

type) diamond film approximately 0.5 to 10 micrometers thick (again this dimension is not limiting). This diamond film is, as described above for the non-diamond film flip chip type embodiment, masked using a mask layer to pattern it to define the contact openings 164A, 164B therethrough. The remaining of the processing is as described above, using a thermally conductive (but electrically insulative) high performance adhesive to bond the heat sink cap 172 to the diamond film passivation layer 160. Thus the process steps in terms of structure are similar to those described above for the non-diamond film flip chip type embodiment, except for the presence of the diamond film passivation layer material.

The above description is illustrative and not limiting; it will be understood by one of ordinary skill in the art that further modifications will be apparent in view of this disclosure, and fall within the scope of the appended claims.

20

We Claim:

1. An integrated circuit comprising:
A semiconductor substrate having a principal surface;
5 a plurality of semiconductor devices formed in the substrate;
a pattern of conductive lines formed overlying the principal surface and in electrical contact with the devices;
10 a diamond film at least partially overlying the pattern of conductive lines;
a thermally conductive plate bonded to the diamond film and overlying the pattern of conductive lines; and
15 a plurality of insulated trenches extending from the principal surface of the substrate through the substrate and to an opposing backside surface thereof.
- 20 2. The integrated circuit of Claim 1, further comprising a plurality of electrically conductive contacts formed on the backside surface of the substrate, each conductive contact being in contact with a selected portion of the backside surface as
25 defined by the plurality of trenches.
3. The integrated circuit of Claim 1, wherein a thickness of the substrate is less than about 50 micrometers.
- 30 4. The integrated circuit of Claim 1, further comprising a second pattern of conductive lines juxtaposed to the plate and in electrical contact with the first pattern.
- 35

5. The integrated circuit of Claim 1, wherein the substrate defines a plurality of conductive vias extending from the principal surface thereof to the backside surface thereof, each via being in electrical contact on the principal surface with a portion of the pattern of conductive lines, and each via forming an electrical contact on the backside surface.

6. The integrated circuit of Claim 5, wherein the electrical contacts on the backside surface are each a post extending from the backside surface.

7. The integrated circuit of Claim 1, wherein the diamond film has a thickness in the range of 0.5 to 10 micrometers.

8. The integrated circuit of Claim 1, wherein the diamond film is bonded to the plate by a thermally conductive adhesive layer.

9. A method of forming an integrated circuit, comprising the steps of:

- providing a semiconductor substrate having a principal surface;
- forming a plurality of semiconductor devices in the substrate;
- forming a plurality of trenches in the substrate extending from the principal surface thereof into the substrate to a particular depth;
- forming a layer of insulating material in each of the trenches;
- forming a pattern of conductive lines overlying the principal surface and in electrical contact with the devices;
- forming a diamond film layer overlying the substrate;

bonding a thermal conductive plate to the diamond film layer and overlying the principal surface of the substrate; and

5 removing a portion of the substrate from a backside surface thereof opposing the principal surface, thereby exposing at least a bottom part of each of the trenches.

10 10. The method of Claim 9, further comprising the steps of:

forming a conductive layer on the backside surface; and

15 patterning the conductive layer into a plurality of contact regions, each contact region being in contact with a selected portion of the backside surface as defined by the plurality of trenches.

20 11. The method of Claim 9 wherein the step of removing leaves a remaining thickness of the substrate of less than about 100 micrometers.

25 12. The method of Claim 9, further comprising the step of forming a second pattern of conductive lines on a surface of the plate prior to the step of bonding;

wherein the step of bonding comprises electrically contacting portions of the second pattern to portions of the first pattern.

30 13. The method of Claim 9 wherein the step of bonding comprises applying a thermally conductive adhesive between the diamond film layer and the plate.

35 14. The method of Claim 9, further comprising the steps of:

forming a plurality of vias extending from the backside surface to the principal surface of the substrate, after the step of removing;

5 providing conductive material in each of the vias, the conductive material in each via being in electrical contact on the principal surface with a portion of the pattern of conductive lines, and the conductive material in each via forming an electrical contact on the backside surface.

10

15. The method of Claim 14, wherein the step of providing conductive material comprises forming a layer of the conductive material on the backside surface, and further comprising:

15 forming the layer of conductive material into a plurality of posts extending outward from the backside surface, each post being electrically connected to the conductive material in one of the vias.

20

16. The method of Claim 9, wherein the diamond film layer is formed to a thickness in a range of 0.5 to 10 micrometers.

AMENDED CLAIMS

[received by the International Bureau on 18 September 1995 (18.09.95);
original claims 1,6-9,11,13 and 16 amended; new claims
17 and 18 added; remaining claims unchanged (4 pages)]

1. An integrated circuit comprising:

5 A semiconductor substrate having a principal
surface and a thickness less than about 100
micrometers;

a plurality of semiconductor devices formed in
the substrate;

10 a pattern of conductive lines formed overlying
the principal surface and in electrical contact with
the devices;

an electrically insulating film at least
partially overlying the pattern of conductive lines;

15 a thermally conductive plate permanently bonded
to the insulating film and overlying the pattern of
conductive lines; and

20 a plurality of insulated trenches extending
from the principal surface of the substrate through
the substrate and to an opposing backside surface
thereof.

2. The integrated circuit of Claim 1, further
comprising a plurality of electrically conductive
contacts formed on the backside surface of the substrate,
25 each conductive contact being in contact with a selected
portion of the backside surface as defined by the
plurality of trenches.

3. The integrated circuit of Claim 1, wherein a
30 thickness of the substrate is less than about
50 micrometers.

4. The integrated circuit of Claim 1, further
comprising a second pattern of conductive lines
35 juxtaposed to the plate and in electrical contact with
the first pattern.

5. The integrated circuit of Claim 1, wherein the substrate defines a plurality of conductive vias extending from the principal surface thereof to the backside surface thereof, each via being in electrical
5 contact on the principal surface with a portion of the pattern of conductive lines, and each via forming an electrical contact on the backside surface.

6. The integrated circuit of Claim 5, wherein the
10 electrical contacts on the backside surface are each a post extending from the backside surface.

7. The integrated circuit of Claim 1, wherein the insulating film has a thickness in the range of 0.5 to 10
15 micrometers.

8. The integrated circuit of Claim 1, wherein the insulating film is bonded to the plate by a thermally conductive adhesive layer.
20

9. A method of forming an integrated circuit, comprising the steps of:

providing a semiconductor substrate having a principal surface;

25 forming a plurality of semiconductor devices in the substrate;

forming a plurality of trenches in the substrate extending from the principal surface thereof into the substrate to a particular depth;

30 forming a layer of insulating material in each of the trenches;

forming a pattern of conductive lines overlying the principal surface and in electrical contact with the devices;

35 forming an electrically insulating film layer overlying the substrate;

permanently bonding a thermal conductive plate to the insulating film layer and overlying the principal surface of the substrate; and

5 removing a portion of the substrate from a backside surface thereof opposing the principal surface, thereby exposing at least a bottom part of each of the trenches and reducing a thickness of the substrate to less than about 100 micrometers.

10 10. The method of Claim 9, further comprising the steps of:

forming a conductive layer on the backside surface; and

15 patterning the conductive layer into a plurality of contact regions, each contact region being in contact with a selected portion of the backside surface as defined by the plurality of trenches.

20 11. The method of Claim 9 wherein the step of removing leaves a remaining thickness of the substrate of less than about 50 micrometers.

25 12. The method of Claim 9, further comprising the step of forming a second pattern of conductive lines on a surface of the plate prior to the step of bonding;

wherein the step of bonding comprises electrically contacting portions of the second pattern to portions of the first pattern.

30 13. The method of Claim 9 wherein the step of bonding comprises applying a thermally conductive adhesive between the insulating film layer and the plate.

35 14. The method of Claim 9, further comprising the steps of:

forming a plurality of vias extending from the backside surface to the principal surface of the substrate, after the step of removing;

5 providing conductive material in each of the vias, the conductive material in each via being in electrical contact on the principal surface with a portion of the pattern of conductive lines, and the conductive material in each via forming an electrical contact on the backside surface.

10

15. The method of Claim 14, wherein the step of providing conductive material comprises forming a layer of the conductive material on the backside surface, and further comprising:

15 forming the layer of conductive material into a plurality of posts extending outward from the backside surface, each post being electrically connected to the conductive material in one of the vias.

20

16. The method of Claim 9, wherein the insulating film layer is formed to a thickness in a range of 0.5 to 10 micrometers.

25 17. The integrated circuit of Claim 1, wherein the insulating film is a diamond film.

