness on the substrate, and a plurality of protrusion parts formed on the coating part, the plurality of protrusion parts having a plurality of polishing members based on the same size in a predetermined pattern thereon.

[0016] The plurality of polishing members may be diamond.

[0017] The coating part may have a spiral structure.

[0018] A particle size of the diamond may be 103 μm to 105 μm.

[0019] An exposed height of an upper part of the coating part to an end part of the diamond may be 89 μm to 90 μm.

[0020] The coating part may have a radial structure.

[0021] The protrusion parts may be arrayed in a dot spiral type on the coating part.

[0022] Between the protrusion parts there may be formed a space to increase a flow level of slurry.

[0023] A distance for the space between the protrusion parts may be 0.5 mm to 1.5 mm.

[0024] According to another embodiment of the invention, a pad conditioner for use in a semiconductor wafer polishing apparatus may comprise a substrate constructed of a flat plate of disk shape, a coating part of circle shape formed with a given thickness on the substrate, and a plurality of protrusion parts formed on the coating part, the plurality of protrusion parts having a plurality of polishing members based on the same size in a predetermined size.

[0025] The protrusion parts may be arrayed in at least one dot-circle shape.

[0026] The protrusion parts may be arrayed in a dot spiral type.

[0027] The protrusion parts may be arrayed in a dot spiral type on the coating part.

[0028] According to another embodiment of the invention, a method of manufacturing a pad conditioner may comprise fusing a coating part on a substrate, forming a plurality of protrusion parts on the coating part, and electroplating numerous diamonds having the same particle size in a predetermined pattern or grouping on the plurality of protrusion parts.

[0029] In addition, in a semiconductor device manufacturing process and in a conditioning of diamond polishing pad, life of the polishing pad may be prolonged by reducing a cutting force of the polishing pad.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] FIG. **1** illustrates removal rates when an oxide CMP using a general diamond disk conditioner is performed on a normal polishing pad and a non-porous pad;

[0031] FIG. **2** illustrates a surface roughness of a normal polishing pad having undergone an oxide CMP process using a general diamond disk conditioner;

[0032] FIG. **3** illustrates a surface roughness of a non-porous polishing pad having undergone an oxide CMP process using a general diamond disk conditioner;

[0033] FIG. **4** is a plan view of a pad conditioner according to the conventional art;

[0034] FIG. **5** is a sectional view illustrating the structure of a pad conditioner according to a conventional art;

[0035] FIG. **6** illustrates an arrangement example when a non-porous polishing pad is conditioned by using an existing pad conditioner;

[0036] FIG. **7** is a plane view illustrating a structure of a pad conditioner according to an embodiment of the invention;

[0037] FIG. **8** is a sectional view illustrating the structure of a pad conditioner according to an embodiment of the invention;

[0038] FIG. **9** illustrates an arrangement example when a non-porous polishing pad is conditioned by using a pad conditioner according to an embodiment of the invention;

[0039] FIG. **10**A illustrates the roughness profile of the surface of a non-porous polishing pad having undergone a conditioning process using a general conditioner;

[0040] FIG. **10**B illustrates the roughness profile of the surface of a non-porous polishing pad having undergone a conditioning process using a pad conditioner according to an embodiment of the invention;

[0041] FIG. **11**A illustrates scratch tracks on a non-porous polishing pad having undergone a conditioning process using a general conditioner;

[0042] FIG. **11**B illustrates scratch tracks on a non-porous polishing pad having undergone a conditioning process using a pad conditioner according to an embodiment of the invention;

[0043] FIG. **12** provides removal rates in a case of a ceria CMP process using a normal polishing pad and an existing pad conditioner, a case of a ceria CMP process using a non-porous polishing pad and an existing pad conditioner, and a

case of a ceria CMP process using a non-porous polishing pad and a pad conditioner according to an embodiment of the invention;

[0044] FIG. **13** provides removal rates when an oxide CMP process is performed on a non-porous polishing pad by using an existing pad conditioner and a pad conditioner according to an embodiment of the invention;