18. The method of Claim 9, wherein the insulating film is a diamond film.

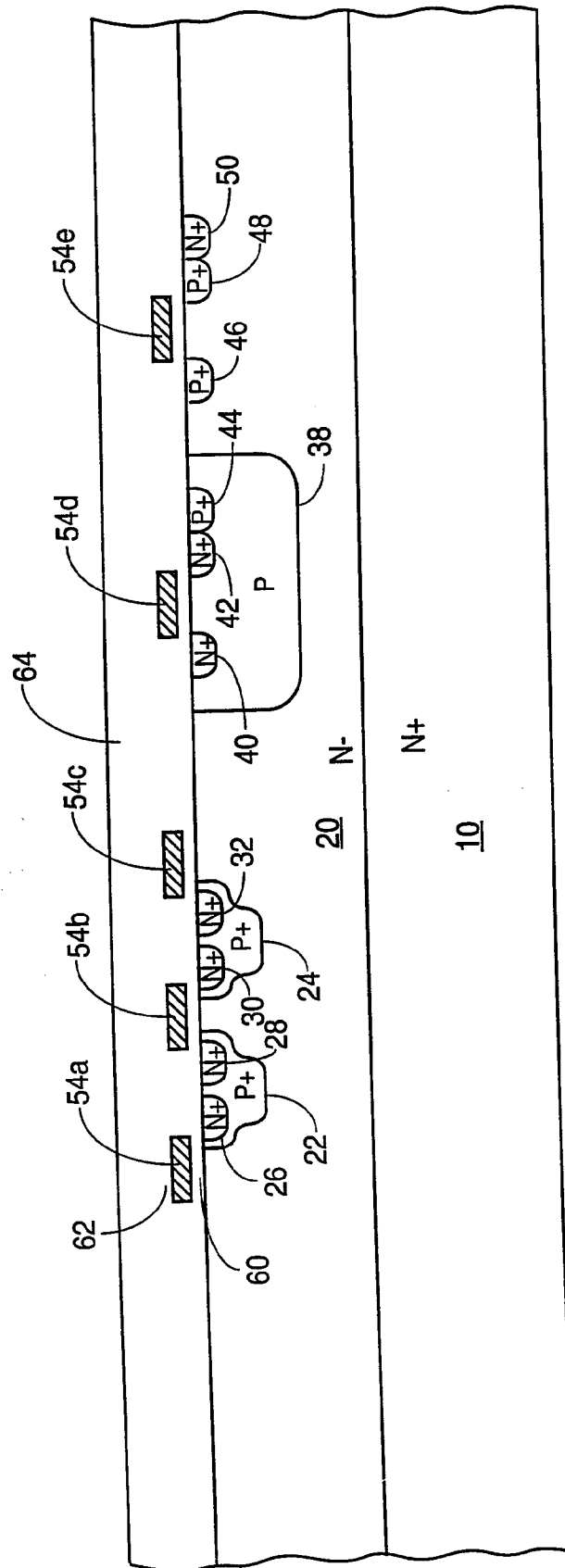


Fig. 1

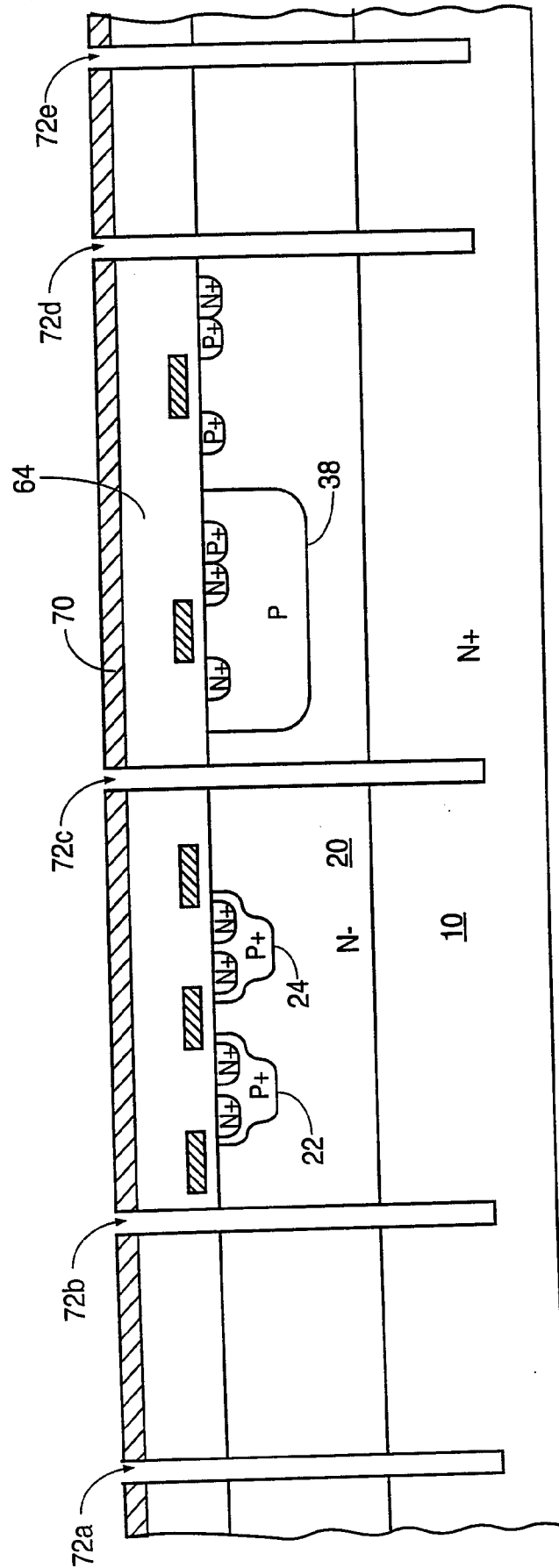


Fig. 2

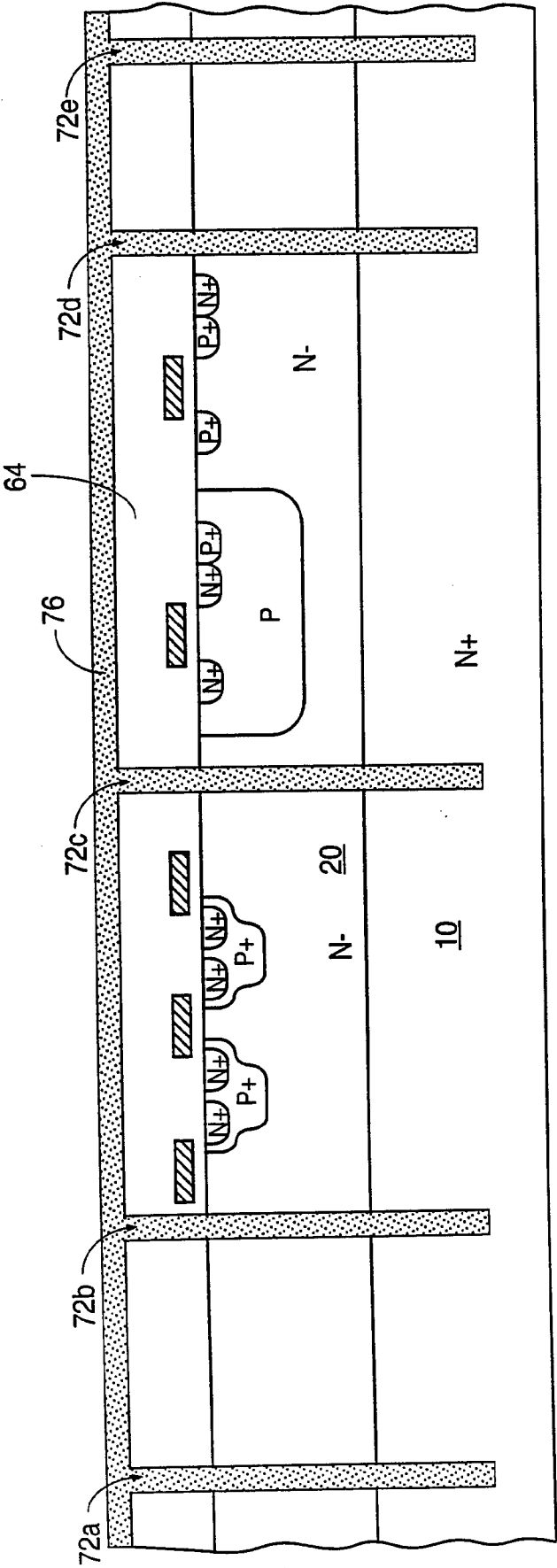


Fig. 3

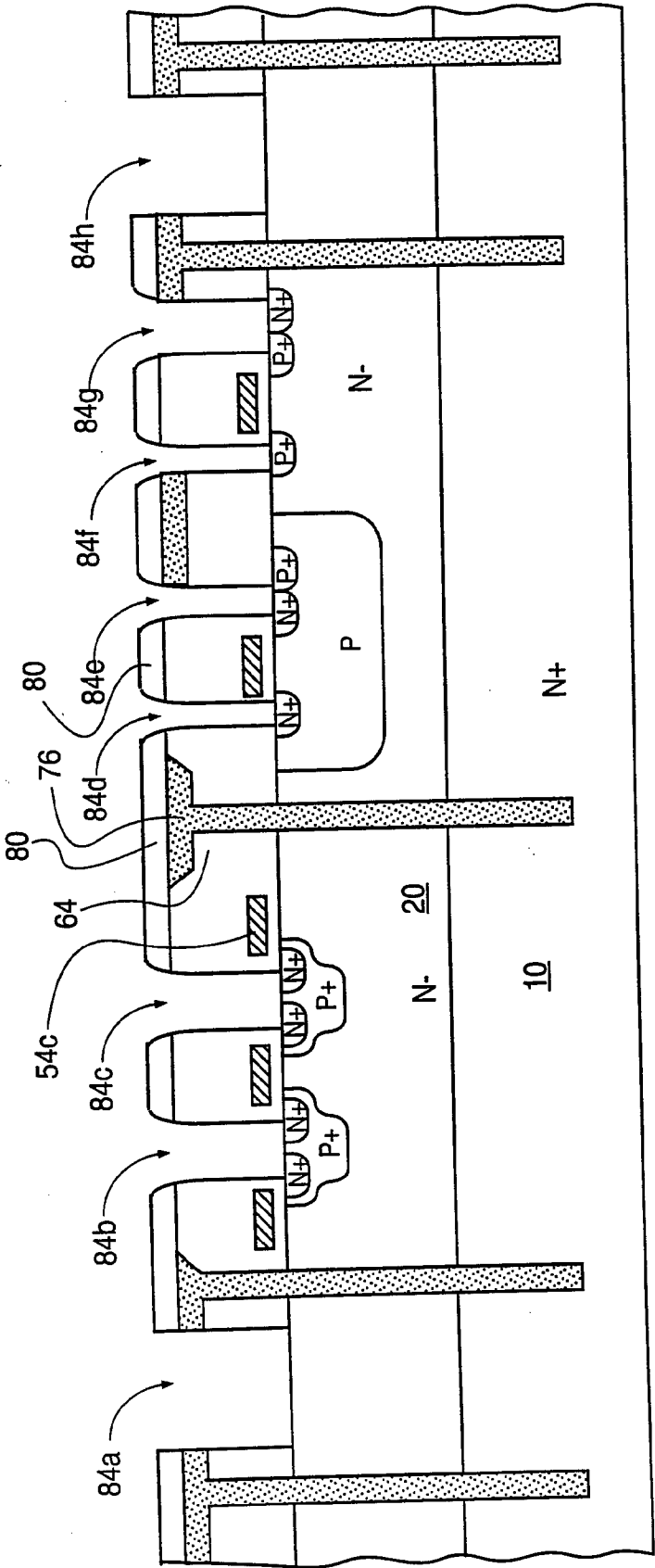


Fig. 4

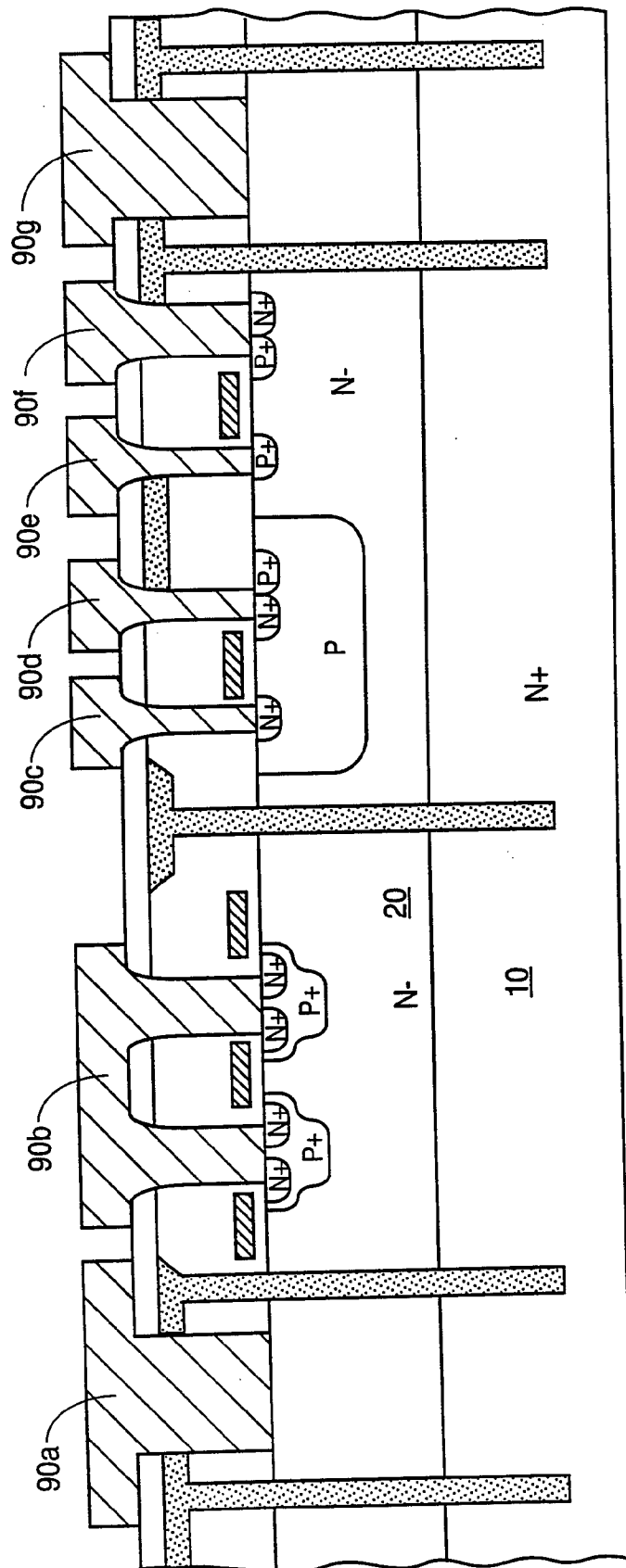


Fig. 5

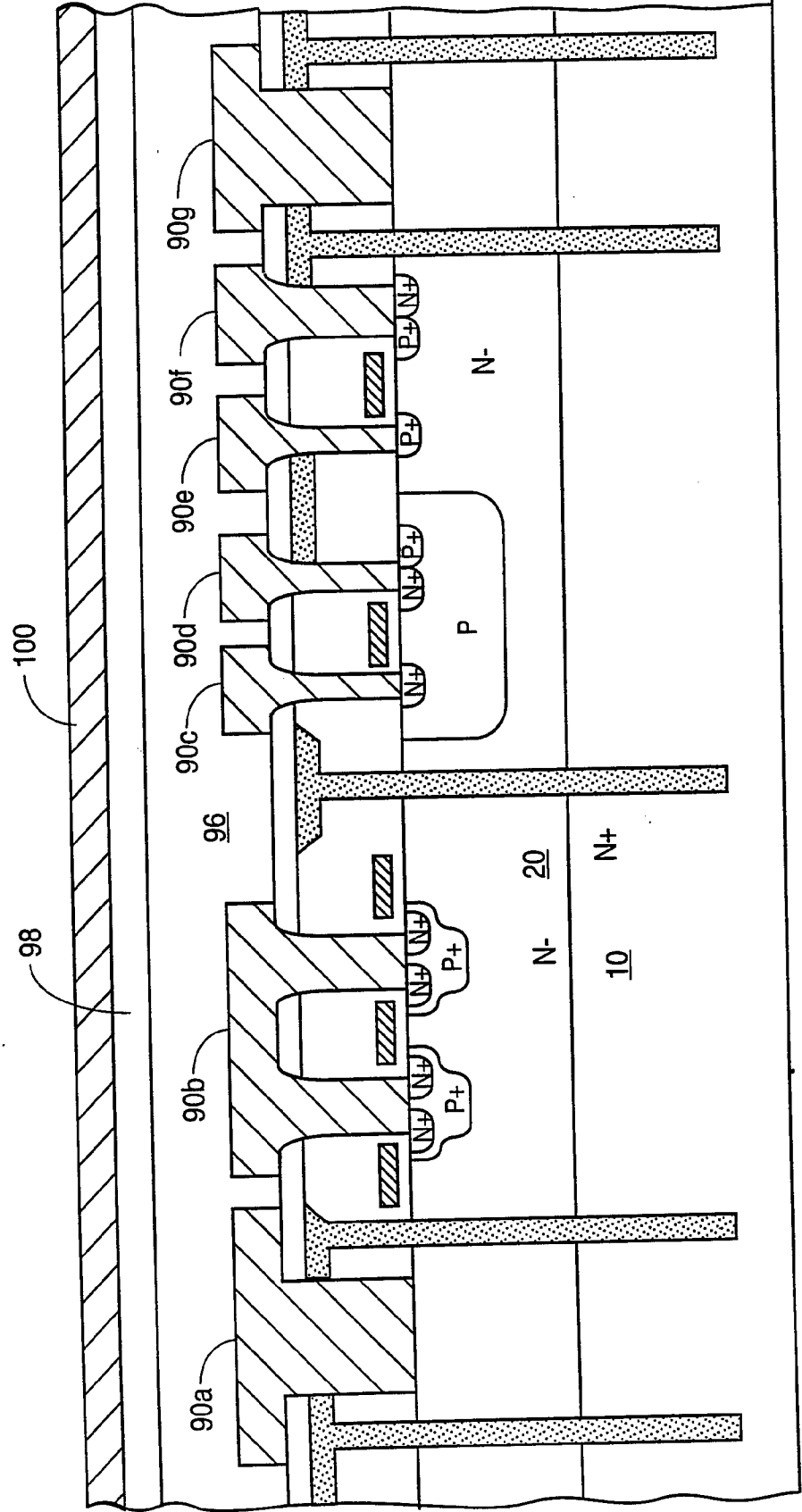


Fig. 6

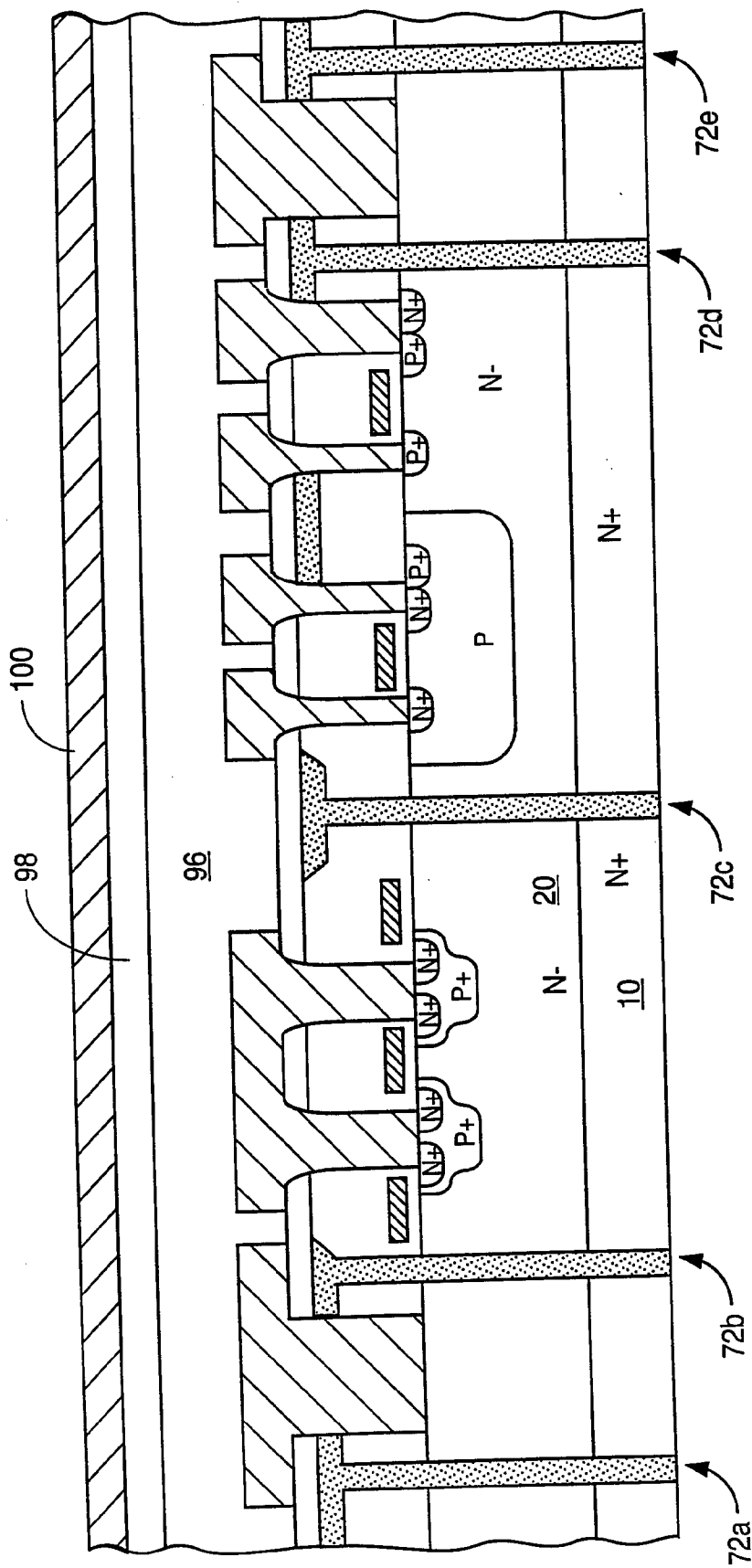


Fig. 7

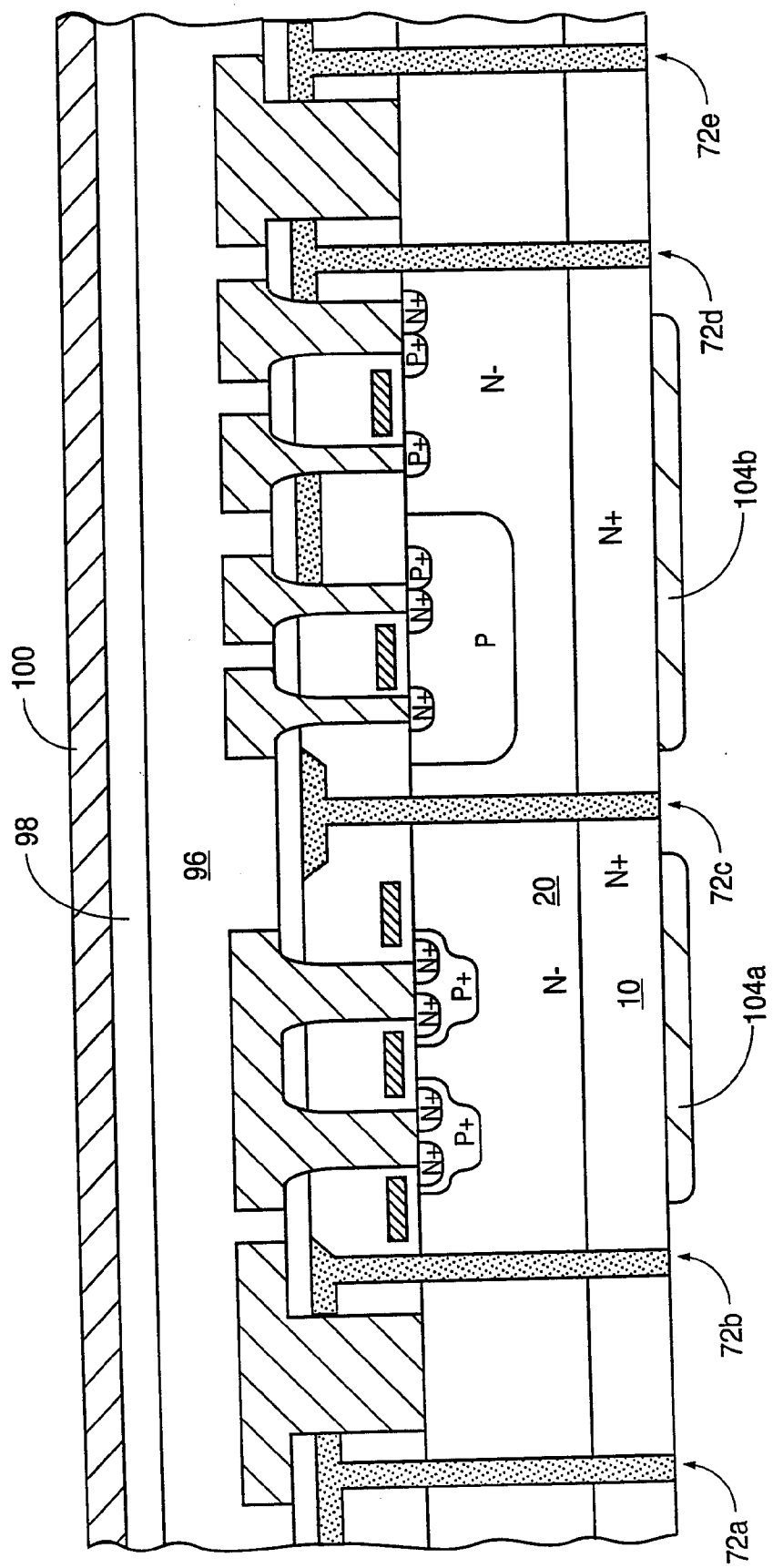


Fig. 8

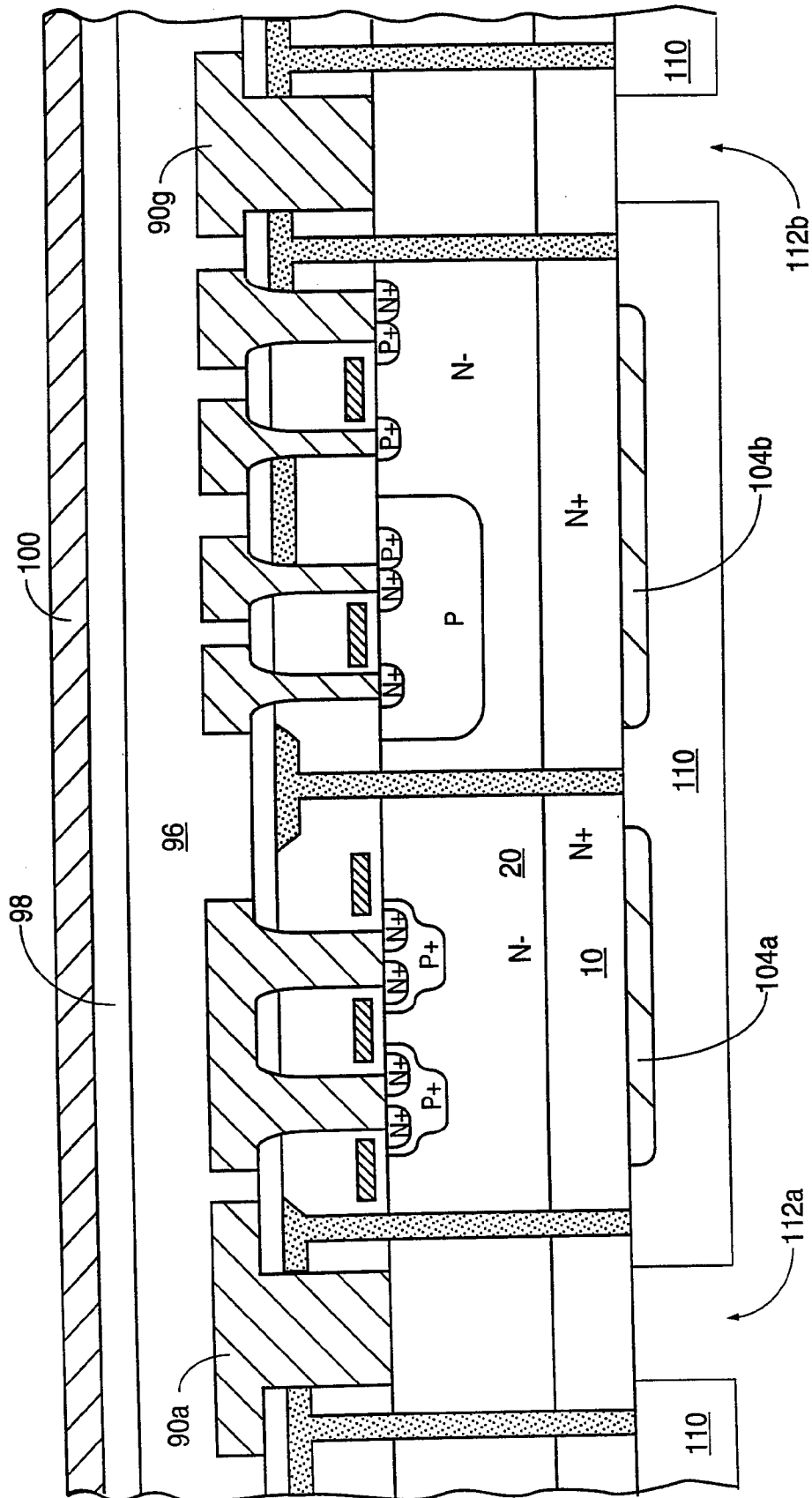


Fig. 9

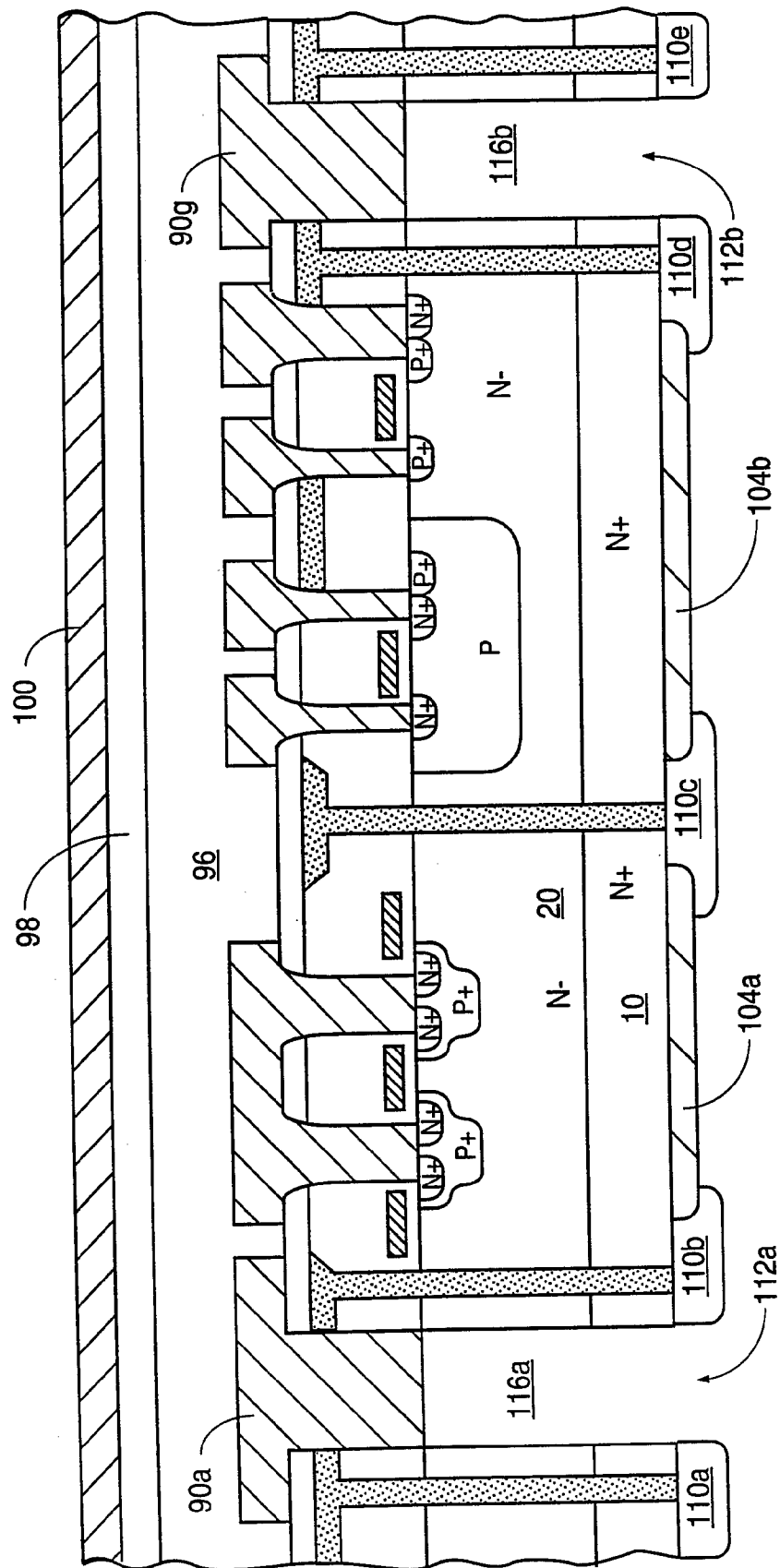


Fig. 10

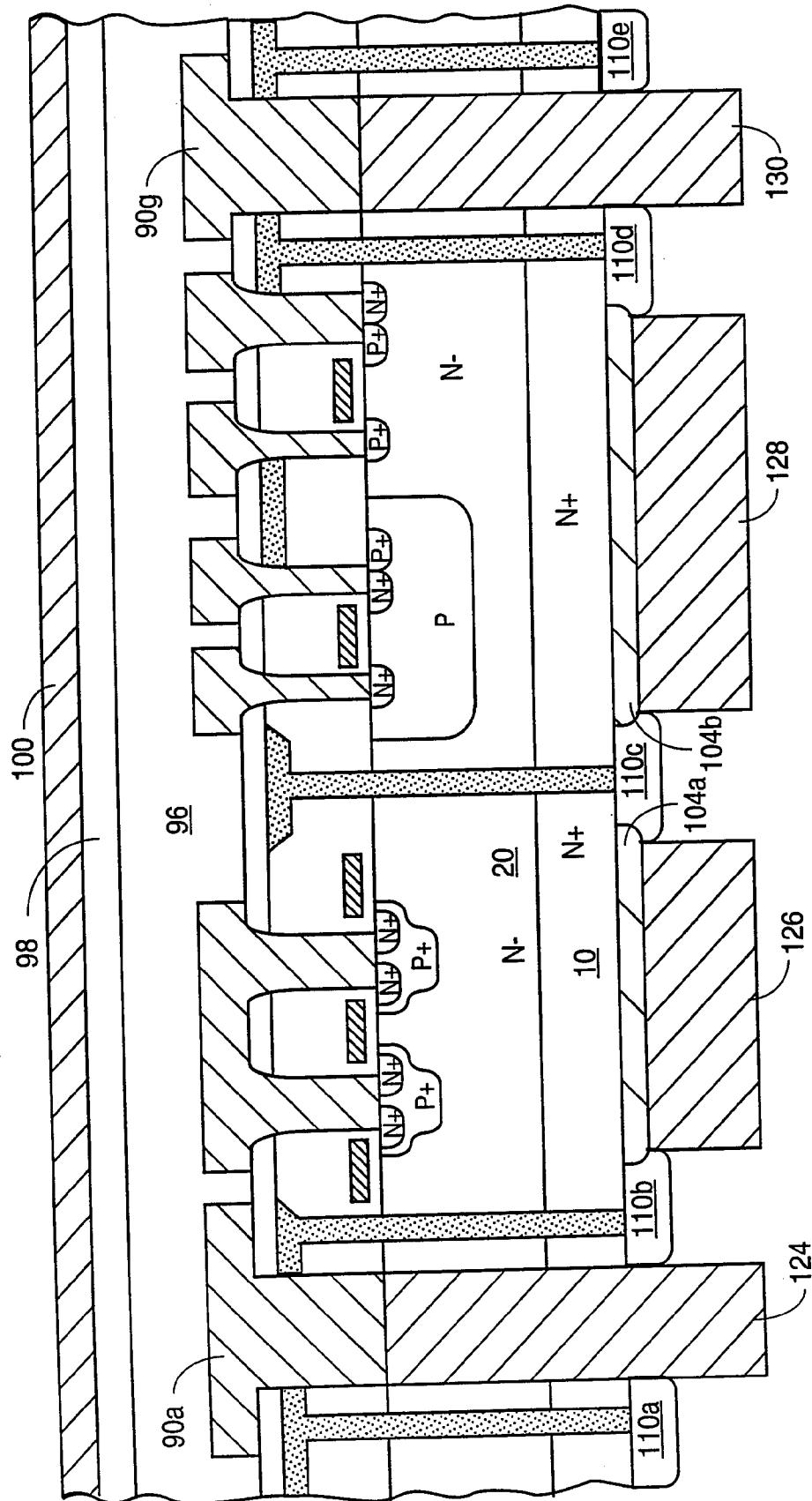


Fig. 11

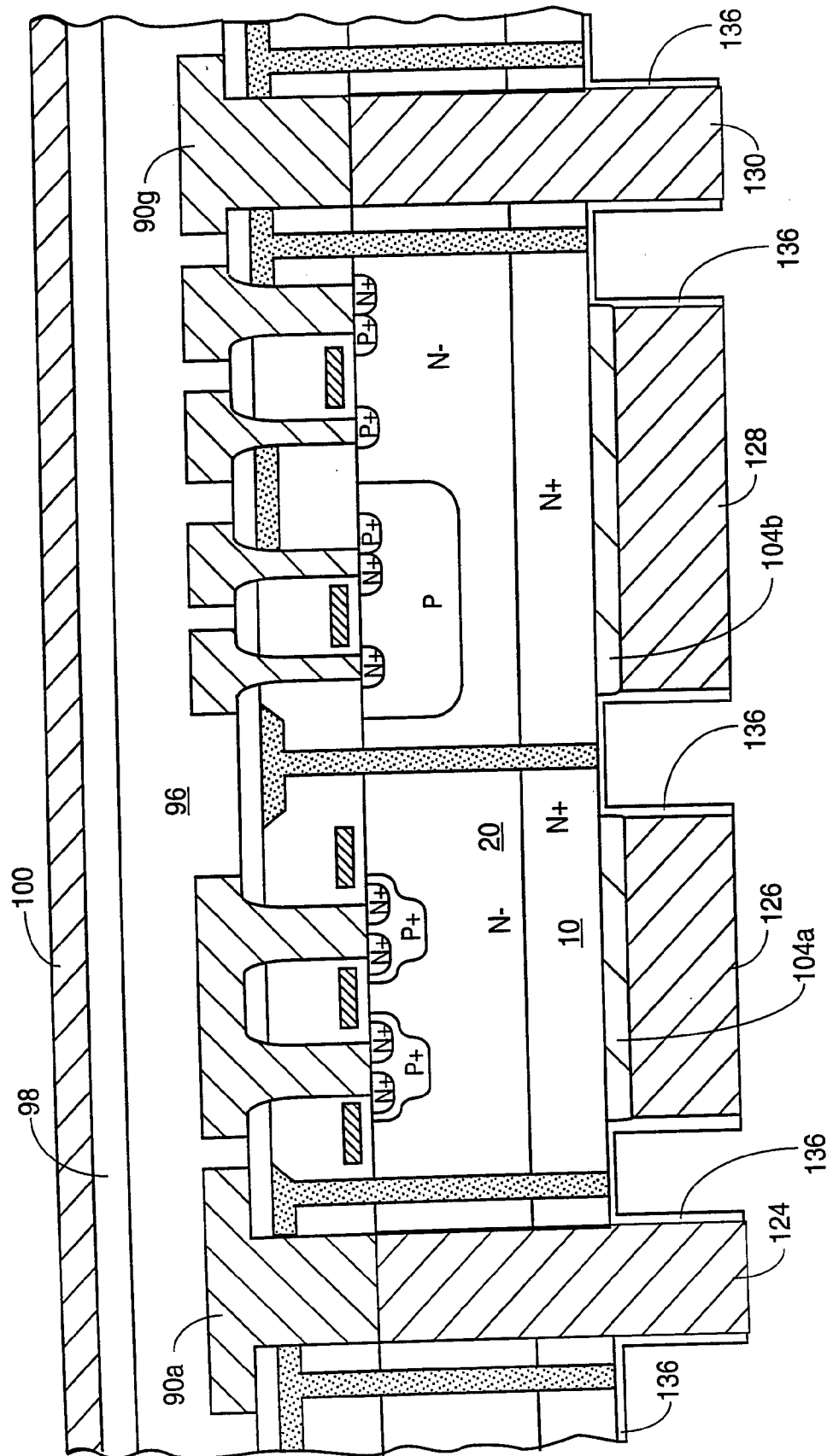


Fig. 12

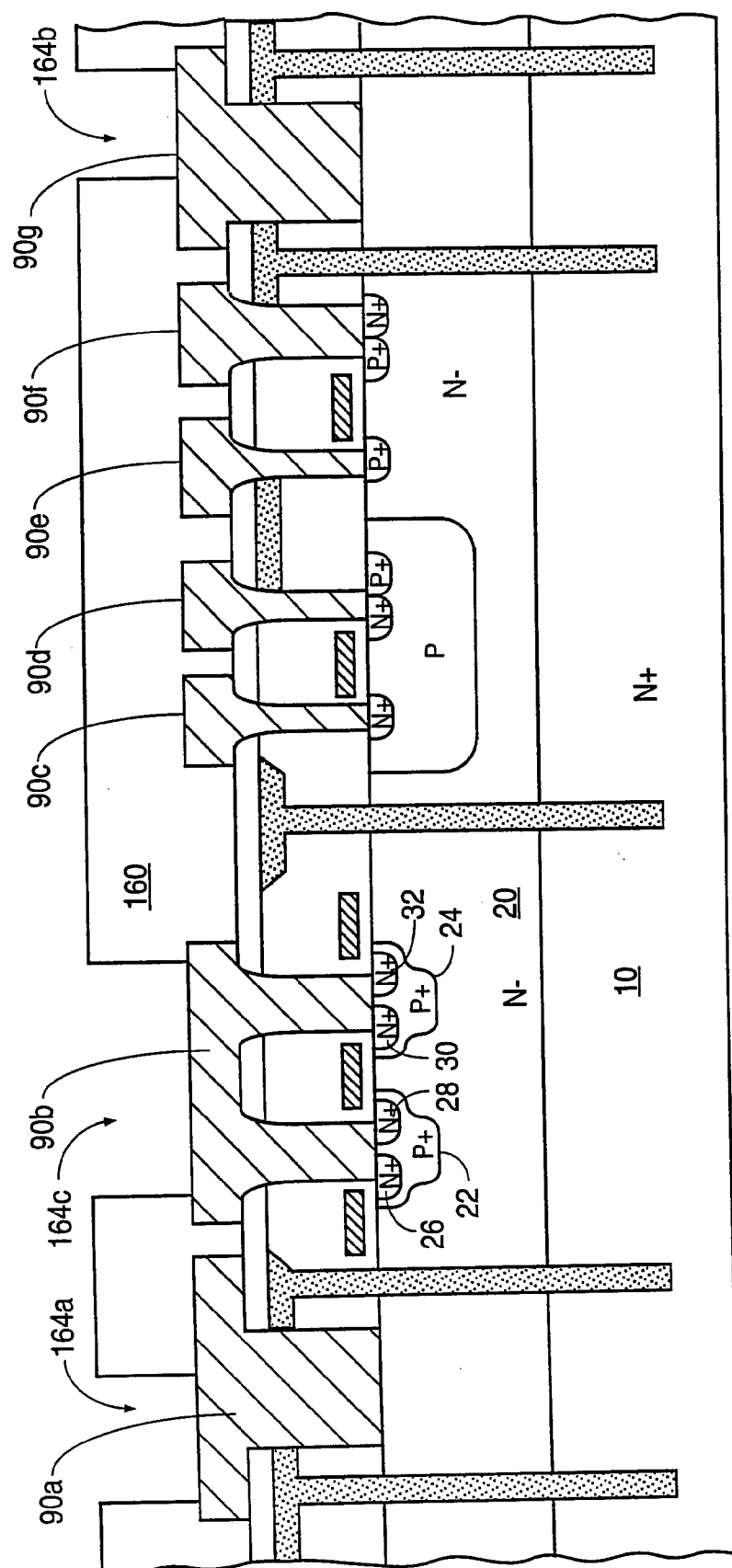


Fig. 13

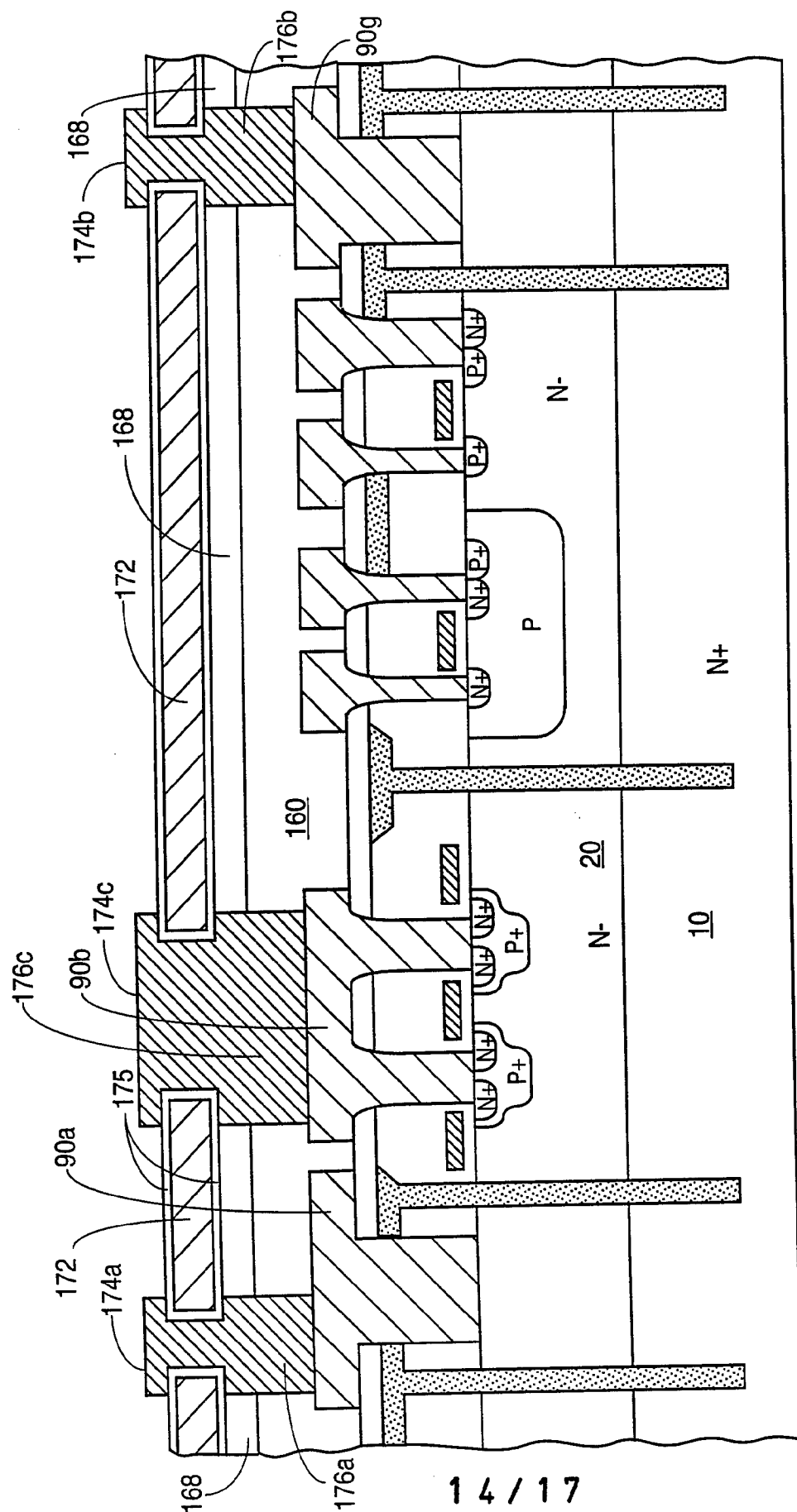


Fig. 14

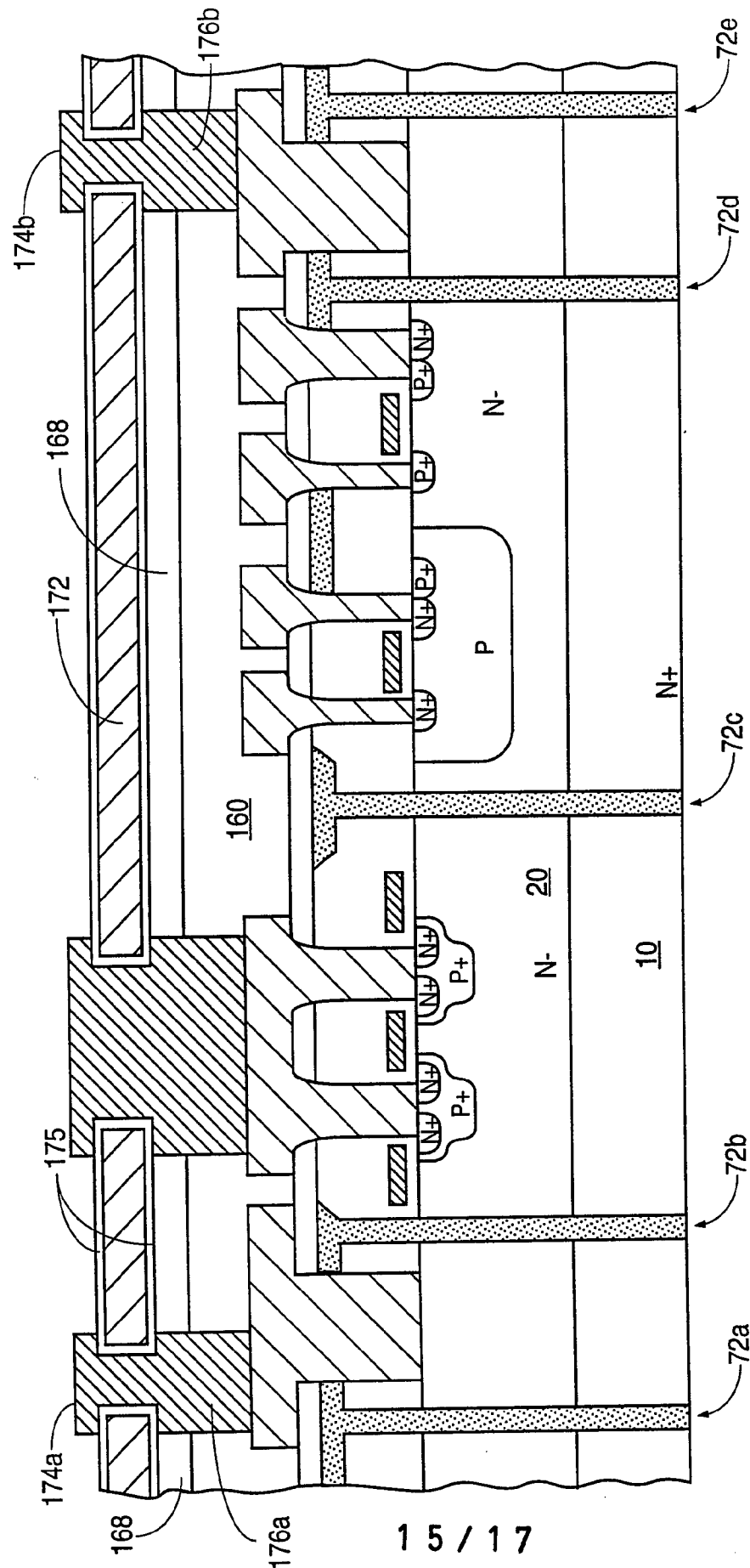


Fig. 15

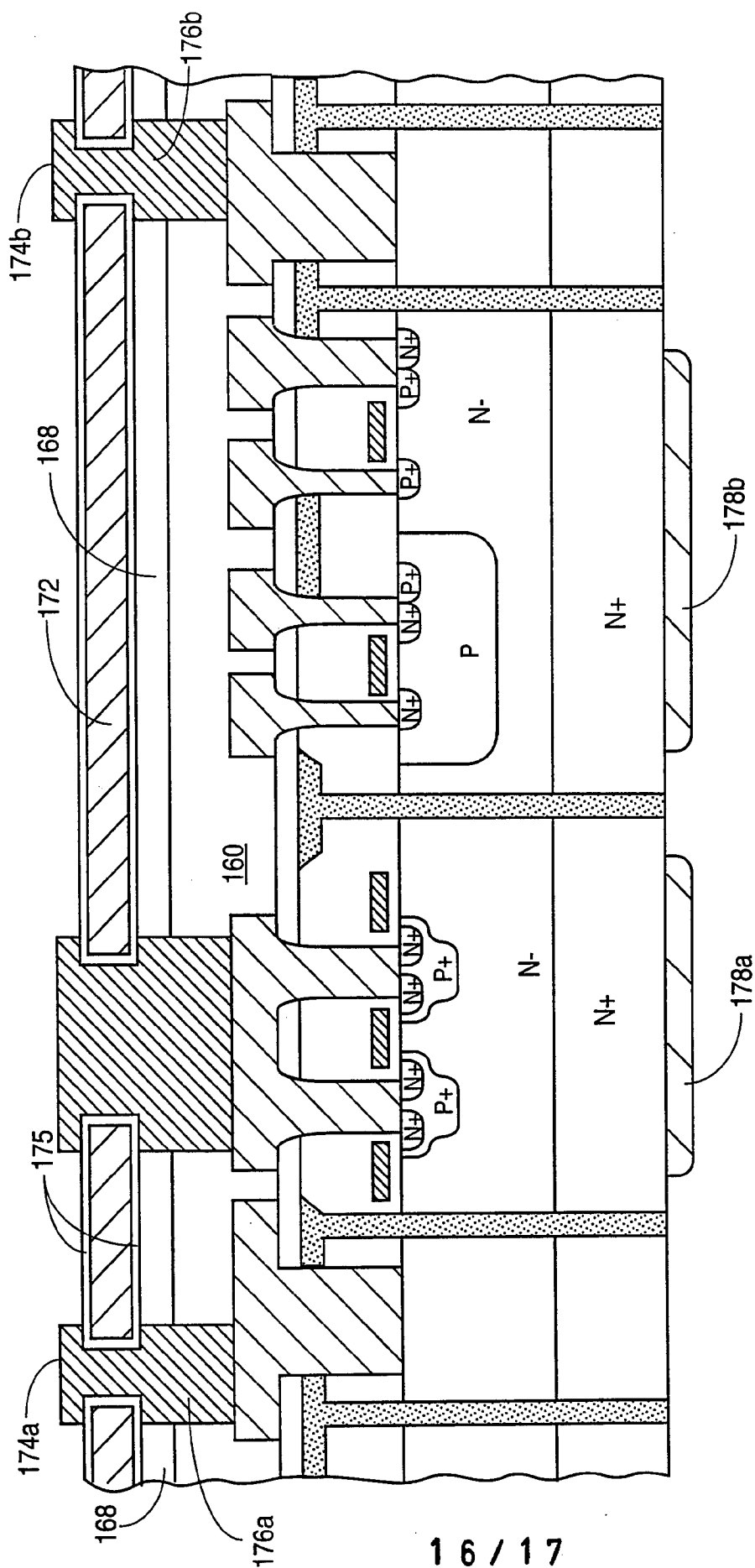


Fig. 16

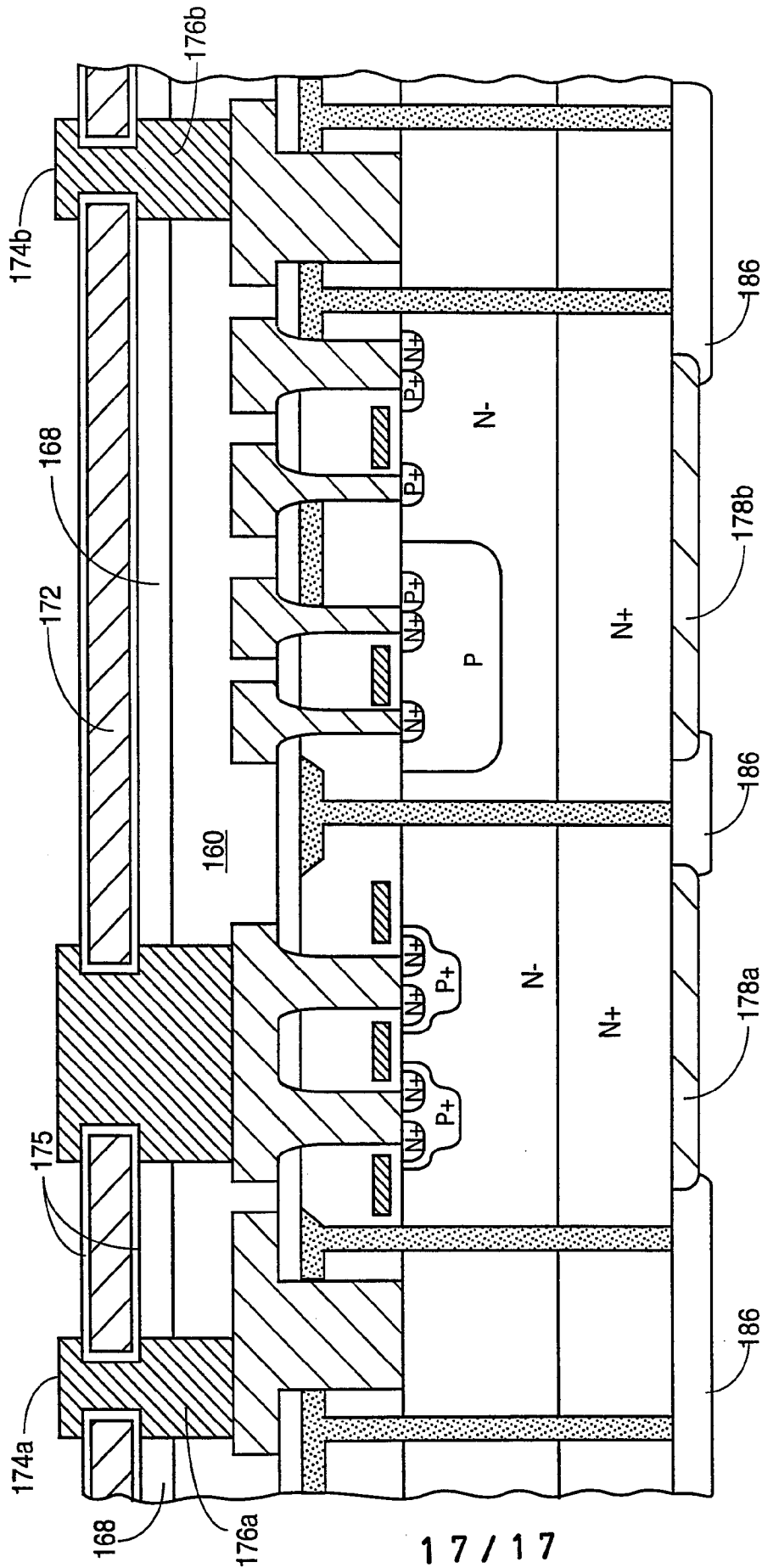


Fig. 17

17 / 17

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A. CLASSIFICATION OF SUBJECT MATTER

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US CL :257/631,686,706,724; 437/62,63

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
USAPS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y, E	US,A 5,426,072 (FINNILA) 20 JUNE 1995, SEE FIGURE 6.	3,5,6, 11,14,15
Y	US,A 5,272,104 (SCHRANTZ ET AL.) 21 DECEMBER 1993, SEE FIGURE 1F.	1-16
Y	US,A 5,229,643 (OHTA ET AL.) 20 JULY 1993, SEE FIGURE 6,30,31.	1-16
Y	US,A 5,170,930 (DOLBEAR ET AL.) 15 DECEMBER 1992, SEE FIGURE 4.	8,13
Y	US,A 5,091,331 (DELGADO ET AL.) 25 FEBRUARY 1992, SEE FIGURE 1E,6,7.	1-16
Y	4,972,250 (OMORI ET AL.) 20 NOVEMBER 1990, SEE WHOLE DOCUMENT	1-16

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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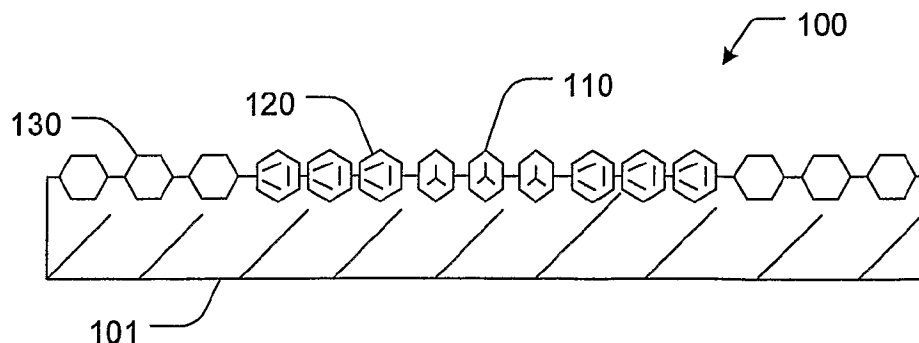
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ning of each regular issue of the PCT Gazette.*

(54) Title: CMP PADE DRESSER WITH ORIENTED PARTICLES AND ASSOCIATED METHODS



(57) Abstract: CMP pad dressers (100) with superabrasive particles (130, 120, 110) oriented into an attitude that controls CMP pad performance, and methods associated therewith are disclosed and described. The controlled CMP pad performance may be selected to optimize CMP pad dressing rate and dresser wear.

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CMP PAD DRESSER WITH ORIENTED PARTICLES AND ASSOCIATED METHODS

FIELD OF THE INVENTION

5 The present invention relates generally to devices and methods for use in connection with dressing or conditioning a chemical mechanical polishing (CMP) pad. Accordingly, the present invention involves the chemical and material science fields.

BACKGROUND OF THE INVENTION

10 Chemical mechanical process (CMP) has become a widely used technique for polishing certain work pieces. Particularly, the computer manufacturing industry has begun to rely heavily on CMP processes for polishing wafers of ceramics, silicon, glass, quartz, metals, and mixtures thereof for use in semiconductor fabrication. Such polishing processes generally entail applying the wafer against a rotating pad made from a durable organic
15 substance such as polyurethane. To the pad is added a chemical slurry containing a chemical solution capable of breaking down the wafer substance and an amount of abrasive particles which act to physically erode the wafer surface. The slurry is continually added to the spinning CMP pad, and the dual chemical and mechanical forces exerted on the wafer cause it to be polished in a desired manner.

20 Of particular importance to the quality of polishing achieved, is the distribution of the abrasive particles throughout the pad. The top of the pad holds the particles, usually by a mechanism such as fibers, or small pores, which provide a friction force sufficient to prevent the particles from being thrown off of the pad due to the centrifugal force exerted by the pad's spinning motion. Therefore, it is important to keep the top of the pad as flexible as
25 possible, and to keep the fibers as erect as possible, or to assure that there are an abundance of openings and pores available to receive new abrasive particles.

 A problem with maintaining the top of the pad is caused by an accumulation of polishing debris coming from the work piece, abrasive slurry, and dressing disk. This accumulation causes a "glazing" or hardening of the top of the pad that mats the fibers down,
30 thus making the pad less able to hold the abrasive particles of the slurry, and thus significantly decreases the pad's overall polishing performance. Further, with many pads the pores used to hold the slurry become clogged, and the overall asperity of the pad's polishing surface becomes depressed and matted. Therefore, attempts have been made to revive the top of the pad by "combing" or "cutting" it with various devices. This process has come to be

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known as “dressing” or “conditioning” the CMP pad. Many types of devices and processes have been used for this purpose. One such device is a disk with a plurality of super hard crystalline particles, such as diamond particles attached to a surface, or substrate thereof.

Yet another disadvantage with modern CMP pad dressers is reduced life of the pad conditioner and CMP pad. As noted, abrasive particles and CMP pads can wear out prematurely when the particles cut too deeply into the pad and consume the pad unnecessarily. Such premature wear reduces the ability of the CMP pad dresser to effectively polish the work piece. When functioning optimally, the abrasive particles act to refurbish the asperities in the CMP pad, and thus create an optimal polishing environment.

The rate at which a CMP pad is dressed may affect the surface roughness of the pad, which in turn may determine the amount of slurry held on the surface and thus affect polishing rate. In general, the polishing rate of the wafer is proportional to the dressing rate. However, if the dressing rate is excessive, the pad surface may become overly rough, and thus decrease the uniformity of the polished wafer. As such, optimizing the dressing rate may improve polishing rate without adversely affecting the quality of the wafer.

In view of the foregoing, it is desirable to obtain CMP pad dressers and methods configured to control dresser performance in order to achieve optimal dressing results, with maximized efficiency and lifespan for various applications.

SUMMARY OF THE INVENTION

Accordingly, in one aspect, the present invention provides methods and CMP pad dresser configurations for controlling CMP pad dresser performance. In one such method, a CMP pad dresser is provided which employs a plurality of superabrasive particles each coupled to a substrate member and oriented into an attitude that provides anticipated performance characteristic as part of the CMP pad dresser fabrication performance. In other aspects, the performance characteristic of the present invention can optimize dressing rate and dresser wear. Furthermore, in another aspect of the present invention, the performance characteristic can be an optimized balance of dressing rate and dresser wear. It has been discovered that orienting the superabrasive particles in a predetermined pattern or configuration can enhance and optimize the dressing rate and dresser wear. More particularly, a method that employs superabrasive particles to have a predetermined attitude can control the dresser performance characteristics.

In accordance with one aspect of the present invention, the method involves providing a substrate, and then coupling a plurality of superabrasive particles to the substrate such that

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the superabrasive particles are oriented in an attitude that provides optimal dresser characteristics. The coupled superabrasive particles can be substantially configured in an attitude having an apex portion oriented towards a pad to be dressed. Further, the superabrasive particles can be configured in an attitude having an edge portion or face portion oriented towards a pad to be dressed. Such varied orientation can alter the dresser performance characteristics to obtain a dresser that has an optimized dressing rate and dresser wear.

In an another aspect, superabrasive particles in a central location can be oriented in an attitude having an apex portion oriented toward a pad to be dressed and superabrasive particles in a peripheral location can be disposed on the substrate or surface in an attitude having either a face or an edge portion oriented toward a pad to be dressed. Varied orientations can create various asperity patterns in the CMP pad. Such patterns can provide variability in the dresser performance by providing asperities that increase the wafer polishing rate while reducing the particle wear. For example, in one aspect, the dresser rate and dresser wear can be balanced by configuring the attitude of centrally located particles to be an apex, the attitude of the peripherally located particles to be a face and any particles therebetween to have an attitude of an edge oriented towards a pad to be dressed.

In yet another aspect of the present invention, a method for optimizing dresser performance may include providing a CMP pad dresser having a plurality of superabrasive particles centrally located which are of a lower quality than peripherally located superabrasive particles. The lower quality can be a number of characteristics such as, lower internal quality, lower shape quality, etc. It has been found that particles of lower shape quality, such as irregular shapes, can dress a CMP pad more aggressively than those of higher shape quality, however, the lower quality particles have a slower pad dressing rate because they are prone to chipping and breaking. On the other hand, the higher shape qualities, such as octahedral or cubo-octahedral, dress less aggressively, however, have more durability, allowing for a higher dressing rate. The durability also helps shield the inner or central particles from excessive wear. Therefore, placing a lower quality particle in the central location of the pad dresser and a higher quality particle on the peripheral, can result in a balanced dressing rate and dresser wear.

In addition to the above-recited methods of use, the present invention also includes methods for producing a CMP pad dresser that optimizes dresser performance by orienting the superabrasive particles in a predetermined pattern. Generally speaking, such a method may include providing a substrate, selecting an attitude for superabrasive particles that

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provides an anticipated performance characteristic, orienting the superabrasive particles in an attitude in relation to the substrate, and bonding the superabrasive particles to the substrate in the selected attitude.

Using the methods described above, CMP pad dressers exhibiting considerable advantages may be created. For example, the CMP pad dressing performance can be controlled to optimize CMP pad dressing rate and dresser wear. Such optimized performance can create a balance between dresser wear and dressing rate, thus lengthening the service life of the dresser, while maximizing the rate at which the dresser grooms the pad.

The above-recited features and advantages of the present invention will become apparent from a consideration of the following detailed description presented in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of a CMP pad dresser in accordance with one embodiment of the present invention.

FIG. 2 is a side view of a CMP pad dresser in accordance with one embodiment of the present invention.

FIG. 3 is a side view of a CMP pad dresser in accordance with one embodiment of the present invention.

FIG. 4 is a side view of a CMP pad dresser in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Before the present CMP pad dresser and accompanying methods of use and manufacture are disclosed and described, it is to be understood that this invention is not limited to the particular process steps and materials disclosed herein, but is extended to equivalents thereof as would be recognized by those ordinarily skilled in the relevant arts. It should also be understood that terminology employed herein is used for the purpose of describing particular embodiments only and is not intended to be limiting.

It must be noted that, as used in this specification and the appended claims, the singular forms "a," and, "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to an "abrasive particle" or a "grit" includes reference to one or more of such abrasive particles or grits.

Definitions

In describing and claiming the present invention, the following terminology will be used in accordance with the definitions set forth below.

As used herein, “superabrasive particles” and “superabrasive grit” or similar phrases
5 may be used interchangeably, and refer to any natural or synthetic super hard crystalline, or polycrystalline substance, or mixture of substances and include but are not limited to diamond, polycrystalline diamond (PCD), cubic boron nitride (cBN), and polycrystalline cubic boron nitride (PcBN). Further, the terms “abrasive particle,” “grit,” “diamond,” “polycrystalline diamond (PCD),” “cubic boron nitride,” and “polycrystalline cubic boron
10 nitride, (PcBN),” may be used interchangeably.

As used herein, “superhard” and “superabrasive” may be used interchangeably, and refer to a crystalline, or polycrystalline material, or mixture of such materials having a Vicker’s hardness of about 4000 Kg/mm² or greater. Such materials may include without
15 limitation, diamond, and cubic boron nitride (cBN), as well as other materials known to those skilled in the art. While superabrasive materials are very inert and thus difficult to form chemical bonds with, it is known that certain reactive elements, such as chromium and titanium are capable of chemically reacting with superabrasive materials at certain
temperatures.

As used herein, “substrate” means a portion of a CMP dresser which supports
20 abrasive particles, and to which abrasive particles may be affixed. Substrates useful in the present invention may be any shape, thickness, or material, that is capable of supporting abrasive particles in a manner that is sufficient provide a tool useful for its intended purpose. Substrates may be of a solid material, a powdered material that becomes solid when processed, or a flexible material. Examples of typical substrate materials include without
25 limitation, metals, metal alloys, ceramics, and mixtures thereof. Further the substrate may include brazing alloy material.

As used herein, “leading edge” means the edge of a CMP pad dresser that is a frontal edge based on the direction that the CMP pad is moving, or the direction that the pad is moving, or both. Notably, in some aspects, the leading edge may be considered to
30 encompass not only the area specifically at the edge of a dresser, but may also include portions of the dresser which extend slightly inward from the actual edge. In one aspect, the leading edge may be located along an outer edge of the CMP pad dresser. In another aspect, the CMP pad dresser may be configured with a pattern of abrasive particles that provides at least one effective leading edge on a central or inner portion of the CMP pad dresser working

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surface. In other words, a central or inner portion of the dresser may be configured to provide a functional effect similar to that of a leading edge on the outer edge of the dresser.

As used herein, "sharp portion" means any narrow portion to which a crystal may come, including but not limited to corners, ridges, edges, obelisks, and other protrusions.

5 As used herein, "centrally located particle," "particle in a central location" and the like mean any particle of a dresser that is located in an area of a dresser that originates at a center point of the dresser and extends outwardly towards the dresser's edge for up to about 90% of the radius of the dresser. In some aspects, the area may extend outwardly from about 20% to about 90% of the radius. In other aspects, the area may extend out to about 50% of
10 the radius. In yet another aspect, the area may extend out to about 33% of the radius of a dresser.

As used herein, "peripherally located," "particles in a peripheral location" and the like, mean any particle of a dresser that is located in an area that originates at the leading edge or outer rim of a dresser and extends inwardly towards the center for up to about 90% of
15 the radius of the dresser. In some aspects, the area may extend inwardly from about 20% to 90% of the radius. In other aspects, the area may extend in to about 50% of the radius. In yet another aspect, the area may extend in to about 33% of the radius of a dresser (i.e. 66% away from the center).

As used herein, "working end" refers to an end of a particle which is oriented towards
20 the CMP pad and during a dressing operation makes contact with the pad. Most often the working end of a particle will be distal from a substrate to which the particle is attached.

As used herein, "quality" means a degree or grade of excellence. Each characteristic or property of a superabrasive particle such as internal crystalline perfection, shape, etc. may be ranked in order to determine the quality of the particle. A number of established quality
25 scales exist in the area of diamonds and other superabrasives, such as the Gemological Institute of America (GIA) Diamond Grading Report or the GIA Scale, which will be well recognized by those of ordinary skill in the art.

As used herein, "amorphous braze" refers to a homogenous braze composition having a non-crystalline structure. Such alloys contain substantially no eutectic phases that melt
30 incongruently when heated. Although precise alloy composition is difficult to ensure, the amorphous brazing alloy as used herein should exhibit a substantially congruent melting behavior over a narrow temperature range.

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As used herein, "alloy" refers to a solid or liquid mixture of a metal with a second material, said second material may be a non-metal, such as carbon, a metal, or an alloy which enhances or improves the properties of the metal.

As used herein, "metal brazing alloy," "brazing alloy," "braze alloy," "braze material," and "braze," may be used interchangeably, and refer to a metal alloy which is capable of chemically bonding to superabrasive particles, and to a matrix support material, or substrate, so as to substantially bind the two together. The particular braze alloy components and compositions disclosed herein are not limited to the particular embodiment disclosed in conjunction therewith, but may be used in any of the embodiments of the present invention disclosed herein.

As used herein, the process of "brazing" is intended to refer to the creation of chemical bonds between the atoms of the superabrasive particles and the braze material. Further, "chemical bond" means a covalent bond, such as a carbide, nitride, or boride bond, rather than mechanical or weaker inter-atom attractive forces. Thus, when "brazing" is used in connection with superabrasive particles a true chemical bond is being formed. However, when "brazing" is used in connection with metal to metal bonding the term is used in the more traditional sense of a metallurgical bond. Therefore, brazing of a superabrasive segment to a tool body does not require the presence of a carbide, nitride, or boride former.

As used herein, in conjunction with the brazing process, "directly" is intended to identify the formation of a chemical bond between the superabrasive particles and the identified material using a single brazing metal or alloy as the bonding medium.

As used herein, "ceramic" refers to a hard, often crystalline, substantially heat and corrosion resistant material which may be made by firing a non-metallic material, sometimes with a metallic material. A number of oxide, nitride, and carbide materials considered to be ceramic are well known in the art, including without limitation, aluminum oxides, silicon oxides, boron nitrides, silicon nitrides, and silicon carbides, tungsten carbides, etc.

As used herein, "metallic" means any type of metal, metal alloy, or mixture thereof, and specifically includes but is not limited to steel, iron, and stainless steel.

As used herein, "grid" means a pattern of lines forming multiple squares.

As used herein with respect to distances and sizes, "uniform" refers to dimensions that differ by less than about 75 total micrometers.

As used herein, "attitude" means the position or arrangement of a superabrasive particle in relation to a defined surface, such as a substrate to which it is attached, or a CMP pad to which it is to be applied during a work operation. For example, a superabrasive

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particle can have an attitude that provides a specific portion of the particle in orientation toward a CMP pad.

As used herein, "working end" refers to an end of a particle which is oriented towards the CMP pad and during a dressing operation makes contact with the pad. Most often the working end of a particle will be distal from a substrate to which the particle is attached.

As used herein, a plurality of items, structural elements, compositional elements, and/or materials may be presented in a common list for convenience. However, these lists should be construed as though each member of the list is individually identified as a separate and unique member. Thus, no individual member of such list should be construed as a de facto equivalent of any other member of the same list solely based on their presentation in a common group without indications to the contrary.

Concentrations, amounts, and other numerical data may be expressed or presented herein in a range format. It is to be understood that such a range format is used merely for convenience and brevity and thus should be interpreted flexibly to include not only the numerical values explicitly recited as the limits of the range, but also to include all the individual numerical values or sub-ranges encompassed within that range as if each numerical value and sub-range is explicitly recited. As an illustration, a numerical range of "about 1 to about 5" should be interpreted to include not only the explicitly recited values of about 1 to about 5, but also include individual values and sub-ranges within the indicated range. Thus, included in this numerical range are individual values such as 2, 3, and 4 and sub-ranges such as from 1-3, from 2-4, and from 3-5, etc.

This same principle applies to ranges reciting only one numerical value. Furthermore, such an interpretation should apply regardless of the breadth of the range or the characteristics being described.

The Invention

The present invention provides devices and methods for optimizing the dressing performance of a chemical mechanical polishing (CMP) pad dresser that employs superabrasive particles. By orienting such particles into certain attitudes, it has been discovered that the dressing rate and dresser wear can be controlled. In one aspect, performance is optimized through configurations that improve the longevity of the superabrasive particles on the dresser and the useful service life of the CMP pad, while maintaining sufficient CMP pad dressing rates.

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FIG. 1 shows a CMP pad dresser in accordance with one embodiment of the present invention. The CMP pad conditioner 100 includes a substantially flat substrate 101, having a plurality of superabrasive particles 110, 120, and 130 coupled thereto. Each of the superabrasive particles is oriented in a particular attitude that provides a desired working portion such as an apex, an edge, or a face that contacts the CMP pad during a dressing operation.

The optimization of wear of the dresser and the dressing rate of a CMP pad is dependent on many factors, among them the orientation of the superabrasive particles. Various types of superabrasive particles may be utilized in various aspects of the present invention. For example, such materials may include without limitation, diamond, polycrystalline diamond (PCD), cubic boron nitride (cBN) and polycrystalline cubic boron nitride (PcBN). In some aspects, the superabrasive particles may include diamond. In one aspect, the diamond superabrasive particles may exhibit a combination of cubic and octahedral faces. Further, the superabrasive particles can be of a predetermined shape. For example, the superabrasive particles can be a euhedral shape or either a octahedral or cubo-octahedral shape. Though virtually any size of superabrasive particle would be considered to be within the scope of the present invention, in one aspect the particles may range in size from about 100 to 350 micrometers. Additionally, the superabrasive particles can be oriented in many directions relative to the pad, but there are three major orientations or attitudes that may affect the particle's cutting or grooming behavior. These attitudes expose either an apex, an edge, or a face of the superabrasive particle towards a CMP pad being dressed.

Orienting the superabrasive particles in a specific attitude in relation to the CMP pad to be dressed creates different asperities in the pad surface, thus altering the performance of the CMP pad. Different asperities retain slurry in different manners and thus polish the silicon chip wafer differently according to asperity depth, width, density, etc. The superabrasive particles of a CMP pad dresser can be oriented according to the desired polishing characteristics of the CMP pad. For example, if the superabrasive particles predominantly have an apex oriented towards the CMP pad, the asperities of the pad will be narrow and deep. The advantage of narrow and deep asperities are that the pad can better retain the polishing slurry, and thus the polishing rate of the wafer increases. However, the increased polishing rate may also increase the wear rate of the superabrasive particles. As such, wear rate may vary considerably depending on the attitude of the superabrasive particles, and therefore, the orientation of each superabrasive particle may be considered when designing a device with desired performance characteristics. Generally speaking,

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superabrasive particle attitudes that provide higher dressing rates (i.e. deeper penetration into a pad) also wear particles out at a higher rate.

In contrast, if the superabrasive particles are oriented with a face towards the pad, the resulting asperities may polish at a lower rate. The face of the particle is generally thought to be more durable, but does not typically cut deep and narrow asperities in the pad, but rather asperities that are shallow and broad. Therefore the face portion of a particle will dress a CMP pad at a reduced rate compared to the apex portion of a particle, but the superabrasive particle will wear at a much lower rate.

The edge portions of a superabrasive particle have dressing and wear characteristics that are between those of the face and apex portions. It has been thought that if the edge portion is utilized to dress a CMP pad, the asperities are not as deep or narrow as those dressed with an apex portion, but may provide asperities having desirable intermediate characteristics. Further, the edge portion of the particle does not wear at such a high rate as that of an apex. Hence, a CMP pad dresser utilizing all or a portion of superabrasive particles having exposed edge portions may provide a number of advantages.

Referring again to FIG. 1, the plurality of superabrasive particles are shown having various attitudes with respect to the substrate 101. Such attitudes may include an apex oriented toward a pad to be dressed as with centrally located particles 110, and edge oriented toward a pad to be dressed as with particles 120, or a face oriented toward the pad to be dressed as with peripherally located particles 130. Such an embodiment of the present invention may provide both dressing rate and dresser wear advantages. The arrangement provides centrally located particles that have aggressive dressing characteristics, while the particles located on the periphery may be more durable and shield the inner and central particles from excessive wear.

In another aspect of the present invention, FIG. 2 shows a CMP pad dresser 200 having a plurality of superabrasive particles disposed along a substrate 101, where the centrally located superabrasive particles 110 are disposed in an attitude with an apex oriented toward a pad to be dressed, and the remaining superabrasive particles 130 are disposed in an attitude with a face oriented toward a pad to be dressed.

FIG. 3 shows yet another embodiment of the present invention. In this embodiment, a CMP pad dresser 300 is shown having a plurality of superabrasive particles disposed along a substrate 101, where the superabrasive particles that are centrally located are disposed in an attitude with an apex oriented toward a pad to be dressed 110, and the remaining superabrasive particles have an attitude of an edge oriented toward a pad to be dressed 120.

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In still another aspect of the present invention, as depicted in FIG. 4, a CMP pad dresser 400 is shown, having a plurality of abrasive particles disposed along a substrate 101, where centrally located superabrasive particles are oriented in an attitude having an edge portion oriented toward a CMP pad to be dressed 120, and peripherally located superabrasive particles being oriented in an attitude having a face orient towards the CMP pad 130. In other aspects, substantially all of the superabrasive particles may be oriented in an attitude having an apex oriented towards the CMP pad (not shown), or substantially all superabrasive particles may be oriented in an attitude having an edge oriented toward the CMP pad (not shown). Various aspects are also contemplated wherein substantially all of the superabrasive particles may be oriented in an attitude having a face oriented toward the CMP pad (not shown).

In an alternative embodiment (not illustrated), the present invention discloses a method for optimizing CMP pad dressing performance by utilizing abrasive particles of different qualities. The qualities referred to can include external superabrasive particle shapes and internal superabrasive particle flaws or defects. Irregular shaped (euhedral shaped) particles often contain sharp portions or apexes which enable aggressive dressing. These sharp portions cut deep asperities in the pad that tend to increase polishing rate. However, because the irregular particles can be of a lower internal quality, they are prone to chipping that may cause wafer scratching. In contrast, abrasive particles exhibiting octahedral or cubo-octahedral shapes provide a higher shape quality and/or higher durability quality. The higher quality particles lacks sharp portions as compared to irregular particles, and are thus less prone to chipping, breaking, and subsequently scratching the wafer.

The present invention further provides a method to utilize abrasive particles having different qualities. For example, the present invention discloses a CMP pad dresser having a plurality of superabrasive particles coupled to a substrate, where the centrally located superabrasive particles are of a lower quality than the peripherally located superabrasive particles. In other words, the peripherally located superabrasive particles are of a higher quality. Lower quality can include a lower internal quality, a lower shape quality, etc. A lower internal quality can include the number of flaws and/or inclusions in a superabrasive particle. A lower shape quality can include a superabrasive particle having an irregular shape, while a higher shape quality can include a superabrasive particle having an octahedral or cubo-octahedral shape. The present invention presents an arrangement of superabrasive particles where the higher quality superabrasive particles are located near the periphery of the dresser, which helps to protect and shield the centrally located lower quality particles from

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chipping and breaking. The present configuration can control CMP pad dresser performance, thus optimizing dresser wear and dressing rate.

The present invention additionally encompasses methods for manufacturing a CMP pad dresser as recited herein. In one aspect, such a method may include providing a
5 substrate, selecting an attitude for superabrasive particles that provides an anticipated performance characteristic, orienting the superabrasive particles into the selected attitude in relation to the substrate, and bonding the abrasive particles to the substrate in the selected attitude. The substrate of the various aspects of the present invention can be made of a metallic, a ceramic, a powder, a metallic powder, or a flexible material. In a one embodiment
10 the substrate can be stainless steel.

Particle placement and methods and materials for affixing superabrasive particles to a substrate in predetermined configurations, such as grid, may be found in U.S. Patent 6,039,641, U.S. Patent 6,286,498, U.S. Patent 6,368,198, and Applicant's copending U.S. Patent Application Serial No. 10/109,531 filed March 27, 2002, each of which is incorporated
15 herein by reference in their entirety.

Finally, the superabrasive particles may be coupled to a substrate that is made of metallic powders. Metallic powders may be selected from a number of materials known for forming a substrate. Further such metallic powder may contain brazing alloys to facilitate the brazing of the superabrasive particles. In a preprocess step, in forming a substrate, the
20 superabrasive particles may be disposed into the metallic powder prior to solidification or consolidation. During the brazing or consolidation step, the abrasive particles are chemically bonded to the substrate, providing a durable CMP pad dresser which may be less vulnerable to particle chipping and dislodging. In addition, to the brazing method previously described, the particles may be affixed to a substrate through electroplating methods.

In various aspects of the present invention, orienting the superabrasive particles in a particular attitude can be accomplished by using magnetic fields or vacuums. Placement and orientation of superabrasive particles through magnetic methods are discussed in U.S. Patent 4,916,869 and U.S. Patent 5,203,881, which are incorporated herein by reference. An example of a suitable vacuum method may be found in U.S. Patent 4,680,199, which is
30 incorporated herein by reference. Essentially, a vacuum having a chuck designed to retrieve abrasive particles through vacuum means and then dispose the abrasive particles on a substrate is discussed. The vacuum chuck tubes in the chuck can be configured with openings that orient the superabrasive particles into selected attitudes through a mechanical matching process. Once the superabrasive particles have been properly oriented, the vacuum

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disposes the superabrasive particles on the substrate to which they will be fixed without disturbing or altering the attitude of the particles. The result is a CMP pad dresser with oriented particles configured to optimize dresser performance for a desired aspect.

Numerous modifications and alternative arrangements may be devised by those skilled in the art without departing from the spirit and scope of the present invention and the appended claims are intended to cover such modifications and arrangements. Thus, while the present invention has been described above with particularity and detail in connection with what is presently deemed to be the most practical and preferred embodiments of the invention, it will be apparent to those of ordinary skill in the art that numerous modifications, including, but not limited to, variations in size, materials, shape, form, function, manner of operation, assembly, and use may be made without departing from the principles and concepts set forth herein.

CLAIMS

1. A method for controlling CMP pad dresser performance in a CMP pad dresser as part of the pad dresser fabrication process, the pad dresser employing a plurality of superabrasive
5 particles comprising:
 orienting the superabrasive particles into an attitude that provides an anticipated performance characteristic.
2. The method of claim 1, wherein the performance characteristic is an optimal pad
10 dressing rate.
3. The method of claim 1, wherein the performance characteristic is optimal pad dresser wear.
- 15 4. The method of claim 1, wherein the performance characteristic is an optimized balance of dressing rate and dresser wear.
5. The method of claim 1, wherein the superabrasive particles include members selected from a group consisting of: diamond, polycrystalline diamond (PCD), cubic boron nitride
20 (cBN), and polycrystalline cubic boron nitride (PCBN).
6. The method of claim 5, wherein the superabrasive particles include diamond.
7. The method of claim 1, wherein the superabrasive particles are arranged in a
25 predetermined pattern.
8. The method of claim 7, wherein the predetermined pattern is a grid.
9. The method of claim 1, wherein the superabrasive particles have a predetermined
30 shape.
10. The method of claim 9, wherein the predetermined shape is a euهدral shape.

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11. The method of claim 9, wherein the predetermined shape is either an octahedral or cubo-octahedral shape.

12. The method of claim 1, wherein the superabrasive particles are attached to a substrate
5 selected from the group consisting essentially of metallic materials, flexible materials, ceramic materials and mixtures thereof.

13. The method claim 1, wherein said superabrasive particles are substantially all
10 configured in an attitude having an apex portion oriented towards a pad to be dressed.

14. The method of claim 1, wherein said superabrasive particles are substantially all
configured in an attitude having an edge portion oriented toward a pad to be dressed.

15. The method of claim 1, wherein said superabrasive particles are substantially all
15 configured in an attitude having a face portion oriented toward a pad to be dressed.

16. The method of claim 12, wherein said superabrasive particles are chemically bonded
to said substrate.

17. The method of claim 12, wherein said superabrasive particles are electroplated to said
20 substrate.

18. The method of claim 1, wherein superabrasive particles in a central location on the
dresser are disposed in an attitude with an apex oriented toward a pad to be dressed, and
25 remaining abrasive particles are disposed in an attitude of either a face or an edge oriented
toward a pad to be dressed.

19. The method of claim 1, wherein superabrasive particles in a central location on the
dresser are disposed in an attitude with an apex oriented toward a pad to be dressed,
30 superabrasive particles in a peripheral location on the dresser are disposed in an attitude with
a face oriented toward a pad to be dressed, and any particles therebetween are disposed in an
attitude with an edge oriented towards a pad to be dressed.

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20. The method of claim 1, wherein superabrasive particles in a central location on the dresser are of a lower quality than superabrasive particles in a peripheral location on the dresser.
- 5 21. The method of claim 20, wherein the lower quality is a lower internal quality.
22. The method of claim 20, wherein the lower quality is a lower shape quality
23. The method of claim 22, wherein the lower quality is an irregular shape.
- 10 24. The method of claim 20, wherein the peripherally located superabrasive particles have either an octahedral or cubo-octahedral shape.
25. The method of claim 23, wherein the irregular shape provides a more aggressive
- 15 dressing action than an octahedral shape.
26. The method of claim 1, wherein said superabrasive particles have a size from about 100 to 350 micrometers.
- 20 27. A chemical mechanical polishing (CMP) pad dresser comprising:
a substrate; and
a plurality of superabrasive particles attached to the substrate, said particles being configured in an attitude that controls CMP pad dresser performance.
- 25 28. The CMP pad dresser of claim 27, wherein said superabrasive particles include members selected from the group consisting of: diamond, polycrystalline diamond (PCD), cubic boron nitride (cBN), and polycrystalline cubic boron nitride (PCBN).
29. The CMP pad dresser of claim 28, wherein said superabrasive particles include
- 30 diamond.
30. The CMP pad dresser of claim 29, wherein said superabrasive particles have a predetermined shape.

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31. The CMP pad dresser of claim 30, wherein the predetermined shape is a euhedral shape.

32. The CMP pad dresser of claim 30, wherein the predetermined shape is a octahedral or
5 cubo-octahedral shape.

33. The CMP pad dresser of claim 27, wherein said superabrasive particles are
substantially all configured in an attitude having an apex portion oriented towards a pad to be
dressed.
10

34. The CMP pad dresser of claim 27, wherein said superabrasive particles are
substantially all configured in an attitude having an edge portion oriented toward a pad to be
dressed.

15 35. The CMP pad dresser of claim 27, wherein said superabrasive particles are
substantially all configured in an attitude having a face portion oriented toward a pad to be
dressed.

36. The CMP pad dresser of claim 27, wherein said superabrasive particles are arranged
20 in a predetermined pattern.

37. The CMP pad dresser of claim 36, wherein the predetermined pattern is a grid.

38. The CMP pad dresser of claim 27, wherein said superabrasive particles are chemically
25 bonded to said substrate.

39. The CMP pad dresser of claim 27, wherein said superabrasive particles are
electroplated to said substrate.

30 40. The CMP pad dresser of claim 27, wherein superabrasive particles that are centrally
located are disposed in an attitude with an apex oriented toward a pad to be dressed, and any
remaining abrasive particles are disposed in an attitude of either a face or an edge oriented
toward a pad to be dressed.

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41. The CMP pad dresser of claim 27, wherein superabrasive particles that are centrally located are disposed in an attitude with an apex oriented toward a pad to be dressed, superabrasive particles that are peripherally located are disposed in an attitude with a face oriented toward a pad to be dressed, and any particles therebetween are disposed in an attitude of an edge oriented toward a pad to be dressed.

42. The CMP pad dresser of claim 27, wherein centrally located superabrasive particles are of a lower quality than peripherally located particles.

43. The CMP pad dresser of claim 42, wherein the lower quality is a lower internal quality.

44. The CMP pad dresser of claim 42, wherein the lower quality is a lower shape quality.

45. The CMP pad dresser of claim 44, wherein the lower quality is an irregular shape.

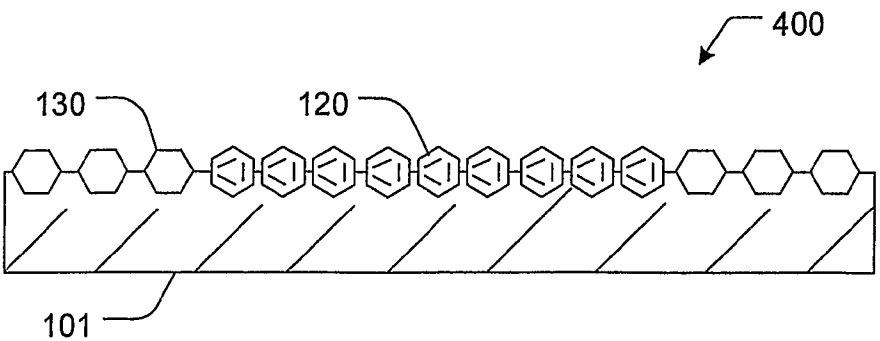
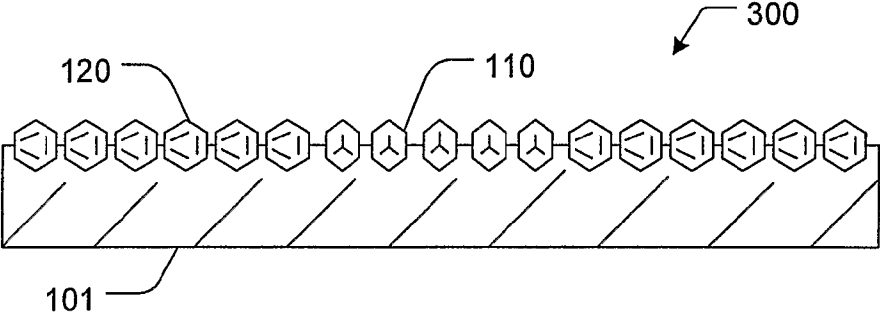
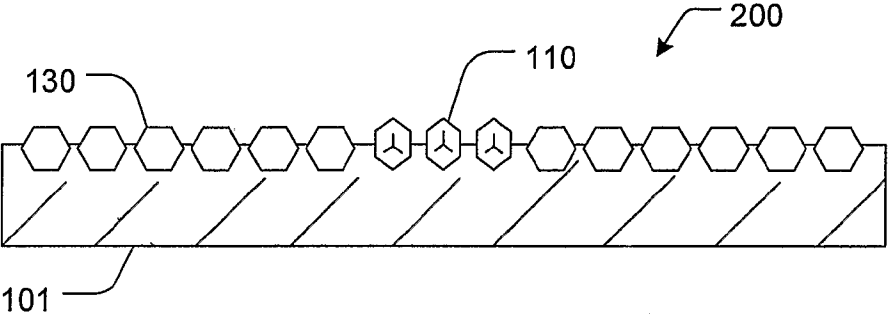
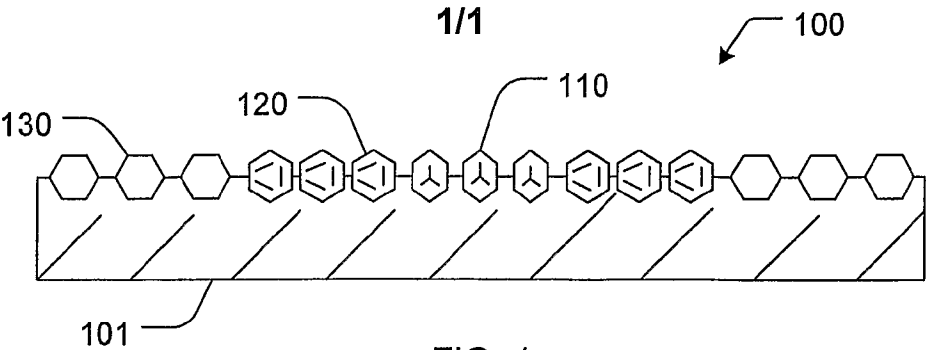
46. The CMP pad dresser of claim 42, wherein the higher quality shape is an octahedral or cubo-octahedral shape.

47. The CMP pad dresser of claim 45, wherein the irregular shape provides a more aggressive dressing action than the octahedral shape.

48. The CMP pad dresser of claim 27, wherein said superabrasive particles have a size from about 100 to 350 micrometers.

49. A method for manufacturing a CMP pad dresser as recited in Claim 27, comprising the steps of:

- providing a substrate;
- selecting an attitude for superabrasive particles that provides an anticipated performance characteristic;
- orienting the superabrasive particles into the selected attitude in relation to the substrate; and
- bonding the abrasive particles to the substrate in the selected attitude.





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[Continued on next page]

(54) **Title:** CMP PAD CONDITIONERS WITH MOSAIC ABRASIVE SEGMENTS AND ASSOCIATED METHODS

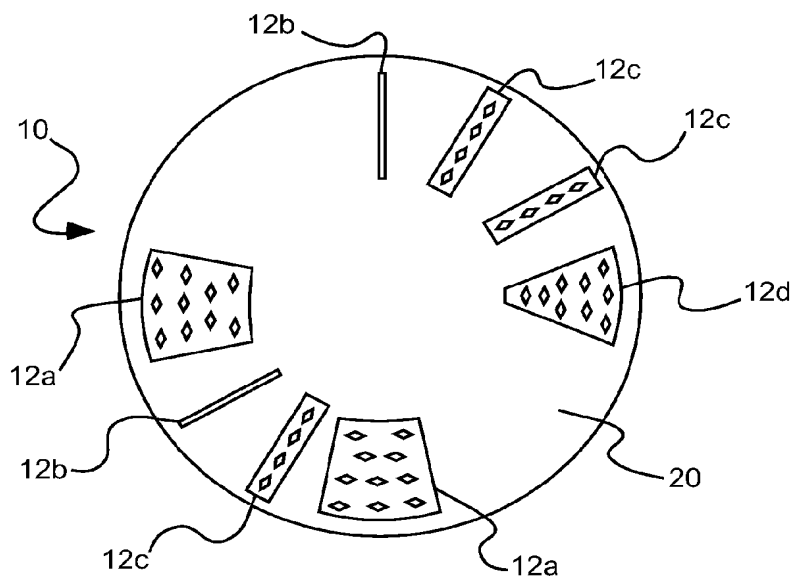


FIG. 1

(57) **Abstract:** A CMP pad conditioner comprises a plurality of abrasive segments. Each abrasive segment includes a segment blank and an abrasive layer attached to the segment blank, the abrasive layer including a superhard abrasive material. A pad conditioner substrate is also provided. Each of the plurality of abrasive segments is permanently affixed to the pad conditioner substrate in an orientation that enables removal of material from a CMP pad by the abrasive layer as the pad conditioner and the CMP pad are moved relative to one another.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/078208**A. CLASSIFICATION OF SUBJECT MATTER****B24D 7/06(2006.01)i, B24B 53/12(2006.01)i, B24B 37/00(2006.01)i, H01L 21/304(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8: B24D 7/06, B24B 53/12, B24B 37/00, H01L 21/304

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility models since 1975

Japanese Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO internal)&keywords: "abrasive", "conditioner"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2003/0054746 A1 (NUSSBAUMER, J. et al.) 20 March 2003 See abstract and figures 1 & 2	1-41
A	US 6905571 B2 (SAKUMA, N.; TSUNENARI, K.) 14 June 2005 See abstract and figure 1	1-41
A	JP 2003-071718 A (NIPPON STEEL CORP.) 12 March 2003 See abstract and figure 1	1-41

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003-0054746 A1	20.03.2003	AU 2002-300433 B2	13.09.2007
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(54) Title: CMP PAD DRESSERS

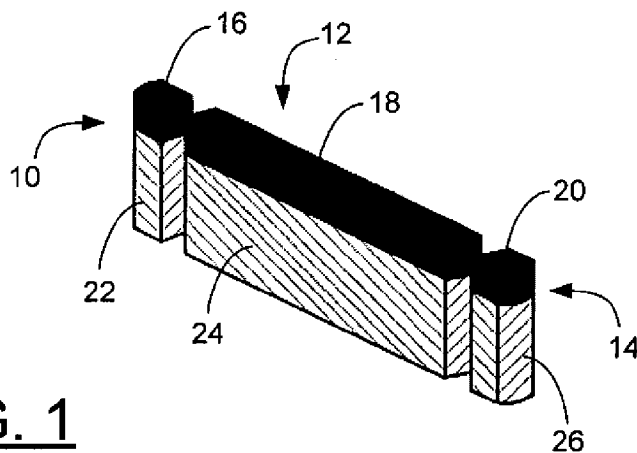


FIG. 1

(57) Abstract: An abrasive tool (112) includes an assembly of tool precursors (116). At least one of the tool precursors has a continuous polycrystalline diamond, polycrystalline cubic boron nitride, or ceramic material cutting element (18) formed into a blade shape. The abrasive tool can additionally include a setting material (68), which is configured to attach the tool precursors and form a single mass. The selection, arrangement, and setting of the tool precursors can result in an abrasive tool having a predetermined cutting configuration. Methods for forming such an abrasive tool are also disclosed.

WO 2009/064677 A2

CMP PAD DRESSERS**PRIORITY CLAIM**

This application claims the benefit of: U.S. Provisional Patent Application Serial No. 60/987,687, filed November 13, 2007; and U.S. Provisional Patent Application Serial No. 60/988,643, filed November 16, 2007, each of which is hereby incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates generally to devices and methods for use in connection with dressing or conditioning a chemical mechanical polishing (CMP) pad. Accordingly, the present invention involves the fields of chemical engineering, chemistry, metallurgy, and materials science.

BACKGROUND OF THE INVENTION

Chemical mechanical process (CMP) has become a widely used technique for polishing certain work pieces. Particularly, the computer manufacturing industry has begun to rely heavily on CMP processes for polishing wafers of ceramics, silicon, glass, quartz, metals, and mixtures thereof for use in semiconductor fabrication. Such polishing processes generally entail applying the wafer against a rotating pad made from a durable organic substance such as polyurethane. To the pad is added a chemical slurry containing a chemical solution capable of breaking down the wafer substance and an amount of abrasive particles which act to physically erode the wafer surface. The slurry is continually added to the spinning CMP pad, and the dual chemical and mechanical forces exerted on the wafer cause it to be polished in a desired manner.

To effectively work over a period of time, a CMP pad needs to be kept in good condition so that distribution of abrasive particles is optimized for each polishing. One method of reducing "glazing" or accumulation of debris on the CMP pad is dressing or conditioning the pad. Dressing refers to attempts made to revive the top of the pad by "combing" or "cutting" it with various devices. Many types of devices and processes have been used for this purpose. Some CMP pad dressers cause the CMP pads to prematurely wear out.

SUMMARY OF THE INVENTION

In accordance with one aspect of the invention, an abrasive tool can be provided and can include an assembly of tool precursors. At least one of the tool precursors can include a continuous polycrystalline diamond or polycrystalline cubic boron nitride, or
5 other ceramic material cutting element formed into a blade shape. The abrasive tool can additionally include a setting material, which is configured to attach the tool precursors and form a single mass. The selection, arrangement, and setting of the tool precursors can result in an abrasive tool having a predetermined cutting configuration.

In accordance with another aspect of the invention, an abrasive tool can be
10 provided and can include an assembly of tool precursors. The tool precursors can include at least one elongated substrate with a continuous polycrystalline diamond, cubic boron nitride (cBN), or other ceramic material cutting element on a surface thereof. The precursor assembly can provide a tool having a surface with a predetermined cutting configuration. The abrasive tool can further include a setting material configured to
15 attach the tool precursors into a single mass that forms the predetermined cutting configuration.

In accordance with another aspect of the invention, a method of forming an abrasive tool can be provided, including providing a plurality of tool precursors. At least one of the tool precursors can have a continuous diamond or cubic boron nitride, or other
20 ceramic cutting element formed in a blade shape. The method can further include securing the tool precursors together to form a tool having a working surface that includes the polycrystalline diamond, cubic boron nitride, or other ceramic material cutting element formed into a blade shape.

In accordance with another aspect of the invention, a CMP pad conditioner can
25 be provided, including a base and a plurality of cutting elements extending from the base. The plurality of cutting elements can each have a cutting tip operable to engage material of the CMP pad. At least some of the cutting elements can have a cutting tip oriented at a different elevation relative to cutting tips of other cutting elements.

In accordance with another aspect of the invention, at least one of the cutting
30 elements can include a cutting tip oriented at a greater elevation, relative to a base of

the pad conditioner, than does a cutting tip of an immediately adjacent cutting element.

In accordance with another aspect of the invention, the at least one cutting element abuts the immediately adjacent cutting element.

5 In accordance with another aspect of the invention, the cutting elements can include a cutting face oriented at 90 degrees or less relative to a surface of the CMP pad conditioned by the cutting elements.

In accordance with another aspect of the invention, the cutting elements can include a trailing edge angled to provide a relief area between the cutting elements and
10 a surface of the CMP pad conditioned by the cutting elements.

In accordance with another aspect of the invention, the cutting elements and the base can be formed from an integral piece of material. In one embodiment, the cutting elements and the base are formed from an integral piece of a polycrystalline diamond compact.

15 In accordance with another aspect of the invention, the cutting elements can be coupled to the base.

In accordance with another aspect of the invention, at least two of the cutting elements are arranged such that movement of the pad conditioner and the CMP pad relative to one another results in a first, lower elevation cutting element removing
20 material from the CMP pad, followed by a second, higher elevation cutting element removing further material from the CMP pad.

In accordance with another aspect of the invention, a method of conditioning a CMP pad is provided, including: engaging material of the CMP pad with a cutting tip of at least one cutting element; moving the cutting element and the CMP pad relative
25 to one another to thereby remove material from the CMP pad with the cutting tip of the cutting element to create an exposed layer of CMP pad material; engaging the exposed layer of CMP pad material with the cutting tip of the cutting element, or with a cutting tip of a second cutting element; and moving the cutting element engaged with the exposed layer of CMP pad material and the CMP pad relative to one another
30 to thereby remove the exposed layer of CMP pad material.

In accordance with another aspect of the invention, engaging the exposed layer of CMP pad material comprises engaging the exposed layer with the cutting tip of the cutting element used to create the exposed layer.

In one embodiment, engaging the exposed layer of CMP pad material
5 comprises engaging the exposed layer with the cutting tip of the second cutting element.

In accordance with another aspect of the invention, the cutting element and the second cutting element extend from a common base.

In accordance with another aspect of the invention, a method of conditioning a
10 CMP pad is provided, including: removing, with a cutting element, a thin layer of material from the CMP pad; and removing, with the same or a different cutting element, a second layer of material from the CMP, the second layer of material being revealed by removal of the thin layer of material.

There has thus been outlined, rather broadly, various features of the invention so
15 that the detailed description thereof that follows may be better understood, and so that the present contribution to the art may be better appreciated. Other features of the present invention will become clearer from the following detailed description of the invention, taken with the accompanying claims, or may be learned by the practice of the invention.

20 **BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 is a side perspective view of a plurality of tool precursors, in accordance with an embodiment of the present invention;

FIG. 2 is a side perspective view of a tool precursor having a PCD or cBN, or ceramic layer in a blade formation, in accordance with an embodiment of the present
25 invention;

FIG. 3 is a side perspective view of a tool precursor having a PCD or cBN, or ceramic layer formed in a plurality of asperities, in accordance with an embodiment of the present invention;

FIG. 4 is a side perspective view of an assembly of tool precursors, in accordance
30 with an embodiment of the present invention;

FIG. 5 is a side perspective view of an assembly of tool precursors, in accordance with an embodiment of the present invention;

FIG. 6 is a side perspective view of an assembly of tool precursors, in accordance with an embodiment of the present invention;

5 FIG. 7 is a side perspective view of an assembly of tool precursors, in accordance with an embodiment of the present invention;

FIG. 8 is a side view of a tool precursors leveled and set in an epoxy, thus forming an abrasive tool, in accordance with an embodiment of the present invention;

10 FIG. 9 is a top view of an abrasive tool having tool precursors arranged in a spoke formation, in accordance with an embodiment of the present invention;

FIG. 10 is a perspective view of a mass from which tool precursors can optionally be formed, in accordance with an embodiment of the present invention;

FIG. 11 is a perspective view of a mass from which tool precursors can optionally be formed, in accordance with an embodiment of the present invention;

15 FIG. 12 is a side view of a mass, similar to FIG. 11, from which tool precursors can optionally be formed, in accordance with an embodiment of the present invention;

FIG. 13 is a side perspective view of a tool precursor having a PCD or CBN or ceramic layer in a blade formation, in accordance with an embodiment of the present invention;

20 FIG. 14 is a side perspective view of an assembly of tool precursors, in accordance with an embodiment of the present invention;

FIG. 15 is a side cross-sectional view of an abrasive tool, in accordance with an embodiment of the present invention;

25 FIG. 16 is a side view of a pad conditioner engaging a CMP pad in accordance with an embodiment of the invention;

FIG. 17 is a side view of another pad conditioner engaging a CMP pad in accordance with an embodiment of the invention;

FIG. 18 is a side view of another pad conditioner engaging a CMP pad in accordance with an embodiment of the invention;

30 FIG. 19 is a partial view of a pad being conditioned in accordance with another embodiment of the invention;

FIG. 20 is a top view of an exemplary pad conditioner illustrating one possible arrangement of cutting elements across the face of the pad conditioner;

FIG. 21 is a top view of another exemplary pad conditioner illustrating one possible arrangement of cutting elements across the face of the pad conditioner;

5 FIG. 22 is a top view of another exemplary pad conditioner illustrating one possible arrangement of cutting elements across the face of the pad conditioner;

FIG. 23 is a top view of another exemplary pad conditioner illustrating one possible arrangement of cutting elements across the face of the pad conditioner;

10 FIG. 24 illustrates the performance of various cutting teeth (varied in both shape and spacing) of the present invention; and

FIG. 25 illustrates a comparison of a pad dresser in accordance with the present invention as compared to conventional technology.

15 It will be understood that the above figures are merely for illustrative purposes in furthering an understanding of the invention. Further, the figures are not drawn to scale, thus dimensions and other aspects may, and generally are, exaggerated or changed to make illustrations thereof clearer. Therefore, departure can be made from the specific dimensions and aspects shown in the figures in order to produce abrasive tools or tool precursors of the present invention.

20 **DETAILED DESCRIPTION**

Before the present invention is disclosed and described, it is to be understood that this invention is not limited to the particular structures, process steps, or materials disclosed herein, but is extended to equivalents thereof as would be recognized by those ordinarily skilled in the relevant arts. It should also be understood that terminology
25 employed herein is used for the purpose of describing particular embodiments only and is not intended to be limiting.

It must be noted that, as used in this specification and the appended claims, the singular forms “a,” “an” and, “the” include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to “a CMP pad dresser” includes one or
30 more of such dressers, reference to “an operating parameter” includes reference to one or

more of such operating parameters, and reference to "the asperity" includes reference to one or more of such asperities.

Definitions

In describing and claiming the present invention, the following terminology will
5 be used in accordance with the definitions set forth below.

As used herein, the term "substantially" refers to the complete or nearly complete extent or degree of an action, characteristic, property, state, structure, item, or result. For example, an object that is "substantially" translucent would mean that the object is either completely translucent or nearly completely translucent. The exact allowable degree of
10 deviation from absolute completeness may in some cases depend on the specific context. However, generally speaking the nearness of completion will be so as to have the same overall result as if absolute and total completion were obtained. The use of "substantially" is equally applicable when used in a negative connotation to refer to the complete or near complete lack of an action, characteristic, property, state, structure,
15 item, or result. In other words, a composition that is "substantially free of" an ingredient or element may still actually contain such item as long as there is no measurable effect thereof.

The terms "dressing" and "conditioning" are interchangeable and refer to the process of rejuvenating a CMP pad by removing debris from the pad, as well as
20 optionally lifting matted fibers and creating new grooves. Likewise, the terms "dresser" and "conditioner" are used interchangeably and indicate the apparatus used for dressing or conditioning.