[0045] FIG. **14** illustrates surface non-uniformity when an oxide CMP is performed on a non-porous polishing pad by using an existing pad conditioner and a pad conditioner according to an embodiment of the invention;

[0046] FIG. **15** is a graph illustrating a change in pad cutting force of each of different kinds of pad conditioners with time;

[0047] FIG. **16** is a graph illustrating a change in a removal rate for a long time in an oxide CMP using an existing pad conditioner and in an oxide CMP using a pad conditioner according to an embodiment of the invention;

[0048] FIG. **17** is a plan view illustrating a structure of pad conditioner according to an embodiment of the invention;

[0049] FIG. **18** is a plan view illustrating a structure of pad conditioner according to an embodiment of the invention; and

[0050] FIG. **19** is a plan view illustrating a structure of pad conditioner according to an embodiment of the invention.

DETAILED DESCRIPTION

[0051] The invention now will be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like reference numerals refer to like elements throughout the description of the figures.

[0052] It will be understood that when an element is referred to as being "on" another element, it can be directly on the other element or intervening elements may be present. In contrast, when an element is referred to as being "directly on" another element, there are no intervening elements present. It will be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element or intervening elements may be present. In contrast, when an element is referred to as being "directly connected or coupled" to another element, there are no intervening elements present. Furthermore, "connected" or "coupled" as used herein may include wirelessly connected or coupled. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0053] It will be understood that, although the terms first, second, etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first layer could be termed a second layer, and, similarly, a second layer could be termed a first layer without departing from the teachings of the disclosure.

[0054] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," or "includes" and/or "including" when used in this specification, specify the presence of stated features, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, regions, integers, steps, operations, elements, components, and/or groups thereof.

[0055] Furthermore, relative terms, such as "lower" or "bottom" and "upper" or "top," may be used herein to describe one element's relationship to other elements as illustrated in the Figures. It will be understood that relative terms are intended to encompass different orientations of the device in addition to the orientation depicted in the Figures. For example, if the device in one of the figures were turned over, elements described as being on the "lower" side of other elements would then be oriented on "upper" sides of the other elements. The exemplary term "lower", can therefore, encompass both an orientation of "lower" and "upper," depending of the particular orientation of the figure. Similarly, if the device in one of the figures is turned over, elements described as "below" or "beneath" other elements would then be oriented "above" the other elements. The exemplary terms "below" or "beneath" can, therefore, encompass both an orientation of above and below.

[0056] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and the present disclosure, and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0057] Embodiments of the present invention are described herein with reference to cross section illustrations that are schematic illustrations of idealized embodiments of the present invention. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, embodiments of the present invention should not be construed as limited to the particular shapes of regions illustrated herein but are to include deviations in shapes that result, for example, from manufacturing. For example, a region illustrated or described as flat may, typically, have rough and/or nonlinear features. Moreover, sharp angles that are illustrated may be rounded. Thus, the regions illustrated in the figures are schematic in nature and their shapes are not intended to illustrate the precise shape of a region and are not intended to limit the scope of the present invention.

[0058] In the description, a term "substrate" used herein may include a structure based on a semiconductor, having a semiconductor surface exposed. It should be understood that such a structure may contain silicon, silicon on insulator, silicon on sapphire, doped or undoped silicon, epitaxial layer supported by a semiconductor substrate, or another structure of a semiconductor. And, the semiconductor may be silicon-germanium, germanium, or germanium arsenide, not limited to silicon. In addition, the substrate described hereinafter may be one in which regions, conductive layers, insulation layers, their patterns, and/or junctions are formed.

[0059] In order to facilitate understanding of the invention, the drawings according to the conventional art are described below, with the description of the invention.

[0060] Referring to FIGS. **4** and **5**, a pad conditioner **22** for use in a semiconductor wafer polishing apparatus according to a conventional art may comprise a substrate **10** constructed of a flat plate of disk shape, a coating part **12** having a radial structure of a spiral type on the substrate **10**, and numerous diamond particles **14** electroplated with a given interval from each other on the coating part **12**.