As used herein, "substrate" means a material which supports or can support a PCD or cBN, or ceramic layer, and to which a PCD or cBN, or ceramic layer may be
25 affixed. Substrates useful in the present invention may be any shape, thickness, or material, that is capable of supporting abrasive particles in a manner that is sufficient provide a tool useful for its intended purpose. Substrates may be of a solid material, a powdered material that becomes solid when processed, or a flexible material. Examples of typical substrate materials include without limitation, metals, metal
30 alloys, ceramics, solidified resins and polymeric materials and mixtures thereof.

As used herein, the terms "base" or "substrate" can be used to refer to a

portion of a pad conditioner that supports abrasive materials, and to which abrasive materials may be affixed, or may extend from. Substrates useful in the present invention may be any shape, thickness, or material, that is capable of supporting abrasive materials in a manner that is sufficient provide a pad conditioner useful for its intended purpose. Substrates may be of a solid material, a powdered material that becomes solid when processed, or a flexible material. Examples of typical substrate materials include without limitation, metals, metal alloys, ceramics, relatively hard polymers or other organic materials, glasses, and mixtures thereof. Further the substrate may include material that aids in attaching abrasive materials to the substrate, including, without limitation, brazing alloy material, sintering aids and the like. The substrate and the abrasive cutting elements can, in some embodiments, be formed from the same material and can be formed from an integral, single piece of material.

As used herein, "leading edge" means the edge of a CMP pad dresser that is a frontal edge based on the direction that the CMP pad is moving, or the direction that the pad is moving, or both. Notably, in some aspects, the leading edge may be considered to encompass not only the area specifically at the edge of a dresser, but may also include portions of the dresser which extend slightly inward from the actual edge. In one aspect, the leading edge may be located along an outer edge of the CMP pad dresser. In another aspect, the CMP pad dresser may be configured with a pattern of abrasive particles that provides at least one effective leading edge on a central or inner portion of the CMP pad dresser working surface. In other words, a central or inner portion of the dresser may be configured to provide a functional effect similar to that of a leading edge on the outer edge of the dresser.

As used herein, the process of "brazing" is intended to refer to the creation of chemical bonds between the atoms of the non-metallic, such as diamond, CBN, or ceramic materials and the braze material. Further, "chemical bond" means a covalent bond, such as a carbide, nitride, or boride bond, rather than mechanical or weaker inter-atom attractive forces. Thus, when "brazing" is used in connection with superabrasive particles a true chemical bond is being formed. However, when "brazing" is used in connection with metal to metal bonding the term is used in the

more traditional sense of a metallurgical bond. Therefore, brazing of a superabrasive segment to a tool body does not require the presence of a carbide, nitride, or boride former.

As used herein, "ceramic" refers to a hard, often crystalline, substantially heat and corrosion resistant material which may be made by firing a non-metallic material, sometimes with a metallic material. A number of oxide, nitride, and carbide materials considered to be ceramic are well known in the art, including without limitation, aluminum oxides, silicon oxides, boron nitrides, silicon nitrides, and silicon carbides, tungsten carbides, etc.

As used herein, "metallic" means any type of metal, metal alloy, or mixture thereof, and specifically includes but is not limited to steel, iron, and stainless steel.

As used herein, "abrasive profile" is to be understood to refer to a shape or a space defined by abrasive materials that can be used to remove material from a CMP pad. Examples of abrasive profiles include, without limitation, rectangular shapes, tapering rectangular shapes, truncated wedge shapes, wedge shapes, and the like. In some embodiments, the abrasive profile exhibited by abrasive segments of the present invention will be apparent when viewed through a plane in which the CMP pad will be oriented during removal of material from the CMP pad.

As used herein, "superhard" may be used to refer to any crystalline, or polycrystalline material, or mixture of such materials which has a Mohr's hardness of about 8 or greater. In some aspects, the Mohr's hardness may be about 9.5 or greater. Such materials include but are not limited to diamond, polycrystalline diamond (PCD), cubic boron nitride (cBN), polycrystalline cubic boron nitride (PcBN), corundum and sapphire, as well as other superhard materials known to those skilled in the art. Superhard materials may be incorporated into the present invention in a variety of forms including particles, grits, films, layers, pieces, segments, etc. In some cases, the superhard materials of the present invention are in the form of polycrystalline superhard materials, such as PCD and PcBN materials.

As used herein, "organic material" refers to a semisolid or solid complex amorphous mix of organic compounds. As such, "organic material layer" and "organic material matrix" may be used interchangeably, refer to a layer or mass of a

semisolid or solid complex amorphous mix of organic compounds. Preferably the organic material will be a polymer or copolymer formed from the polymerization of one or more monomers.

As used herein, "particle" and "grit" may be used interchangeably.

- 5 As used herein, the term "abrasive" can be used to describe a variety of structures capable of removing (e.g., cutting, polishing, scraping) material from a CMP pad. An abrasive can include a mass having several cutting points, ridges or mesas formed thereon or therein. It is notable that such cutting points, ridges or mesas may be from a multiplicity of protrusions or asperities included in the mass.
- 10 Furthermore, an abrasive can include a plurality of individual abrasive particles that may have only one cutting point, ridge or mesa formed thereon or therein. An abrasive can also include composite masses, such as PCD pieces, segment or blanks, either individually comprising the abrasive layer or collectively comprising the abrasive layer.

- 15 As used herein, the term "cutting tip" is generally used to refer to a portion of a cutting element that engages and removes material from a workpiece (generally a CMP pad). "Cutting tips" can include points, edges, surfaces, etc., that are capable of cutting material from a CMP pad. The terms "cutting tip," "edge," "blade," etc., can be, but are not always, used interchangeably.

- 20 As used herein, a plurality of components may be presented in a common list for convenience. However, these lists should be construed as though each member of the list is individually identified as a separate and unique member. Thus, no individual member of such list should be construed as a *de facto* equivalent of any other member of the same list solely based on their presentation in a common group
- 25 without indications to the contrary.

- Concentrations, amounts, particle sizes, volumes, and other numerical data may be expressed or presented herein in a range format. It is to be understood that such a range format is used merely for convenience and brevity and thus should be interpreted flexibly to include not only the numerical values explicitly recited as the
- 30 limits of the range, but also to include all the individual numerical values or sub-

ranges encompassed within that range as if each numerical value and sub-range is explicitly recited.

As an illustration, a numerical range of “about 1 to about 5” should be interpreted to include not only the explicitly recited values of about 1 to about 5, but also include individual values and sub-ranges within the indicated range. Thus, included in this numerical range are individual values such as 2, 3, and 4 and sub-ranges such as from 1-3, from 2-4, and from 3-5, etc. This same principle applies to ranges reciting only one numerical value. Furthermore, such an interpretation should apply regardless of the breadth of the range or the characteristics being described.

10 **The Invention**

It has been found that the overall CMP process can be improved through dressing or conditioning with a CMP pad dresser that effectively dresses the CMP pad, so as to optimally allow for extended CMP pad life, while reducing glazing and other negative effects on the CMP pad. Such improvements can occur as a result of precisely-machined CMP pad dressers. By utilizing dressers as disclosed herein, CMP pads can be refreshed, without losing CMP pad life as with the use of typical CMP pad dressers. Furthermore, the methods disclosed herein for creating such dressers provide a relative fast and economical way to create such precise tools. Additionally, the method provides for the creation of a CMP pad dresser that has a predetermined working surface.

In accordance with embodiments presented herein, various details are provided which are applicable to each of the CMP pad dressers and method for creating or forming the CMP pad dressers. Thus, discussion of one specific embodiment is related to and provides support for this discussion in the context of the other related embodiments.

An abrasive tool can include an assembly of tool precursors. Tool precursors can be of a variety of shapes and sizes. FIGs 1-3 illustrate a plurality of tool precursors. FIG. 1 illustrates three tool precursors 10, 12, 14. Each of the illustrated precursors includes a polycrystalline diamond (PCD), cubic boron nitride (PeBN), or ceramic layer 16, 18, 20, on one surface of a substrate 22, 24, 26, of the tool precursor. In each embodiment, the layer could alternatively comprise or consist essentially of

either PCD or PcBN. Additionally, the layer may comprise or consist of diamond in other forms, including CVD deposited diamond and also various ceramic materials.

In one embodiment (not shown), the layer may be a ceramic or PcBN layer which is overlaid with an outer layer of CVD diamond. The layers illustrated are

- 5 substantially uniform in thickness across the full area of the surface of the substrate. Tool precursor 12 illustrates an elongated tool precursor having a continuous polycrystalline diamond or polycrystalline cubic boron nitride cutting element formed thereon. In one embodiment, the tool precursor 12 of FIG. 1 can be further machined to form a blade shape as illustrated in FIG. 2. As shown, the tool precursor 30
- 10 includes an elongated substrate 32 and a continuous polycrystalline diamond or cubic boron nitride cutting element 34 on a surface of the substrate. The cutting element is formed into of a blade shape, having a single tip 36 of the cutting element substantially along the length the elongated tool precursor.

- It should be understood that while much discussion is directed to PCD,
- 15 diamond, PcBN, and/or cubic boron nitride cutting elements, other materials can be used as the cutting element, either alone or in combination with other materials, and are to be included in the scope of the disclosure herein. For example, the cutting element can comprise or consist essentially of ceramics, or other diamond or cBN films, including those deposited via chemical vapor deposition (CVD). Non-limiting
- 20 examples of ceramics that can be used as a cutting element include alumina, aluminum carbide, silica, silicon carbide, silicon nitride, zirconia, zirconium carbide, and mixtures thereof. Cutting elements can be, in one embodiment, sintered masses, partially sintered masses, and/or layers of material attached to the substrate of the tool precursor according to any method known in the art. The cutting element can, in one
- 25 aspect, include a mixture, homogeneous or otherwise, of a plurality of materials, optionally including abrasive particles. In another aspect, the cutting element can include a plurality of layers of material. As a non-limiting example, the cutting element can include a ceramic overcoated with CVD diamond.

- In one aspect, the tool precursor of FIG. 2 can be further machined to form a
- 30 plurality of asperities as illustrated in FIG. 3. As shown, the tool precursor 40 has an elongated substrate 42 with a continuous polycrystalline diamond or cubic boron

nitride cutting element 44 on one surface of the substrate. The diamond or cubic boron nitride cutting element is formed into a plurality of asperities 46 having a single tip or point. As shown, the asperities are of a pyramidal shape. Although pyramidal shape is illustrated as the asperity shape, any shape having a tip that can form an

5 asperity is to be explicitly included herein. Regarding pyramidal shapes, the pyramidal shaped asperities can include irregular and regularly shaped pyramids. Such asperities can include any three-dimensional shape having triangular non-base surfaces that converge on one point. The base shape is typically quadrilateral or trilateral, but can be any polygon shape. In the case of FIG. 3, pyramid shaped

10 asperities having a triangular base are shown and such pyramids have a substantially flat vertical side as will be explained in more detail. Alternatively, pyramids with a cubic base could be used. One of the faces of the pyramidal asperities of FIG. 3 is substantially perpendicular to the plane of the substrate surface. In such case, it is possible to pair two similar tool precursors in a back-to-front manner so as to form a

15 pyramid shape having a larger base, i.e. each tool precursor would provide approximately one half of the asperity. In the case of arranging the tool precursors of FIG. 3 in a back-to-front manner, the pyramids formed by aligning two of the tool precursors together to form a single line of pyramidal asperities have a quadrilateral base shape, with half of each base being provided by a single tool precursor. In

20 one embodiment, tool precursors of the present invention can be prepared by forming a PCD or PcBN blank with a PCD or PcBN layer attached to a substrate as shown in FIG. 10, and an elongated segment can be removed as shown. Next, an electro discharge machining (EDM) wire can be used to form the tool precursors by shaping the PCD or PcBN layer of each segment. The precursors can then be assembled into a

25 finished tool.

In one aspect, a substrate having a continuous PCD or PcBN layer can be formed into a blade shape, either through EDM wire or other grinding or material removal method. Such blade shape is illustrated in FIG. 2. With the blade shape formed, asperities can be formed through use of EDM wire, or other precise material

30 removal method. In forming asperities from a blade shape, the asperities can be formed immediately adjacent to each other, or can be spaced. The angles of each

asperity can be uniform or non-uniform. The EDM wire and other tools are easily used to sculpt the PCD or PcBN of the segments because of the fact that the individual segments present a two dimensional area to be carved rather than a three dimensional area that would have portions not easily accessible by the wire.

5 As noted, the abrasive tool is an assembly of tool precursors. The assembly can include any number of tool precursors, and can include tool precursors of varying design. Alternatively, the assembly can include a plurality of tool precursors having substantially the same shape and cutting elements. The assembly can be arranged so as to have a pattern of cutting element design. In one embodiment, an alternating
10 design may be desirable. Furthermore, assembly of the tool precursors can include varying the height dimension, or the difference of asperity or blade projection in relation to adjacent tool precursors to effectuate a particular predetermined cutting configuration.

 Non-limiting examples of arrangement of tool precursors includes alternating,
15 as illustrated in FIG. 4, with alternating asperities 50 and blades 52 tool precursors; leading as in FIG. 5, with a blade 54 on one end and a plurality of asperity tool 56 precursors attached thereto; a following pattern as in FIG. 6, with a plurality of asperities aligned such that each tip is substantially in line with the asperities of the adjacent tool precursors; and offset patterns as in FIG. 7 with a plurality of tool
20 precursors having asperities, where the asperities are aligned so as to not be in line with the asperities of the adjacent tool precursors. It should be noted that the illustrations are non-limiting arrangements of the tool precursors. Those illustrated could be combined in various ways. Additionally, blanks could be used in a variety of ways with patterns and predetermined placement so as to create a predetermined
25 cutting configuration. Blanks can include simple substrate without PCD, or could include a layer of PCD or PcBN, continuous or discontinuous, as an unformed layer or coating. Furthermore, the arrangements illustrated do not account for the variety obtained from orienting one or more tool precursor in a reverse direction, such as the back-to-front orientation with the pyramidal shaped asperities. Such orientation of the
30 tool precursors greatly increases the possibilities available for creating a cutting configuration. It should also be noted that the assemblies of tool precursors illustrated

in FIGs 4-7 can, along with a setting material, constitute the abrasive tool, or they may alternatively be a portion of an assembly of tool precursors in an abrasive tool.

Substrates used in the abrasive tool can be of a variety of compositions and shapes. In one aspect, the substrate can comprise or consist essentially of metals,
5 metallics, ceramics, organics, and combinations thereof. Furthermore, the substrate can be directly in contact with the PCD or PcBN layer, or may include a layer, continuous or discontinuous, along the interface of the PCD or PcBN and substrate.

Forming an abrasive tool includes providing a plurality of tool precursors and securing the tool precursors together, into a tool having a working surface. The
10 working surface can include a polycrystalline diamond or polycrystalline cubic boron nitride cutting element thereon. Securing the tool precursors together can include a variety of steps. In one aspect, a setting material can be used to form the consolidated tool. Non-limiting examples of steps used to secure the assembly of tool precursors include brazing, soldering, sintering, cementing, and combinations thereof. As such,
15 setting materials can include braze material, soldering material, sintering agents, cementing material, organic materials including polymeric materials and resins, and combinations thereof. Furthermore, a setting material can include an adhesive.

Any process and any related material or materials can be used to set the tool precursors into a single mass. Such materials can be distributed or used between
20 some or each of the tool precursors, or can be used to encompass that thereby set the tool precursors. One non-limiting example of a process that can be used to secure abrasive tool precursors can include securing the abrasive precursors with an organic material. The abrasive precursors can be arranged as desired against a steel or other plate, with the asperity, blade, or other tips arranged as desired. In the illustrated case
25 of FIG. 8, the tips 60 of the asperities of the tool precursors 62 are arranged against a plate 64 so as to be level. The tips can be covered with an adhesive or other covering 66, and then an epoxy 68 can be placed over the arranged tool precursors. In one aspect, the epoxy can be reinforced with glass fibers, color-coded with pigments, reinforced with backing, or any combination thereof. Once the epoxy is cured, the
30 tool precursors are arranged and set in a manner so as to provide a desired cutting surface. It should be noted that arranging the asperities and other tips in a level

manner is illustrated by the example, however such arrangement is only one embodiment of the present method and tool. It can be beneficial to deliberately arrange the tips tool precursors so as to provide for a vertical pattern, such that the asperity and other tips or points protrude different amounts from the working surface.

5

Various reverse casting methods may be utilized to set the tool precursors into a single mass. For example, a spacer layer of a material sufficiently soft so as to allow penetration of at least a tip portion of the precursors thereinto, may be applied to a working surface of a temporary substrate. The tool precursors can be arranged so that at least a portion of the cutting element of each precursor is at least partially embedded in the spacer layer and comes in contact with, or nearly in contact with, the temporary substrate. In one aspect, the tool precursors can be pressed by any mechanism or means such that the tips of asperities and/or blades come into contact with the temporary substrate. In this manner, the temporary substrate can define the final leveling contour of the assembled mass. As such, the temporary substrate can include any contour, levelness, slope, stepped, etc., according to the desired contours of the assembled mass. In an alternative aspect, the spacer layer may be optional. In yet another aspect, the spacer may be an adhesive or other organic resin.

An adhesive may be optionally applied to the temporary substrate and/or the spacer layer and/or the cutting elements to facilitate proper arrangement and temporary attachment. The adhesive used on any noted surface may be any adhesive known to one skilled in the art, such as, without limitation, a polyvinyl alcohol (PVA), a polyvinyl butyral (PVB), a polyethylene glycol (PEG), a paraffin, a phenolic resin, a wax emulsion, an acrylic resin, or combinations thereof. In one aspect, the fixative is a sprayed acrylic glue.

The spacer layer may be made from any soft, deformable material with a relatively uniform thickness, and may be selected according to particular needs of manufacturing, future use, compositional considerations of tool precursors, etc. Examples of useful materials include, but are not limited to, rubbers, plastics, waxes, graphites, clays, tapes, grafoils, metals, powders, and combinations thereof. In one aspect, the spacer layer may be a rolled sheet comprising a metal or other powder and

a binder. For example, the metal may be a stainless steel powder and a polyethylene glycol binder. Various binders can be utilized, which are well known to those skilled in the art, such as, but not limited to, a polyvinyl alcohol (PVA), a polyvinyl butyral (PVB), a polyethylene glycol (PEG), a paraffin, a phenolic resin, a wax emulsions, an
5 acrylic resin, and combinations thereof.

An at least partially uncured resin material can be applied to the spacer layer opposite of the temporary substrate. A mold, e.g. of stainless steel or otherwise, may be utilized to contain the uncured resin material during manufacture. Upon curing the resin material, a resin layer is formed, cementing at least a portion of tool precursor.
10 Optionally, a permanent tool substrate may be coupled to the resin layer to facilitate its use in dressing a CMP pad or in other uses. In one aspect, the permanent substrate may be coupled to the resin layer by means of an appropriate adhesive. The coupling may be facilitated by roughing the contact surfaces between the permanent substrate and the resin layer. In another aspect, the permanent substrate may be associated with
15 the resin material, and thus become coupled to the resin layer as a result of curing.

The mold and the temporary substrate can subsequently be removed from the CMP pad dresser once the resin is cured. Additionally, the spacer layer can be removed from the resin layer. This may be accomplished by any mechanism known in the art including peeling, grinding, sandblasting, scraping, rubbing, abrasion, etc.
20 Therefore, the protrusion of the tool precursors from the resin is dependent on the amount covered or concealed by the spacer layer. Additionally, the arrangement of the tool precursors is relatively fixed by the resin. As such, the tool precursors can be placed in a variety of configurations, thus creating a variety of configurations of a surface of an assembled tool.

25 Furthermore, the tool precursors can be set in a parallel formation, such as illustrated in FIGs 4-7, or can be placed in any arrangement that forms a desired cutting configuration. In one aspect, the tool precursors can be arranged in a spoke formation as illustrated in FIG. 9, wherein the tool precursors 70 are arranged as spokes of a wheel of the illustrated circular abrasive tool.

30 Tool precursors can be arranged at various angles to form abrasive tools. Blades can be angled to better interact with the various materials they contact. For

example, it may be found that angling a blade shaped tool precursor at a specific angle, or angling a plurality of blade shaped tool precursors at differing angles, can better handle material removal from a CMP pad.

In one embodiment, the tool precursors can be formed from a single mass. For
5 example, a substrate, such as tungsten carbide, can be formed into a desired overall tool shape. Such formation of the overall tool is not required. In FIG. 10, however, a single substrate 72 is formed into a truncated cylindrical shape. One of the circular surfaces can be covered with a PCD or PcBN layer 74. A continuous layer is illustrated in the figure; however, a discontinuous layer could likewise be used. With
10 the PCD or PcBN layer on the substrate, the individual tool precursors can be cut from the overall piece shown in FIG. 10. Once cut from the larger body, they can be of the form illustrated in FIG. 1, or any other shape cut from the larger body. Once cut, they can be further shaped, if desired. Once the tool precursors are formed, they can be optionally returned to the larger body, wherein each piece includes an inverse-image
15 of neighboring surfaces as from being cut from the same original mass. Thus would form an abrasive tool having a substantially continuous PCD or PcBN layer, supposing the original mass included a substantially continuous PCD or PcBN layer. Optionally, only portions of the original mass can be reformed into the abrasive tool. In such case, the working surface of the abrasive tool may or may not include a
20 substantially continuous PCD or PcBN layer, depending on the tool precursors selected to form the abrasive tool.

In another embodiment, another overall piece, such as that shown in FIG. 10, can be cut at a different angle, as illustrated in FIG. 11. As with FIG. 10, FIG. 11 depicts a single substrate 72 formed into a truncated cylindrical shape, with one of the
25 circular surfaces covered with a PCD or PcBN layer 74. In this case, however, the overall piece is cut at a plane between perpendicular and parallel to the surface of the PCD or PcBN layer. A view of the side of the overall piece, including an additional cutting line and illustrating the cutting angle of FIG. 11 is illustrated in FIG. 12. Cutting or dividing the overall piece at an angle can produce a tool precursor as shown
30 in FIG. 13, having an elongated substrate 78 and a continuous polycrystalline diamond or continuous polycrystalline cubic boron nitride, or other ceramic material cutting

element 80 on a surface of the substrate. The cutting element is formed into a blade shape, having a single tip of the cutting element substantially along the length the elongated tool precursor, as a result of cutting the tool precursor from the overall piece. To compare, the tool precursor of FIG. 13 is similar to the tool precursor of
5 FIG. 2, where the FIG. 2 tool precursor has been cut and undergone a shaping step to produce the blade formation. One notable difference between the two tool precursors is the flat base of the elongated substrate in FIG. 2 versus the angled base of the elongated substrate of FIG. 13.

The cutting element of the abrasive tool precursors of FIG. 13 can be further
10 shaped as with the other tool precursors disclosed herein. In a specific embodiment, a plurality of asperities can optionally be formed of the blade shape of the cutting element. Furthermore, the cutting elements having the angled base can be assembled as with other tool precursors disclosed herein. One non-limiting example is illustrated in FIG. 14, wherein abrasive precursors having a blade shaped cutting element and
15 those having pyramidal asperities are alternated. It should be noted that blanks, i.e. substrates having no cutting element, other spacers, and other configurations of tool precursors in patterned or random arrangement are contemplated by the present disclosure. Furthermore, the tool precursors having angled bases and those having flat bases can be used in combination to form abrasive tools.

20 As with previously-disclosed tool precursors, the tool precursors having a angled bases can be included in an abrasive tool. Such tool precursors can be included along with other tool precursors, or the abrasive tool can be composed of tool precursors only having the angled bases. An example abrasive tool is shown as FIG. 15, wherein the substrates 82 and cutting element 74, in this embodiment, each
25 shaped with a plurality of asperities, are held together with an epoxy 86. Such tool can be manufactured according to the methods disclosed herein, particularly with respect to the discussion around FIG. 8, and the resulting tool differs from previous embodiments primarily in that the base of the tool precursors is angled and thus creates a zig-zag design along the epoxy interface 88.

30 FIGs. 21-23 illustrate various other manners in which the tool precursors or cutting elements 70 can be arranged on the abrasive tool or pad dresser 112 to

maximize particular abrading functions while minimizing possible damage to the pad or workpiece being abraded. In these embodiments, the precursors or cutting elements are arranged such that the pad dresser or abrasive tool can “sweep” across the pad and completely, or nearly completely, dress the pad without internal features of cutting
5 elements catching or “snagging” the pad to cause unwanted asperities.

As will be appreciated, a periphery of any particular cutting element (or precursor) “knot” or assemblage is closed, such that the precursor assemblage can approach a portion of a pad (or the pad can approach the precursor assemblage) from any angle without having internal angles formed by the precursors “snag” on the pad
10 material. Also, using this technique, more of the cutting tips can be faced outwardly (from any particular assemblage of cutting elements or precursors) in the direction of pad movement. The inner side can contain fewer cutting tips for less work (and less wear). In essence, one precursor (or cutting element) assemblage is defined in the embodiments of FIGs. 21 and 22 (each assemblage formed from a plurality of the
15 precursors 70), whereas a plurality of knots or assemblages 71 are illustrated in FIG. 23, each formed from 3 precursors 70.

Turning now to FIGs. 16-20, in accordance with another aspect of the invention, various cutting devices and associated methods are provided that can be used to remove material from a CMP pad 118 in a manner that creates a smooth and
20 even surface on the CMP pad. In accordance with one embodiment, the invention provides a CMP pad conditioner (shown by arbitrary example 112 in FIG. 20) that can include a base (e.g., 114 in FIG. 20) and a plurality of cutting elements 116 extending from the base. The cutting elements 116 shown in FIG. 20 are shown in one exemplary orientation showing one manner of spacing, placement, relative size, etc.,
25 of the cutting elements. Other embodiments can include a variety of differing sizes of cutting elements or blades, different physical layouts (e.g., spacing, angular arrangement, etc.), lengths of cutting elements or blades, etc., are also encompassed by the present invention.

As shown in FIG. 16, the cutting elements 116a, 116b, etc., can each have a
30 cutting tip 120a, 120b, etc., that is operable to engage material of the CMP pad 118. At least some of the cutting elements can have a cutting tip oriented at a different

elevation relative to cutting tips of other cutting elements. For example, in the embodiment illustrated in FIG. 16, cutting tip 120a of cutting element 116a is oriented at a lower elevation than is cutting tip 120b of cutting element 116b (it is noted that, as used herein, the term "elevation" is used only to compare relative distances of elements, and does not limit the invention to orientations in a vertical plane).

In the aspect shown in FIG. 16, the pad 118 and the cutting elements 116 are moved relative to one another (e.g., the cutting elements can be moved in the direction indicated at 122) to remove material from the pad. As the cutting elements and pad are moved relative to one another, the leading cutting element 116a first engages the material of the pad and can remove a relatively thin layer of pad material. As the cutting elements progress over the pad material, trailing cutting element 116b engages the pad material and removes an additional thin layer of material. Thus, the pad material can be incrementally removed in thin layers until a smooth, even surface is applied to the pad.

In the embodiment shown in FIG. 11, the leading cutting element 116a includes a cutting tip 120a that is oriented at a greater elevation (relative to a base of the pad conditioner, which would be positioned above the cutting elements shown FIG. 16) than does the cutting tip 120b of immediately adjacent cutting element 116b.

The embodiment of FIG. 16 also includes a pair of secondary trailing cutting elements 116c, 116d having cutting tips that are aligned at about the same elevation as cutting tip 120b. In this embodiment, the cutting tips 120a and 120b perform the work of removing thin layers of the pad material, while the secondary trailing cutting elements (116c, 116d) can perform very fine smoothing of any bumps or ridges remaining after the pass of cutting tips 120a and 120b.

In the embodiment shown in FIG. 16, the cutting elements are positioned so as to abut one another and pass over (and/or through) the pad material in rapid succession. It will be appreciated from FIG. 17 that the cutting elements can also be spaced some distance from another. This aspect of the invention can be advantageous in that the pad material may be deformed slightly by the leading cutting element, and may be given time to return to a relaxed condition prior to the succeeding trailing blade passing over the location recently cut or conditioned by the leading blade.

While not so required, in one embodiment of the invention, the cutting elements can include a cutting faces (122a, for example) that are oriented at 90 degrees or less relative to a surface 126 of the CMP pad that is formed by the cutting elements. The cutting faces of the cutting elements shown in FIGs. 16 and 17 are
5 formed at about 90 degrees, while the cutting faces of the cutting elements shown in FIG. 18 are formed at an angle less than 90 degrees relative to the surface 126 formed on the pad material. In addition, the faces of the cutting blades can be curved or arcuate in nature

In the embodiment shown in FIGs. 16 and 17, the cutting elements include a
10 trailing edge 130a, 130b, etc. that is angled to provide a relief area between the cutting elements and the conditioned surface 126 of the CMP pad created by the cutting elements. However, as shown in FIG. 18, the trailing edges 140a, 140b, etc. can also be formed in a substantially parallel relationship with the surface 126 created on the pad material by the cutting elements.

15 It will be appreciated that the number of cutting elements, and the relative elevational position of the cutting tip of each cutting element, can vary. In the embodiment illustrated in FIG. 19, three cutting elements 136a, 136b and 136c are provided, each including a different elevation. In other embodiments, the cutting tips of two or more cutting elements can share a substantially common elevation, while
20 others are staggered upwardly or downwardly relative to this common elevation. In some embodiments, leading blades (e.g., blades that will first contact the pad material) will be at a relatively higher elevation than are trailing blades, as the trailing blades would not otherwise contact pad material remaining after the leading blade has passed. One exception to this generalization may be in the case of pad conditioners
25 that include trailing blades that are slightly higher than an adjacent leading blade, in the case clean up of very rough surfaces created by the leading blade requires removal of protrusions created by the leading blade. In other embodiments, many of the blades may share a common elevation. The variety of differing configurations made possible by the present invention provides a great deal of flexibility in tailoring pad
30 conditioners for specific applications.

The cutting elements or blades can be formed in a variety of manners. One

embodiment includes forming the cutting elements from a polycrystalline diamond compact or a polycrystalline cubic boron nitride compact (individual cutting elements can be formed from the compacts and attached to the base, or the base and the cutting elements can be formed from an integral piece of the compact).

5 In another aspect, the cutting elements can be formed by creating a sintered alumina plate having the basic shape of the cutting elements extending therefrom. A layer of DLC can be coated over this resulting patterned surface. Also, CVDD can be coated over a patterned surface of ceramic. In addition, a sintered SiC plate (with molten silicon used to infiltrate the pores) can be used. In another embodiment,
10 sintered silicon nitride (Si₃N₄) can be used.

 In addition, other materials can be used as the cutting elements or blades, either alone or in combination with other materials, and are to be included in the scope of the disclosure herein. For example, the cutting element can comprise or consist essentially of ceramics, or other diamond or cBN films, including those deposited via
15 chemical vapor deposition (CVD).

 Non-limiting examples of ceramics that can be used as a cutting element include alumina, aluminum carbide, silica, silicon carbide, silicon nitride, zirconia, zirconium carbide, and mixtures thereof. Cutting elements can be, in one embodiment, sintered masses, partially sintered masses, and/or layers of material
20 attached to the substrate of the tool precursor according to any method known in the art. The cutting element can, in one aspect, include a mixture, homogeneous or otherwise, of a plurality of materials, optionally including abrasive particles. In another aspect, the cutting element can include a plurality of layers of material. As a non-limiting example, the cutting element can include a ceramic overcoated with
25 CVD diamond.

 In some embodiments, the cutting elements can be generally tooth-like, individual projections. In other aspects of the invention, the cutting elements can include cutting blades. As used herein, a "cutting blade" is to be understood to refer to a cutting element that includes a length (or width, the portion referenced being the
30 portion that cuts the pad material) greater than a height (the portion that is "sunk" below an initial surface of the pad material). The cutting blades can advantageously

be used to remove a larger percentage of pad material per pass. The cutting blades can also include varying cutting angles along the length of the cutting blades, and can include individual teeth formed thereon, or therewith. Serrations, protrusions, and the like can also be formed on or in the cutting blades, or attached thereto, to enhance the cutting ability of the teeth or blades.

The cutting elements of the present invention can be associated with the base 114 in a variety of manners. In one embodiment, the cutting elements and the base are formed from an integral piece of material, such as a polycrystalline diamond compact, a polycrystalline cubic boron nitride compact, and the like. In other aspects, the cutting elements can be bonded, welded or otherwise attached to the base.

Also, various reverse casting methods may be utilized to associate the cutting elements with the base. For example, a spacer layer may be applied to a working surface of a temporary substrate. The cutting elements can be arranged so that at least a portion of each the cutting elements is at least partially embedded in the spacer layer. In one aspect, the cutting elements can be pressed by a variety of mechanisms or means such that tips of the cutting elements come into contact with the temporary substrate. In this manner, the temporary substrate can define the final leveling configuration (e.g., contour) of the finished pad conditioner/cutting tool. As such, the temporary substrate can include varying degrees and combinations of contour, levelness, slope, steps, etc., according to the desired contours of the pad conditioner/cutting tool.

An adhesive may be optionally applied to the temporary substrate and/or the spacer layer and/or the cutting elements to facilitate proper arrangement and temporary attachment. The adhesive used on any noted surface may be any adhesive known to one skilled in the art, such as, without limitation, a polyvinyl alcohol (PVA), a polyvinyl butyral (PVB), a polyethylene glycol (PEG), a paraffin, a phenolic resin, a wax emulsion, an acrylic resin, or combinations thereof. In one aspect, the fixative is a sprayed acrylic glue.

The spacer layer may be made from any soft, deformable material with a relatively uniform thickness, and may be selected according to particular needs of manufacturing, future use, compositional considerations of tool precursors, etc.

Examples of useful materials include, but are not limited to, rubbers, plastics, waxes, graphites, clays, tapes, grafoils, metals, powders, and combinations thereof. In one aspect, the spacer layer may be a rolled sheet comprising a metal or other powder and a binder. For example, the metal may be a stainless steel powder and a polyethylene glycol binder. Various binders can be utilized, which are well known to those skilled in the art, such as, but not limited to, a polyvinyl alcohol (PVA), a polyvinyl butyral (PVB), a polyethylene glycol (PEG), a paraffin, a phenolic resin, a wax emulsions, an acrylic resin, and combinations thereof.

An at least partially uncured resin material can be applied to the spacer layer opposite of the temporary substrate. A mold, e.g. of stainless steel or otherwise, may be utilized to contain the uncured resin material during manufacture. Upon curing the resin material, a resin layer is formed, cementing at least a portion of a cutting element. Optionally, a permanent tool substrate may be coupled to the resin layer to facilitate its use in dressing a CMP pad or in other uses. In one aspect, the permanent substrate may be coupled to the resin layer by means of an appropriate adhesive. The coupling may be facilitated by roughing the contact surfaces between the permanent substrate and the resin layer. In another aspect, the permanent substrate may be associated with the resin material, and thus become coupled to the resin layer as a result of curing. The mold and the temporary substrate can subsequently be removed from the CMP pad dresser once the resin is cured. Additionally, the spacer layer can be removed from the resin layer. This may be accomplished by any means known in the art including peeling, grinding, sandblasting, scraping, rubbing, abrasion, etc. Therefore, the protrusion of the cutting elements from the resin is dependent on the amount covered or concealed by the spacer layer. Additionally, the arrangement of the cutting elements can be relatively fixed by the resin. As such, the cutting elements can be placed in a variety of configurations, thus creating a variety of configurations of a surface of an assembled tool (e.g., pad conditioner).

Each of the cutting elements can include a substantially planar trailing face (e.g., 140a, 140b in FIG. 18 and 140c in FIG. 20) that can define a workpiece contact area. A combined workpiece contact area of all of the cutting elements can comprise from between about 5% of a total area of the base to about 20% of a total area of the

base. Thus, in one aspect of the invention, if a pad dresser has a diameter of about 100 mm, and the combined contact areas of the cutting element will be about 10% of that total, then the total contact area of all cutting elements can be about 7850 mm². An edge-to-area ratio of each cutting element can be about 4/mm, resulting in a total
5 edge length being about 31400 mm.

The cutting devices of the present invention can be utilized in either a wet system or a dry system. In a dry application, the cutting elements can be used to cut or plane chips from a workpiece without the presence of a liquid slurry. In a typical application, the cutting device can be mounted to a holder cushion that can be coupled
10 to a rotatable chuck. The workpiece, for example, a silicon wafer or a CMP pad, can be coupled to a vacuum chuck that provides for rotation of the workpiece. Both the rotatable chuck and the vacuum chuck can be rotated in either a clockwise or a counterclockwise direction to remove material from the workpiece. By changing the rotation of one element relative to another, more or less material can be removed in a
15 single rotation of the workpiece. For example, if the workpiece and cutting elements are rotated in the same direction (but at different speeds), less material will be removed than if they are rotated counter to one another.

In this typical application, a slurry can be applied that can aid in planing the workpiece surface. The slurry can be either a water slurry or a chemical slurry. In the
20 case where a chemical slurry is used, the chemical can be selected to provide cooling or to react with the surface of the workpiece to soften the workpiece to provide a more efficient cutting process. It has been found that the wear rate of a silicon wafer can be dramatically increased by softening its surface. For example, a chemical slurry that contains an oxidizing agent (e.g. H₂O₂) may be used to form a relatively highly
25 viscous oxide that will tend to "cling" on the wafer surface. In this case, the PCD cutting devices of the present invention need not necessarily cut the wafer, but rather can scrape the oxide off the surface of the wafer. Consequently, the sharpness of the cutting edge becomes less critical. In addition, the service life of the cutting device can be greatly extended by utilizing a slurry. For example, a PCD scraper used with a
30 slurry may last 1000 times longer than a PCD cutter.

In addition to the structural aspects discussed above, the present invention also

provides a method of conditioning a CMP pad is provided, including: engaging material of the CMP pad with a cutting tip of at least one cutting element; moving the cutting element and the CMP pad relative to one another to thereby remove material from the CMP pad with the cutting tip of the cutting element to create an exposed
5 layer of CMP pad material; engaging the exposed layer of CMP pad material with the cutting tip of the cutting element, or with a cutting tip of a second cutting element; and moving the cutting element engaged with the exposed layer of CMP pad material and the CMP pad relative to one another to thereby remove the exposed layer of CMP pad material.

10 Engaging the exposed layer of CMP pad material can comprise engaging the exposed layer with the cutting tip of the cutting element used to create the exposed layer.

Engaging the exposed layer of CMP pad material can comprise engaging the exposed layer with the cutting tip of the second cutting element.

15 The present invention also provides a method of conditioning a CMP pad, including: removing, with a cutting element, a thin layer of material from the CMP pad; and removing, with the same or a different cutting element, a second layer of material from the CMP, the second layer of material being revealed by removal of the thin layer of material.

20 Abrasive tools formed according to the methods presented herein can be used as a final abrasive tool, e.g. utilized as a CMP dresser. Alternatively, the abrasive tools can be combined, or used as an element or elements in an abrasive tool assembly to form a CMP dresser.

FIGs. 24 and 25 illustrate data associated with another aspect of the invention,
25 in which a sharpness and spacing of cutting “teeth” of various cutting elements or precursors are varied to address issues relating to asperities formed in the pad during dressing. As will be appreciated from FIG. 24, the more “rolling” cutting teeth illustrated with an angle of about 150 degrees have been shown to provide a better abrading profile than do the slightly wavy cutting teeth at about 130 degrees, and the
30 more sharp cutting teeth formed at about 90 degrees. The more rolling cutting teeth are advantageous in that tips of the cutting teeth are not prone to breakage during use,

and during manufacture or formation of the cutting teeth. This advantage increases the precision with which the cutting teeth can dress pads, and increases the life of the cutting teeth, and greatly decreases the cost for which the dressers can be manufactured.

5 The data presented in FIG. 25 illustrates the wafer profile for a WCMP with in-situ dressing of the present pad conditioner as compared to a conventional brazed diamond dressing pad. Due to the simultaneous dressing and polishing provided by the present invention, the throughput could be increased by as much as 25%.

 It is to be understood that the above-described arrangements are only
10 illustrative of the application of the principles of the present invention. Numerous modifications and alternative arrangements may be devised by those skilled in the art without departing from the spirit and scope of the present invention and any appended or following claims are intended to cover such modifications and arrangements. Thus, while the present invention has been described above with particularity and detail in
15 connection with what is presently deemed to be the most practical and preferred embodiments of the invention, it will be apparent to those of ordinary skill in the art that numerous modifications, including, but not limited to, variations in size, materials, shape, form, function and manner of operation, assembly and use may be made without departing from the principles and concepts set forth herein.

20

CLAIMS

What is claimed is:

1. An abrasive tool, comprising:
 - an assembly of tool precursors including at least one elongated substrate
 - 5 having a continuous cutting element of polycrystalline diamond, polycrystalline cubic boron nitride, or ceramic formed into a blade shape on a surface thereof; and
 - a setting material configured to attach the tool precursors into a single mass that forms a predetermined cutting configuration.
- 10 2. The abrasive tool of claim 1, comprising a plurality tool precursors having elongated substrates having a continuous cutting element formed into a blade shape on a surface thereof.
3. The abrasive tool of claim 2, wherein the blade shaped tool precursors are arranged
- 15 in a pattern, wherein the surfaces having the cutting element are oriented into substantially a single plane.
4. The abrasive tool of claim 3, wherein the pattern is an alternating pattern with at least one blank elongated substrates or elongated substrates having a continuous
- 20 cutting element formed into a non-blade shape on a surface thereof.
5. The abrasive tool of claim 1, further comprising at least one elongated substrate having a continuous cutting element formed into a plurality of asperities.
- 25 6. The abrasive tool of claim 5, wherein the plurality of asperities include pyramidal shapes.
7. The abrasive tool of claim 5, wherein the abrasive tool includes at two abrasive precursors having elongated substrates that, when placed together, form asperities
- 30 having substantially pyramidal shapes.

8. The abrasive tool of claim 1, wherein the abrasive precursors having a continuous cutting element on a surface thereof are arranged such that the protruding portions of the cutting element are substantially level.

5 9. The abrasive tool of claim 1, wherein the cutting element is polycrystalline diamond.

10. The abrasive tool of claim 1, wherein at least one abrasive tool is used as an element in an abrasive tool assembly.

10

11. The abrasive tool of claim 1, wherein the assembly includes a plurality of elongated tool precursors in a substantially parallel formation.

12. The abrasive tool of claim 1, wherein a plurality of tool precursors include
15 surfaces having an inverse profile of another tool precursor.

13. An abrasive tool, comprising:

an assembly of tool precursors, including an elongated substrate having a continuous cutting element of polycrystalline diamond polycrystalline cubic boron
20 nitride, or a ceramic material on a surface thereof, said precursor assembly providing a tool having a working surface with a predetermined cutting configuration; and
a setting material configured to attach the tool precursors into a single mass that forms the predetermined cutting configuration.

25 14. The abrasive tool of claim 13, wherein the assembly includes a plurality of tool precursors having elongated substrates and having a continuous cutting element on a surface thereof.

15. The abrasive tool of claim 14, wherein at least one of the plurality of tool
30 precursors includes a tool precursor having the continuous cutting element formed into a plurality of asperities.

16. A method of forming an abrasive tool, comprising:

providing a plurality of tool precursors, including an elongated substrate
having a continuous cutting element on a surface thereof; and

5 securing the tool precursors together, into a tool having a working surface with
a predetermined cutting configuration.

17. The method of claim 16, wherein the plurality of tool precursors includes at least one
tool precursor having a continuous cutting element formed into a plurality of asperities on
10 a surface thereof.

18. The method of claim 16, wherein the securing includes a reverse casting of the tool
precursors and setting with a setting material.

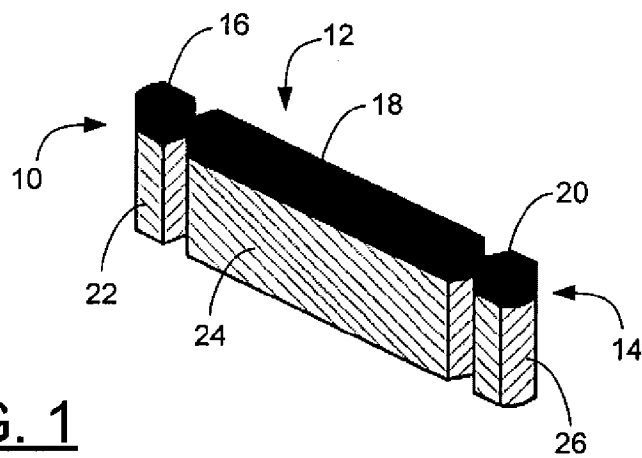
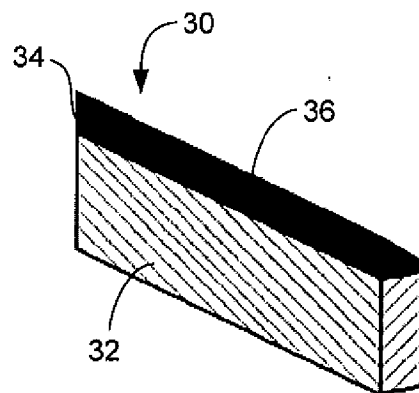
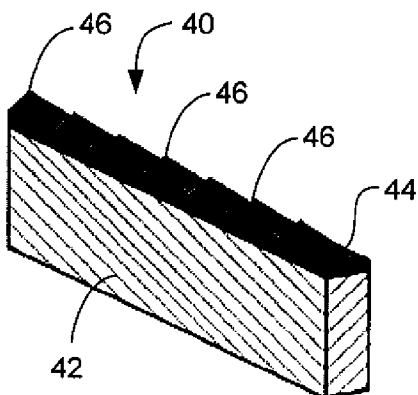
19. A method of forming an abrasive tool, comprising:

ordering a plurality of tool precursors, including at least one elongated
substrate having a continuous cutting element of polycrystalline diamond, cubic boron
nitride, or a ceramic material formed into a blade shape on a surface thereof into a
preselected design;

20 vertically arranging the plurality of tool precursors;
masking a portion of cutting element with a masking material;
setting the tool precursors together using a resinous setting material; and
removing the masking material to reveal a tool having a predetermined
working surface.

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FIG. 1FIG. 2FIG. 3

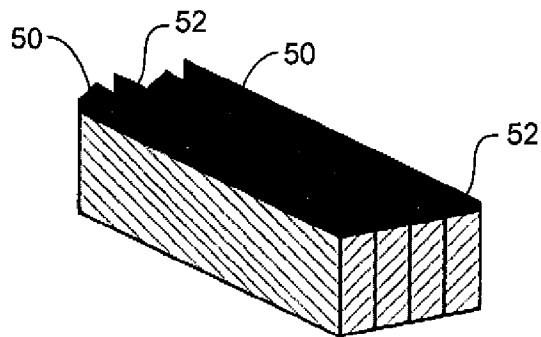


FIG. 4

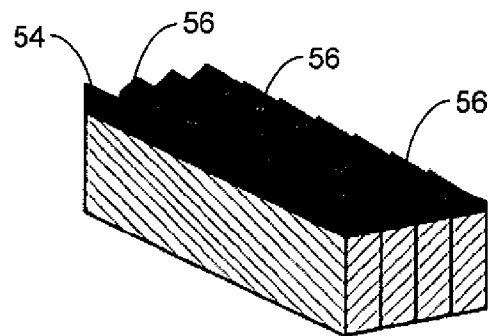


FIG. 5

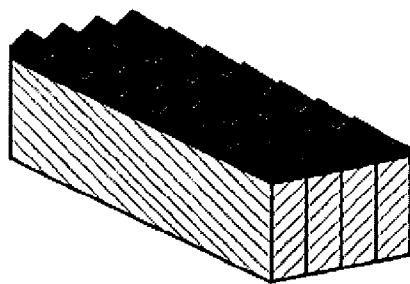


FIG. 6

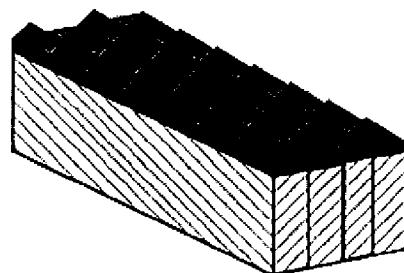
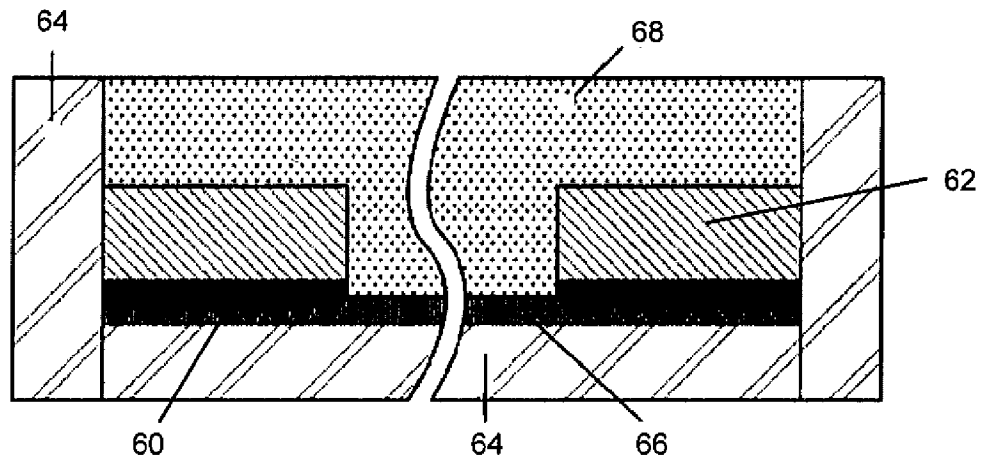
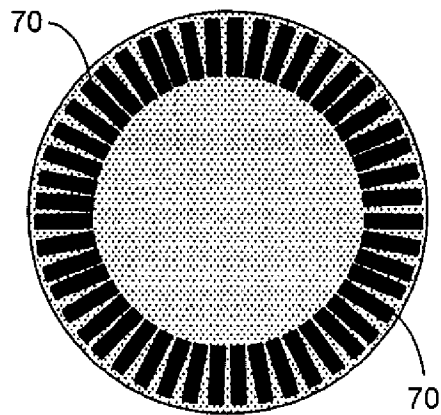
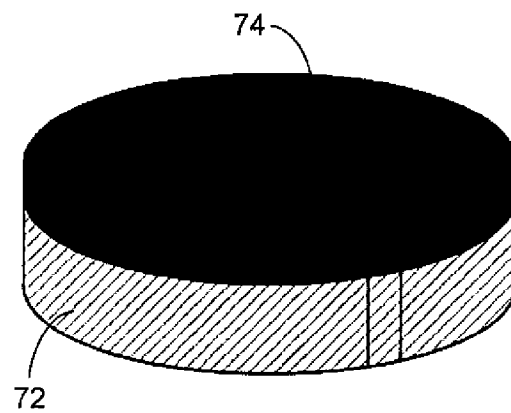
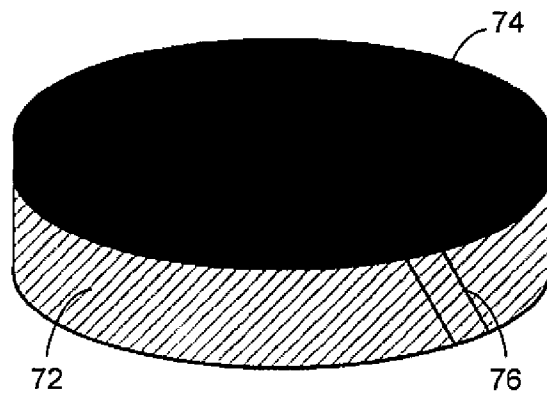
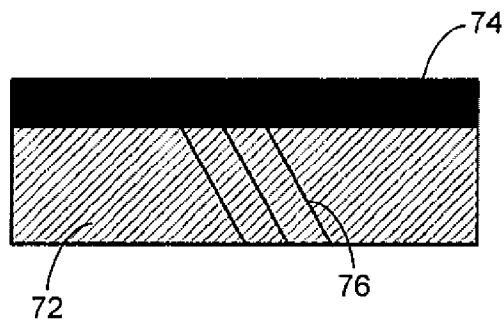
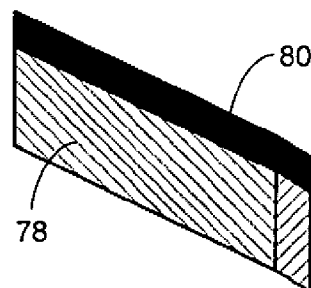


FIG. 7

FIG. 8FIG. 9FIG. 10

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FIG. 11FIG. 12FIG. 13

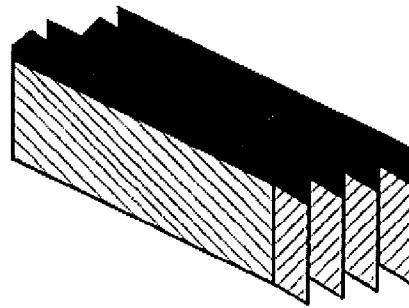


FIG. 14

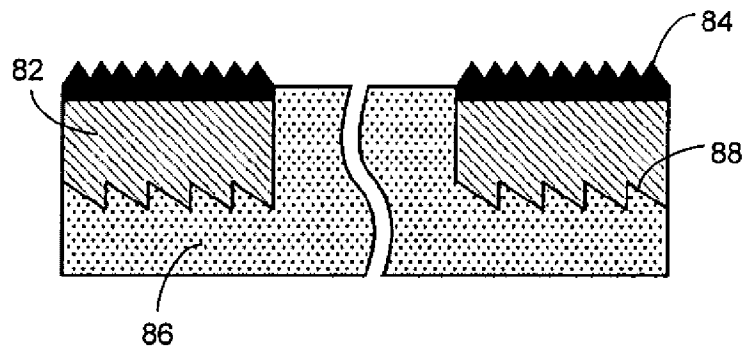
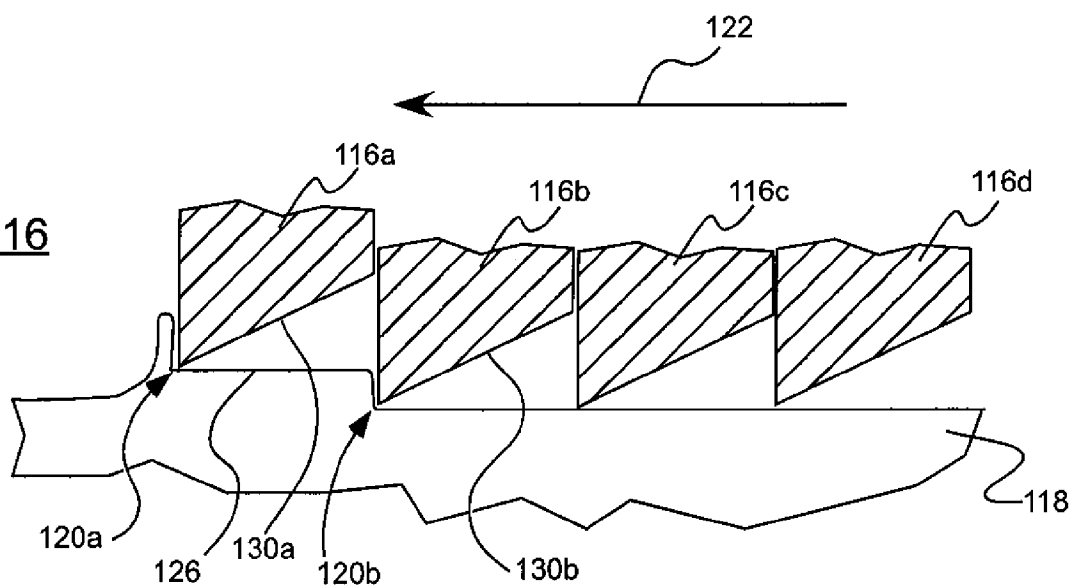
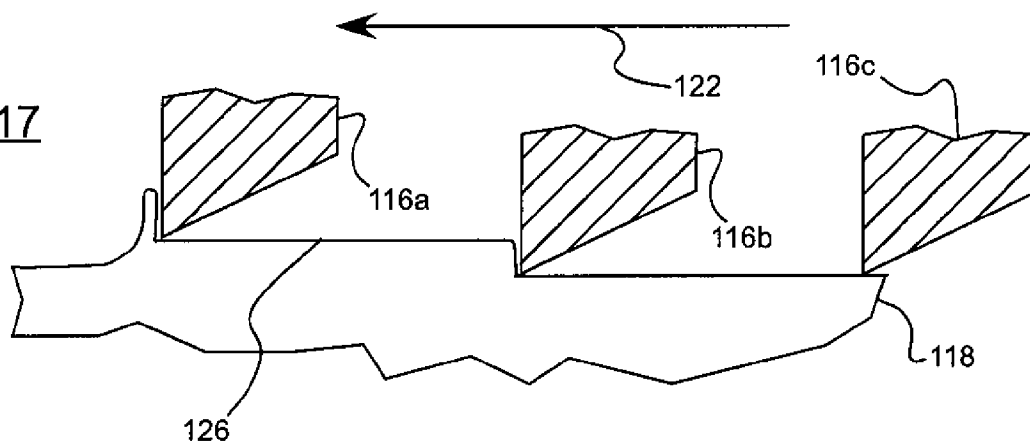
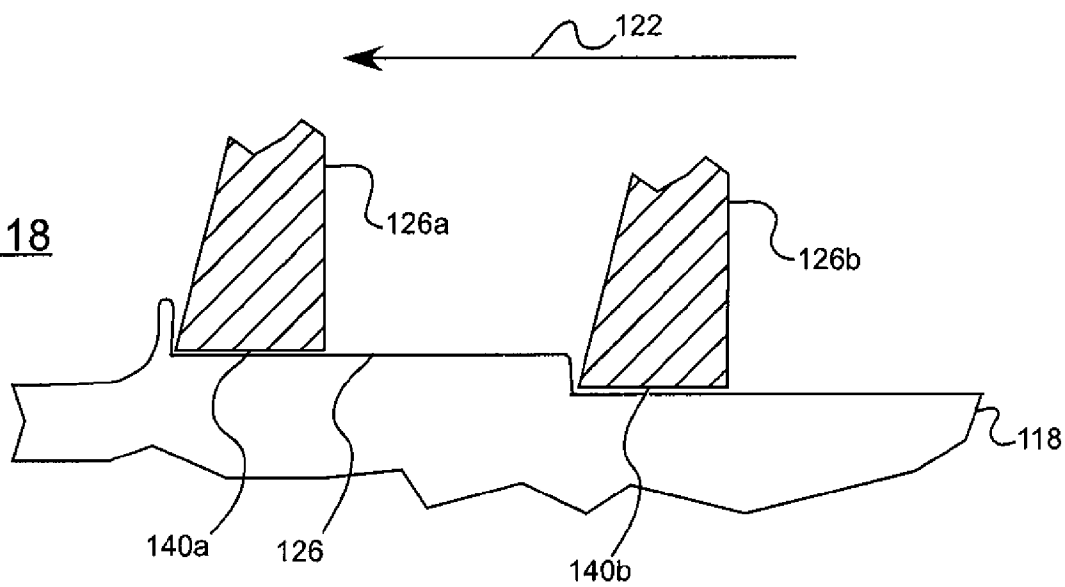
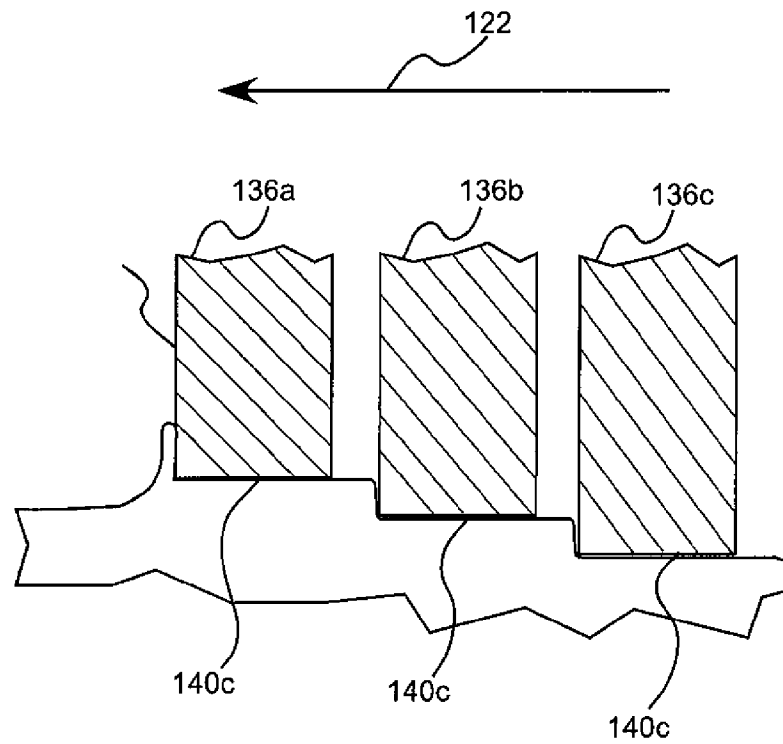
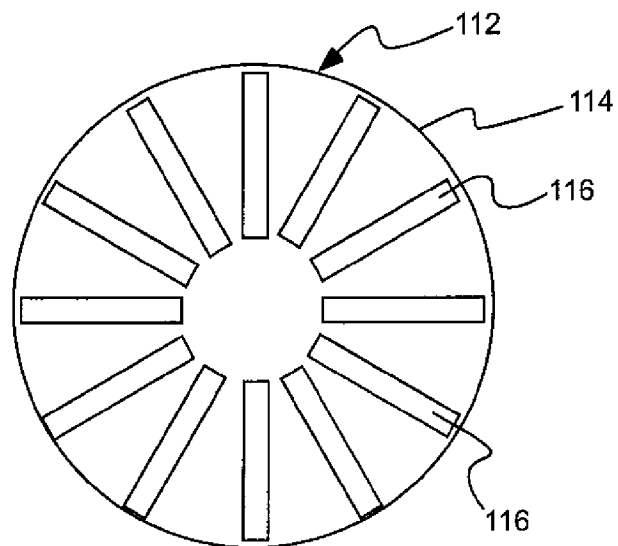


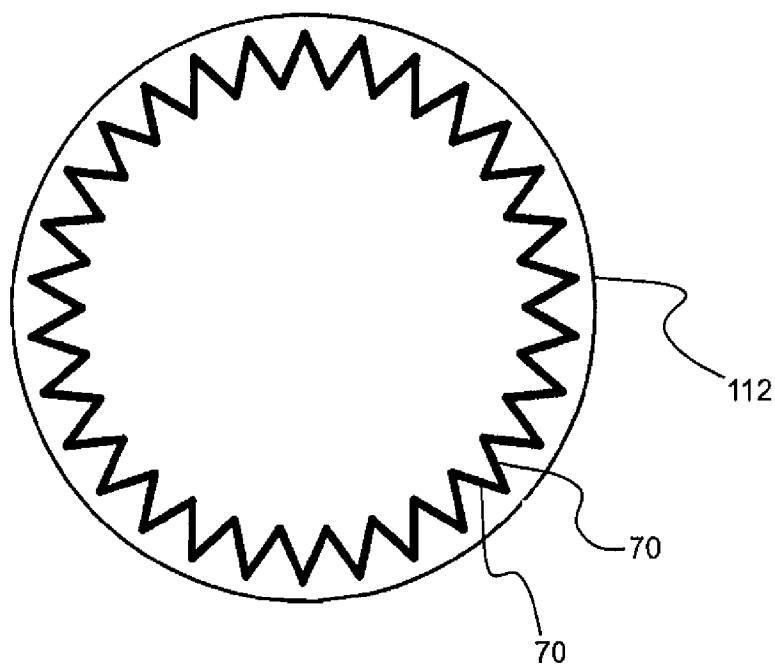
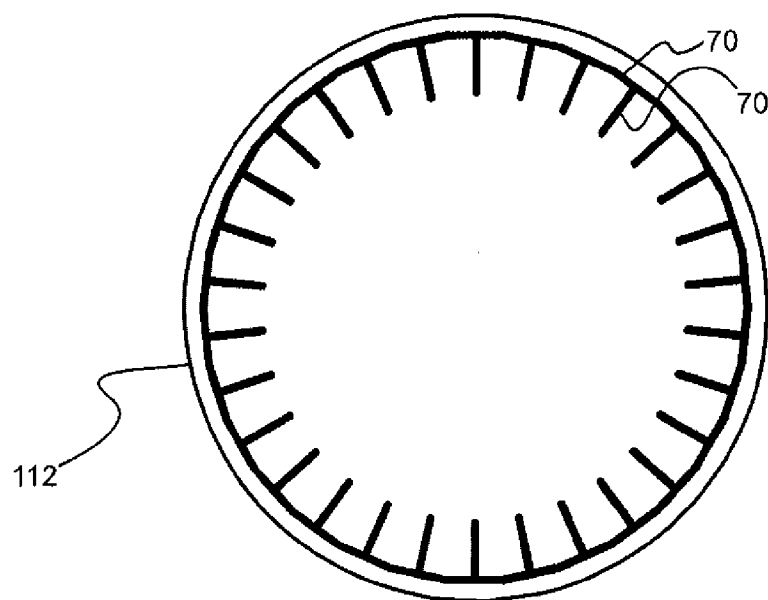
FIG. 15

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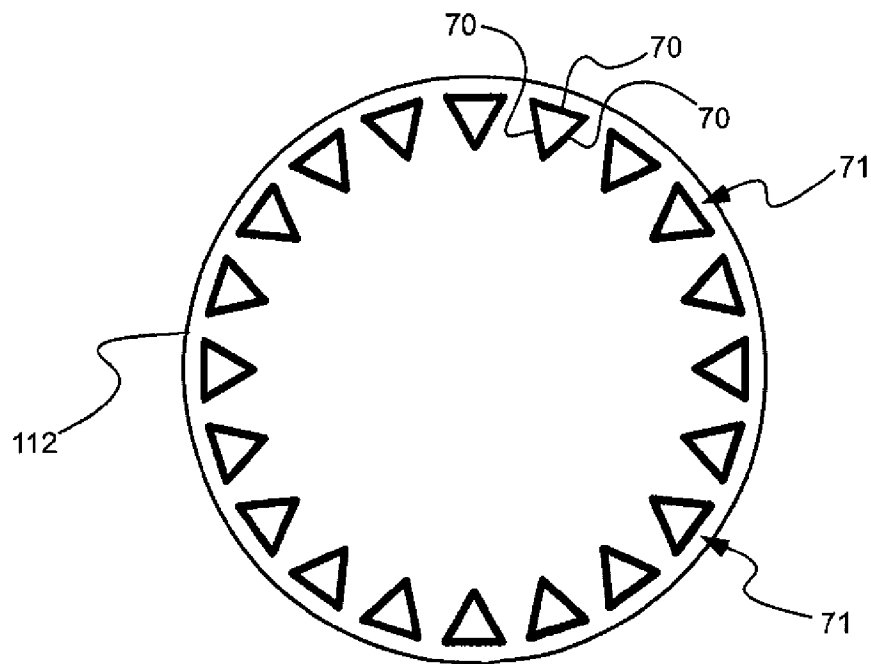
FIG. 16**FIG. 17****FIG. 18**

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FIG. 19FIG. 20

FIG. 21FIG. 22

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FIG. 23

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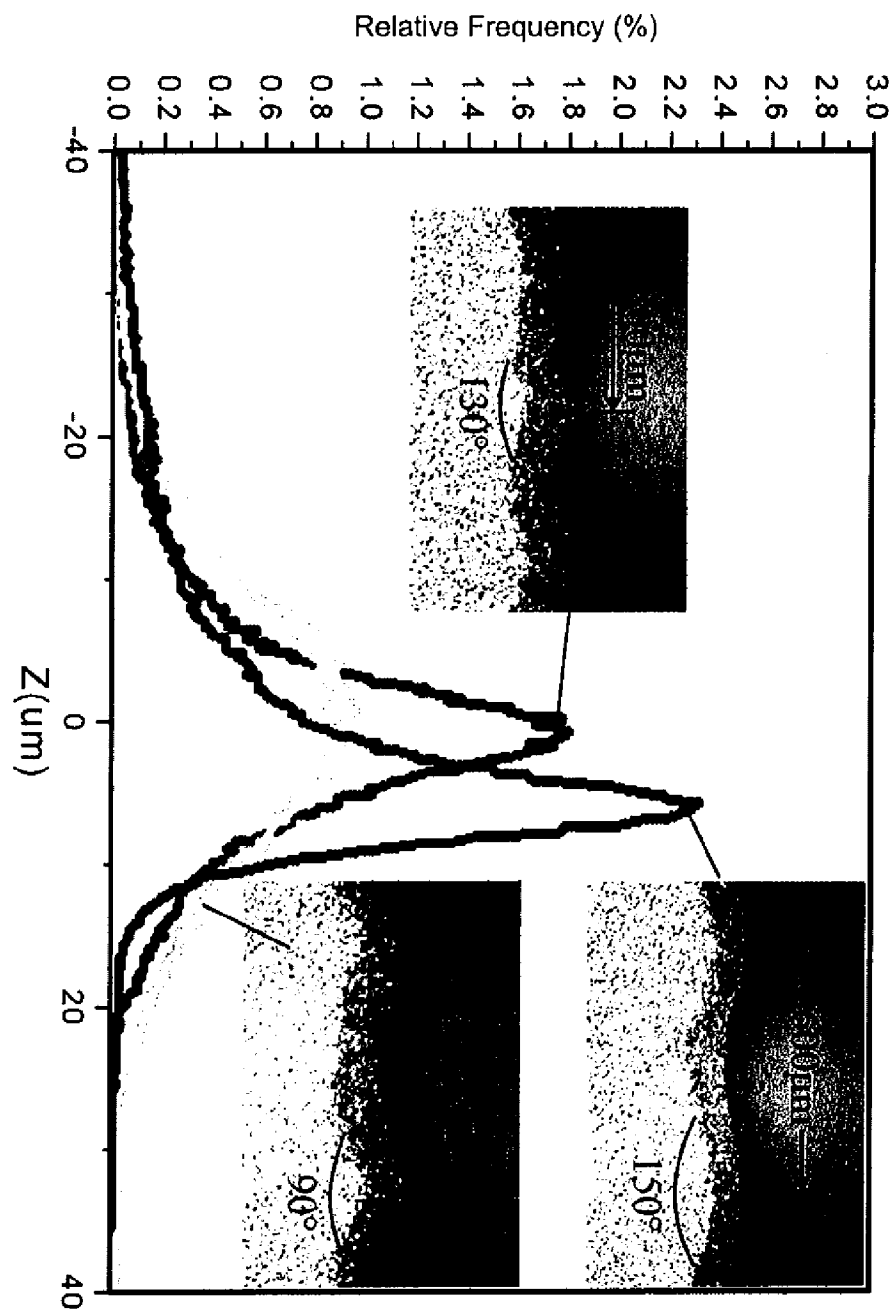


FIG. 24

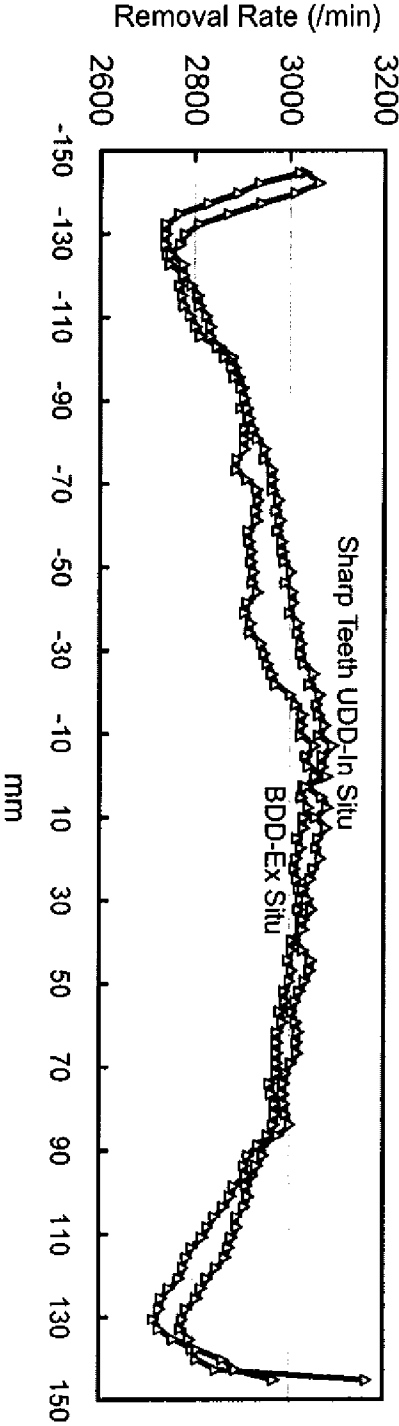


FIG. 25



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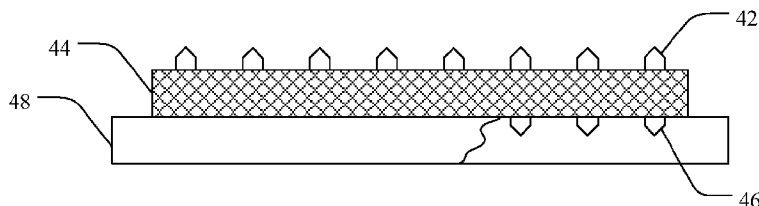


FIG. 4

(57) Abstract: Superabrasive tools and methods for making and using the same are provided. In one aspect, for example, a CMP pad dresser includes a first monolayer of superabrasive particles disposed on and coupled to one side of a metal support layer and a second monolayer of superabrasive particles disposed on and coupled to the metal support layer on an opposite side from the first monolayer. The superabrasive particles of the second monolayer are positioned to have substantially the same distribution as the superabrasive particles of the first monolayer.



WO 2012/040374 A2

SUPERABRASIVE TOOLS HAVING SUBSTANTIALLY LEVELED PARTICLE TIPS AND ASSOCIATED METHODS

PRIORITY DATA

5 This application claims the benefit of United States Provisional Patent Application Serial Nos. 61/384,976 and 61/468,917, filed on September 21, 2010 and March 29, 2011 respectively, each of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

10 The semiconductor industry currently spends in excess of one billion U.S. dollars each year manufacturing silicon wafers that must exhibit very flat and smooth surfaces. Known techniques to manufacture smooth and even-surfaced silicon wafers are plentiful. The most common of these involves the process known as Chemical Mechanical Polishing (CMP) which includes the use of a polishing pad in combination with an
15 abrasive slurry. Of central importance in all CMP processes is the attainment of high performance levels in aspects such as uniformity of polished wafer, smoothness of the IC circuitry, removal rate for productivity, longevity of consumables for CMP economics, etc.

SUMMARY OF THE INVENTION

20 The present disclosure provides superabrasive tools and methods for making and using the same. In one aspect, for example, a CMP pad dresser is provided. Such a dresser includes a first monolayer of superabrasive particles disposed on and coupled to one side of a metal support layer and a second monolayer of superabrasive
25 particles disposed on and coupled to the metal support layer on an opposite side from the first monolayer. The superabrasive particles of the second monolayer are positioned to have substantially the same distribution as the superabrasive particles of the first monolayer. In another aspect, the superabrasive particles of the second monolayer are positioned to have the same distribution as the superabrasive particles
30 of the first monolayer. In yet another aspect, a rigid support can be coupled to the second monolayer of superabrasive particles opposite the first monolayer.

 Various materials are contemplated for use as superabrasive particles in the first monolayer and/or the second monolayer, and any known superabrasive particle

material is considered to be within the present scope. Non-limiting examples of superabrasive particle materials include diamond materials, nitride materials, ceramics, and the like, including combinations thereof. In one specific aspect, the superabrasive particles include a diamond material. In another specific aspect, the
5 superabrasive particles include a cubic boron nitride material.

The present disclosure additionally provides methods of making CMP pad dressers. In one aspect, a method of making a CMP pad dresser can include disposing a first monolayer of superabrasive particles on a metal support layer, and disposing a second monolayer of superabrasive particles on the metal support layer on a side
10 opposite the first monolayer, where the superabrasive particles of the second monolayer are positioned to have substantially the same distribution as the superabrasive particles of the first monolayer. The method further includes bonding the first monolayer of superabrasive particles and the second monolayer of superabrasive particles to the metal support layer such that symmetrical forces due to
15 the substantially similar distribution between the first monolayer and the second monolayer precludes substantial warping of the metal support layer.

The superabrasive particles of the first monolayer and/or the second monolayer can be coupled to the metal support layer using a variety of contemplated techniques. It is understood that any technique for coupling superabrasive particles to
20 a support is considered to be within the present scope. Non-limiting examples can include brazing, pressurized heating, sintering, electroplating, polymeric binding, and the like, including combinations thereof. In one specific aspect, at least one of the first monolayer of superabrasive particles or the second monolayer of superabrasive particles is coupled to the metal support layer with a braze alloy. In another aspect,
25 both the first monolayer of superabrasive particles and the second monolayer of superabrasive particles are coupled to the metal support layer with a braze alloy. In yet another aspect, the bonding of at least one of the first monolayer or the second monolayer is under heat and pressure. In a further aspect, the heat and pressure bonds at least one of the first monolayer or the second monolayer directly to the metal
30 support layer. In another aspect, the bonding of at least one of the first monolayer and the second monolayer further includes disposing a sintering compound on the metal support layer in contact with at least one of the first monolayer or the second monolayer, and sintering the sintering compound to bond the at least one of the first

monolayer or the second monolayer to the metal support layer. In one specific aspect the method can also include infiltrating the sintering compound with a braze material during bonding.

In one aspect, the method can further include coupling the second monolayer of superabrasive particles to a rigid support. Various techniques for coupling the rigid support to the second monolayer are contemplated, and any known technique is considered to be within the present scope. Non-limiting aspects of such techniques include hot pressing, brazing, sintering, soldering, electroplating, polymeric binding, and combinations thereof. In one specific aspect, the coupling of the second monolayer of superabrasive particles to the rigid support is accomplished by polymeric bonding.

The present disclosure additionally provides methods of minimizing warpage of a CMP pad dresser during manufacture. In one aspect, such a method can include substantially equalizing warping forces on opposing sides of a metal support layer during bonding of a plurality of superabrasive particles thereto, where warpage of the support layer is minimized during bonding due to the equalized forces on opposing sides. In one specific aspect, substantially equalizing forces includes arranging the plurality of superabrasive particles on opposing sides of the support layer such that the plurality of superabrasive particles has substantially the same distribution on either side of the support layer to substantially equalize warping forces during bonding.

There has thus been outlined, rather broadly, various features of the invention so that the detailed description thereof that follows may be better understood, and so that the present contribution to the art may be better appreciated. Other features of the present invention will become clearer from the following detailed description of the invention, taken with the accompanying claims, or may be learned by the practice of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention;

FIG. 2 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention;

FIG. 3 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention; and

FIG. 4 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention.

5 It will be understood that the above figures are merely for illustrative purposes in furthering an understanding of the invention. Further, the figures are not drawn to scale, thus dimensions, particle sizes, and other aspects may, and generally are, exaggerated to make illustrations thereof clearer. Therefore, departure can be made from the specific dimensions and aspects shown in the figures in order to produce the heat spreaders of the
10 present invention.

DETAILED DESCRIPTION

Before the present invention is disclosed and described, it is to be understood that this invention is not limited to the particular structures, method steps, or materials
15 disclosed herein, but is extended to equivalents thereof as would be recognized by those ordinarily skilled in the relevant arts. It should also be understood that terminology employed herein is used for the purpose of describing particular embodiments only and is not intended to be limiting.

It must be noted that, as used in this specification and the appended claims, the singular forms “a,” “an” and, “the” include plural referents unless the context clearly
20 dictates otherwise. Thus, for example, reference to “a diamond particle” includes one or more of such particles and reference to “the layer” includes reference to one or more of such layers.

Definitions

25 In describing and claiming the present invention, the following terminology will be used in accordance with the definitions set forth below.

As used herein, the terms “conditioner” and “dresser” can be used interchangeably, and refer to a tool used to condition or dress a pad, such as a CMP pad.

30 As used herein, “superabrasive” may be used to refer to any crystalline, or polycrystalline material, or mixture of such materials which has a Mohr’s hardness of about 8 or greater. In some aspects, the Mohr’s hardness may be about 9.5 or greater. Such materials include but are not limited to diamond, polycrystalline diamond

(PCD), cubic boron nitride (cBN), polycrystalline cubic boron nitride (PcBN), corundum and sapphire, as well as other superabrasive materials known to those skilled in the art. Superabrasive materials may be incorporated into aspects of the present disclosure in a variety of forms including particles, grits, films, layers, pieces, segments, etc.

As used herein, "particle" refers to a particulate form of a material. Such particles may take a variety of shapes, including round, oblong, square, euhebral, etc., can be either single crystal or polycrystalline, and can have a number of mesh sizes. As is known in the art, "mesh" refers to the number of holes per unit area as in the case of U.S. meshes. All mesh sizes referred to herein are U.S. mesh unless otherwise indicated. Further, mesh sizes are generally understood to indicate an average mesh size of a given collection of particles since each particle within a particular "mesh size" may actually vary over a small distribution of sizes.

As used herein, the process of "brazing" is intended to refer to the creation of chemical bonds between the atoms of the superabrasive particles/materials and the braze material. Further, "chemical bond" means a covalent bond, such as a carbide or boride bond, rather than mechanical or weaker inter-atom attractive forces. Thus, when "brazing" is used in connection with superabrasive particles a true chemical bond is being formed. However, when "brazing" is used in connection with metal to metal bonding the term is used in the more traditional sense of a metallurgical bond. Therefore, brazing of a superabrasive segment to a tool body does not necessarily require the presence of a carbide former.