[0061] The substrate **10** may be formed of, for example, stainless steel. On a rim part and a center part of the substrate **10**, the coating part **12** may not be formed. The radial width of the rim part may be 6 mm and the diameter of the center part may be 10 mm. The coating part **12** may be formed of metal material such as nickel or chrome. The coating part **12** may be fused on the substrate **10**, and a plurality of diamond particles **14** may be electroplated on the coating part **12**.

[0062] The size of each diamond particle **14** may be typically 151 μm to 181 μm, a distance between diamond particles may be about 300 μm, the height of the top of each diamond particle from the top surface of the coating part **12** may be 40 μm to 50 μm, and the number of diamond particles **14** may be 50,000 to 60,000.

[0063] FIG. **6** illustrates an arrangement example when a non-porous polishing pad is conditioned by using an existing pad conditioner. Referring to FIG. **6**, slurry may be supplied to a non-porous polishing pad **20** to be conditioned and a pad conditioner **22** may be positioned above the non-porous polishing pad **20**. The non-porous polishing pad **20** may be formed of a polymeric material such as polyurethane. The polishing pad **20** may be formed of a top pad and a bottom pad. The top pad undergoes the CMP, and the bottom pad provides compressibility. Polishing solution may contain polishing particles such as silica, alumina or ceria etc. When the pad conditioner **22** conditions the non-porous polishing pad **20**, the diamond particles **14** of the pad conditioner **22** may be closely spaced, that is, there may be formed a small space between diamond particles, thus reducing flow speed of slurry. Furthermore, the sizes of polishing diamond particles **14** may be about 151 μm to 181 μm, and thus very rough scratch tracks may be formed on the non-porous polishing pad **20** (see, FIG. **11**A).

[0064] Referring to FIGS. **7** and **8**, a pad conditioner according to an embodiment of the invention may comprise a substrate **30** constructed of a flat plate of disk shape, a coating part **32** having a spiral structure on the substrate **30**, and a plurality of protrusion parts **34** formed with a given distance on the coating part **32**. On the plurality of protrusion parts **34**, numerous diamond particles **36** of the same size may be formed in a predetermined grouping or pattern.

[0065] The sizes of the diamond particles **36** may be 103 μm to 115 μm, and a distance between center parts of the protrusion parts **34** may be about 1000 μm, and the height of the top of each diamond particle **36** from the top surface of the coating part **32** may be 80 μm to 90 μm. And the number of diamond particles **14** may be 100,000 to 130,000. Further, the height of the top surface of the coating part **32** from the substrate may be 40 μm to 45 μm, and the height of the top of each diamond particle **36** from the top surface of the coating part **32** may be 40 μm to 45 μm.

[0066] Referring to FIG. **9**, an arrangement example when a polishing pad is conditioned by a pad conditioner according to an embodiment of the invention is illustrated. A slurry may be supplied onto a polishing pad **40** to be conditioned, and a pad conditioner **42** may be positioned above the polishing pad **40**.

[0067] The coating part **32** may be fused on the substrate **30**, and on the coating part **32**, a plurality of protrusion parts **34** may be formed. On the plurality of protrusion parts **34**, a plurality of diamond particles **36** having a particle size of 103 μm to 115 μm, may be electroplated. A distance between the protrusion parts **34** may be 0.5 mm to 1.5 mm. Space formed with a given distance between the protrusion parts **34** may be to increase a flow speed of slurry in the CMP process.

[0068] FIG. **10**A illustrates the roughness profile of a surface of a non-porous polishing pad having undergone a conditioning process using a general pad conditioner, and FIG. **10**B illustrates the roughness profile of a surface of a non-porous polishing pad having undergone a conditioning process using a pad conditioner according to an embodiment of the invention. FIG. **11**A illustrates scratch tracks on a non-porous polishing pad having undergone a conditioning process using a general conditioner, and FIG. **11**B illustrates scratch tracks on a non-porous polishing pad having undergone a conditioning process using a pad conditioner according to an embodiment of the invention.