As used herein, "sintering" refers to the joining of two or more individual particles to form a continuous solid mass. The process of sintering involves the consolidation of particles to at least partially eliminate voids between particles. Sintering of diamond particles generally is facilitated by ultrahigh pressures and the presence of a carbon solvent as a diamond sintering aid.

The term "metallic" refers to both metals and metalloids. Metals include those compounds typically considered metals found within the transition metals, alkali and alkali earth metals. Examples of metals are Ag, Au, Cu, Al, and Fe. Metalloids include specifically Si, B, Ge, Sb, As, and Te. Metallic materials also include alloys or mixtures that include metallic materials. Such alloys or mixtures may further include additional additives. In the present invention, carbide formers and carbon

wetting agents may be included as alloys or mixtures, but are not anticipated to be the only metallic component. Examples of such carbide formers are Sc, Y, Ti, Zr, Hf, V, Nb, Cr, Mo, Mn, Ta, W, and Tc. Examples of carbon wetting agents are Co, Ni, Mn, and Cr.

5 As used herein, “infiltrating” refers to when a material is heated to its melting point and then flows as a liquid through the interstitial voids between particles.

 As used herein, the term “substantially” refers to the complete or nearly complete extent or degree of an action, characteristic, property, state, structure, item, or result. For example, an object that is “substantially” enclosed would mean that the
10 object is either completely enclosed or nearly completely enclosed. The exact allowable degree of deviation from absolute completeness may in some cases depend on the specific context. However, generally speaking the nearness of completion will be so as to have the same overall result as if absolute and total completion were obtained.

15 The use of “substantially” is equally applicable when used in a negative connotation to refer to the complete or near complete lack of an action, characteristic, property, state, structure, item, or result. For example, a composition that is “substantially free of” particles would either completely lack particles, or so nearly completely lack particles that the effect would be the same as if it completely lacked
20 particles. In other words, a composition that is “substantially free of” an ingredient or element may still actually contain such item as long as there is no measurable effect thereof.

 As used herein, the term “about” is used to provide flexibility to a numerical range endpoint by providing that a given value may be “a little above” or “a little
25 below” the endpoint.

 As used herein, a plurality of items, structural elements, compositional elements, and/or materials may be presented in a common list for convenience. However, these lists should be construed as though each member of the list is individually identified as a separate and unique member. Thus, no individual member
30 of such list should be construed as a de facto equivalent of any other member of the same list solely based on their presentation in a common group without indications to the contrary.

Concentrations, amounts, and other numerical data may be expressed or presented herein in a range format. It is to be understood that such a range format is used merely for convenience and brevity and thus should be interpreted flexibly to include not only the numerical values explicitly recited as the limits of the range, but

5 also to include all the individual numerical values or sub-ranges encompassed within that range as if each numerical value and sub-range is explicitly recited. As an illustration, a numerical range of “about 1 to about 5” should be interpreted to include not only the explicitly recited values of about 1 to about 5, but also include individual values and sub-ranges within the indicated range. Thus, included in this numerical

10 range are individual values such as 2, 3, and 4 and sub-ranges such as from 1-3, from 2-4, and from 3-5, etc., as well as 1, 2, 3, 4, and 5, individually. This same principle applies to ranges reciting only one numerical value as a minimum or a maximum. Furthermore, such an interpretation should apply regardless of the breadth of the range or the characteristics being described.

15

The Invention

The present disclosure generally provides superabrasive tools and methods for the making and use thereof. In one aspect, such superabrasive tools can include CMP pad dressers that can be utilized in conditioning (e.g., smoothing, polishing, dressing) a CMP pad. CMP pad dressers according to aspects the present disclosure can be advantageously utilized, for example, in dressing CMP pads that are used in polishing, finishing or otherwise affecting semiconductor materials. These dressers can be made such that they have superabrasive particles with substantially leveled tips. Traditional CMP pad dresser manufacturing methods, even many of those describing techniques for leveling superabrasive particle tips prior to fixation, generally contain significant variation in tip height across the surface of the dresser. Often, the superabrasive particles are affixed to the CMP pad dresser support in a manner that disrupts any leveling that has occurred. For example, fixation techniques that utilize high heat and/or pressure can cause warping of the dresser support as the dresser cools. Thus, unless steps are taken to avoid such warpage, superabrasive particles are not maintained in their leveled state following cooling of the dresser. This can be particularly problematic with brazing techniques.

Accordingly, minimizing the warpage of the metal support layer can maintain a greater degree of leveling of superabrasive particle tips in the finished tool. When heat and/or pressure are used to make a superabrasive tool, warpage of the metal support layer can cause great variations in tip height level, even for those particles that were leveled prior to heating and/or applying pressure. By distributing the warpage forces equally or substantially equally on both sides of the metal support layer through the arrangement of the superabrasive particles, these forces effectively cancel each other with respect to the degree of warping occurring in the metal support layer, thus also minimizing the relative height movement of the superabrasive particles relative to one another.

The present CMP pad dressers include a layer of superabrasive particles having substantially leveled tips across the working surface of the finished CMP pad dresser. A CMP pad dresser having such substantially leveled tip arrangements can have a low scratch rate because superabrasive particles are less likely to pull out of the matrix layer due to their more uniform protrusion distribution compared to traditional dressers. Additionally, the more uniform protrusion distributions of such a

dressers allows the conditioning of CMP pads in such a manner as to facilitate good polishing rates while at the same time extending the effective working life of the dresser. These benefits can be affected by, for example, uniform asperity spacing and size distribution in the CMP pad.

5 In one aspect of the present disclosure, superabrasive tip leveling can be accomplished by manufacturing the CMP pad dresser in such a way that the effects of warpage are minimized. For example, in one aspect a CMP pad dresser can be made in at least a two stage process, where the first stage is performed in a manner that minimizes perturbations of the leveled tips in a process that would normally
10 significantly move the superabrasive tips out of a leveled arrangement, such as, for example, by brazing. The second stage of the process can further enhance the leveling of superabrasive particle tips across the CMP pad dresser.

 Various exemplary configurations of CMP pad dressers having substantially leveled tips are contemplated. In one aspect, for example, a CMP pad dresser can
15 include a first monolayer of superabrasive particles disposed on and coupled to one side of a metal support layer and a second monolayer of superabrasive particles disposed on and coupled to the metal support layer on an opposite side from the first monolayer. The superabrasive particles of the second monolayer are positioned to have substantially the same distribution as the superabrasive particles of the first
20 monolayer. In one aspect, a rigid support is coupled to the second monolayer of superabrasive particles opposite the first monolayer to provide support to the dresser. The disposition of a single superabrasive particle layer on each side of the metal support layer can moderate the thermal shrinkage from a high temperature process such as brazing that would otherwise buckle a distribution of diamond on one side.
25 By applying a superabrasive layer to each side of the metal support layer, warping forces such as thermal movement and pressure can be equalized or substantially equalized on both sides. As such, the warpage of the metal or support layer can be minimized. In other words, the forces responsible for warping are applied substantially equally to each side of the metal support layer and can thus cancel one
30 another out, thus minimizing warpage that can otherwise occur.

 In one aspect, as is shown in FIG. 1 for example, a first monolayer of superabrasive particles 12 is arranged on a surface of a metal support layer 14. A second monolayer of superabrasive particles 16 is arranged on the metal support layer

14 on a side that is opposite to the first monolayer. As is discussed further below, in some cases the first and second monolayers of superabrasive particles can be arranged such that corresponding superabrasive particles across the metal support layer are in substantial alignment, as is shown in FIG. 1. In other cases, the superabrasive
5 particles of the first and second monolayers can be arranged in a substantially similar distribution, but may or may not be substantially aligned with one another across the metal support layer.

A variety of materials are contemplated for use as superabrasive particles. Any superabrasive known that can be utilized in a CMP pad dresser should be
10 considered to be within the present scope. Non-limiting examples of such materials include diamond materials, nitride materials, ceramics, and the like. In one aspect, the superabrasive particles include diamond materials. Such diamond materials can include natural or synthetic diamond, single crystal, polycrystalline, and the like. In another aspect, the superabrasive particles include cubic boron nitride materials.
15 Additionally, various diamond particles sizes can be used, including mesh sizes such as 10/20, 30/40, 80/90, 90/100, 100/120, 120/140, 140/170, 170/200, 200/230, 230/270, 270/325, and 325/400.

The metal support layer can be any material capable of supporting the diamond monolayer during tool formation. Such materials can include, without
20 limitation, metal materials, metal alloy materials, braze alloy materials, ceramic materials, composites, and the like, including combinations thereof. It should be noted that the metal support layer can be of a variety of configurations. In one aspect, for example, a metal support layer can be a solid metal such as a metal plate or a metal foil. In another aspect, a metal support layer can be a pressed powder. For
25 example, a metal powder can be placed in a mold and cold pressed to form a metal support layer.

Additionally, the metal support layer can be any thickness capable of supporting the superabrasive particles. For example, in one aspect the metal support layer can be greater than about 10 mm thick. In another aspect, the metal support
30 layer can be from about 2 mm thick to about 10 mm thick. In another aspect, the metal support layer can be from about 1 μm to about 200 μm thick. In yet another aspect, the metal support layer can be from about 1 μm to about 100 μm thick. In a

further aspect, the metal support layer can be from about 100 μm to about 3 mm. In a yet further aspect, the metal support layer can be from about 500 μm to about 2 mm.

In some aspects, the superabrasive particles of either or both of the monolayers can be arranged into a predetermined pattern. Such a pattern can be a
5 uniformly distributed pattern or a non-uniformly distributed pattern. Additionally, a variety of techniques are contemplated to facilitate the arrangement of superabrasive particles into a predetermined pattern. Predetermined is understood to mean a non-random pattern that has been determined prior to arranging the superabrasive particles. In one aspect, a predetermined pattern can also apply to a predetermined
10 spacing between particles. Non-limiting examples of such techniques include arrangement by a template, arrangement using spots of adhesives, arrangement on a first substrate followed by a pattern specific transfer from the first substrate to the metal support layer, and the like, including combinations thereof. The superabrasive particles from either of the monolayers can be temporarily held in position in the
15 predetermined pattern using a variety of techniques, including, without limitation, adhesives, dimpled locations on the metal support matrix, a supporting compound such as, for example, a wax, and the like, including combinations thereof. In one specific aspect, the superabrasive particles can be temporarily coupled to the metal support layer using an adhesive that then volatilizes away and is eliminated during
20 construction of the dresser.

The disposition of a monolayer of superabrasive particles on each side of the metal layer thus moderates the thermal shrinkage from the brazing temperature that would otherwise buckle a distribution of superabrasive particles arranged on just one side. By applying a monolayer to each side of the metal support layer, warping forces
25 such as thermal movement and pressure can be equalized or substantially equalized on both sides. As such, the warpage of the metal support layer can be minimized. In other words, the forces responsible for warping are applied substantially equally to each side of the metal layer and can thus at least partially cancel one another out, thus minimizing warpage that can otherwise occur. In some aspects, the superabrasive
30 particles making up the monolayers on each side of the metal layer can have matching configurations, patterns, or orientations to one another. In this way there can be a substantially matching spatial arrangement of superabrasive particles on each side of the metal layer. In another aspect, the configurations, patterns, or orientations can be

different or varied from one another, or may be partially matching. In yet another aspect, the patterned placement of the superabrasive particles on one side of the metal support layer can be substantially aligned with the pattern of superabrasive particles on the other side of the metal layer so that particle locations match one another. In some aspects, there can be a direct correspondence between the spatial positioning of superabrasive particles on one side of the metal support layer and the spatial positioning of superabrasive particles on the other side of the metal support layer. In another aspect, the patterns of superabrasive particles may match or substantially match one another, but may be offset on opposite sides of the metal support layer so that particle locations do not match one another.

In another aspect, as is shown in FIG. 2, a first monolayer of superabrasive particles 22 is arranged on a surface of a metal support layer 24. A second monolayer of superabrasive particles 26 is arranged on the metal support layer 24 on a side that is opposite to the first monolayer. A bonding material 28 secures the first monolayer and the second monolayer to the metal support layer 24. The bonding material can be any material capable of securing the first and second monolayer to the metal support layer. In some aspect, the bonding material can be the same for securing the first monolayer and the second monolayer, while in other aspects the bonding material can be different for securing the first monolayer and the second monolayer.

The bonding material can be any material capable of securing superabrasive particles therein. Non-limiting examples of bonding materials include metal brazes, metal braze alloys, organic matrix materials, sintered materials, electroplated materials, and the like, including combinations thereof.

In one aspect, for example, the superabrasive particles can be brazed to the metal support layer, and thus the bonding material can be a metal braze or metal braze alloy. Metal brazing techniques are known in the art. A green braze material can be applied to the metal support layer on or around the superabrasive particles. The metal braze can be applied in any known configuration, including braze sheets, powders, pastes, sprays, and the like, including combinations thereof. Once applied to the metal support layer, the braze can be heated and melted to coat at least a portion of the metal support layer and to bond the superabrasive particles. The heating temperature can vary depending on the braze material used, but in one aspect can be from about 700°C to about 1200°C. The superabrasive particles in the first and

second monolayer are thus arranged such that thermal forces exerted on the metal support layer during heating and cooling are substantially equalize in order to minimize warping.

5 In one non-limiting example, the superabrasive particles can be bonded to the metal support layer by brazing with a nickel-based alloy, with or without chromium. In another example, the brazing can include pressing the superabrasive particles with a flat ceramic material that cannot be bonded to the braze in order to level the superabrasive particle tips. Various braze alloys are contemplated, including non-limiting examples such as BNi_2 , BNi_7 , and the like.

10 Additionally, in one aspect at least one of the first and second monolayers of superabrasive particles can be coupled to the metal support layer by an electrodeposition process, and thus the bonding material can be an electrodeposited metal material. In one aspect, a monolayer of superabrasive particles can be disposed on the metal support layer which is then placed into an ionic solution containing metal
15 ions. An electrical current is introduced into the ionic solution such that a metal layer is electroplated onto the metal substrate to secure the superabrasive particles. Thus by this method, the superabrasive particles are coupled to the metal support layer. As an example of a suitable method for positioning and retaining superabrasive materials prior to and during the electrodeposition process, a mold can be used that includes an
20 insulating material that can effectively prevent the accumulation of electrodeposited material on the molding surface. Superabrasive particles can thus be held on the molding surface of the mold during electrodeposition. As such, the accumulation of electrodeposited material can be prevented from occurring on the particle tips and the working surface of the pad conditioner substrate. Such techniques are described in
25 U.S. Patent Application Serial No. 11/292,938, filed December 2, 2005, which is hereby incorporated herein by reference.

In another aspect, the superabrasive particles can be bonded to the metal support layer by sintering, and thus the bonding material can include a sintering material. For example, the bonding of the superabrasive particles to the metal support
30 layer can include disposing a sintering compound on the metal support layer in contact with at least one of the first monolayer and the second monolayer and sintering the sintering compound to bond the superabrasive particles to the metal support layer. Suitable sintering methods will be readily appreciated by one of

ordinary skill in the art having possession of this disclosure. Basically, a sintering compound is applied around the superabrasive particles and in contact with the metal support layer. The sintering compound can be any known sintering material that can be used to secure superabrasive particles to a substrate. Non-limiting examples of such materials can include metal and metal alloy powders, ceramic powders, and the like. One specific non-limiting example of a sintering compound is cobalt powder. Once the sintering compound has been applied around the superabrasive particles and to the metal support substrate, heat and in some cases pressure can be applied to cause sintering to occur. In some aspects, a braze or braze alloy can be infiltrated into the sintering compound during bonding to further strengthen the bonding material matrix.

In another aspect, as is shown in FIG. 3, heat and pressure can be applied to bond the first monolayer of superabrasive particles 32 and/or the second monolayer of superabrasive particles 36 directly into the metal support layer 34. Thus, upon the application of heat and pressure, the metal support layer 34 is softened or partially melted. The superabrasive particles in one or more of the monolayers are then pressed into the metal support layer. A planar leveling surface can be used to apply pressure to the monolayer and thus maintain the level nature of the superabrasive particle tips as the superabrasive particles are pressed into the metal support layer. Upon cooling, the distribution of superabrasive particles on either side of the metal support layer at least partially equalizes the thermal forces acting on the metal support layer, thus minimizing warping. Additionally, heat and pressures useful in making such a device can vary depending on the materials and equipment used. In one aspect, for example, the heat is from about 700° C to about 1000° C. In another aspect, the pressure is from about 10 MPa to about 50 MPa.

In yet another aspect, as is shown in FIG. 4, a CMP pad dresser can include a first monolayer of superabrasive particles 42 and a second monolayer of superabrasive particles 46 coupled to a metal support layer 44. The superabrasive particles can be coupled to the metal support layer directly or via a bonding material. The second monolayer of superabrasive particles 46 is coupled to a rigid support 48. A portion of the rigid support 48 is shown removed in FIG. 4 to expose the second monolayer. The rigid support 48 can facilitate handling and use of the CMP pad dresser. By bonding the superabrasive particles of the second monolayer to the rigid

support, the first monolayer of superabrasive particles remains exposed for CMP pad conditioning operations.

The rigid support can be made from any material compatible with the abrading or dressing process. Such materials can include polymeric materials, metal materials, ceramic materials, glasses, composites, and the like. In one aspect, the rigid support can be a polymeric material and the second monolayer of superabrasive particles can be embedded therein using heat, pressure, adhesives, etc. In some aspects, the rigid support can be a non-polymeric material such as a metal layer. In such cases, the superabrasive particles can be bonded to the rigid support by adhesive attachment, soldering, brazing, electroplating, and the like. For brazing techniques, care can be taken to minimize or eliminate warpage in the metal layer during the heating and cooling process. In another aspect, one or more magnetic elements can be placed into the rigid support to attract and hold the CMP pad dresser in place, thus forming a temporary attachment. An optional locking mechanism can be utilized to further immobilize the CMP pad dresser to the rigid support during use. In some aspects the rigid support can include surface features to hold the dresser in place during rotational movement against a CMP pad. The rigid support can have approximately the same diameter as the metal support layer, a larger diameter than the metal support layer, or, in some cases, a smaller diameter than the metal support layer.

Various polymeric materials are contemplated for use as a rigid support. Examples of suitable materials include, without limitation, amino resins, acrylate resins, alkyd resins, polyester resins, polyamide resins, polyimide resins, polyurethane resins, phenolic resins, phenolic/latex resins, epoxy resins, isocyanate resins, isocyanurate resins, polysiloxane resins, reactive vinyl resins, polyethylene resins, polypropylene resins, polystyrene resins, phenoxy resins, perylene resins, polysulfone resins, acrylonitrile-butadiene-styrene resins, acrylic resins, polycarbonate resins, polyimide resins, and mixtures thereof. In one specific aspect, the polymeric material can be an epoxy resin. In another aspect, the polymeric material can be a polyimide resin. In yet another aspect, the polymeric material can be a polyurethane resin.

When an polymeric material is utilized, methods of curing the polymeric material can be a variety of processes known to one skilled in the art that cause a phase transition in the polymeric material from at least a pliable state to at least a rigid state. Curing can occur, without limitation, by exposing the polymeric material to

energy in the form of heat, electromagnetic radiation, such as ultraviolet, infrared, and microwave radiation, particle bombardment, such as an electron beam, organic catalysts, inorganic catalysts, or any other curing method known to one skilled in the art.

5 In one aspect of the present invention, the polymeric material can be a thermoplastic material. Thermoplastic materials can be reversibly hardened and softened by cooling and heating respectively. In another aspect, the polymeric material layer may be a thermosetting material. Thermosetting materials cannot be reversibly hardened and softened as with the thermoplastic materials. In other words,
10 once curing has occurred, the process can be essentially irreversible, if desired.

 Additionally, in one aspect a coupling agent or an organometallic compound may be coated onto the surface of a superabrasive material to facilitate the retention of the superabrasive particles in the polymeric material via chemical bonding. A wide variety of organic and organometallic compounds is known to those of ordinary skill
15 in the art and may be used. Organometallic coupling agents can form chemical bonds between the superabrasive materials and the polymeric material, thus increasing the bonding between the second monolayer of superabrasive particles and the polymeric material. In this way, the organometallic coupling agent can serve as a bridge to form bonds between the polymeric material and the surface of the
20 superabrasive material. In one aspect, the organometallic coupling agent can be a titanate, zirconate, silane, or mixture thereof. The amount of organometallic coupling agent used can depend upon the coupling agent and on the surface area of the superabrasive material. In one aspect, 0.05% to 10% by weight of the polymeric material layer can be sufficient.

25 In another aspect of the present disclosure, a method of making a CMP pad dresser can include disposing a first monolayer of superabrasive particles on a metal support layer, and disposing a second monolayer of superabrasive particles on the metal support layer on a side opposite the first monolayer. The superabrasive particles of the second monolayer are positioned to have substantially the same
30 distribution as the superabrasive particles of the first monolayer. The method can further include bonding the first monolayer of superabrasive particles and the second monolayer of superabrasive particles to the metal support layer such that symmetrical

forces due to the substantially similar distribution between the first monolayer and the second monolayer precludes substantial warping of the metal support layer.

In yet another aspect, disposing at least one of the first monolayer of superabrasive particles or the second monolayer of superabrasive particles can include
5 adhering a plurality of superabrasive particles to an adhesive transfer sheet in a predetermined pattern established by apertures in a template, and removing the template from the adhesive transfer sheet such that the plurality of superabrasive particles remain adhered to the adhesive transfer sheet in the predetermined pattern. The plurality of superabrasive particles is then transferred with the adhesive transfer
10 sheet to the metal support layer, and the adhesive transfer sheet is removed from the plurality of superabrasive particles to form at least one of the first monolayer of superabrasive particles or the second monolayer of superabrasive particles.

In a further aspect of the present disclosure, a method of minimizing warpage of a CMP pad dresser during manufacture can include substantially equalizing
15 warping forces on opposing sides of a metal support layer during bonding of a plurality of superabrasive particles thereto, wherein warpage of the support layer is minimized during bonding due to the equalized forces on opposing sides. In one aspect, substantially equalizing forces includes arranging the plurality of
20 superabrasive particles on opposing sides of the support layer such that the plurality of superabrasive particles has substantially the same distribution on either side of the support layer to substantially equalize warping forces during bonding.

It is noted that, while the above disclosure refers primarily to CMP pad dressers, other precision grinding and/or abrading tools are considered to be within the present scope. As such, the techniques and teaching disclosed herein can
25 additionally be applied to such tools.

The following examples present various methods for making the heat spreaders of the present invention. Such examples are illustrative only, and no limitation on the present invention is meant thereby.

30

Examples

Example 1

A thin metal layer (e.g. Cu 100 microns thick) has an adhesive (e.g. 3M manufacture, 25 microns, fugitive, i.e. can vaporize to leave no residue carbon behind) on each side. Ti coated diamond particles (e.g. about 50 microns) are spread on both sides create a diamond particle monolayer on each side. Excess diamond particles are removed. The layer is placed in a graphite mold that is covered with a thin layer of Cu powder. An additional layer of Cu powder is applied on top of the layer. The assembly is then hot pressed (e.g. 900 C for 20 minutes) under vacuum or in an inert atmosphere to form a disk having diamond particles protruding from both sides. Due to the presence of Ti coating, Cu can bond the diamond particles firmly. The flatness of the disk is maintained by the flat mold surface.

Example 2

Same as with Example 1, with the exception that the thin metal Cu layer has a braze alloy layer (e.g. Cu-Sn-Ti or Ag-Cu-Ti) coupled to each side. Uncoated diamond particles are then arranged on the exposed sides of the braze alloy layers with the adhesive. The assembly is then heated to melt the braze in a vacuum furnace, resulting in a copper layer covered with diamond particles on both sides.

Example 3

The diamond-attached layer of Example 2 is suspended in an electrolyte of CuSO_4 solution with connection to a cathode. The anode is a copper electrode. After passing current through the electrolyte, Cu will be plated on the copper layer and in the gaps between the diamond particles to strengthen the bonding of the diamond particles to the Cu metal layer.

Example 4

Same as Example 2, with the exception that that the Cu layer is replaced with a thin Ni layer, and the braze layers are Ni-Cr-B-Si (BNi2, e.g. Nichrobraz LM made by Wall Colmonoy), and the diamond particles (e.g. 150 microns) are arranged in a grid pattern (e.g. pitch of 500 microns intervals).

Example 5

The article of Example 4 is pressed against a flat substrate (108 mm in diameter by 6.5 mm in thickness) and heated with a thermal plastic adhesive in between (e.g. 150 C for 10 minutes). The result is a tool such as a CMP pad conditioner having a flat surface. A layer on each side moderates the thermal shrinkage from the brazing temperature (e.g. 1020 C for 10 minutes) that would buckle an asymmetrical distribution of diamond on one side.

Of course, it is to be understood that the above-described arrangements are only illustrative of the application of the principles of the present invention. Numerous modifications and alternative arrangements may be devised by those skilled in the art without departing from the spirit and scope of the present invention and the appended claims are intended to cover such modifications and arrangements. Thus, while the present invention has been described above with particularity and detail in connection with what is presently deemed to be the most practical and preferred embodiments of the invention, it will be apparent to those of ordinary skill in the art that numerous modifications, including, but not limited to, variations in size, materials, shape, form, function and manner of operation, assembly and use may be made without departing from the principles and concepts set forth herein.

CLAIMS

What is claimed is:

1. A CMP pad dresser, comprising:
 - 5 a first monolayer of superabrasive particles disposed on and coupled to one side of a metal support layer; and
 - a second monolayer of superabrasive particles disposed on and coupled to the metal support layer on an opposite side from the first monolayer, wherein the superabrasive particles of the second monolayer are positioned to have substantially
 - 10 the same distribution as the superabrasive particles of the first monolayer.
2. The dresser of claim 1, wherein the superabrasive particles in the first monolayer include a member selected from the group consisting of diamond materials, nitride materials, ceramics, or a combination thereof.
- 15 3. The dresser of claim 1, wherein the superabrasive particles in the first monolayer are a diamond material.
4. The dresser of claim 1, wherein the superabrasive particles in the first monolayer
- 20 are a cubic boron nitride material.
5. The dresser of claim 1, wherein the superabrasive particles in the second monolayer include a member selected from the group consisting of diamond materials, nitride materials, ceramics, or a combination thereof.
- 25 6. The dresser of claim 1, wherein the superabrasive particles in the second monolayer are a diamond material.
7. The dresser of claim 1, wherein the superabrasive particles in the second
- 30 monolayer are a cubic boron nitride material.
8. The dresser of claim 1, further comprising a rigid support coupled to the second monolayer of superabrasive particles opposite the first monolayer.

9. The dresser of claim 1, wherein at least one of the first monolayer of superabrasive particles or the second monolayer of superabrasive particles is coupled to the metal support layer with a braze alloy.

5

10. The dresser of claim 1, wherein both the first monolayer of superabrasive particles and the second monolayer of superabrasive particles are coupled to the metal support layer with a braze alloy.

10 11. The dresser of claim 1, wherein the superabrasive particles of the second monolayer are positioned to have the same distribution as the superabrasive particles of the first monolayer.

12. A method of making a CMP pad dresser, comprising:

15 disposing a first monolayer of superabrasive particles on a metal support layer;

disposing a second monolayer of superabrasive particles on the metal support layer on a side opposite the first monolayer, wherein the superabrasive particles of the second monolayer are positioned to have substantially the same distribution as the

20 superabrasive particles of the first monolayer; and

bonding the first monolayer of superabrasive particles and the second monolayer of superabrasive particles to the metal support layer such that symmetrical forces due to the substantially similar distribution between the first monolayer and the second monolayer precludes substantial warping of the metal support layer.

25

13. The method of claim 12, wherein the bonding of at least one of the first monolayer or the second monolayer is by brazing with a braze alloy.

14. The method of claim 12, wherein the bonding of at least one of the first
30 monolayer or the second monolayer is under heat and pressure.

15. The method of claim 14, wherein the bonding of at least one of the first monolayer and the second monolayer further includes:

disposing a sintering compound on the metal support layer in contact with at least one of the first monolayer or the second monolayer; and

sintering the sintering compound to bond the at least one of the first monolayer or the second monolayer to the metal support layer.

5

16. The method of claim 15, further comprising infiltrating the sintering compound with a braze material during bonding.

17. The method of claim 14, wherein the heat and pressure bonds at least one of the first monolayer or the second monolayer directly to the metal support layer.

10

18. The method of claim 12, wherein the superabrasive particles of the second monolayer are positioned to align with the superabrasive particles of the first monolayer.

15

19. The method of claim 12, further comprising coupling the second monolayer of superabrasive particles to a rigid support.

20. The method of claim 19, wherein the coupling of the second monolayer of superabrasive particles to the rigid support is accomplished by a technique selected from the group consisting of hot pressing, brazing, sintering, soldering, electroplating, polymeric bonding, and combinations thereof.

20

21. The method of claim 19, wherein the coupling of the second monolayer of superabrasive particles to the rigid support is accomplished by polymeric bonding.

25

22. A method of minimizing warpage of a CMP pad dresser during manufacture, comprising:

substantially equalizing warping forces on opposing sides of a metal support layer during bonding of a plurality of superabrasive particles thereto, wherein warpage of the support layer is minimized during bonding due to the equalized forces on opposing sides.

30

23. The method of claim 22, wherein substantially equalizing forces includes arranging the plurality of superabrasive particles on opposing sides of the support layer such that the plurality of superabrasive particles has substantially the same distribution on either side of the support layer to substantially equalize warping forces
- 5 during bonding.

1/2

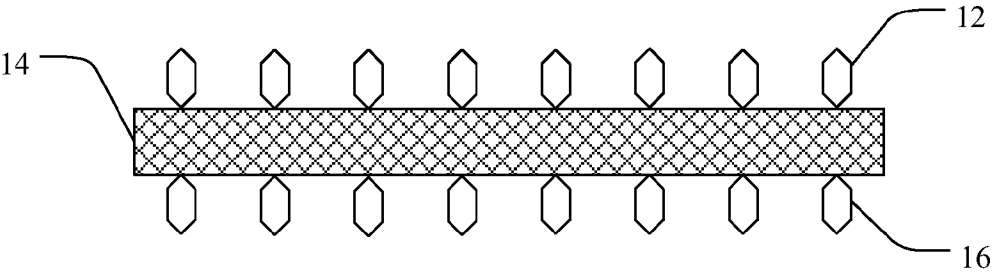


FIG. 1

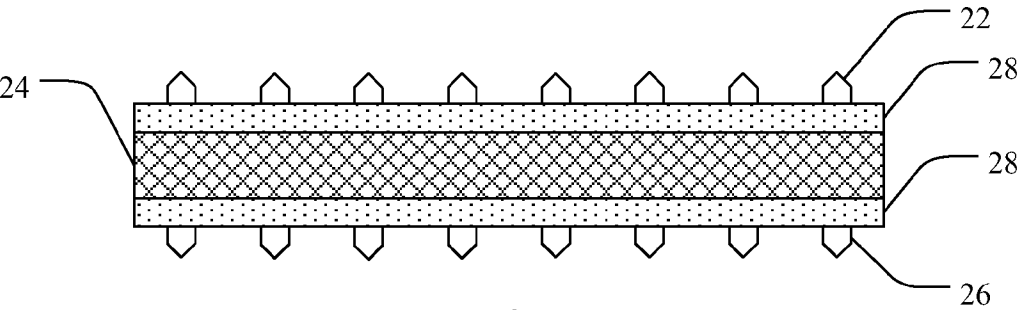


FIG. 2

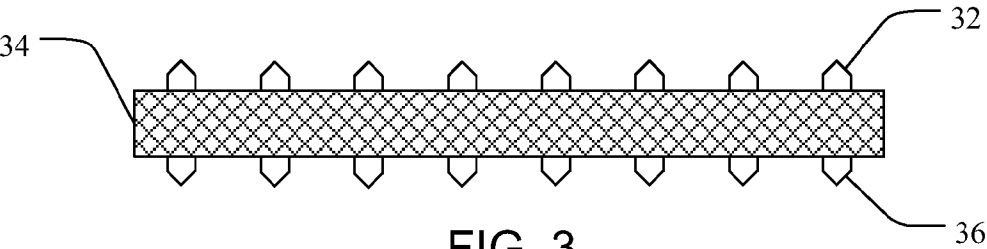


FIG. 3

2/2

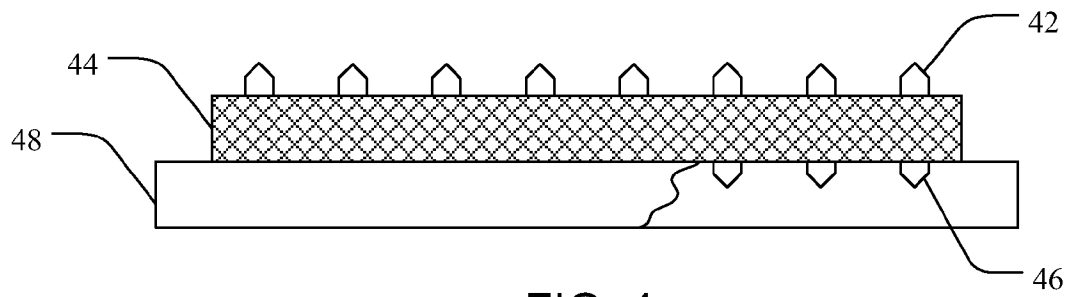


FIG. 4

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

OSBORNE DAVID W.

THORPE NORTH & WESTERN, LLP PO BOX 1219
SANDY UT 84091-1219 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing
(day/month/year) **23 MAY 2011 (23.05.2011)**

Applicant's or agent's file reference

00802-24462.NP.CIP.

FOR FURTHER ACTION

See paragraph 2 below

International application No.

PCT/US2007/024165

International filing date (day/month/year)

16 NOVEMBER 2007 (16.11.2007)

Priority date(day/month/year)

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International Patent Classification (IPC) or both national classification and IPC

B24D 7/06(2006.01)i, H01L 21/304(2006.01)i, B24D 18/00(2006.01)i, B24D 3/02(2006.01)i

Applicant

SUNG CHIEN-MIN

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
Government Complex-Daejeon, 189
Cheongsa-ro, Seo-gu, Daejeon 302-
701, Republic of Korea
Facsimile No. 82-42-472-7140



Date of completion of this opinion

23 MAY 2011 (23.05.2011)

Authorized officer

KIM, DONG JIN

Telephone No.82-42-481-5415



Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :
 - ☒ the international application in the language in which it was filed
 - ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:
 - a. type of material
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material
 - ☐ on paper
 - ☐ in electronic form
 - c. time of filing/furnishing
 - ☐ contained in the international application as filed.
 - ☐ filed together with the international application in electronic form.
 - ☐ furnished subsequently to this Authority for the purposes of search.
4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	9, 10, 12-14, 21-45	YES
	Claims	1-8, 11, 15-20	NO
Inventive step (IS)	Claims	9, 10, 14, 23-24, 31-40, 43-45	YES
	Claims	1-8, 11-13, 15-22, 25-30, 41, 42	NO
Industrial applicability (IA)	Claims	1-45	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following documents:

D1: JP 2004-025401 A (AIRTEC JAPAN:KK et al.) 29 January 2004
D2: US 6319108 B1 (ADEFRIS; NEGUS B. et al.) 20 November 2001
D3: US 2006-0135050 A1 (JOHN PETERSEN et al.) 22 June 2006

1. Novelty and Inventive Step

1.1 Claims 1-10

1.1.1 Claim 1

D1, which is considered to be the closest prior art to the subject matter of claim 1, discloses a diamond grinding wheel comprising a abrasive chip and an abrasive element. Accordingly, claim 1 is substantially the same as D1. Therefore, claim 1 lacks novelty under PCT Article 33(2).

1.1.2 Claim 2

The cutting tip of claim 2 is already disclosed in document D1(see figure 4). Therefore, claim 2 lacks novelty under PCT Article 33(2).

1.1.3 Claims 3-8

The additional feature of claims 3-8 is already disclosed in document D1(see figure 1). Therefore, claims 3-8 lack novelty under PCT Article 33(2).

1.1.4 Claims 9 and 10

The cutting device of claim 9 differs from the disclosures of D1-D3 in that it includes the cutting elements distributed on the cutting device in alternating orientations. The cutting device of claim 10 differs from the disclosures of D1-D3 in that it includes the secondary cutting element. Therefore, claims 9 and 10 meet the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

1.2 Claims 11-24

1.2.1 Claim 11

D1, which is considered to be the closest prior art to the subject matter of claim 11, discloses abrasive element and abrasive tip. Accordingly, claim 11 is substantially the same as D1. Therefore, claim 11 lacks novelty under PCT Article 33(2).

1.2.2 Claim 12

D2, which is considered to be the closest prior art to the subject matter of claim 12, discloses uniformly distributed cutting element. Accordingly, claim 12 is substantially correspond as D1 and D2. Therefore, claim 12 lacks inventive step under PCT Article 33(3).

Continued on Supplemental Box

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

Box V

1.2.3 Claim 13

The cutting device of claim 13 dependent on claim 11 is not disclosed in D1, but was generally known in the art at the time of filing this application. Accordingly, claim 13 does not involve an inventive step under PCT Article 33(3).

1.2.4 Claim 14

The cutting device of claim 14 differs from the disclosures of D1-D3 in that it includes the cutting depth of less than about 20 microns when used to abrade a workpiece. Therefore, claim 14 meets the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

1.2.5 Claim 15

The cutting device of claim 15 dependent on claim 11 is already disclosed in document D1(see figure 4). Therefore, claim 15 lacks novelty under PCT Article 33(2).

1.2.6 Claims 16-20

The additional feature of claims 16-21 is already disclosed in document D1(see figure 1). Therefore, claims 16-21 lack novelty under PCT Article 33(2).

1.2.7 Claims 21-22

The cutting device of claims 21 and 22 dependent on claim 11 is not disclosed in D1, but was generally known in the art at the time of filing this application. Accordingly, claims 21 and 22 do not involve an inventive step under PCT Article 33(3).

1.2.8 Claims 23-24

The cutting device of claim 23 differs from the disclosures of D1-D3 in that it includes the distance of from about 100 microns to about 800 microns. The cutting device of claim 24 differs from the disclosures of D1-D3 in that it includes the distance of about 500 microns. Therefore, claims 23 and 24 meet the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

1.3 Claims 25-30, 41 and 42

The cutting device of claims 25-30, 41 and 42 dependent on claims 1 or 11 is not disclosed in D1, but was generally known in the art at the time of filing this application. Accordingly, claims 25-30, 41 and 42 do not involve an inventive step under PCT Article 33(3).

1.4 Claims 31-40, 43-45

The method of forming a cutting device of claim 31 differs from the disclosures of D1-D3 in that it includes arranging on the substrate a plurality of individual polycrystalline cutting elements, each of the plurality of individual polycrystalline cutting elements having a substantially matching geometric configuration. And it is not obvious to a person skilled in the art by the documents, taken alone or in combination. Therefore, claims 32-40 and 43-45 meet the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

2. Industrial Applicability

Claims 1-45 are industrially applicable under PCT Article 33(4).

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 3356-32820.PCT1	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/US2011/052626	International filing date (<i>day/month/year</i>) 21 SEPTEMBER 2011 (21.09.2011)	(Earliest) Priority Date (<i>day/month/year</i>) 21 SEPTEMBER 2010 (21.09.2010)
Applicant SUNG CHIEN-MIN et al		

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6bis(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (See Box No. II)

3. ☐ **Unity of invention is lacking** (See Box No. III)

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the drawings,

a. the figure of the **drawings** to be published with the abstract is Figure No. 1

☒ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☐ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figure is to be published with the abstract.

A. CLASSIFICATION OF SUBJECT MATTER**H01L 23/34(2006.01)i, H05K 7/20(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01L 23/34; H01L 23/36; H01L 23/06; H01L 29/06; H01L 21/31

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: thermally, reduce, heat, spreader, diamond, mono-layer, metal, expansion, coefficient, thin, matrix, material, bonding.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010-0102442 A1 (CHIEN-MIN SUNG) 29 April 2010 See abstract, paragraph [0065]–[0080], claims 1,2,6,26–30,36 and figures 2–5b.	1–19
A	US 05008737 A (ROBERT D. BURNHAM et al.) 16 April 1991 See abstract, column 6, line 4–line 50, claims 1,3,4,6,8 and figure 1.	1–19
A	US 2007-0232074 A1 (KRAMADHATI RAVI et al.) 04 October 2007 See abstract, paragraph [0019]–[0027], claims 1,5,6 and figures 1A–1F.	1–19
A	US 7067903 B2 (TAKESHI TACHIBANA et al.) 27 June 2006 See abstract, column 6, line 20–35, column 8, line 30–48, claims 1–4 and figures 5A–7B.	1–19

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

01 MAY 2012 (01.05.2012)

Date of mailing of the international search report

02 MAY 2012 (02.05.2012)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon, 189 Cheongsu-ro,
Seo-gu, Daejeon 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

KIM, Jung Jin

Telephone No. 82-42-481-5962



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2011/052626

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010-0102442 A1	29.04.2010	US 2011-0056672 A1 US 7791188 B2	10.03.2011 07.09.2010
US 05008737A	16.04.1991	EP 0364155 A3 JP 02-170452 A US 05130771 A	10.10.1990 02.07.1990 14.07.1992
US 2007-0232074 A1	04.10.2007	None	
US 7067903 B2	27.06.2006	CN 1499620 C0 JP 2004-158726 A JP 2004-158727 A TW 239606 A US 2004-0238946 A1	02.04.2008 03.06.2004 03.06.2004 11.09.2005 02.12.2004

Electronic Patent Application Fee Transmittal

Application Number:	13802112			
Filing Date:	13-Mar-2013			
Title of Invention:	CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS			
First Named Inventor/Applicant Name:	Chien-Min Sung			
Filer:	David William Osborne/Warren Archibald			
Attorney Docket Number:	02074-24012.NP.CIP			
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
Submission- Information Disclosure Stmt	2806	1	90	90
Total in USD (\$)				90

Electronic Acknowledgement Receipt

EFS ID:	20964598
Application Number:	13802112
International Application Number:	
Confirmation Number:	1021
Title of Invention:	CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS
First Named Inventor/Applicant Name:	Chien-Min Sung
Customer Number:	20551
Filer:	David William Osborne/Warren Archibald
Filer Authorized By:	David William Osborne
Attorney Docket Number:	02074-24012.NP.CIP
Receipt Date:	15-DEC-2014
Filing Date:	13-MAR-2013
Time Stamp:	16:20:29
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$90
RAM confirmation Number	3372
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	trasmittal.PDF	79524	no	4
			691b1a2d8329d6516ee05a555388e66cd904df29		
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	a.PDF	137273	no	2
			979393b05ca7e74fce8f8399bae68be51734247		
Warnings:					
Information:					
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3	Information Disclosure Statement (IDS) Form (SB08)	b.PDF	99254	no	2
			ac31d4a67470eafd4bcd7ab346302df8b5ee46c5		
Warnings:					
Information:					
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4	Foreign Reference	EP1075898A2.pdf	1325134	no	28
			d5ea068bc02e8a8f88ffdcff1bc768f558aec418		
Warnings:					
Information:					
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5	Foreign Reference	GB2366804A.pdf	790441	no	27
			696da841eae064f6a2f5ec023b19981bcbdc6176		
Warnings:					
Information:					
6	Foreign Reference	WO9531006A1.pdf	1767289	no	47
			1909d991b02ad5d57a319d3b4726990fd2d9e74f		
Warnings:					
Information:					
7	Foreign Reference	WO2006039413A2.pdf	1110779	no	20
			e1fd136aa4453d610d9c967f2dc1e4011662086b		
Warnings:					
Information:					

8	Foreign Reference	WO2009043058A3.pdf	152607	no	4
			bc22572969f8b54ad5bb9d505f4f462db2504270		
Warnings:					
Information:					
9	Foreign Reference	WO2009064677A2.pdf	1704000	no	43
			9f05662445ddbaf29d9cafdb015ca7c74e0e5eea		
Warnings:					
Information:					
10	Foreign Reference	WO2012040374A2.pdf	1244966	no	26
			b1cccef42aad84873aec313480570d861e519cca		
Warnings:					
Information:					
11	Other Reference-Patent/App/Search documents	PCTUS2007024165searchMay232011.pdf	185219	no	4
			c18d595c271c59d17763e46bf1a72f2e1948c44d		
Warnings:					
Information:					
12	Other Reference-Patent/App/Search documents	PCTUS2011052626searchMay2012.pdf	129829	no	3
			4aec3185b082f48cf535145d2ce293d91247c17		
Warnings:					
Information:					
13	Fee Worksheet (SB06)	fee-info.pdf	30597	no	2
			837abf11ed4e6d4bbf514f5f034fad280175e3f1		
Warnings:					
Information:					
Total Files Size (in bytes):			8756912		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

ART UNIT: 3723 EXAMINER: FIRST NAMED INVENTOR: Chien-Min Sung SERIAL NO.: 13/802,112 FILED: 3/13/2013 CONF. NO.: 1021 FOR: CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS DOCKET NO.: 02074-24012.NP.CIP	<u>CERTIFICATE OF MAILING</u> <u>UNDER 37 C.F.R. § 1.8</u> DATE OF DEPOSIT: <u>December 15, 2014</u> I hereby certify that this paper or fee (along with any paper or fee referred to as being attached or enclosed) is being submitted on the date indicated above via: ☒ EFS Web ☐ facsimile to _____ ☐ the United States Postal Service with sufficient postage as first class mail addressed to: Mail Stop _____, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450. _____ /Warren Archibald/ Warren Archibald
--	---

**SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. §§ 1.56, 1.97 and 1.98**

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir/Madam:

Pursuant to the duty of disclosure under 37 C.F.R. §§ 1.56, 1.97 and 1.98, the Applicant requests consideration of this Information Disclosure Statement, which is being submitted in accordance with:

- ☐ 37 C.F.R. § 1.97(b)(1) or (3), within three months of the filing date of the application, or before a first office action on the merits, whichever occurs last;
- ☒ 37 C.F.R. § 1.97(c), after a first office action on the merits, but before a Final Office Action or a Notice of Allowance, whichever occurs first, and is accompanied by **EITHER** a statement in accordance with 37 C.F.R. § 1.97(e), **OR** the fee set forth in 37 C.F.R. § 1.17(p); or
- ☐ 37 C.F.R. § 1.97(d), after a Final Office Action or Notice of Allowance, whichever occurs first, but on or before payment of the issue fee, and is accompanied by **BOTH** a statement in

accordance with 37 C.F.R. § 1.97(e), **AND** the fee set forth in 37 C.F.R. § 1.17(p).

SUBMISSIONS

Please find enclosed, pursuant to 37 C.F.R. §§ 1.97 and 1.98:

- ☒ Form **PTO/SB/08A** and/or **PTO/SB/08B** listing the references submitted for consideration, which contains a list of all patents, publications and all other items that have come to the attention of one or more of the individuals designated in 37 C.F.R. § 1.56(c).
- ☒ Legible copies of the listed non-patent documents, unpublished U.S. applications and foreign documents or their relevant portions are included.
- ☒ All English translations of each non-English reference, if any, within the possession, custody, control or availability of anyone designated in 37 C.F.R. § 1.56(c) (see 37 C.F.R. § 1.98 are included.
- ☐ For all listed references that are not either in the English language, or accompanied by a translation into English, a concise explanation of relevance as required under 37 C.F.R. § 1.98(a)(3) is enclosed attached to each.

Copies of references listed on the enclosed PTO/SB/08A and/or PTO/SB/08B are **not** enclosed:

- ☐ because, under 37 C.F.R. § 1.98.(d), they were previously cited by or submitted to the Office in application number _____, which is relied upon for an earlier filing date under 37 C.F.R. § 1.20.
- ☐ because they are substantially cumulative of an enclosed reference.

STATEMENT IN ACCORDANCE WITH 37 C.F.R. § 1.97(e)

☐ I hereby certify that each item contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement.

☐ I hereby certify that no item contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in §1.56(c) more than three months prior to the filing of the information disclosure statement.

REMARKS

While no representation is made that any of these references may be “prior art” within the meaning of that term in accordance with 37 C.F.R. §§ 102 or 103, the enclosed list of references is disclosed so as to comply with the duty of disclosure set forth in 37 C.F.R. § 1.56.

Moreover, while no representation is made that a specific search of office files or patent office records has been conducted or that no better art exists, the undersigned attorney of record believes that the references listed, together with any other references which may have been previously submitted or listed, are the closest to the claimed invention (taken in its entirety) of which the undersigned is presently aware, and no art which is closer to the claimed invention (taken in its entirety) has been knowingly withheld.

☒ Credit card payment in the amount of \$ 90 (amount in § 1.17(p)) constituting the submission fee set forth in 37 C.F.R. § 1.17(p) is enclosed.

In the event that 37 C.F.R. § 1.97(c) applies and the Examiner is not satisfied that the Statement meets the requirements of 37 C.F.R. § 1.97(e), or in any other event remediable by a fee, please credit any over payment or charge any additional fees to Deposit Account No. 20-0100 of the undersigned.

Dated this 15th day of December, 2014.

Respectfully submitted,

/David W. Osborne/

David W. Osborne
Attorney for Applicant
Registration No. 44989

THORPE NORTH & WESTERN, LLP
Customer No. 20,551
P.O. Box 1219
Sandy, Utah 84091-1219
Telephone: (801) 566-6633

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)			Complete if Known		
			Application Number	13/802,112	
			Filing Date	3/13/2013	
			First Named Inventor	Chien-Min Sung	
			Art Unit	3723	
			Examiner Name	George Nguyen	
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No. ¹	Include name of author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		US Application 13/021,350; filed 02/04/2011; Chien-Min Sung; office action dated 03/20/2013	
		US Application 13/479,148; filing date 05/23/2012; Chien-Min Sung; Notice of Allowance mailed 12/09/2014	
		US Application 13/644,790; filing date 10/04/2012; Chien-Min Sung; office action dated 12/24/2014	

Examiner Signature		Date Considered	
--------------------	--	-----------------	--

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹Applicant's unique citation designation number (optional). ²Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **Send to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

Electronic Patent Application Fee Transmittal

Application Number:	13802112			
Filing Date:	13-Mar-2013			
Title of Invention:	CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS			
First Named Inventor/Applicant Name:	Chien-Min Sung			
Filer:	David William Osborne/Warren Archibald			
Attorney Docket Number:	02074-24012.NP.CIP			
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
Submission- Information Disclosure Stmt	2806	1	90	90
Total in USD (\$)				90

Electronic Acknowledgement Receipt

EFS ID:	21176118
Application Number:	13802112
International Application Number:	
Confirmation Number:	1021
Title of Invention:	CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS
First Named Inventor/Applicant Name:	Chien-Min Sung
Customer Number:	20551
Filer:	David William Osborne/Warren Archibald
Filer Authorized By:	David William Osborne
Attorney Docket Number:	02074-24012.NP.CIP
Receipt Date:	09-JAN-2015
Filing Date:	13-MAR-2013
Time Stamp:	20:34:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$90
RAM confirmation Number	6043
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	transmittal.PDF	79781	no	4
			9d89c587d42ac0e3e972d95a277be1fdb7f4577		
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	b.PDF	78714	no	1
			c2b14bcdaba8c8ce572cf78a7aebd10f9f65bda4		
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Fee Worksheet (SB06)	fee-info.pdf	30597	no	2
			eb5f7e3c4045ee988c443b56d2f9e4dbe7407e74		
Warnings:					
Information:					
Total Files Size (in bytes):			189092		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

ART UNIT: 3723 EXAMINER: George Nguyen FIRST NAMED INVENTOR: Chien-Min Sung SERIAL NO.: 13/802,112 FILED: 3/13/2013 CONF. NO.: 1021 FOR: CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS DOCKET NO.: 02074-24012.NP.CIP	<u>CERTIFICATE OF MAILING</u> <u>UNDER 37 C.F.R. § 1.8</u> DATE OF DEPOSIT: <u>January 9, 2015</u> I hereby certify that this paper or fee (along with any paper or fee referred to as being attached or enclosed) is being submitted on the date indicated above via: ☒ EFS Web ☐ facsimile to _____ ☐ the United States Postal Service with sufficient postage as first class mail addressed to: Mail Stop _____, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450. _____ /Warren Archibald/ Warren Archibald
--	---

**SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. §§ 1.56, 1.97 and 1.98**

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir/Madam:

Pursuant to the duty of disclosure under 37 C.F.R. §§ 1.56, 1.97 and 1.98, the Applicant requests consideration of this Information Disclosure Statement, which is being submitted in accordance with:

- ☐ 37 C.F.R. § 1.97(b)(1) or (3), within three months of the filing date of the application, or before a first office action on the merits, whichever occurs last;
- ☒ 37 C.F.R. § 1.97(c), after a first office action on the merits, but before a Final Office Action or a Notice of Allowance, whichever occurs first, and is accompanied by **EITHER** a statement in accordance with 37 C.F.R. § 1.97(e), **OR** the fee set forth in 37 C.F.R. § 1.17(p); or
- ☐ 37 C.F.R. § 1.97(d), after a Final Office Action or Notice of Allowance, whichever occurs first, but on or before payment of the issue fee, and is accompanied by **BOTH** a statement in

accordance with 37 C.F.R. § 1.97(e), **AND** the fee set forth in 37 C.F.R. § 1.17(p).

SUBMISSIONS

Please find enclosed, pursuant to 37 C.F.R. §§ 1.97 and 1.98:

- ☒ Form **PTO/SB/08A** and/or **PTO/SB/08B** listing the references submitted for consideration, which contains a list of all patents, publications and all other items that have come to the attention of one or more of the individuals designated in 37 C.F.R. § 1.56(c).
- ☐ Legible copies of the listed non-patent documents, unpublished U.S. applications and foreign documents or their relevant portions are included.
- ☐ All English translations of each non-English reference, if any, within the possession, custody, control or availability of anyone designated in 37 C.F.R. § 1.56(c) (see 37 C.F.R. § 1.98 are included.
- ☐ For all listed references that are not either in the English language, or accompanied by a translation into English, a concise explanation of relevance as required under 37 C.F.R. § 1.98(a)(3) is enclosed attached to each.

Copies of references listed on the enclosed PTO/SB/08A and/or PTO/SB/08B are **not** enclosed:

- ☐ because, under 37 C.F.R. § 1.98.(d), they were previously cited by or submitted to the Office in application number _____, which is relied upon for an earlier filing date under 37 C.F.R. § 1.20.
- ☐ because they are substantially cumulative of an enclosed reference.

STATEMENT IN ACCORDANCE WITH 37 C.F.R. § 1.97(e)

☐ I hereby certify that each item contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement.

☐ I hereby certify that no item contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in §1.56(c) more than three months prior to the filing of the information disclosure statement.

REMARKS

While no representation is made that any of these references may be “prior art” within the meaning of that term in accordance with 37 C.F.R. §§ 102 or 103, the enclosed list of references is disclosed so as to comply with the duty of disclosure set forth in 37 C.F.R. § 1.56.

Moreover, while no representation is made that a specific search of office files or patent office records has been conducted or that no better art exists, the undersigned attorney of record believes that the references listed, together with any other references which may have been previously submitted or listed, are the closest to the claimed invention (taken in its entirety) of which the undersigned is presently aware, and no art which is closer to the claimed invention (taken in its entirety) has been knowingly withheld.

☒ Credit card payment in the amount of \$ 90. (amount in § 1.17(p)) constituting the submission fee set forth in 37 C.F.R. § 1.17(p) is enclosed.

In the event that 37 C.F.R. § 1.97(c) applies and the Examiner is not satisfied that the Statement meets the requirements of 37 C.F.R. § 1.97(e), or in any other event remediable by a fee, please credit any over payment or charge any additional fees to Deposit Account No. 20-0100 of the undersigned.

Dated this 9th day of January, 2015.

Respectfully submitted,

/David W. Osborne/

David W. Osborne
Attorney for Applicant
Registration No. 44989

THORPE NORTH & WESTERN, LLP
Customer No. 20,551
P.O. Box 1219
Sandy, Utah 84091-1219
Telephone: (801) 566-6633

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)				Complete if Known	
				Application Number	13/802,112
				Filing Date	3/13/2013
				First Named Inventor	Chien-Min Sung
				Art Unit	3723
				Examiner Name	George Nguyen
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

[illegible]

Examiner Signature		Date Considered	
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*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹Applicant's unique citation designation number (optional). ²Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **Send to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	21490748
Application Number:	13802112
International Application Number:	
Confirmation Number:	1021
Title of Invention:	CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS
First Named Inventor/Applicant Name:	Chien-Min Sung
Customer Number:	20551
Filer:	David William Osborne/Warren Archibald
Filer Authorized By:	David William Osborne
Attorney Docket Number:	02074-24012.NP.CIP
Receipt Date:	12-FEB-2015
Filing Date:	13-MAR-2013
Time Stamp:	20:11:30
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	Transmittal.PDF	80456 ea87c4ac8239301f01f7aa86be63f1248c7898d7	no	4

Warnings:

Information:

2	Information Disclosure Statement (IDS) Form (SB08)	b.PDF	78407 12f8a8b58bbc738936f93784c05307889b5 214b1	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
Total Files Size (in bytes):				158863	
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

ART UNIT: 3723 EXAMINER: George Nguyen FIRST NAMED INVENTOR: Chien-Min Sung SERIAL NO.: 13/802,112 FILED: 3/13/2013 CONF. NO.: 1021 FOR: CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS DOCKET NO.: 02074-24012.NP.CIP	<u>CERTIFICATE OF MAILING</u> <u>UNDER 37 C.F.R. § 1.8</u> DATE OF DEPOSIT: <u>February 12, 2015</u> I hereby certify that this paper or fee (along with any paper or fee referred to as being attached or enclosed) is being submitted on the date indicated above via: ☒ EFS Web ☐ facsimile to _____ ☐ the United States Postal Service with sufficient postage as first class mail addressed to: Mail Stop _____, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450. _____ /Warren Archibald/ Warren Archibald
--	--

**SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. §§ 1.56, 1.97 and 1.98**

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir/Madam:

Pursuant to the duty of disclosure under 37 C.F.R. §§ 1.56, 1.97 and 1.98, the Applicant requests consideration of this Information Disclosure Statement, which is being submitted in accordance with:

- ☐ 37 C.F.R. § 1.97(b)(1) or (3), within three months of the filing date of the application, or before a first office action on the merits, whichever occurs last;
- ☒ 37 C.F.R. § 1.97(c), after a first office action on the merits, but before a Final Office Action or a Notice of Allowance, whichever occurs first, and is accompanied by **EITHER** a statement in accordance with 37 C.F.R. § 1.97(e), **OR** the fee set forth in 37 C.F.R. § 1.17(p); or
- ☐ 37 C.F.R. § 1.97(d), after a Final Office Action or Notice of Allowance, whichever occurs first, but on or before payment of the issue fee, and is accompanied by **BOTH** a statement in

accordance with 37 C.F.R. § 1.97(e), **AND** the fee set forth in 37 C.F.R. § 1.17(p).

- ☒ 37 C.F.R. § 1.704(d), within 30 days of receipt of a first citation in any communication from a patent office in a counterpart foreign or international application or from the Office, in accordance with 37 C.F.R. § 1.97 and 1.98.

SUBMISSIONS

Please find enclosed, pursuant to 37 C.F.R. §§ 1.97 and 1.98:

- ☒ Form **PTO/SB/08A** and/or **PTO/SB/08B** listing the references submitted for consideration, which contains a list of all patents, publications and all other items that have come to the attention of one or more of the individuals designated in 37 C.F.R. § 1.56(c).
- ☐ Legible copies of the listed non-patent documents, unpublished U.S. applications and foreign documents or their relevant portions are included.
- ☐ All English translations of each non-English reference, if any, within the possession, custody, control or availability of anyone designated in 37 C.F.R. § 1.56(c) (see 37 C.F.R. § 1.98 are included.
- ☐ For all listed references that are not either in the English language, or accompanied by a translation into English, a concise explanation of relevance as required under 37 C.F.R. § 1.98(a)(3) is enclosed attached to each.

Copies of references listed on the enclosed PTO/SB/08A and/or PTO/SB/08B are **not** enclosed:

- ☐ because, under 37 C.F.R. § 1.98.(d), they were previously cited by or submitted to the Office in application number _____, which is relied upon for an earlier filing date under 37 C.F.R. § 1.20.
- ☐ because they are substantially cumulative of an enclosed reference.

STATEMENT IN ACCORDANCE WITH 37 C.F.R. § 1.97(e)

☐ I hereby certify that each item contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement.

☒ I hereby certify that no item contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in §1.56(c) more than three months prior to the filing of the information disclosure statement.

REMARKS

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Moreover, while no representation is made that a specific search of office files or patent office records has been conducted or that no better art exists, the undersigned attorney of record believes that the references listed, together with any other references which may have been previously submitted or listed, are the closest to the claimed invention (taken in its entirety) of which the undersigned is presently aware, and no art which is closer to the claimed invention (taken in its entirety) has been knowingly withheld.

☐ Check No. ____ in the amount of \$ ____ (amount in § 1.17(p)) constituting the submission fee set forth in 37 C.F.R. § 1.17(p) is enclosed.

In the event that 37 C.F.R. § 1.97(c) applies and the Examiner is not satisfied that the Statement

meets the requirements of 37 C.F.R. § 1.97(e), or in any other event remediable by a fee, please credit any over payment or charge any additional fees to Deposit Account No. 20-0100 of the undersigned.

Dated this 12th day of February, 2015.

Respectfully submitted,

/David W. Osborne/

David W. Osborne
Attorney for Applicant
Registration No. 44989

THORPE NORTH & WESTERN, LLP
Customer No. 20,551
P.O. Box 1219
Sandy, Utah 84091-1219
Telephone: (801) 566-6633

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)			Complete if Known		
			Application Number	13/802,112	
			Filing Date	3/13/2013	
			First Named Inventor	Chien-Min Sung	
			Art Unit	3723	
Examiner Name	George Nguyen				
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No. ¹	Include name of author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		U.S. Application No. 13/113,779; Filing date May 23, 2011; Chien-Min Sung; U.S. Office Action mailed February 10, 2015.	
		U.S. Application No. 13/153,176; Filing date June 3, 2011; Chien-Min Sung; U.S. Office Action mailed February 10, 2015.	
		U.S. Application 13/794,164; Filing date March 11, 2013; Chien-Min Sung; Notice of Allowance mailed February 13, 2015.	
		U.S. Application No. 13/633,082; Filing date October 1, 2012; Chien-Min Sung; U.S. Office Action mailed February 26, 2015.	
		U.S. Application No. 13/407,634; Filing date February 28, 2012; Chien-Min Sung; Office Action mailed March 5, 2015.	

Examiner Signature		Date Considered	
--------------------	--	-----------------	--

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹Applicant's unique citation designation number (optional). ²Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **Send to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	21934746
Application Number:	13802112
International Application Number:	
Confirmation Number:	1021
Title of Invention:	CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS
First Named Inventor/Applicant Name:	Chien-Min Sung
Customer Number:	20551
Filer:	David William Osborne/Stephen Neville
Filer Authorized By:	David William Osborne
Attorney Docket Number:	02074-24012.NP.CIP
Receipt Date:	31-MAR-2015
Filing Date:	13-MAR-2013
Time Stamp:	18:51:03
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	STRand.PDF	79521 3c3f913bed7931af1087cf79842846c12d695d71	no	4

Warnings:

Information:

2	Information Disclosure Statement (IDS) Form (SB08)	Aaaa.PDF	104230 497e89bec37d0f82f6f988e42423ab3f362a4ade	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Information Disclosure Statement (IDS) Form (SB08)	Bbbb.PDF	81617 914e2578be3473a3ece9c44cac4a3fbb73f6c327	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
Total Files Size (in bytes):				265368	
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

ART UNIT: 3723 EXAMINER: George Nguyen FIRST NAMED INVENTOR: Chien-Min Sung SERIAL NO.: 13/802,112 FILED: 3/13/2013 CONF. NO.: 1021 FOR: CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS DOCKET NO.: 02074-24012.NP.CIP	<u>CERTIFICATE OF MAILING</u> <u>UNDER 37 C.F.R. § 1.8</u> DATE OF DEPOSIT: <u>March 31, 2015</u> I hereby certify that this paper or fee (along with any paper or fee referred to as being attached or enclosed) is being submitted on the date indicated above via: ☒ EFS Web ☐ facsimile to _____ ☐ the United States Postal Service with sufficient postage as first class mail addressed to: Mail Stop _____, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450. _____ /Stephen R. Neville/ Stephen R. Neville
--	---

**SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. §§ 1.56, 1.97 and 1.98**

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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- ☐ 37 C.F.R. § 1.97(b)(1) or (3), within three months of the filing date of the application, or before a first office action on the merits, whichever occurs last;
- ☒ 37 C.F.R. § 1.97(c), after a first office action on the merits, but before a Final Office Action or a Notice of Allowance, whichever occurs first, and is accompanied by **EITHER** a statement in accordance with 37 C.F.R. § 1.97(e), **OR** the fee set forth in 37 C.F.R. § 1.17(p); or
- ☐ 37 C.F.R. § 1.97(d), after a Final Office Action or Notice of Allowance, whichever occurs first, but on or before payment of the issue fee, and is accompanied by **BOTH** a statement in

accordance with 37 C.F.R. § 1.97(e), **AND** the fee set forth in 37 C.F.R. § 1.17(p).

SUBMISSIONS

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STATEMENT IN ACCORDANCE WITH 37 C.F.R. § 1.97(e)

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a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement.

☒ I hereby certify that no item contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in §1.56(c) more than three months prior to the filing of the information disclosure statement.

REMARKS

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☐ Check No. ____ in the amount of \$ ____ (amount in § 1.17(p)) constituting the submission fee set forth in 37 C.F.R. § 1.17(p) is enclosed.

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Dated this 31st day of March, 2015.

Respectfully submitted,

/David W. Osborne/

David W. Osborne
Attorney for Applicant
Registration No. 44989

THORPE NORTH & WESTERN, LLP
Customer No. 20,551
P.O. Box 1219
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Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)				Complete if Known	
				Application Number	13/802,112
				Filing Date	3/13/2013
				First Named Inventor	Chien-Min Sung
				Art Unit	3723
				Examiner Name	George Nguyen
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

[illegible][illegible]

Examiner Signature		Date Considered	
-----------------------	--	--------------------	--

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. ¹ Applicant's unique citation designation number (optional). ² See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

ART UNIT: 3723	<u>CERTIFICATE OF MAILING</u> <u>UNDER 37 C.F.R. § 1.8</u> DATE OF DEPOSIT: <u>April 6, 2015</u> I hereby certify that this paper or fee (along with any paper or fee referred to as being attached or enclosed) is being submitted on the date indicated above via: ☒ EFS Web ☐ facsimile to _____ ☐ the United States Postal Service with sufficient postage as first class mail addressed to: Mail Stop _____, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450. _____ /Nicole Solomon/ Nicole Solomon
EXAMINER: George Binh Minh Nguyen	
FIRST NAMED INVENTOR: Chien-Min Sung	
SERIAL NO.: 13/802,112	
FILED: 3/13/2013	
CONFRM. NO.: 1021	
FOR: CMP Pad Dresser Having Leveled Tips and Associated Methods	
DOCKET NO.: 02074-240 12.NP.CIP	

THORPE NORTH & WESTERN, LLP
8180 South 700 East, Suite 350
Sandy, Utah 84070

RESPONSE UNDER 37 C.F.R. § 1.111

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In response to the Office Action of November 6, 2014, please enter this amendment and reconsider this application in view of the remarks provided below. A petition for a two-month extension of time and the associated fee are enclosed herewith.

AMENDMENTS TO THE SPECIFICATION

Please amend the “Brief Description of the Drawings” section on page 10 as follows:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention;

FIG. 2 is a flow chart diagram showing steps of a method of dressing a CMP pad in accordance with an embodiment of the present invention;

FIG. 3 is a flow chart diagram showing steps of a method of ~~dressing a CMP pad~~ polishing a workpiece in accordance with an embodiment of the present invention;

FIG. 4 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention;

FIG. 5 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention;

FIG. 6 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention; and

FIG. 7 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention.

REMARKS

In the Office Action of November 6, 2014, claims 1-20 were pending for consideration. All of the claims were rejected on various statutory grounds, each of which is addressed in turn below. Claims 1-20 remain pending in the present application. Applicant respectfully submits that the present claims are allowable over the cited references.

Specification Objections:

The specification was objected to over an inadvertent typographical error in the brief description of FIG. 3 on page 10. Applicant thanks Examiner for noting the error, which has been corrected by the present amendment.

35 U.S.C. § 103 Rejections:

While the Applicant is confident that the Examiner is well acquainted with the requirements necessary to establish a *prima facie* case of obviousness, it is thought prudent to briefly review the required elements. Specifically, in order to meet the burden of establishing a *prima facie* case of obvious, the Patent Office must show that: 1) each and every element of the invention as set forth in the claims is taught or suggested by the reference as modified or the combination of references; 2) that there is sufficient motivation or articulated reasoning for one of ordinary skill in the art to modify or combine the reference; and 3) that one of ordinary skill in the art would find a sufficient likelihood of successfully making the modification or combination asserted. Applicant respectfully submits that the Patent Office has failed to satisfy these requirements with any of the asserted rejections, and thus has not established a *prima facie* case of obviousness.

Examiner has rejected claims 1-20 under 35 U.S.C. § 103(a) as being allegedly unpatentable over Dinh-Ngoc (2010/0248595) in view of Sung (2008/0292869). Examiner argues that Dinh-Ngoc discloses a method of conditioning a CMP pad, where the CMP pad dresser has a monolayer of superabrasive particles protruding from a matrix layer, wherein the difference between the highest protruding tip and the second highest protruding tip of the monolayer of superabrasive particles is less than or equal to about 50 microns. Examiner states that Dinh-Ngoc does not teach a difference in protrusion distance between the highest 10 protruding tips of the monolayer of superabrasive particles that is within about 20 microns or less, and also does not teach rotating the dresser against the CMP pad generates asperities in the CMP pad having a maximum cutting depth of about 60 microns. Examiner further argues that Sung teaches these missing elements, and that the combination of these references would be obvious. Applicant respectfully disagrees for at least the following reasons.

For example, Examiner argues that Sung discloses that superabrasive particles protruding to a predetermined height produce a cutting depth of less than 20 microns, and infers that this recitation of cutting depth reads on the claim limitation that the highest 10 protruding tips are within about 20 microns or less. It is noted, however, that the depth to which a particle cuts into a deformable substance like a CMP pad is not necessarily a teaching of the protrusion distance of that particle. For example, the downward pressure of the particle as the pad dresser is pressed into the pad can cause compression of the pad material in the direction of the downward pressure. This compression effect in the direction away from the dresser may cause the cutting depth to be less than the protrusion of the dresser particles. Additionally, as the dresser moves across the pad surface, the downward force can cause compression between the leading side of

the dresser and the trailing side of the dresser leading to an uneven movement of the pad surface beneath the dresser. The cutting of the pad is at least in part due to these compressive forces overcoming the atomic forces of the pad material.

The combination of the downward compression with the compression radiating from the leading side of the cutting particle demonstrates that a recitation of cutting depth is not necessarily a measurement or teaching of the protrusion height of a particle. Accordingly, Applicant respectfully submits that the teaching of cutting depth in Sung does not remedy the missing element of Dinh-Ngoc that the difference in protrusion distance between the highest 10 protruding tips of the monolayer of superabrasive particles are within about 20 microns or less. As such, a *prima facie* case of obviousness has not been established by the Patent Office with respect to claim 1. It is therefore requested that the rejection of claim 1 be withdrawn. Additionally, claims 2-20 depend from claim 1 and are thus considered to be narrower in scope. These claims will not be discussed in detail, and it is respectfully requested that these rejections be withdrawn due to the dependency on claim 1.

It is noted that any lack of discussion by Applicant regarding any arguments or issue raised by Examiner with respect to any of claims 1-20 should not be seen as being in agreement with Examiner. Applicant reserves the right to pursue any argument or issue at a later time.

CONCLUSION

In view of the foregoing, Applicant asserts that claims 1-20 of the present application present allowable subject matter and the allowance thereof is requested. If any impediment to the allowance of these claims remains after consideration of the present amendment and above remarks, and such impediment could be removed during a telephone interview, the Examiner is invited to telephone the undersigned attorney so that such issues may be resolved as expeditiously as possible.

It is believed that no fee is due herewith; however, the Commissioner is hereby authorized to charge any required fee (except for Issue Fees) or credit any overpayment to Deposit Account No. 20-0100.

Dated this 6th day of April, 2015.

Respectfully submitted,

THORPE, NORTH & WESTERN, LLP

/David W. Osborne/

David W. Osborne
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Facsimile: (801) 566-0750

DWO/TBA/ns

Electronic Patent Application Fee Transmittal

Application Number:	13802112			
Filing Date:	13-Mar-2013			
Title of Invention:	CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS			
First Named Inventor/Applicant Name:	Chien-Min Sung			
Filer:	David William Osborne/Nicole Solomon			
Attorney Docket Number:	02074-24012.NP.CIP			
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension - 2 months with \$0 paid	2252	1	300	300
Miscellaneous:				
Total in USD (\$)				300

Electronic Acknowledgement Receipt

EFS ID:	21985777
Application Number:	13802112
International Application Number:	
Confirmation Number:	1021
Title of Invention:	CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS
First Named Inventor/Applicant Name:	Chien-Min Sung
Customer Number:	20551
Filer:	David William Osborne/Nicole Solomon
Filer Authorized By:	David William Osborne
Attorney Docket Number:	02074-24012.NP.CIP
Receipt Date:	06-APR-2015
Filing Date:	13-MAR-2013
Time Stamp:	21:20:21
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$ 300
RAM confirmation Number	7508
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Extension of Time	24012_NP_CIP_Extension.pdf	127940	no	1
			ef1d68f6ca17e8a0d32921388122519358c9abe		
Warnings:					
Information:					
2		24012_NP_CIP_Response.pdf	82036	yes	6
			a0090a25ff8fe4d6460d8386b47e77179b34bcd8		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Amendment/Req. Reconsideration-After Non-Final Reject		1	1	
	Specification		2	2	
	Applicant Arguments/Remarks Made in an Amendment		3	6	
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30719	no	2
			335cde2a2ee1e451e4c4c2df3e9a74e5db5bcd9		
Warnings:					
Information:					
Total Files Size (in bytes):			240695		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)		Docket Number (Optional) 02074-24012.NP.CIP
Application Number 13/802,112	Filed 03/13/2013	
For CMP Pad Dresser Having Leveled Tips and Associated Methods		
Art Unit 3723	Examiner George Binh Minh Nguyen	

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	<u>Fee</u>	<u>Small Entity Fee</u>	<u>Micro Entity Fee</u>	
☐ One month (37 CFR 1.17(a)(1))	\$200	\$100	\$50	\$ _____
☒ Two months (37 CFR 1.17(a)(2))	\$600	\$300	\$150	\$ 300
☐ Three months (37 CFR 1.17(a)(3))	\$1,400	\$700	\$350	\$ _____
☐ Four months (37 CFR 1.17(a)(4))	\$2,200	\$1,100	\$550	\$ _____
☐ Five months (37 CFR 1.17(a)(5))	\$3,000	\$1,500	\$750	\$ _____

☒ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☒ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☒ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to
Deposit Account Number 20-0100.

☒ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☒ attorney or agent of record. Registration number 44989.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/David W. Osborne/

Signature

David W. Osborne

Typed or printed name

April 6, 2015

Date

801-566-6633

Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/802,112	Filing Date 03/13/2013	☐ To be Mailed
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ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO**APPLICATION AS FILED – PART I**

(Column 1)

(Column 2)

FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X \$ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X \$ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
			TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

(Column 1)

(Column 2)

(Column 3)

AMENDMENT	04/06/2015	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X \$40 =	0
	Independent (37 CFR 1.16(h))	* 1	Minus	***3	= 0	X \$210 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	0

(Column 1)

(Column 2)

(Column 3)

AMENDMENT	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X \$ =
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X \$ =
	☐ Application Size Fee (37 CFR 1.16(s))					
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					
						TOTAL ADD'L FEE

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/PATRICIA F. LEWIS/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.