[0069] FIG. **12** illustrates removal rates in a case of a CMP process using a normal polishing pad and an existing pad conditioner, a case of a CMP process using a non-porous polishing pad and an existing pad conditioner, and a case of a CMP process using a non-porous polishing pad and a pad conditioner according to an embodiment of the invention. In performing a CMP on a normal polishing pad by using an existing pad conditioner, a removal rate is represented as shown by a reference symbol A of FIG. **12**. In performing a CMP on a non-porous polishing pad **20** by using an existing pad conditioner **22**, a removal rate is represented as shown by a reference symbol B of FIG. **12**. In performing a CMP on a non-porous polishing pad **40** by using the pad conditioner **42** according to an embodiment of the invention, a removal rate is represented as shown by a reference symbol C of FIG. **12**.

[0070] FIG. **13** provides removal rates when an oxide CMP process is performed on a non-porous polishing pad by using an existing pad conditioner and a pad conditioner according to an embodiment of the invention. FIG. **14** provides surface non-uniformity of a non-porous polishing pad having undergone an oxide CMP process using an existing pad conditioner and surface non-uniformity of a non-porous polishing pad having undergone an oxide CMP process using a pad conditioner according to an embodiment of the invention.

[0071] FIG. **15** illustrates a change in the pad cutting force of different kinds of pad conditioners with time. In FIG. **15**, graphs denoted by reference symbols A and B indicate a cutting force change of each of different kinds of existing pad conditioners when a CMP process is performed by use of the corresponding pad conditioner, and graphs denoted by reference symbols C and D indicate a cutting force change of each of different kinds of pad conditioners according to embodiments of the invention when a CMP process is performed by use of the corresponding pad conditioner.

[0072] FIG. **16** is a graph illustrating a change in a removal rate for a long time in an oxide CMP using an existing pad conditioner and in an oxide CMP using a pad conditioner according to an embodiment of the invention.

[0073] The sizes of the diamond particles **36** may be 103 μm to 115 μm, and a distance between center parts of the protrusion parts **34** may be about 1000 μm, and the height of the top of each diamond particle **36** from the top surface of the coating part **32** may be, 80 μm to 90 μm. Further, the number of diamond particles **36** may be 100,000 to 130,000. Accord-

ing to an embodiment of the invention, since the height H of the top of each diamond particle **36** from the top surface of the coating part **32** may be 80 μm to 90 μm, a scratch characteristic is improved as compared to the existing pad conditioner **22** in which the height of the top of each diamond particle **14** from the top surface of the coating part **12** is 40 μm to 45 μm (see FIG. **11**B).

[0074] Referring to FIG. **9**, when the pad conditioner **42** with such configuration described above conditions the non-porous polishing pad **40**, slurry may be supplied onto the polishing pad **40** to be conditioned. The non-porous polishing pad **40** may be formed of material of synthetic polyurethane group and formed of a top pad and a bottom pad. The top pad undergoes the CMP, and the bottom pad provides compressibility. Polishing solution may contain polishing particles such as silica, alumina or ceria etc.

[0075] In the pad conditioner **42** according to an embodiment of the invention, an interval between protrusion parts **34** of the pad conditioner **42** may be provided and may be, for example, about 1000 μm. Therefore, a sufficient amount slurry can flows when a CMP process is performed. Further, since the sizes of polishing diamond particles **36** may be small (e.g. about 103 μm to 115 μm), if a CMP process is performed by use of the pad conditioner **42**, scratch tracks are uniformly formed on the non-porous polishing pad **40** as shown in FIG. **11**B.

[0076] In case of conditioning a non-porous polishing pad by using the existing pad conditioner **22**, the roughness of the non-porous pad is represented as shown in FIG. **10**A.

[0077] However, according to an embodiment of the invention, in polishing the non-porous polishing pad **40** by using the pad conditioner **42**, the surface roughness of the non-porous pad is represented as shown in FIG. **10**B. Referring to Table 1, the mean depth and greatest depth of scratches and interval between scratches caused in case of using a pad conditioner according to an embodiment of the invention are compared to those in case of using an existing pad conditioner.

TABLE 1

	Mean Depth Ra(μm)	Greatest Scratch Depth RY(μm)	Scratch interval S(mm)
Existing pad conditioner	1.236	37.555	0.434
Pad conditioner according to an embodiment of the invention	1.586	33.361	0.306

[0078] In performing an oxide CMP on a normal polishing pad by using an existing pad conditioner, a removal rate is represented as shown by a reference symbol A of FIG. **12**. In performing an oxide CMP on the non-porous polishing pad **20** by using the existing pad conditioner **22**, a removal rate is represented as shown by a reference symbol B of FIG. **12**. In performing an oxide CMP on the non-porous polishing pad **40** by using the pad conditioner **42** according to an embodiment of the invention, a removal rate is represented as shown by a reference symbol C of FIG. **12**.

[0079] In performing the oxide CMP on the non-porous polishing pad **20** by using the existing pad conditioner **22**, the non-uniformity of the surface of the non-porous polishing pad **20** is represented as shown by a reference symbol B of FIG. **14**.

[0080] However, in performing the oxide CMP on the non-porous polishing pad **40** by using the pad conditioner **42** according to an embodiment of the invention, the non-uniformity of the surface of the non-porous polishing pad **40** is represented as shown by a reference symbol A of FIG. **14**. As can be seen in FIG. **14**, uniformity is enhanced.

[0081] Further, in performing the oxide CMP on non-porous polishing pads **20** by using different kinds of existing pad conditioners **22**, a change of cutting force of each pad conditioner **22** with time is represented as graph A or B shown in FIG. **15**.

[0082] In performing the oxide CMP on non-porous polishing pads **40** by using different kinds of pad conditioners **42** according to embodiments of the invention, a change of cutting force of each pad conditioner **40** with time is represented as graph C or D shown in FIG. **15**. As shown in FIG. **15**, the cutting force of the pad conditioner **42** according to an embodiment of the invention may be maintained for a longer time as compared to that of the existing pad conditioner.

[0083] Further, in performing the CMP on a non-porous polishing pad **20** by using the existing pad conditioner **22**, a change in the removal rate of the non-porous polishing pad **20** with diamond disk usage time is represented as graph A shown in FIG. **16**. In performing the CMP on the non-porous polishing pad **40** by using the pad conditioner **42** according to an embodiment of the invention, a change in the removal rate of the polishing pad **40** with diamond disk usage time is represented as a graph B shown in FIG. **16**. As can be seen form FIG. **16**, the removal rate may be improved.

[0084] Although the coating part **32** formed on the substrate **30** may be provided above in a spiral type according to an embodiment of the invention, the coating part **32** may be formed in a radial type (see FIG. **17**), and the protrusion parts **34** may be formed with a uniform interval or in a random interval on the coating part **32**. Further numerous diamond particles **36** may be electroplated being grouped on the protrusion parts **34**, without deviating from the scope of the invention.

[0085] In addition, although the protrusion part is described above being formed on the fore face of the coating part **32** of spiral type formed on the substrate **30** according to an embodiment of the invention, the coating part **32** may be formed in a circle type as shown in FIG. **18**, and then the protrusion parts **34** may be formed in a dot-spiral type with a uniform interval or in random on the coating part **32**, and then numerous diamond particles **36** may be electroplated in a group type on the protrusion parts **34**, without deviating from the scope of the invention.

[0086] According to another embodiment of the invention, as shown in FIG. **19**, the coating part **32** may be formed in a circle shape and then the protrusion parts **34** may be formed in a dot-circle shape with a uniform interval or in random on the coating part **32**, and then numerous diamond particles **36** may be electroplated in a group type on the protrusion parts **34** without deviating from the scope of the invention. Here, the protrusion parts **34** may be formed in at least one dot-circle array.

[0087] As described above, according to some embodiments of the invention, in a semiconductor device manufacturing process and in a conditioning of diamond polishing pad, a life of polishing pad may be prolonged by reducing a cutting force of the polishing pad.

[0088] It will be apparent to those skilled in the art that modifications and variations can be made in the present

invention without deviating from the spirit or scope of the invention. Thus, it is intended that the present invention cover any such modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents. Accordingly, these and other changes and modifications are seen to be within the true spirit and scope of the invention as defined by the appended claims.

[0089] In the drawings and specification, there have been disclosed typical embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being set forth in the following claims.

What is claimed is:

1. A pad conditioner for use in a semiconductor wafer polishing apparatus, the conditioner comprising:
- a substrate constructed of a flat plate of disk shape;
- a coating part formed with a given thickness on the substrate; and
- a plurality of protrusion parts formed on the coating part, the plurality of protrusion parts having a plurality of polishing members in a predetermined grouping thereon.

2. The conditioner of claim **1**, wherein the plurality of polishing members are diamond particles.

3. The conditioner of claim **1**, wherein the coating part is formed with a spiral structure.

4. The conditioner of claim **1**, wherein the sizes of the polishing members are 103 μm to 105 μm.

5. The conditioner of claim **1**, wherein the height of the top of each of the polishing members from the top surface of the coating part is 80 μm to 90 μm.

6. The conditioner of claim **1**, wherein the coating part is formed with a radial structure.

7. The conditioner of claim **1**, wherein the protrusion parts are arrayed in a dot spiral type on the coating part.

8. The conditioner of claim **1**, wherein between the protrusion parts an interval to increase a flow level of slurry is formed.

9. The conditioner of claim **8**, wherein the interval between the protrusion parts is 0.5 mm to 1.5 mm.

10. A pad conditioner for use in a semiconductor wafer polishing apparatus, the conditioner comprising:
- a substrate constructed of a flat plate of disk shape;
- a coating part of circle shape formed with a given thickness on the substrate; and
- a plurality of protrusion parts formed on the coating part, the plurality of protrusion parts having a plurality of polishing members in a predetermined grouping.

11. The conditioner of claim **10**, wherein the plurality of polishing members are diamond particles.

12. The conditioner of claim **10**, wherein the sizes of the polishing members are 103 μm to 105 μm.

13. The conditioner of claim **10**, wherein the height of the top of each of the polishing members from the top surface of the coating part is 80 μm to 90 μm.

14. The conditioner of claim **10**, wherein between the protrusion parts an interval to increase a flow level of slurry is formed.

15. The conditioner of claim **14**, wherein the interval between the protrusion parts is 0.5 mm to 1.5 mm.

16. The conditioner of claim **10**, wherein the protrusion parts are arrayed in at least one dot circle shape.

17. The conditioner of claim **10**, wherein the protrusion parts are arrayed in a dot spiral type.

18. A method of manufacturing a pad conditioner, comprising:
- fusing a coating part on a substrate;
- forming a plurality of protrusion parts on the coating part; and
- electroplating numerous polishing members in a predetermined grouping on the plurality of protrusion parts.

19. The method of claim **18**, wherein an interval between the protrusion parts is 0.5 mm to 1.5 mm, and the protrusion parts have a mutually spaced space to increase a flow level of slurry in a CMP (Chemical Mechanical Polishing) process.

20. The method of claim **18**, wherein the coating part is formed with a spiral structure.

21. The method of claim **18**, wherein the sizes of the polishing members are 103 μm to 105 μm.

22. The method of claim **18**, wherein the height of the top of each of the polishing members from the top surface of the coating part is 80 μm to 90 μm.

23. The method of claim **18**, wherein the coating part is formed with a radial structure.

24. The method of claim **18**, wherein the protrusion parts are arrayed in a dot spiral type on the coating part.

25. The method of claim **18**, wherein the polishing members are diamond particles.

* * * * *