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NOTICE OF ALLOWANCE AND FEE(S) DUE

20551 7590 05/15/2015
THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

EXAMINER

NGUYEN, GEORGE BINH MINH

ART UNIT

PAPER NUMBER

3723

DATE MAILED: 05/15/2015

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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13/802,112

03/13/2013

Chien-Min Sung

02074-24012.NP.CIP

1021

TITLE OF INVENTION: CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$480	\$0	\$0	\$480	08/17/2015

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

20551 7590 05/15/2015
THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/802,112	03/13/2013	Chien-Min Sung	02074-24012.NP.CIP	1021

TITLE OF INVENTION: CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$480	\$0	\$0	\$480	08/17/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
NGUYEN, GEORGE BINH MINH	3723	451-443000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

- (1) The names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
- (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____
- 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☐ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☐ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____

Date _____

Typed or printed name _____

Registration No. _____



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United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/802,112	03/13/2013	Chien-Min Sung	02074-24012.NP.CIP	1021

20551 7590 05/15/2015
THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

EXAMINER

NGUYEN, GEORGE BINH MINH

ART UNIT	PAPER NUMBER
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3723

DATE MAILED: 05/15/2015

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 13/802,112	Applicant(s) SUNG, CHIEN-MIN	
	Examiner GEORGE NGUYEN	Art Unit 3723	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to applicant amendment filed on April 6, 2015.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are 1-20. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
a) ☐ All b) ☐ Some *c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892) 2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date <u>3/31/2015;02/12/2015;12/15/2014;01/09/2015;</u> 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material 4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____.	5. ☐ Examiner's Amendment/Comment 6. ☐ Examiner's Statement of Reasons for Allowance 7. ☐ Other _____.
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/GEORGE NGUYEN/ Primary Examiner, Art Unit 3723	
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Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)		Complete if Known			
		Application Number	13/802,112		
		Filing Date	3/13/2013		
		First Named Inventor	Chien-Min Sung		
		Art Unit	3723		
Examiner Name	George Nguyen				
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No. ¹	Include name of author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		US Application 13/021,350; filed 02/04/2011; Chien-Min Sung; office action dated 03/20/2013	
		US Application 13/479,148; filing date 05/23/2012; Chien-Min Sung; Notice of Allowance mailed 12/09/2014	
		US Application 13/644,790; filing date 10/04/2012; Chien-Min Sung; office action dated 12/24/2014	

Examiner Signature	/George Nguyen/ (05/06/2015)	Date Considered	
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*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹Applicant's unique citation designation number (optional). ²Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **Send to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /G.N./

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)				Complete if Known	
				Application Number	13/802,112
				Filing Date	3/13/2013
				First Named Inventor	Chien-Min Sung
				Art Unit	3723
				Examiner Name	George Nguyen
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

[illegible][illegible]

Examiner Signature	/George Nguyen/ (05/06/2015)	Date Considered	
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. ¹Applicant's unique citation designation number (optional). ²See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. ³Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴For Japanese patent documents, indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁶Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /G.N./

Search Notes 	Application/Control No. 13802112	Applicant(s)/Patent Under Reexamination SUNG, CHIEN-MIN
	Examiner GEORGE NGUYEN	Art Unit 3723

CPC- SEARCHED		
Symbol	Date	Examiner
b24b53/07;53/017;3/125	11/3/2014	GN
updated search above	5/6/2015	GN
B24B53/12;37/04;37/042;57/02	5/6/2015	GN

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
451	443,444,548,56	11/3/2014	GN
51	295,309	11/3/2014	GN
	updated search 451 above	5/6/2015	GN

SEARCH NOTES		
Search Notes	Date	Examiner
updated parent search 13/479,148	11/3/2014	GN
Inventor search	11/3/2014	GN

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
	Please see search history	5/6/2015	GN

	/GEORGE NGUYEN/ Primary Examiner.Art Unit 3723
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Issue Classification 	Application/Control No. 13802112	Applicant(s)/Patent Under Reexamination SUNG, CHIEN-MIN	
	Examiner GEORGE NGUYEN	Art Unit 3723	

CPC						
Symbol					Type	Version
B24B		53		017	F	2013-01-01

CPC Combination Sets				
Symbol	Type	Set	Ranking	Version
				
				

NONE		Total Claims Allowed: 20	
(Assistant Examiner)	(Date)		
/GEORGE NGUYEN/ Primary Examiner.Art Unit 3723	05/06/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

Issue Classification 	Application/Control No. 13802112	Applicant(s)/Patent Under Reexamination SUNG, CHIEN-MIN
	Examiner GEORGE NGUYEN	Art Unit 3723

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		17												
	2		18												
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	15														
	16														

NONE		Total Claims Allowed: 20	
(Assistant Examiner)	(Date)		
/GEORGE NGUYEN/ Primary Examiner.Art Unit 3723	05/06/2015	O.G. Print Claim(s) 1	O.G. Print Figure 2
(Primary Examiner)	(Date)		

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	35	("20020014041" "20020164928" "20030092357" "20040023610" "20050032469" "20050095959" "20050118939" "20050227590" "20070232074" "20080153398" "20090073774" "20090123705" "20090215363" "20110293905" "20120192499" "20120260582" "20120302146" "3664662" "3706650" "4151154" "4405411" "4737162" "4863573" "5224469" "5868806" "6159087" "6200360" "6312324" "6416878" "6769969" "6837979" "7067903" "7651368" "7762872").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/05/06 14:43
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S2	6	("20070232074" "20080271384" "20090073774" "7067903" "7198553" "7651386").PN.	US-PGPUB; USPAT	OR	OFF	2013/07/09 08:42
S3	10	("20040180617" "20080076338" "20100015898" "6899592" "7150677").PN.	US-PGPUB; USPAT; USOCR;	OR	OFF	2013/07/09 08:42

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S6	462	451/444.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/07/09 10:02
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S10	180	S9 and (flatness warping)	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/07/09 10:47
S11	2468	51/295.ccls.	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/07/09 12:31
S12	86	S11 and (flatness warping)	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/07/09 12:32
S13	1378	451/56.ccls.	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/07/09 12:37
S14	204	S13 and (flatness warping)	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/07/09 12:37
S15	180	("1854071" "1988065" "0187593" "2027087" "2027307" "2033991" "2035521" "2075354" "2184348" "2187624" "2194253" "2268663" "2281558" "2318570" "2334572" "2612348" "2652951" "2725693" "2811960" "2867086" "2876086" "2947608" "2952951" "20010003884" "20010009844" "20020042200" "20020127962" "20020173234" "20030054746" "20030084894" "20030114094" "20030207659" "20040009742" "20040060243" "20040079033"	US- PGPUB; USPAT; USOCR	OR	OFF	2013/07/09 12:47

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S17	672	first near2 monolayer near2 second	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/07/16 11:42
S18	81761	rigid near2 support	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/07/16 11:43
S19	0	S17 with S18	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/07/16 11:43
S20	341	sung-chien-min.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/07/16 11:47
S24	655	b24b53/07.cpc.	US-PGPUB; USPAT;	OR	OFF	2014/02/24 11:04

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S25	3143	b24b53/017.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/02/24 11:07
S26	608	451/443.ccls.	USPAT	OR	OFF	2014/02/24 11:31
S27	331	451/444.ccls.	USPAT	OR	OFF	2014/02/24 11:34
S28	912	451/548.ccls.	USPAT	OR	OFF	2014/02/24 11:37
S29	1838	b24b53/12.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/02/24 11:40
S34	6	("20040203325" "20070266639" "20100203811" "20100248595" "20120241943" "6196911").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/02/25 09:10
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S38	48	(US-20120302146-\$ or US- 20130165023-\$ or US-20120244790- \$ or US-20010046835-\$ or US- 20070066194-\$ or US-20070060026- \$ or US-20070264918-\$ or US-	US-PGPUB; USPAT	OR	OFF	2014/04/01 15:23

		20080171503-\$ or US-20080292869-\$ or US-20100139174-\$ or US-20100221990-\$ or US-20110212670-\$ or US-20060068691-\$ or US-20070215486-\$ or US-20070289223-\$ or US-20020139680-\$ or US-20070175765-\$ or US-20020173234-\$.did. or (US-6517424-\$ or US-7300338-\$ or US-7651386-\$ or US-7690971-\$ or US-7901272-\$ or US-8414362-\$ or US-5976205-\$ or US-7241206-\$ or US-7393264-\$ or US-7494404-\$ or US-5492771-\$ or US-5511718-\$ or US-6884155-\$ or US-7124753-\$ or US-7201645-\$ or US-7258708-\$ or US-7285039-\$ or US-7473162-\$ or US-7491116-\$ or US-7544117-\$ or US-7749050-\$ or US-7771498-\$ or US-8043145-\$ or US-8104464-\$ or US-8142261-\$ or US-8298043-\$.did. or (US-8298048-\$ or US-8449357-\$ or US-8491358-\$ or US-8678878-\$.did.				
S39	1	"7198553".pn.	US-PGPUB; USPAT	OR	OFF	2014/04/01 15:41
S40	1203	tip adj (level leveling)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 11:42
S41	113033	"451"/\$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 11:43
S42	8	S40 and S41	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 11:43
S43	14761	"51"/\$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 12:52
S44	3	S40 and S43	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 12:53
S45	1212	tip adj (level leveling leveled)	US-PGPUB; USPAT;	OR	OFF	2014/05/07 12:54

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S46	8	S45 and S41	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 12:54
S47	59	protrusion adj difference	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 13:42
S48	4102	heat near2 pressure near2 bonding	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 13:59
S49	9	S48 and S43	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 14:00
S50	263	sintering adj compound	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 14:05
S51	3	S50 and S43	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 14:06
S52	4	S50 and S41	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 14:06
S53	1160	adhesive near2 transfer near2 sheet	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 15:46

S54	12	S53 and S43	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 15:46
S55	971	aperture near2 template	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 16:09
S56	0	S53 with S55	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 16:10
S57	0	S53 same S55	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/07 16:10
S58	44	("2223063" "2642654" "3817719" "3894673" "4018576" "4042559" "4311489" "4378975" "4621031" "4652275" "4799939" "4925457" "5000273" "5049165" "5131924" "5203880" "5203881" "5251802" "5264011" "5304342" "5380390" "5486131" "5492188" "5511718" "5569062" "5605499" "5707276" "5782679" "5832360" "5833021" "5871060" "6039641" "6123612" "6361423" "6434946" "6679243").PN. OR ("7198553").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/05/08 22:41
S59	53542	hot adj pressing	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/09 08:18
S60	14766	"51"/\$.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/09 08:18
S61	581	S59 and S60	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2014/05/09 08:18

			IBM_TDB			
S62	126	warping adj (reducing reduction minimizing mininized)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/09 08:51
S63	0	S62 and S60	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/09 08:51
S64	113048	"451"/\$.cls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/09 08:51
S65	0	S62 and S64	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/05/09 08:52
S66	4	("20080014845" "20090094902" "20110104989" "20130225052").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/10/30 09:43
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S106	458	b24b53/12.cpc.	USPAT; EPO	OR	OFF	2015/05/06 13:48
S107	1018	b24b37/04.cpc.	USPAT; EPO	OR	OFF	2015/05/06 13:50
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EAST Search History (I nterference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S21	608	first near2 monolayer near2 second	US-PGPUB; USPAT; UPAD	OR	OFF	2013/07/16 11:56
S22	53464	rigid near2 support	US-PGPUB; USPAT; UPAD	OR	OFF	2013/07/16 11:56
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S31	55259	rigid near2 support	US-PGPUB; USPAT; UPAD	OR	OFF	2014/02/24 11:38
S32	19881	(superabrasive abrasive) adj particles	US-PGPUB; USPAT; UPAD	OR	OFF	2014/02/24 11:39
S33	1	S30 same S31 same S32	US-PGPUB; USPAT; UPAD	OR	OFF	2014/02/24 11:39

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		Application Number	13/802,112	
		Filing Date	3/13/2013	
		First Named Inventor	Chien-Min Sung	
		Art Unit	3723	
Examiner Name				
Sheet		of	Attorney Docket Number	02074-24012.NP.CIP

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No. ¹	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number-Kind Code ² (if known)			
		2002/0014041	02/2002	Baldonai et al.	
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Examiner Initials*	Cite No. ¹	Foreign Patent Document	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T ⁶
		Country Code ³ - Number ⁴ - Kind Code ⁵ (if known)				
		EP 1075898	02/14/2001	Mitsubishi		
		GB 2366804	03/02/2002	Kinik Company		
		WO 95/31006	11/16/1995	Siliconix Incorporated		
		WO 2006/039413	04/13/2006	Sung		
		WO 2009/043058	04/02/2009	Sung et al.		
		WO 2009/064677	05/22/2009	Sung		
		WO 2012/040374 A2	03/29/2012	Rite Dia Corporation		

Receipt date: 12/15/2014

13802112 - GAU: 3723
PTO/SB/08A (08-03)

Approved for use through 07/31/2006. OMB 0651-0031

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		Art Unit	3723	
		Examiner Name		
Sheet		of	Attorney Docket Number	02074-24012.NP.CIP

Examiner Signature	/George Nguyen/ (05/06/2015)	Date Considered	
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		First Named Inventor	Chien-Min Sung		
		Art Unit	3723		
Examiner Name	George Nguyen				
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No. ¹	Include name of author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		U.S. Application No. 13/113,779; Filing date May 23, 2011; Chien-Min Sung; U.S. Office Action mailed February 10, 2015.	
		U.S. Application No. 13/153,176; Filing date June 3, 2011; Chien-Min Sung; U.S. Office Action mailed February 10, 2015.	
		U.S. Application 13/794,164; Filing date March 11, 2013; Chien-Min Sung; Notice of Allowance mailed February 13, 2015.	
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		U.S. Application No. 13/407,634; Filing date February 28, 2012; Chien-Min Sung; Office Action mailed March 5, 2015.	

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				Filing Date	3/13/2013
				First Named Inventor	Chien-Min Sung
				Art Unit	3723
				Examiner Name	George Nguyen
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

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Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)			Complete if Known		
			Application Number	13/802,112	
			Filing Date	3/13/2013	
			First Named Inventor	Chien-Min Sung	
			Art Unit	3723	
Examiner Name					
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No. ¹	Include name of author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		PCT Application PCT/US2007/024165; filed 11/16/2007; Chien-Min Sung; Internaitonal Search Report mailed 05/23/2011	
		PCT Application PCT/US2011/052626; filing date 09/21/2011; Chien-Min Sung; International Search Report mailed 05/02/2012	
		US Application 12/255,823; filing date 10/22/2005; Chien-Min Sung; office action issued 03/07/2012	
		US Application 12/267,172; filing date 11/07/2008; Chien-Min Sung; office action issued 01/03/2012	
		US Application 12/267,172; filing date 01/31/2012; Chien-Min Sung; office action issued 07/09/2012	
		US Application 12/715,583; filing date 03/02/2010; Chien-Min Sung; office action issued 03/21/2012	
		US Application 12/715,583;; filing date 03/02/2010; Chien-Min Sung; office action issued 08/09/2012	
		US Application 12/715,583; filing date 03/02/2010; Chien-Min Sung; office action issued 10/25/2011	
		US Application 13/479,148; filing date 05/23/2012; Chien-Min Sung; office action dated 05/15/2014	
		US Application 13/362,917; filed 01/31/2012; Chien-Min Sung; office action dated 0614/2012	
		US Application 12/328,338; filed 12/04/2008; Chien-Min Sung; office action issued 05/10/2011	
		US Application 13/021,350; filing date 02/04/2011; Chien-Min Sung; office action issued 08/31/2011	
		US Application 13/021,350; filed 02/04/2011; Chien-Min Sung; office action issued 02/07/2012	
		US Application 13/012,350; filed 02/04//2011; Chien-Min Sung; office action dated 03/20/2014	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /G.N./

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Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)			Complete if Known		
			Application Number	13/802,112	
			Filing Date	3/13/2013	
			First Named Inventor	Chien-Min Sung	
			Art Unit	3723	
Examiner Name					
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

		US Application 13/794,164; filing date 03/11/2013; Chien-Min Sung; office action dated 07/16/2014	
		US Application 13/113/779; filing date 05/23/2011; Chien-Min Sung; office action dated 10/09/2014	
		US Application 13/153,176; filing date 06/03/2011; Chien-Min Sung; office action dated 10/10/2014	
		US Application 13/407,634; filing date 02/28/2012; Chien-Min Sung; office action dated 10/29/2014	

Examiner Signature	/George Nguyen/ (05/06/2015)	Date Considered	
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*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹Applicant's unique citation designation number (optional). ²Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **Send to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

20551
THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

Nicole Solomon	(Depositor's name)
/Nicole Solomon/	(Signature)
July 13, 2015	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/802,112	03/13/2013	Chien-Min Sung	02074-24012.NP.CIP	1021

TITLE OF INVENTION: CMP Pad Dresser Having Leveled Tips and Associated Methods

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$480	\$0	\$0	\$480	08/17/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
NGUYEN, GEORGE BINH MINH	3723	451-443000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Thorpe North & Western, LLP

2

3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☒ Issue Fee
☐ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
☒ Payment by credit card. Form PTO-2038 is attached.
☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 20-0100 (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
☐ Applicant asserting small entity status. See 37 CFR 1.27
☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /David W. Osborne/

Date July 13, 2015

Typed or printed name David W. Osborne

Registration No. 44989

**DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING
AN APPLICATION DATA SHEET (37 CFR 1.76)**

Title of Invention	CMP Pad Dresser Having Levelled Tips and Associated Methods
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As the below named inventor, I hereby declare that:

This declaration
is directed to: ☐ The attached application or,

☒ United States application or PCT international application number 13/802,112
filed on March 13, 2013.

The above-identified application was made or authorized to be made by me.

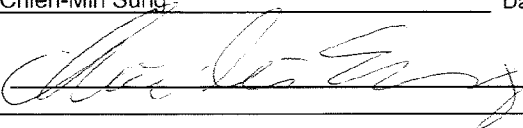
I have reviewed and understand the contents of the above-identified application, including the claims. I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

LEGAL NAME OF INVENTOR

Inventor: Chien-Min Sung Date (Optional): 6/22/15

Signature: 

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/AIA/01 form for each additional inventor.

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

ART UNIT: 3723	<u>CERTIFICATE OF MAILING</u> <u>UNDER 37 C.F.R. § 1.8</u> DATE OF DEPOSIT: <u>July 13, 2015</u> I hereby certify that this paper or fee (along with any paper or fee referred to as being attached or enclosed) is being submitted on the date indicated above via: ☒ EFS Web ☐ facsimile to _____ ☐ the United States Postal Service with sufficient postage as first class mail addressed to: Mail Stop _____, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450. _____ /Nicole Solomon/ Nicole Solomon
EXAMINER: George Nguyen	
FIRST NAMED INVENTOR: Chien-Min Sung	
SERIAL NO.: 13/802,112	
FILED: 3/13/2013	
CONF. NO.: 1021	
FOR: CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS	
DOCKET NO.: 02074-24012.NP.CIP	

**SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. §§ 1.56, 1.97 and 1.98**

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir/Madam:

Pursuant to the duty of disclosure under 37 C.F.R. §§ 1.56, 1.97 and 1.98, the Applicant requests consideration of this Information Disclosure Statement, which is being submitted in accordance with:

- ☐ 37 C.F.R. § 1.97(b)(1) or (3), within three months of the filing date of the application, or before a first office action on the merits, whichever occurs last;
- ☐ 37 C.F.R. § 1.97(c), after a first office action on the merits, but before a Final Office Action or a Notice of Allowance, whichever occurs first, and is accompanied by **EITHER** a statement in accordance with 37 C.F.R. § 1.97(e), **OR** the fee set forth in 37 C.F.R. § 1.17(p); or
- ☒ 37 C.F.R. § 1.97(d), after a Final Office Action or Notice of Allowance, whichever occurs first, but on or before payment of the issue fee, and is accompanied by **BOTH** a statement in

accordance with 37 C.F.R. § 1.97(e), **AND** the fee set forth in 37 C.F.R. § 1.17(p).

SUBMISSIONS

Please find enclosed, pursuant to 37 C.F.R. §§ 1.97 and 1.98:

- ☒ Form **PTO/SB/08A** and/or **PTO/SB/08B** listing the references submitted for consideration, which contains a list of all patents, publications and all other items that have come to the attention of one or more of the individuals designated in 37 C.F.R. § 1.56(c).
- ☐ Legible copies of the listed non-patent documents, unpublished U.S. applications and foreign documents or their relevant portions are included.
- ☐ All English translations of each non-English reference, if any, within the possession, custody, control or availability of anyone designated in 37 C.F.R. § 1.56(c) (see 37 C.F.R. § 1.98 are included.
- ☐ For all listed references that are not either in the English language, or accompanied by a translation into English, a concise explanation of relevance as required under 37 C.F.R. § 1.98(a)(3) is enclosed attached to each.

Copies of references listed on the enclosed PTO/SB/08A and/or PTO/SB/08B are **not** enclosed:

- ☐ because, under 37 C.F.R. § 1.98.(d), they were previously cited by or submitted to the Office in application number _____, which is relied upon for an earlier filing date under 37 C.F.R. § 1.20.
- ☐ because they are substantially cumulative of an enclosed reference.

STATEMENT IN ACCORDANCE WITH 37 C.F.R. § 1.97(e)

- ☐ I hereby certify that each item contained in the information disclosure statement was first cited in

a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement.

☒ I hereby certify that no item contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in §1.56(c) more than three months prior to the filing of the information disclosure statement.

REMARKS

While no representation is made that any of these references may be “prior art” within the meaning of that term in accordance with 37 C.F.R. §§ 102 or 103, the enclosed list of references is disclosed so as to comply with the duty of disclosure set forth in 37 C.F.R. § 1.56.

Moreover, while no representation is made that a specific search of office files or patent office records has been conducted or that no better art exists, the undersigned attorney of record believes that the references listed, together with any other references which may have been previously submitted or listed, are the closest to the claimed invention (taken in its entirety) of which the undersigned is presently aware, and no art which is closer to the claimed invention (taken in its entirety) has been knowingly withheld.

☒ Credit Card payment in the amount of \$90 (amount in § 1.17(p)) constituting the submission fee set forth in 37 C.F.R. § 1.17(p) is enclosed.

In the event that 37 C.F.R. § 1.97(c) applies and the Examiner is not satisfied that the Statement meets the requirements of 37 C.F.R. § 1.97(e), or in any other event remediable by a fee, please credit any over payment or charge any additional fees to Deposit Account No. 20-0100 of the undersigned.

Dated this 13th day of July, 2015.

Respectfully submitted,

/David W. Osborne/

David W. Osborne
Attorney for Applicant
Registration No. 44989

THORPE NORTH & WESTERN, LLP
Customer No. 20,551
P.O. Box 1219
Sandy, Utah 84091-1219
Telephone: (801) 566-6633

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Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)			Complete if Known		
			Application Number	13/802,112	
			Filing Date	3/13/2013	
			First Named Inventor	Chien-Min Sung	
			Art Unit	3723	
Examiner Name	George Nguyen				
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No. ¹	Include name of author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		U.S. Application No. 13/416,201; Filing date March 9, 2012; Chien-Min Sung; Office Action dated May 15, 2015.	
		U.S. Application No. 13/644,790; Filing date October 4, 2012; Chien-Min Sung; Notice of Allowance mailed June 8, 2015.	

Examiner Signature		Date Considered	
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*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹Applicant's unique citation designation number (optional). ²Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **Send to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

Electronic Patent Application Fee Transmittal				
Application Number:		13802112		
Filing Date:		13-Mar-2013		
Title of Invention:		CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS		
First Named Inventor/Applicant Name:		Chien-Min Sung		
Filer:		David William Osborne/Nicole Solomon		
Attorney Docket Number:		02074-24012.NP.CIP		
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl Issue Fee	2501	1	480	480

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Submission- Information Disclosure Stmt	2806	1	90	90
Total in USD (\$)				570

Electronic Acknowledgement Receipt

EFS ID:	22892552
Application Number:	13802112
International Application Number:	
Confirmation Number:	1021
Title of Invention:	CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS
First Named Inventor/Applicant Name:	Chien-Min Sung
Customer Number:	20551
Filer:	David William Osborne/Nicole Solomon
Filer Authorized By:	David William Osborne
Attorney Docket Number:	02074-24012.NP.CIP
Receipt Date:	13-JUL-2015
Filing Date:	13-MAR-2013
Time Stamp:	09:56:43
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$570
RAM confirmation Number	8402
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	02074-24012_NP_CIP_Issue_fee.pdf	104463	no	1
			23e716da99f897213c3da204ebbf0ad03ddbec3f		
Warnings:					
Information:					
2	Oath or Declaration filed	02074-24012_NP_CIP_Declaration.pdf	810307	no	1
			245851ab162345ea84efa8311652c6c7f85cbcae		
Warnings:					
Information:					
3	Transmittal Letter	02074-24012_NP_CIP_IDS_Trans.PDF	79722	no	4
			0614b53d4f0d9bf5f28afd62b2883b7b02e5bf03		
Warnings:					
Information:					
4	Information Disclosure Statement (IDS) Form (SB08)	02074-24012_NP_CIP_IDS_A.PDF	104255	no	1
			4ed01eaf3b780e524cd3671510f61214e9df787c		
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
5	Information Disclosure Statement (IDS) Form (SB08)	02074-24012_NP_CIP_IDS_B.PDF	78551	no	1
			5cd763c9254148c9ebe7d044c242c40a423bc8f4		
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
6	Fee Worksheet (SB06)	fee-info.pdf	32351	no	2
			ac03964dcc25ace6178f4636b06fa707da4c130f		
Warnings:					
Information:					
Total Files Size (in bytes):			1209649		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number. Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)				Complete if Known	
				Application Number	13/802,112
				Filing Date	3/13/2013
				First Named Inventor	Chien-Min Sung
				Art Unit	3723
				Examiner Name	George Nguyen
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

[illegible][illegible]

Examiner Signature		Date Considered	
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. ¹Applicant's unique citation designation number (optional). ²See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. ³Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴For Japanese patent documents, indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁶Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/802,112	03/13/2013	Chien-Min Sung	02074-24012.NP.CIP	1021
7590 07/14/2015 THORPE NORTH & WESTERN, LLP. P.O. Box 1219 SANDY, UT 84091-1219			EXAMINER NGUYEN, GEORGE BINH MINH	
			ART UNIT	PAPER NUMBER
			3723	
			NOTIFICATION DATE	DELIVERY MODE
			07/14/2015	ELECTRONIC

NOTICE REQUIRING INVENTOR'S OATH OR DECLARATION

An inventor's oath or declaration in compliance with 37 CFR 1.63 or 1.64 executed by or with respect to each inventor has not yet been submitted.

An oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each inventor **MUST** be filed **no later than the date on which the issue fee is paid**. See 35 U.S.C. 115(f). Failure to timely comply will result in ABANDONMENT of this application. This period for reply is not extendable under 37 CFR 1.136(a).

Questions relating to this Notice should be directed to the Application Assistance Unit at 571-272-4200.

(571)-272-4200 or 1(888)-786-0101

Patent Publication Branch

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/802,112	03/13/2013	Chien-Min Sung	02074-24012.NP.CIP	1021
20551	7590	07/23/2015		
THORPE NORTH & WESTERN, LLP. P.O. Box 1219 SANDY, UT 84091-1219			EXAMINER NGUYEN, GEORGE BINH MINH	
			ART UNIT 3723	PAPER NUMBER
			NOTIFICATION DATE 07/23/2015	DELIVERY MODE ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patentdocket@tnw.com
rich@tnw.com
annette.fields@tnw.com

Corrected Notice of Allowability	Application No. 13/802,112	Applicant(s) SUNG, CHIEN-MIN	
	Examiner GEORGE NGUYEN	Art Unit 3723	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☐ This communication is responsive to _____.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are 1-20. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

- a) ☐ All b) ☐ Some *c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.

THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

- | | |
|--|---|
| 1. ☐ Notice of References Cited (PTO-892) | 5. ☒ Examiner's Amendment/Comment |
| 2. ☐ Information Disclosure Statements (PTO/SB/08),
Paper No./Mail Date _____ | 6. ☐ Examiner's Statement of Reasons for Allowance |
| 3. ☐ Examiner's Comment Regarding Requirement for Deposit
of Biological Material | 7. ☐ Other _____ |
| 4. ☐ Interview Summary (PTO-413),
Paper No./Mail Date _____ | |

/GEORGE NGUYEN/
 Primary Examiner, Art Unit 3723

The present application is being examined under the pre-AIA first to invent provisions.

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

The application has been amended as follows:

In claim 12, line 1, after "device" changed "," to ".".

Any inquiry concerning this communication or earlier communications from the examiner should be directed to GEORGE NGUYEN whose telephone number is (571)272-4491. The examiner can normally be reached on Monday -Friday from 8 AM-4 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Hail Joseph can be reached on 571-272-4485. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Art Unit: 3723

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

George Nguyen
Primary Examiner
Art Unit 3723

/GEORGE NGUYEN/
Primary Examiner, Art Unit 3723

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Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)		Complete if Known			
		Application Number	13/802,112		
		Filing Date	3/13/2013		
		First Named Inventor	Chien-Min Sung		
		Art Unit	3723		
Examiner Name	George Nguyen				
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No. ¹	Include name of author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		U.S. Application No. 13/416,201; Filing date March 9, 2012; Chien-Min Sung; Office Action dated May 15, 2015.	
		U.S. Application No. 13/644,790; Filing date October 4, 2012; Chien-Min Sung; Notice of Allowance mailed June 8, 2015.	

Examiner Signature	/GEORGE NGUYEN/	Date Considered	07/23/2015
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*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹Applicant's unique citation designation number (optional). ²Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **Send to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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				Art Unit	3723
				Examiner Name	George Nguyen
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

[illegible][illegible]

Examiner Signature	/GEORGE NGUYEN/	Date Considered	07/23/2015
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20551	7590	07/27/2015	EXAMINER	
THORPE NORTH & WESTERN, LLP.			NGUYEN, GEORGE BINH MINH	
P.O. Box 1219			ART UNIT	PAPER NUMBER
SANDY, UT 84091-1219			3723	
			NOTIFICATION DATE	DELIVERY MODE
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APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
13/802,112	13 March, 2013	SUNG, CHIEN-MIN	02074-24012.NP.CIP

THORPE NORTH & WESTERN, LLP. P.O. Box 1219 SANDY, UT 84091-1219		EXAMINER	
		GEORGE NGUYEN	
		ART UNIT	PAPER
		3723	20150723

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/GEORGE NGUYEN/
Primary Examiner, Art Unit 3723

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				Art Unit	3723
				Examiner Name	George Nguyen
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

[illegible][illegible]

Examiner Signature	/GEORGE NGUYEN/	Date Considered	07/23/2015
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/802,112	03/13/2013	Chien-Min Sung	02074-24012.NP.CIP	1021

20551 7590 08/10/2015
THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

EXAMINER

NGUYEN, GEORGE BINH MINH

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3723

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APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
13/802,112	13 March, 2013	SUNG, CHIEN-MIN	02074-24012.NP.CIP

THORPE NORTH & WESTERN, LLP. P.O. Box 1219 SANDY, UT 84091-1219		EXAMINER	
		GEORGE NGUYEN	
		ART UNIT	PAPER
		3723	20150803

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/GEORGE NGUYEN/
Primary Examiner, Art Unit 3723

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				Application Number	13/802,112
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				First Named Inventor	Chien-Min Sung
				Art Unit	3723
				Examiner Name	George Nguyen
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

NON PATENT LITERATURE DOCUMENTS

[illegible]

Examiner Signature	/GEORGE NGUYEN/	Date Considered	08/03/2015
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20551 7590 08/24/2015
THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

EXAMINER

NGUYEN, GEORGE BINH MINH

ART UNIT	PAPER NUMBER
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THORPE NORTH & WESTERN, LLP. P.O. Box 1219 SANDY, UT 84091-1219		EXAMINER	
		GEORGE NGUYEN	
		ART UNIT	PAPER
		3723	20150819

DATE MAILED:

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Commissioner for Patents

Receipt is acknowledged of the IDS filed on 10/04/2013 which was considered and placed of record in the file. Please note that all references of the 10/04/2013 IDS were filed in the parent case 13/479,148, which were considered.

/GEORGE NGUYEN/
Primary Examiner, Art Unit 3723

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			First Named Inventor	Chien-Min Sung	
			Art Unit	3723	
Examiner Name					
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

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Examiner Initials*	Cite No. ¹	Include name of author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		Colmonoy Technical Data Sheet; no. DSP-A; 1993	
		Endecott's Specifications; 2004	
		Kennametal Specification for DMHPM002 Hot Press Matrix N-50 12/06/2001	
		Material Safety Data Sheet (MSDS), Wall Colmonoy Corporation; prepared 07/20/1989	
		Material Safety Data Sheet (MSDS); Kennametal; issued 06/11/2004	
		SUNG et al.; The Eastern Wind of Diamond Synthesis; New Diamond and Frontier Carbon Technology; 2003; pages 47-61; vol. 13, no. 1	
		SUNG et al; Mechanism of the Solvent-Assisted Graphite to Diamond Transition Under High Pressure: Implications for the Selection of Catalysts, High Temperatures-High Pressure; 1995/1996; pages 523-546; vol. 27/28	
		Syndite, CTM302; Announcement, Elementsix Advancing Diamond; 01/14/2003; http://www.e6.com/en/resources/announcementsheets/CTM302.pdf ; as accessed on 12/16/2008	
		Syndite, Elementsix Advancing Diamond; 2 pages 01/14/2003	
		YASINAGA et al; Advances in Abrasive Technology, III; Soc. Of Grinding Engineers (SGE) in Japan; 2000	
		US Application 12/726,786; filed 03/18/2010; Chien-Min Sung; office action dated 03/19/2013	
		US Application 13/362,917; filed 01/31/2012; Chien-Min Sung; office action dated 04/10/2013	
		U.S. Application 13/239,198; filed 09/21/2011; Chien-Min Sung; office action dated 07/23/2013	
		PCT/US2013/042538; filed 05/23/2013; Chien-Min Sung; international search report dated 08/27/2013	

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Examiner Name					
Sheet		of		Attorney Docket Number	02074-24012.NP.CIP

	US Application 12/726,786; filed 03/18/2010; Chien-Min Sung; notice of allowance dated 09/04/2013	
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Examiner Signature	/George Nguyen/ (08/19/2015)	Date Considered	
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /G.N./

AMENDMENTS TO THE SPECIFICATION

3

Change(s) applied to document, Please amend the “Brief Description of the Drawings” section on page ~~10~~ as follows:

/K.P./
7/15/2015

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention;

FIG. 2 is a flow chart diagram showing steps of a method of dressing a CMP pad in accordance with an embodiment of the present invention;

FIG. 3 is a flow chart diagram showing steps of a method of ~~dressing a CMP pad~~ polishing a workpiece in accordance with an embodiment of the present invention;

FIG. 4 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention;

FIG. 5 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention;

FIG. 6 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention; and

FIG. 7 is a schematic side view of a CMP pad dresser in accordance with an embodiment of the present invention.

Receipt date: 08/16/2014

13802112 - GAU: 3723

PTO/SB/08A (08-03)

Approved for use through 07/31/2006. OMB 0651-0031

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Sheet	of	Attorney Docket Number	02074-24012.NP.CIP

		JP 2004/025401	01/29/2009	Airtec Japan KK		
		KR 200339181	01/31/2004	Jang		
		WO 95/27596	10/1995	Ultimate Abrasive System		
		WO 94/27883	12/08/1994	Zeller Plastik Keehan Graebner DE		
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		Application Number	13/802,112	
		Filing Date	3/13/2013	
		First Named Inventor	Chien-Min Sung	
		Art Unit	3723	
Examiner Name				
Sheet		of	Attorney Docket Number	02074-24012.NP.CIP

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		1854071	04/12/1932	Schacht	
		187593	02/1877	Brown et al.	
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		2035521	03/31/1936	Benner	
		2078354	04/1973	Webster	
		2184348	12/26/1939	Kirchner	
		2187624	01/16/1940	Melton	
		2194253	03/19/1940	Benner	
		2268663	01/1942	Kuzmick	
		2281558	05/05/1942	Cross	
		2307461	01/1943	Ogden	
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		2334572	11/16/1943	Melton	
		2612348	09/1952	Catallo	
		2652951	09/1960	Simpson	

Change(s) applied
to document,
/C.S./
8/24/2015

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /G.N./



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/802,112	09/22/2015	9138862	02074-24012.NP.CIP	1021

20551 7590 09/02/2015
THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 107 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

Chien-Min Sung, Tansui, TAIWAN;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

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PATENT - POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS	Patent Number	9,138,862
	Issue Date	September 22, 2015
	First Named Inventor	Chien-Min SUNG
	Title	CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS
	Attorney Docket No.	

I hereby revoke all previous powers of attorney given in the above-identified patent.

☐ A Power of Attorney is submitted herewith.

OR
☒ I hereby appoint Practitioner(s) associated with the Customer Number identified in the box at right as my/our attorney(s) or agent(s) with respect to the patent identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

134688

OR
☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) with respect to the patent identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number

Please recognize or change the correspondence address for the above-identified patent to:

☒ The address associated with the above-identified Customer Number.

OR
☐ The address associated with the Customer Number identified in the box at right:

☐ Firm or
 Individual Name

Address

City

State

Zip

Country

Telephone

Email

I am the:

☒ Applicant.

OR

☐ Patent owner.

Statement under 37 CFR 1.73(c) (Form PTO/AIA/56) submitted herewith or filed on _____

SIGNATURE of Applicant or Patent Owner

Signature

Name

Dr. Chien-Min SUNG

Date

2011/8/18

Telephone

+86-13329862919

Title and Company

NOTE: Signatures of all the applicants or patent owners of the entire interest or their representative(s) are required. If more than one signature is required, submit multiple forms, check the box below, and identify the total number of forms submitted in the blank below.

☐ A total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public, which is to update (and by the USPTO to process) the file of a patent or reexamination proceeding. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)Applicant/Patent Owner: Chien-Min SUNGApplication No./Patent No.: 9,138,862 Filed/Issue Date: September 22, 2015Titled: CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODSChien-Min SUNG, a individual

(Name of Assignee)

(Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☒ The assignee of the entire right, title, and interest.
2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):
- ☐ The extent (by percentage) of its ownership interest is ____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.
- ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (e.g., bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

- A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.
- B. ☒ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: Chien-Min SUNG To: KINIK CompanyThe document was recorded in the United States Patent and Trademark Office at
Reel 033566, Frame 0479, or for which a copy thereof is attached.2. From: KINIK Company To: Chien-Min SUNGThe document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

[Page 1 of 2]

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
 Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
 Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
 Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
 Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).



As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/James M. Lennon/

2021-08-19

Signature

Date

James M. Lennon

56815

Printed or Typed Name

Title or Registration Number

U.S. PATENT ASSIGNMENT

To the extent that KINIK COMPANY ("Assignor"), a corporation organized and existing under the laws of Republic of China (R.O.C.), with a place of business at No. 64 Zhongshan Road, Yingge District, New Taipei City 23942, Taiwan (R.O.C.), is the owner of the following (i) and (ii), or to the extent Assignor owns, controls or has the right to practice, license, or enforce any such patent or patents at any time: (i) United States Patent listed in Schedule A; (ii) any continuations, divisional, continuations-in-part, extensions, substitutions, reissues, renewals and all results of oppositions, reexaminations, supplemental examinations, requests for continued examination and other review procedures of any of the foregoing in subsection (i) (together the "Assigned Patents").

WHEREAS, Dr. Chien-Min Sung ("Assignee") is the rightful owner of the Assigned Patents but is desirous of acquiring complete and clear title in and to the Assigned Patents to the extent that Assignee does not already own such title in and to the Assigned Patents.

WHEREAS, Assignor has asserted certain ownership of its right, title, and interest in and to the Assigned Patents but has now disclaimed that Assignor has such right, title, and interest in and to the Assigned Patents subject to and without prejudice to any of the rights and interests of each of the Parties pursuant to the terms of the Settlement Transcript prepared by the Intellectual Property Court of Taiwan and agreed and executed by the Parties on 13 August 2021 before the judge of the said court (the "Settlement Transcript").

WHEREAS, Assignor desires to sell, assign, and transfer all its right, title, and interest, if any, in the Assigned Patents to Assignee, and Assignee desires to obtain all such right, title, and interest in the Assigned Patents from Assignor.

NOW, THEREFORE, in consideration of good and valuable consideration, the receipt and adequacy of which is hereby acknowledged, to the extent Assignor is the owner of or asserts certain ownership of any right, title and/or interest in the Assigned Patents, Assignor hereby sells, assigns, transfers and conveys unto Assignee, its permitted successors and assigns, all of Assignor's right, title, and interest in and to the Assigned Patents, together with all claims, demands, or causes of action that Assignor has or might have by reason of any infringement of the Assigned Patents prior to the effective date of this assignment, including the right to sue and collect damages for all past, present and future infringement and all lost profits resulting therefrom.

IN WITNESS WHEREOF, this Agreement has been executed by duly authorized representatives of the Parties on the dates below.

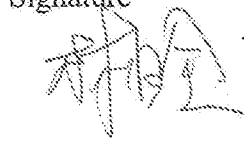
Signature

Dr. Chien-Min Sung

Name

Date:

Signature



Name

Date:

Po-Chuan Lin
Aug 13 / 2021

SCHEDULE A

9868100

9724802

8777699

9138862

8974270

Electronic Acknowledgement Receipt

EFS ID:	43554263
Application Number:	13802112
International Application Number:	
Confirmation Number:	1021
Title of Invention:	CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS
First Named Inventor/Applicant Name:	Chien-Min Sung
Customer Number:	20551
Filer:	James Michael Lennon/Jennifer Picini
Filer Authorized By:	James Michael Lennon
Attorney Docket Number:	02074-24012.NP.CIP
Receipt Date:	19-AUG-2021
Filing Date:	13-MAR-2013
Time Stamp:	15:58:34
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	9138862-POA-signed.pdf	525414	no	1
			46919ce8bcc9805e2814a0b3405fb4519fba67a4		

Warnings:

Information:					
2	Assignee showing of ownership per 37 CFR 3.73	9138862-373c-statement.pdf	104752	no	2
			09001d815a673c915770cad65567cac174328dfc		
Warnings:					
Information:					
3	Miscellaneous Incoming Letter	Assignment-Kinik-to-Sung.pdf	2172382	no	2
			d39afb19dbeecf15c7054343429dd21b2c9dc08e		
Warnings:					
Information:					
Total Files Size (in bytes):			2802548		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/802,112	03/13/2013	Chien-Min Sung	02074-24012.NP.CIP

134688
Devlin Law Firm
1526 Gilpin Ave.
Wilmington, DE 19806

CONFIRMATION NO. 1021
POA ACCEPTANCE LETTER



Date Mailed: 08/24/2021

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/19/2021.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/ytdemisse/



UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

ACKNOWLEDGEMENT OF LOSS OF ENTITLEMENT TO ENTITY STATUS DISCOUNT

APPLICATION #	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET #	REQUEST ID
13/802,112	03/13/2013	Chien-Min Sung	02074-24012.NP.CIP	52440

The entity status change request below filed through Patent Center on 12/07/2022 has been accepted.

Certifications

APPLICANT CHANGING TO REGULAR UNDISCOUNTED FEE STATUS

Signature

I certify, in accordance with 37 CFR 1.4(d)(4), that I am one of the signatories making the entity status change.

Signature	Name	Registration #
/James M Lennon/	James Lennon	56815

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P. 4

2022 DEC 13 PM 12:39

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Sung

Confirmation No.: 1021

Application No.: 13/802,112

Art Unit: 3723

Filing Date: March 13, 2013

For: CMP PAD DRESSER HAVING LEVELED TIPS AND ASSOCIATED METHODS

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450**Notice of Loss of Entitlement to Small Entity Status**

Applicant hereby submits Notice of Loss of Entitlement to Small Entity Status. Small entity status was established in good faith, and fees as a small entity were paid in good faith, but it was recently discovered that entitlement to small entity status was lost and that through error the Office was not notified of the loss of entitlement to small entity status. This was a good faith error without deceptive intent. Applicant submits that this good faith error shall be excused pursuant to 37 CFR § 1.28 as Applicant herewith is complying with the separate submission and itemization requirements of paragraphs (c)(1) and (c)(2) of 37 CFR § 1.28, and the deficiency payment requirement of paragraph (c)(2) of 37 CFR § 1.28.

The fee deficiency is calculated below and has been submitted.

Date Paid	Fee Code	Amount Paid	2022 Amount	Deficiency
9/19/2019	2551	\$800	\$2000	\$1200
9/19/2019	2554	\$80	\$500	\$420
			Total Due	\$1620

The Office is invited to telephone the undersigned attorney to resolve any outstanding issues.

Date: December 7, 2022Respectfully Submitted,
/James M. Lennon/
James M. Lennon
Customer No. 134688
Devlin Law Firm LLC
1526 Gilpin Ave.
Wilmington, DE 19806

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DEC 07 2022

FAX

TO:	Office of Petitions	FROM:	Jennifer Picini
FAX:	571-273-8300	FAX:	
PHONE:	571-272-3282	PHONE:	302-486-3402
SUBJECT:	Petition for Review by the Office of Petitions	DATE:	December 7, 2022

COMMENTS Documents included:
Notice of Loss of Entitlement to Small Entity Status – US 9,138,862 (1 page)
Credit Card Authorization (1 page)

DEC 07 2022

Michelle McClain

1526 Gilpin Ave, Wilmington, DE 19806

(302) 449-9468

DEVLIN

AW FIRM LLC

INTELLECTUAL PROPERTY LAW

DEC 07 2022

FAX COVER SHEET

To: 5712738300

From: Michelle McClain
<mmccclain@devlinlawfirm.com>

Company:

Date: 12/07/2022 17:14

Fax Number: 5712738300

Pages (including cover): 5

Re: Petition for Review by Office of Petitions

Notes: