are cobalt, nickel, iron, bronze or their alloys or mixtures (e.g., tungsten or its carbide). After formation of the matrix support material is then infiltrated by a diamond braze, such as Microbraz L. M. (made by Wall Colmonoy Company), either under a vacuum, typically about 10^{-3} torr, or in an inert atmosphere (e.g., argon (Ar) or nitrogen (N_2)) or a reducing atmosphere (e.g., hydrogen (H_2)). The braze, thus, facilitates bonding between the diamond particles and the matrix support material.

In accordance with another aspect of the present invention, the matrix support material is formed by coarse metal powder (i.e. greater 400 mesh U.S. or 34 microns). While conventional methods require the density of the green body be as high as possible so subsequent sintering can proceed rapidly, it has been found in accordance with the present invention, that it is preferable to use a precursor with a lower packing density to allow the easy flow of the diamond braze. In some situations, the porosity of the precursor body may be intentionally increased by using irregularly shaped matrix particles. This preference is again contrary to the conventional wisdom that requires the particles be as spherical as possible so the packing density can be increased.

In accordance with yet another aspect of the present invention, the diamond particles are placed in a predetermined pattern within the matrix support material, and the diamond impregnated matrix support material is then impregnated with the diamond braze to promote chemical bonding of the diamond material. The predetermined pattern may be substantially planar, i.e. the diamond placement may be controlled by the use of a template, or may be substantially vertical, with channels being formed in the matrix support material to receive diamond particles, which are then infiltrated with the diamond braze.

In accordance with still yet another aspect of the present invention, the matrix support material may contain minor ingredients to enhance certain properties. For example, hard materials such as tungsten, tungsten carbide and silicon carbine may be added to increase wear resistance. Soft materials, such as molybdenum sulfide, copper, and silver, may also be added as solid lubricants.

The supportive material may be prepared by a conventional method. For example, the powder may be mixed with diamond grit thoroughly. An organic binder (e.g., PVA or PVB) may be added to hold the mixture. The mixture is then cold pressed to form the desirable shape (e.g., a saw blade). The precursor is then ready to be infiltrated by a suitable diamond braze.

As discussed, a fine matrix powder used for conventional tools may hinder the infiltration of the diamond braze. Moreover, it would react excessively with the braze so the melting temperature of the braze is raised. As a result, the infiltration may not be complete.

Alternatively, the mixture may be processed following the teaching of applicant's other, copending patent application (U.S. Patent Application, Serial No. 08/832,852 (identified as attorney docket no. TS100), filed April 4, 1997). For example, the powder blend of the supportive material may be cold rolled to form a sheet. The sheet can them be punched out with a desirable shape (e.g., a saw segment) (See Fig. 1). Several such punched segments may be assembled to form the precursor (see Fig. 2,3,4) for infiltration. As described in the pending patent application, by assembling substantially two-dimensional segments to form a three-dimensional body, the distribution of diamond grit in a tool can be positively controlled. Thus, diamond concentration in different parts of the same tool may be adjusted (see FIGS. 1A through 4).

Such a control of diamond distribution is highly desirable to improve the wear characteristics of the tool. For example, the sides of a diamond saw blade are often worn faster then the center, so it is advantageous to add more diamond grit on to the sides (see FIG. 1B).

Current applications require the matrix support material to serve dual functions: to provide the mechanical support of the tool, and to hold the diamond grit in the matrix. These two functions often demand contradictory properties. For example, as the mechanical support, the matrix support material must be strong and wear resistant (e.g., cobalt, or bronze mixed with tungsten carbide). However, the material with good mechanical support is often ineffective to adhere the inert diamond. On the other hand, a braze alloy (e.g., silver-copper-titanum alloys) may hold diamond firm, but are too soft to provide the mechanical support for the tool body. Thus it is desirable to separate these two functions of the matrix support material by using a composite material. In this case, the framework of the composite material is optimized for mechanical support, yet the filler material is designed to hold the diamond.

The composite material may be made by using coated diamond as discussed above. In this case, a diamond braze may be used to coat the diamond grit first and the coated grit is subsequently mixed in the matrix powder. However, the coating incurs an additional cost. Moreover, most diamond brazes are not in a powder form. Even if they were, it is very difficult to coat these brazes uniformly onto the diamond grit. As a result, coated diamond grit is seldom used today in making diamond tools.

The present invention makes the composite matrix support material by infiltrating a diamond braze into a supporting material that contains diamond grit. The

braze includes carbide formers such as chromium, manganese, silicon and aluminum, while avoiding volatile metals such as zinc, lead and tin.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the invention will become apparent from a consideration of the following detailed description presented in connection with the accompanying drawings in which:

FIG. 1A shows a segment from a superabrasive tool formed by a plurality of linear, longitudinal layers disposed adjacent one another to form a three-dimensional superabrasive member;

FIG. 1B shows a cross-sectional view of one typical configuration of the tool segment shown in FIG. 1A, wherein a layer formed by a matrix support material and a relatively large superabrasive is sandwiched between two layers of matrix support materials which have smaller grit and higher concentration of the abrasive;

FIG. 2A shows a segment from a superabrasive tool formed by a plurality of arcuate, longitudinal layers which are attached to one another to form a three-dimensional superabrasive member;

FIG. 2B shows a cross-sectional view of a plurality of layers matrix support material as may be used with the segment shown in FIG. 2A;

FIG. 3 shows another possible layout of a segment of a cutting tool with transverse layers configured with a denser concentration of abrasive material disposed at a forward, cutting end of the three-dimensional superabrasive member;

FIG. 4 shows yet another layout of a segment wherein a three-dimensional superabrasive member is formed with progressively denser abrasive distribution

toward the upper surface of a tool with horizontal layers;

FIGs. 5A through 5D show one possible method for forming layers with controlled superabrasive distribution within the layer;

FIGs. 6A through 6C show an alternate method for forming one or more layers with controlled superabrasive distribution;

FIG. 7A shows a side view of a matrix support material formed in accordance with one aspect of the present invention, wherein a plurality of slots are formed in the matrix support material;

FIG. 7B shows a side view of the matrix support material of FIG. 7A, wherein a plurality of diamond particles are disposed in the slots and brazed to bond with the matrix support material and thereby form a plurality of abrasive fins in the matrix support material; and

FIG. 8 shows a perspective view of the matrix support material similar to that shown in FIGs. 7A and 7b, but with a plurality of abrasive needle structures.

DETAILED DESCRIPTION

Reference will now be made to the drawings in which the various elements of the present invention will be given numeral designations and in which the invention will be discussed so as to enable one skilled in the art to make and use the invention. It is to be understood that the following description is only exemplary of the principles of the present invention, and should not be viewed as narrowing the pending claims.

Referring to FIG. 1A, there is shown a perspective view of a segment, generally indicated at 10, formed by a plurality of layers, 14, 16 and 18. Each of the layers 14, 16 and 18 is formed by matrix

support material 24 impregnated with diamond particles, indicated by the circles 20, and has been infiltrated with a braze 28 selected to bond to the diamond particles and the matrix support material. Preferably, the diamond particles 20 constitute less than 50 percent by volume of the matrix support material - diamond mixture, and more preferably less than 40 percent by volume. Keeping the amount of diamond particles to the minimum helps to minimize cost while optimizing the useful life of the product.

Preferably, the diamond braze contains at least 3% by weight of a member selected from the group consisting of chromium, manganese, silicon and aluminum, and alloys and mixtures thereof. Additionally, the diamond braze should have a liquidus temperature of less than 1,100° C to avoid damage to the diamond during the brazing process.

As discussed in U.S. Patent No. _____ (U.S. Patent Application, Serial No. 08/832,852 (Attorney Docket No. TS100)), which is expressly incorporated herein, forming the segment 10 in a plurality of thin layers provides remarkably improved control over the distribution of the diamond particles 20. By controlling the distribution of the diamond particles 20 within each layer and then combining layers, a three-dimensional segment can be formed in which distribution of the diamond particles is controlled in each dimension. This, in turn, enables the formation of segments which are particularly adapted to the likely use of the segment, be it for polishing, cutting, grinding, etc. By tailoring the distribution and concentration of the superabrasive particles within the segment 10, more precise control is given over performance of the tool under actual working conditions.

The present invention further improves the above technique by infiltrating the matrix support material

24 with a braze 28 which is selected to chemically bond to the diamond particles and to the matrix support material. Thus, while the placement of the diamond particles shown in FIG. 1A is a marked improvement over the prior art, an additional increase in the segment's 10 useful life is obtained by utilizing a braze to form a chemical bond, rather than merely relying on mechanical retention of the diamond particles.

Likewise, the selective placement of differing sizes of diamond particles can used to form a cutting segment formed to resist premature wear to the sides of the segment, thereby extending the cutting segment's useful life. Referring specifically to FIG. 1B, there is shown a cross-sectional view of the cutting segment 10 of FIG. 1A. Unlike the cutting segments of the prior art, the cutting segment 10 is formed of three layers, 14, 16 and 18 respectively. The middle layer 16 has a plurality of superabrasive particles 20a which are of a first size (e.g. 40/50 mesh) and a first concentration. The outer layers 14 and 18, in contrast, have a plurality of superabrasive particles 20b, which are of a second size (e.g. 50/60 mesh) smaller than the first size, and in a second concentration greater than that present in the middle layer 16. The smaller, more densely distributed superabrasive particles 20b provide the outer layers 14 and 18 with a greater resistance to wear as they cut through concrete, rock, asphalt, etc. Because the outer layers 14 and 18 are more resistant to wear, the cutting segment 10 resists formation of a convex outer surface, as has traditionally occurred with cutting elements. By maintaining a more planar cutting surface, the cutting segment is able to maintain a straight cutting path so it can cut more efficiently with a longer useful life.

Furthermore, an additional increase in useful life is obtained by infiltrating the matrix support material 24 with a braze 28 formed from chromium, manganese, silicon, and/or aluminum, or an alloy or mixture thereof. While a wide variety of quantities of these materials may be used, it has been found that it is preferable if the chromium, manganese, silicon or aluminum or alloy or mixture in the diamond braze constitutes at least 3 percent of the braze by weight (and more preferably 5 percent). The braze 28 fills the pores in the matrix support material 24, which is typically powder selected from the group including iron, cobalt, nickel or alloys or mixtures thereof.

Another advantage to the use of multiple layers of matrix with diamond or some other superabrasive particle disposed therein is that the layers are easily formed into other desirable shapes for the cutting, drilling, grinding, etc., segment. For example, FIG. 2A shows a perspective view of a segment, generally indicate at 30, of a superabrasive tool formed by a plurality of arcuate, longitudinal layers which are attached to one another to form a three-dimensional superabrasive member which has been infiltrated with the braze 28 to thereby hold the diamond within the member. The segment 30 is formed from first, second and third layers, 34, 36 and 38, which are each arcuate. When the three are joined together, an arcuate segment 30 is created. Such a segment, of course, may be used on cutting tools which are non linear, e.g. a circular saw blade, and on other types of tools for which a nonlinear superabrasive segment is desired. Because the layers 34, 36 and 38 are initially formed independent of one another, they are much easier to conform to a desired shape, and are able to do so while the brazed diamond particles 20 disposed therein are held in their predetermined positions.

Referring now to FIG. 2B, there is shown a cross-sectional view of a plurality of the layers 34, 36 and 38 of the segment 30. Of course, the configuration of the diamond particles may be used with the segment shown in FIG. 1A or that shown in FIG. 2A. Unlike the embodiment of FIG. 1B, the layers are each provided with the same size and concentration of the diamond particles 20. However, because the spacing is substantially uniform, there is no underspacing or overspacing between the superabrasive particles, and the segment 30 wears more evenly than the segments of the prior art with randomly spaced particles. The more even wear prevents premature failure of the segment 30, and thus extends the life of the tool while keeping the amount of superabrasive used to a minimum. Furthermore, the braze 28 which bonds to the diamond particles and the matrix 24 further strengthens each layer and prevents loss of the diamond particles 20.

FIG. 3 shows another possible embodiment of a segment 50 made in accordance with the teachings of the present invention. The layered structure in a diamond segment may also be assembled transversely or horizontally, and the braze 28 may be applied to every layer, or to select layers as shown in FIG. 3. Thus, the segment 50 in FIG. 3 is formed from a plurality of transverse layers. A first plurality of the layers (i.e. the first four layers), indicated at 56, are provided with a first concentration of diamond particles 20 which are brazed to bond to the matrix support material 24. A second plurality of layers (i.e. the remaining 9 layers), indicated at 58, are provided with a second concentration, less than the first concentration and are also brazed to bond to the matrix support material 24.

Many cutting tools are configured such that the cutting segment 50 is provided with a lead edge which

performs a majority of the cutting and which receives most of the impact force when contacting the surface to be cut. For example, a circular saw blade will usually have a plurality of teeth or segments, each tooth having a leading edge which takes the force of the cutting. Because the leading edge performs a significant portion of the cutting, it is much more susceptible to wear than are rearward portions of the tooth. When formed in accordance with the prior art, the teeth, however, often had relatively consistent concentrations of abrasive disposed thereon. Over time the leading edge wears significantly, but the other portions coated with diamond particles are subjected to minimal wear. Eventually, the abrasive is worn off the leading edge, while significant amounts remain on the other portions of each tooth. Thus, a considerable amount of superabrasive is wasted when the blade is discarded. The embodiment of FIG. 3 is specifically configured to overcome such concerns. The layers 56 and 58 are configured to provide substantially even wear across the cutting segment 50 by placing a larger percentage of the diamond particles 20 near the leading edge, than on the rear portions. Additionally, brazing the diamond particles 20 in layers 56 and 58 further extends tool life.

FIG. 4 shows yet another layout of a segment wherein a three-dimensional superabrasive member is formed with progressively denser abrasive distribution toward the upper surface of a tool with horizontal layers. As with the embodiment of FIG. 3, the controlled distribution of the diamond particles 20 forms an improved abrasive segment 70, while at the same time decreasing the cost of abrasive tools by decreasing the unnecessary consumption of diamond particles. Additionally, brazing may be used on some of the layers, while being omitted from other layers, to thereby customize the abrasive segment 70.

With routine experimentation and the teachings of the method of the present invention, those skilled in the art will be able to customize cutting, drilling, grinding, polishing and other types of abrasive segments which are specifically formed to maximize their abrasive ability (i.e. cutting, drilling, grinding, etc.) over an extended useful life, while simultaneously decreasing the amount of superabrasive which is used to form the tool.

Referring now to FIGs. 5A through 5D, there is shown one method for forming layers in accordance with the principles of the present invention. The first step of the method is to form a sheet 100 of matrix support material 104 which will be bonded to the superabrasive particles 20. The sheet 100 of matrix support material 104 can be formed from conventional powders such as cobalt, nickel, iron, copper or bronze. Additionally, for reasons which are discussed in detail below, it is highly advantageous to use coarse powders, such as those above 34 microns in diameter. While the use of course powders is inconsistent with the prior art teachings that it is desirable to use the finest powder available, considerable benefits may be achieved by combining course powder and braze to secure diamond particles in place.

There are many ways that a matrix powder can be made into the sheets 100. For example, the powder can first be mixed with a suitable binder (typically organic) and a solvent that can dissolve the binder. This mixture is then blended to form a slurry with a proper viscosity. In order to prevent the powder from agglomeration during the processing, a suitable wetting agent (e.g., menhaden oil, phosphate ester) may also be added. The slurry can then be poured onto a plastic tape and pulled underneath a blade or leveling device. By adjusting the gap between the

blade and the tape, the slurry can be cast into a plate with the right thickness. The tape casting method is a well known method for making thin sheets out of powdered materials and it works well with the method of the present invention.

Alternatively, the powder can be mixed with a suitable binder and its solvent to form a deformable cake. The cake can then be extruded through a die with a slit opening. The gap in the opening determines the thickness of the extruded plate. Alternatively, the material can also be drawn between two rollers with adjustable gap to form sheets with the right thickness.

It is desirable to make the sheets pliable for subsequent treatments (e.g., bending over the tool substrate). Therefore, a suitable organic plasticizer can also be added to provide the desired characteristics.

The use of organic agents for powder (metal, plastics, or ceramics) processing is documented in many text books and it is well known by those skilled in the art. Typical binders include polyvinyl alcohol (PVA), polyvinyl butyral (PVB), polyethylene glycol (PEG), pariffin, phenolic resin, wax emulsions, and acrylic resins. Typical binder solvents include methanol, ethanol, acetone, trichlorethylene, toluene, etc. Typical plasticizers are polyethylene glycol, diethyl oxalate, triethylene glycol dihydroabietate, glycerin, octyl phthalate. The organic agents so introduced are to facilitate the fabrication of metal layers. They must be removed before the consolidation of metal powders. The binder removal process (e.g., by heating in a furnace with atmospheric control) is also well known to those skilled in the art.

Once the sheet 100 of matrix support material 104 is formed, a template 110 is laid on the top of the sheet. The template 110 contains apertures 114 that

are larger than one abrasive particle 20, but smaller than two abrasive particles, thereby allowing a single particle of the abrasive to be disposed at each specific location.

The thickness of the template is preferably between 1/3 to 2/3 of the height of the average abrasive particle 20. However, other thicknesses may be used if appropriate accommodations are made for seating the abrasive particles in the desired locations.

After the template 110 is properly positioned, a layer of abrasive particles 20 is then spread over the template so that each aperture 114 receives an abrasive particle. Those particles not falling into the apertures 114 in the template 110 are removed by tilting the substrate, sweeping the template with a broom, or some other methods.

As shown in FIG. 5B, a generally flat surface 120, such as a steel plate, is then laid over the particles 20 which rest in the apertures 114 in the template 110. The flat surface 120 presses the abrasive particles 20 at least partially into the pliable sheet 100 of matrix support material 104 to seat the particles.

After removing the template 110, the flat surface 120 is used again to press the abrasive particles 120 firmly into the sheet 100 of matrix support material 104 as shown in FIG. 5C. While the flat surface 120 is preferable, those skilled in the art will appreciate that there may be occasions when it is desirable to have some of the abrasive particles 20 extend outwardly from the sheet 100 of matrix support material more that other abrasive particles. In such situations, a contoured or otherwise shaped surface could be used to seat some of the abrasive particles 20 deeper into the sheet 100 of matrix support material 104, than other particles.

If desired, the process shown in FIGs. 5A through 5C can be repeated on the other side of the sheet 100 of matrix support material 104 (as shown in FIG. 5D), to form an impregnated layer having diamond particles 20 distributed throughout the layer in some predetermined, desired pattern. The process is typically repeated several times to obtain multiple thin layers or sheets 100 which are impregnated with the diamond particles 20. Of course, each sheet 100 need not have the same distribution pattern for the diamond particles 20, nor need the concentration of the abrasive particles be the same in each sheet.

The abrasive impregnated sheets 100 are then infiltrated with a braze which is formed with chromium, manganese, silicon, aluminum or alloys or mixtures thereof. While prior art brazes typically includes metals which were designed to facilitate flow of the braze material, such as zinc, lead and tin, it has been found in accordance with the present invention that such materials actually impair the brazing process. The materials are generally more volatile, and have a tendency to contaminate the vacuum or inert atmosphere used in infiltration. While very small amounts of the volatile metals will not significantly interfere with brazing, amounts over about 1 or 2 percent can be undesirable. As used herein, substantially free of volatile metals, or substantially free of zinc, etc. is used to characterize such a situation in which the volatile metal is present in sufficiently small amounts as to not provide any impediment to the process of vacuum infiltration.

It is important that the infiltration temperature be kept lower than the melting point of the matrix powder so the tool body can maintain the shape during the infiltration of the diamond braze. Moreover, the brazing temperature must also be low enough to not

cause diamond to degrade. In addition to control the brazing temperature, the brazing time should also be kept short so the braze will not react excessively with diamond and the matrix powder. In the former case, diamond may also be degraded. In the later case, the alloying with the matrix powder may raise the melting point of the diamond braze. As a result, the diamond braze may solidify gradually and eventually stop to flow.

The environment for infiltration also may be controlled to provide superior performance. For example, if the braze material contains a strong getter of oxygen or nitrogen, such as titanium, a high degree of vacuum (e.g., 10^{-5} torr maximum) must be maintained during the infiltration of the braze. On the other hand, if the braze material contains a less sensitive getter, such as chromium and manganese, a lower degree of vacuum (e.g., 10^{-4} torr minimum) or a hydrogen atmosphere may be adequate for the infiltration.

After the infiltration, the produced part (e.g., a saw segment) may be trimmed (e.g., by grinding) to the finished dimension. It can then be mounted (e.g., by brazing) onto a tool body (e.g., a round steel blade) to make a finished product.

As discussed above, this invention uses a diamond braze as the infiltrant that penetrates the matrix powder of a diamond tool. Most diamond brazes can wet easily common matrix powders with major constituents of cobalt, nickel, iron, copper or bronze, so the infiltration may proceed smoothly.

In contrast to a sintering process that eliminates pores in the matrix powder by consolidation, the infiltration allows the diamond braze to fill up these pores. Sintering is achieved by diffusion of atoms mainly along surfaces. In order to facilitate the sintering process the matrix powder

must have large surface areas. Hence, in sintering, it is preferable to use fine powders. The fine powder can allow the sintering to proceed at a lower temperature.

The most widely used matrix powder for making diamond tools (e.g., saw segments) is cobalt powder. The standard sizes of cobalt powder for making conventional diamond tools are less than 2 micrometers. In the last decade, the diamond tool manufacturers have demanded finer and finer matrix powders. The commercial suppliers (e.g., Eurotungsten Co.) are therefore, moving toward making ultrafine (one micrometer), and even ultra-ultrafine (submicron) powders. With such a trend, the sintering temperature is continuously decreasing. A lower sintering temperature can not only reduce the degradation of diamond, it also reduces the cost of manufacturing. For example, the electrical power consumption for heating is lower. Moreover, the oxidation loss of graphite mold is also minimized.

The present invention, however, uses a diamond braze to fill up the pores of the matrix powder. Hence, contrary to a conventional sintering process, coarse-sized powders, i.e. greater than 400 U.S. mesh or 34 microns, are preferred. Moreover, while conventional methods require the packing density be as high as possible so sintering can proceed rapidly, the present invention prefers to use a precursor with a lower packing density to allow the easy flow of the diamond braze. In fact, sometimes, the porosity of the precursor body may be intentionally increased by using irregularly shaped matrix particles. This preference, again, is contrary to the conventional wisdom that requires the particles be as spherical as possible so the packing density can be increased.

As discussed, a fine matrix powder used for conventional tools may hinder the infiltration of the

diamond braze. Moreover, it would react excessively with the braze so the melting temperature of the braze is raised. As a result, the infiltration may not be complete.

The use of a coarse matrix powder has other benefits. For example, a coarse powder can mix better with different compositions. Hence, the diamond grit may distribute more uniformly in the matrix. Moreover, a coarse powder has a smaller surface area, and hence, a lower frictional force for infiltration. Therefore, it can flow easier in the mold. Of course, a coarse matrix powder is also much less expensive, so the production cost may be reduced.

It is important to note that this invention utilizes the matrix merely as the network for holding the diamond grit in place. Hence, the matrix may not have to be made of powder. For example, the matrix body may be made of a piece of steel with openings that contain diamond grits of PCD bodies, such as that which is discussed below with respect to FIGs. 7A and 7B.

The most critical part of this invention is in the selection of a diamond braze. Although there are numerous kinds of diamond brazes, only those that meet the following requirements are applicable. Firstly, the infiltration temperature of the braze must not be so high as to cause significant diamond degradation. The temperature limit is, in general, about 1100° C. The infiltration temperature can be 50° C above the liquidus of the braze. A course matrix powder and a shorter infiltration path requires a lower excess temperature beyond the melting point of the braze.

The diamond braze must wet the diamond and chemically bond with the diamond. As discussed above, a carbide former dissolved in a suitable solvent alloy can meet this requirement. However, the reactivity of the carbide former must be balanced between diamond

and oxygen or other gases such as nitrogen or hydrogen. It is a dilemma that a strong carbide former, such as titanium or zirconium that bonds diamond well are also gas scavengers. They would react quickly with harmful gases in the ambient atmosphere before forming the carbide with diamond.

Most diamond tools are manufactured in a graphite mold often in air or in an inert gas. The minute amount of oxygen or moisture in the atmosphere may oxidize the carbide former so the latter may not bond to diamond. This is true even if the brazing is performed in a vacuum or in a hydrogen atmosphere, unless the vacuum is kept lower than 10^{-6} torr, or the dew point of the gas is kept below - 60° C. Such a stringent requirement of vacuum or dew point often adds unnecessary cost to manufacturing.

On the other hand, if the reactivity is low, such as that of cobalt or nickel, the metal can be processed in graphite mold without being oxidized. However, it cannot bond to diamond either. Hence, there is a compromise for the carbide former between its ability to bond with diamond and its tendency to be oxidized.

In accordance with the present invention, it has been found that the preferred carbide former for the diamond braze is either chromium, manganese, silicon, aluminum or their alloys. The preferred total content of such carbide former is at least 3 percent, and more preferably at least 5 percent by weight. Examples of these brazes are NICROBRAZ LM (Ni-CR-B-Si-Fe), manufactured by Wall Colmonoy Company (U.S.A.), with a melting range of 970-1000° C, and 21/80 (Cu-Mn-Ni), manufactured by Degussa (Germany), with a melting range of 970-990° C. Other possible brazes include: Cu-Mn alloy near the eutectic composition (about 25 wt% Mn) with a melting point of about 880° C; Ni-Si alloy near the eutectic composition (about 50 wt% Si)

with a melting point of about 970° C; Cu-Si alloy near the eutectic composition (about 30 wt% Si) with a melting point of about 810° C; Al-Si alloy near the eutectic composition (about 15 wt% Si) with a melting point of about 600° C.

The above examples of infiltratable diamond brazes cover a wide range of mechanical properties and infiltration temperatures (e.g. about 50° C above the liquidus). The alloys of them may also be used for further adjustments of infiltration temperature and mechanical properties. The selection of diamond braze depends on the intended application. In general, more severe applications, such as sawing granite, concrete, or asphalt) would require a stronger diamond grit that may tolerate a higher temperature of brazing. Brazes which melt at higher temperatures are, in general, more wear resistant. On the other hand, less demanding applications, such as sawing limestone or marble, require lower strength diamond grit. Such a diamond is degraded easily at high temperature so it must be brazed at a lower temperature. Brazes of this type are typically less wear resistant.

The sheets 100 may be first assembled to form the precursor of the tool segment and then infiltrated with diamond braze, or they can be infiltrated by the braze and later assembled to form the tool segment or the entire tool body where appropriate. While the method described in FIGs. 5A through 5D is preferred for many applications, there are instances where it is desirable to have the abrasive particles 20 extend outwardly from the sheet 100 of matrix support material. For example, some tools may only have one layer of abrasive. This can be accomplished simply by leaving the template 110 in place when performing the steps shown in FIG. 5A and 5B, and not further

pressing the particles 20 into the matrix support material once the template has been removed.

In the alternative, FIGs. 6A through 6C show a side view of an alternate to the method discussed in FIGs. 5A through 5D. The sheet 130 of matrix support material in FIGs. 6A through 6C is formed to be of a lesser thickness than the cross-sectional thickness or diameter or the superabrasive particles 20. When the particles or pressed into the sheet 130, the thickness of the sheet forces the particles 20 to protrude from the matrix support material 134. The sheet 130 is then infiltrated with diamond braze in the manner discussed above.

While the use of the diamond braze 28 has been discussed with respect to the patterned distribution of diamond particles, it is equally applicable to the random distribution of diamond particles in a matrix support material. Once the diamonds have been placed in the matrix support material, a diamond braze comprising chromium, manganese, aluminum or silicon, and being substantially free of volatile metals, is melted and poured onto the matrix support material. The liquidous braze infiltrates the matrix support material and bonds the diamond particles to the matrix support material.

In addition to its use with conventional matrix support materials, such as metal powders, the diamond braze also facilitates the use of novel support materials, such as that shown in FIGs. 7A and 7B. Referring specifically to FIG. 7A, there is shown the matrix support material 200 of a saw segment, generally indicated at 210. The matrix support material 200 includes a plurality of slots 214 which are cut in specific intervals.

To form a finished cutting segment, the matrix support material 200 is placed in a mold (e.g. graphite or metal) made of refractory material (e.g.,

graphite). Diamond particles 20 (FIG. 7B) is poured into the slots 214 to fill the open slots. Diamond braze is added on top of these slots. After infiltration, the braze will fill in these slots and bond with the diamond particles 20, and with the matrix support material 200 to form a completed saw segment 210. In this geometry, the diamond particles form blades in the saw segment (FIG. 7B) instead of distributing throughout the matrix body as in the case of a conventional tool. Those skilled in the art will appreciate that such a configuration would be nearly impossible in accordance with the teachings of the prior art, because the matrix support material 200 was required to hold the diamond particles in place mechanically. In contrast, the use of the diamond braze enables the positioning of columns of diamond particles in a slot, hole, etc., because the braze bonds to the diamond and to the support material, the diamonds are secured in place. While the embodiment shown in FIGs. 7A and 7B forms diamond "fins", needle like columns of diamond also can be formed (FIG. 8). Furthermore, the slots, hole, etc, can be formed to provide such columns which are linear, or which curve in any desired direction. Thus, with routine experimentation, those skilled in the art can customise cutting, drilling, polishing, etc., segments which are customized to particular uses. The diamond particles used may be either diamond grit or thermally stable polycrystalline diamond (PCD). The infiltration will not only consolidate the matrix powder, but also bond the diamond firmly, so an integrated diamond tool is formed.

Example 1

40/50 mesh diamond grit (SDA-85+ made by De Beers Company) was mixed with iron powders coarser than 200 U.S. mesh, and an organic binder to form a mixture with diamond concentration of 20 (5% of total volume).

The mixture was cold pressed in a steel mold to form the shape of a saw segment. The precursor was placed in a graphite mold and overlaid with a powder of Nicrobraz LM. The mold was heated under vacuum to about 1,050° C for 20 minutes. The infiltrated braze had bonded diamond and matrix powder together to form a segment. Twenty-four of such segments were manufactured and they were trimmed to desirable tolerances. These segments were brazed onto a 14 inch round steel circular saw blade. The blade was used to cut granite at a faster cutting rate than was possible with conventional diamond saw blades. Additionally, the brazed saw blades had a longer useful life than a conventional diamond saw blade.

A distinct advantage cutting tools of the present invention have over the prior art cutting tools lies in the manner in which the tool may be used. Diamond saws are typically made in the form of a circular blade that cuts the workpiece by rotation in the same direction with each rotation. This one directional movement causes a "tail" to be formed, wherein the matrix material rotationally forward of the diamond particle is worn away, but the matrix material behind the diamond particle is protected by the diamond particle itself. Thus, the matrix material behind the diamond continues to hold the diamond particle in place. If the saw rotation were to be reversed, the diamond particle could easily be knocked free of the matrix.

Round saws, however, can only cut the work piece to a depth of less than one-half the diameter of the saw. In order to cut thicker work pieces, a frame or gang saw is typically used. Because these saws move reciprocally, the diamond particles must be securely held on each side. As a result, tails of diamond matrix cannot be maintained to hold the diamond particles in place. It is for this reason that

reciprocating diamond saws have not been used to saw hard rock such as granite. Rather, they are used to cut only soft materials such as marble.

This invention allows diamond to be held chemically by a braze. Hence, matrix tails are not needed to support the diamond. As a result, tools made according to the present invention can be used on reciprocating saws to cut hard materials. This breakthrough can expand diamond applications to markets which were previously unavailable due to limitations of the prior art.

Thus, there is disclosed an improved method for making diamond saw blades. The above description and examples are intended only to illustrate certain potential uses of this invention. It will be readily understood by those person skilled in the art that the present invention is susceptible of a broad utility and applications. Many embodiments and adaptations of the present invention other than those herein described, as well as many variations, modifications and equivalent arrangements will be apparent from or reasonably suggested by the present invention and the forgoing description thereof without departing from the substance for scope of the present invention. Accordingly, while the present invention has been described herein in detail in relation to its preferred embodiment, it is to be understood that this disclosure is only illustrative and exemplary of the present invention and is made merely for purpose of providing a full and enabling disclosure of the invention. The forgoing disclosure is not intended or to e construed to limit the present invention or otherwise to exclude any such other embodiment, adaptations, variations, modifications and equivalent arrangements, the present invention being limited only by the claims appended hereto and the equivalents thereof.

CLAIMS

What is claimed is:

1. An abrasive tool comprising:

a matrix support material configured for holding diamond particles to be used as abrasives;

a plurality of diamond particles disposed in the matrix support material; and

an alloy infiltrated through the matrix support material and the diamond particles, the alloy being bonded to the diamond particles and the matrix support materials, the alloy comprising a metal alloy that contains 2 to 50 percent of an element selected from the group consisting of chromium, manganese, silicon and aluminum, and being substantially free of zinc.

2. The abrasive tool according to claim 1, wherein the matrix support material contains more than 50 percent by weight of material selected from the group consisting of cobalt, nickel, iron, copper and bronze and mixtures and alloys thereof.

3. The abrasive tool according to claim 1, wherein the matrix support material occupies more volume than the diamond particles.

4. The abrasive tool according to claim 1, wherein the diamond particles are less than 40 percent of the volume of the matrix support material and diamond particles combined.

5. The abrasive tool according to claim 1, wherein the matrix support material is formed of coarse-sized powders greater than 400 U.S. mesh.

6. The abrasive tool according to claim 1, wherein the diamond particles are disposed in the matrix support material in a predetermined pattern.

7. The abrasive tool according to claim 1, wherein the matrix support material is formed by a plurality of diamond impregnated sheets.

8. The abrasive tool according to claim 7, wherein the diamond impregnated sheets are made by rolling, extruding, or tape casting a mixture of metal powder and diamond grits.

9. The abrasive tool according to claim 7, wherein the diamond impregnated sheets are made by mechanically planing diamond grits into the metal sheet.

10. The abrasive tool according to claim 9, wherein the metal sheet is formed by the group consisting of rolling from an ingot and prepared from a metal powder.

11. The abrasive tool according to claim 7, wherein at least one of the diamond impregnated sheets has been infiltrated with the alloy.

12. The abrasive tool according to claim 1, wherein the alloy is substantially free of interfering metals selected from the group consisting of zinc, lead and tin.

13. The abrasive tool of claim 1, wherein the alloy comprises at least 3 percent by weight of a material selected from the group consisting essentially of chromium, manganese, silicon, and aluminum and mixtures and alloys thereof.

14. The abrasive tool according to claim 1 and characterized further in that the alloy is selected from the group consisting essentially of MICROBRAZ LM,

copper-manganese alloy, copper-silicon alloy, and aluminum-silicon alloy.

15. The abrasive tool of claim 1, wherein the alloy has a liquidus temperature of less than 1,100° C.

16. The abrasive tool of claim 1, wherein the matrix support materials has a plurality of slots formed therein, and wherein the diamond particles are disposed within the slots.

17. The abrasive tool of claim 16, wherein the slots are filled with an alloy to bond the diamonds disposed within the slots to the matrix support material defining the slots.

18. The abrasive tool of claim 1, wherein the diamond particles are disposed in columns extending into the matrix support material, and wherein the diamonds are held in place by the alloy.

19. The abrasive tool of claim 18, wherein the column is substantially linear.

20. The abrasive tool of claim 18, wherein the column is curved.

21. The abrasive tool of claim 1, wherein the tool is a circular saw blade.

22. The abrasive tool of claim 1, wherein the tool is a linear saw blade.

23. A method for forming a diamond impregnated tool comprising:

(a) forming a matrix support material configured for holding diamond particles to be used as abrasives;

(b) distributing diamond particles in the matrix supportive material; and

(c) infiltrating the matrix support material with an alloy that contains between 2 and 50 percent of an element selected from the group consisting essentially of chromium, manganese, silicon and aluminum, and being substantially free of zinc.

24. The method according to claim 23, wherein step (a) comprises, more specifically, forming the matrix support material from powder larger than 400 mesh.

25. The method according to claim 23, wherein step (a) comprises, more specifically, forming the matrix support material from irregularly shaped particles.

26. The method according to claim 23, wherein the method comprises, more specifically, distributing the diamond particles in the matrix support material in a predetermined pattern.

27. The method according to claim 23, wherein the method comprises, more specifically, infiltrating the matrix support material with an alloy substantially free of interfering metals selected from the group consisting of zinc, lead and tin.

28. The method according to claim 23, wherein the method comprises, more specifically, forming a plurality of slots in the matrix support material, and distributing diamond particles into the slots.

29. The method according to claim 23, wherein the method further comprises infiltrating the slots with alloy braze to bond the diamond to the matrix support material.

30. The method according to claim 23, wherein the method further comprises subjecting the matrix support material and diamond particles to a vacuum of at least 10^{-3} torr during infiltration.

31. The method according to claim 23, wherein the method comprises, more specifically, infiltrating the matrix support material and diamond particles with an alloy having at least 5 percent by weight of a carbide former selected from the group consisting essentially of chromium, manganese, aluminum and silicon and mixtures and alloys thereof.

32. The method according to claim 23, wherein the alloy is selected from the group consisting of Nicrobraz LM; an alloy including copper and manganese; an alloy including copper and silicon; an alloy including aluminum and silicon and an alloy including nickel and silicon.

33. The abrasive tool according to claim 1, wherein the tool is a wire saw.

34. The abrasive tool according to claim 33, wherein the tool is a diamond wire saw.

35. the abrasive tool according to claim 34, wherein the tool is a diamond wire saw that contains beads fitted over a steel cable.

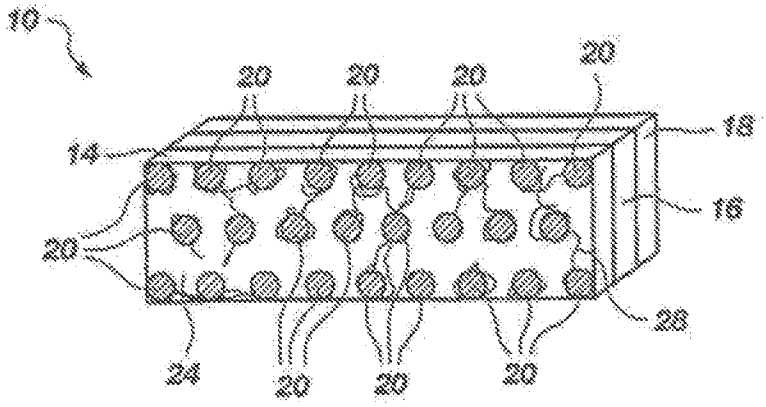


Fig. 1A

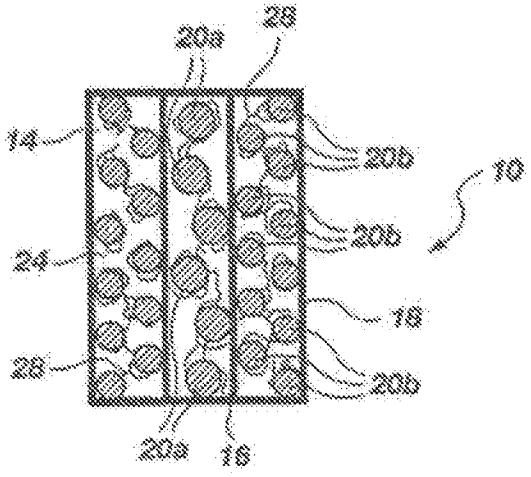


Fig. 1B

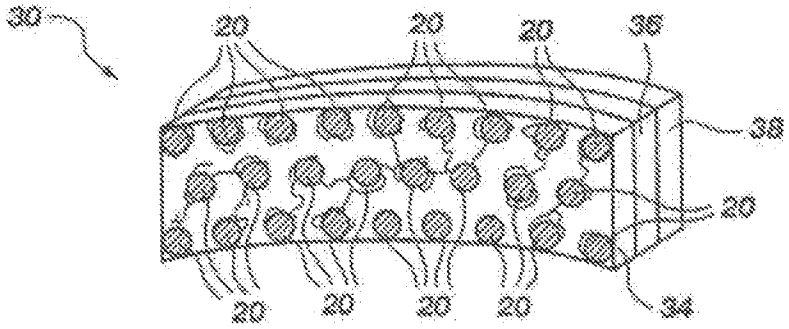


Fig. 2A

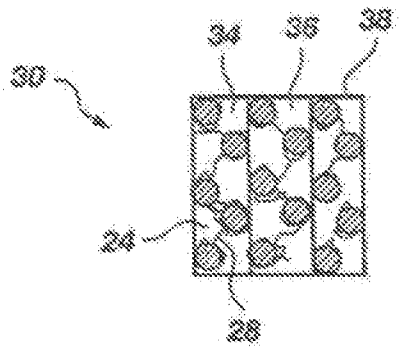


Fig. 2B

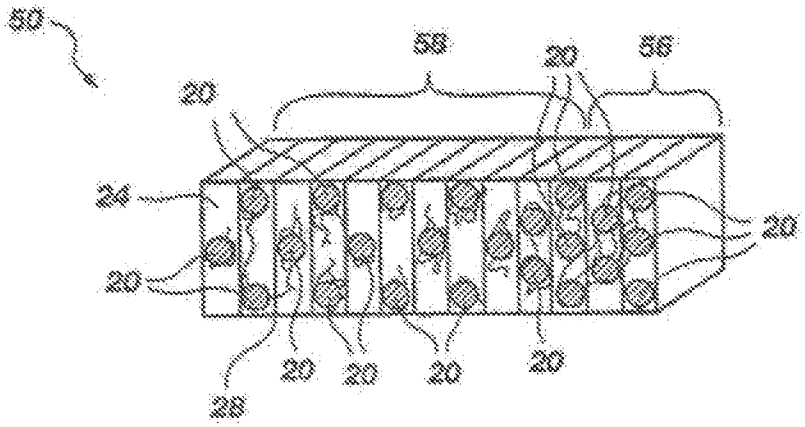


Fig. 3

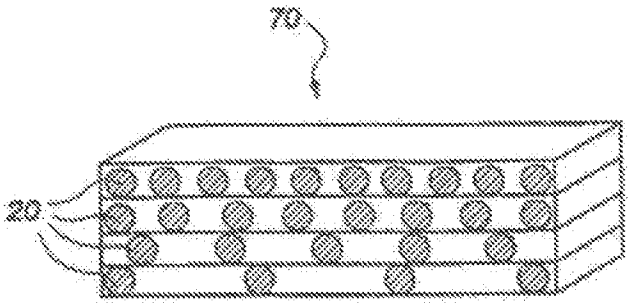


Fig. 4

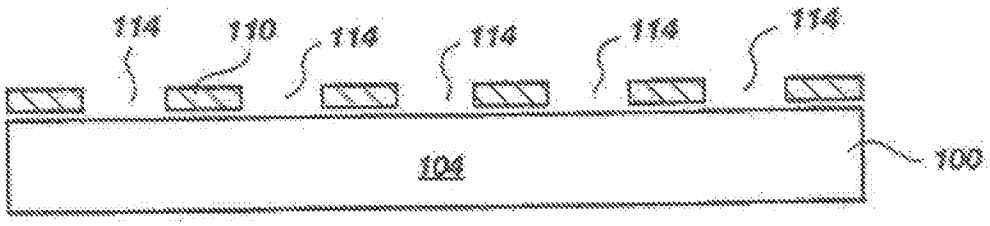


Fig. 5A

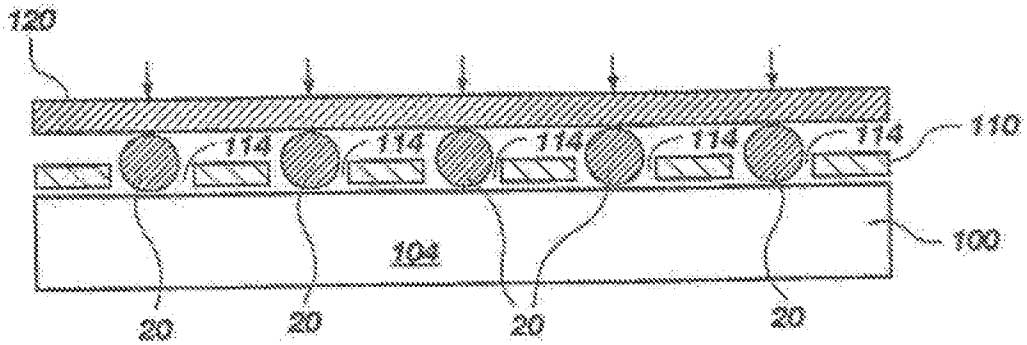


Fig. 5B

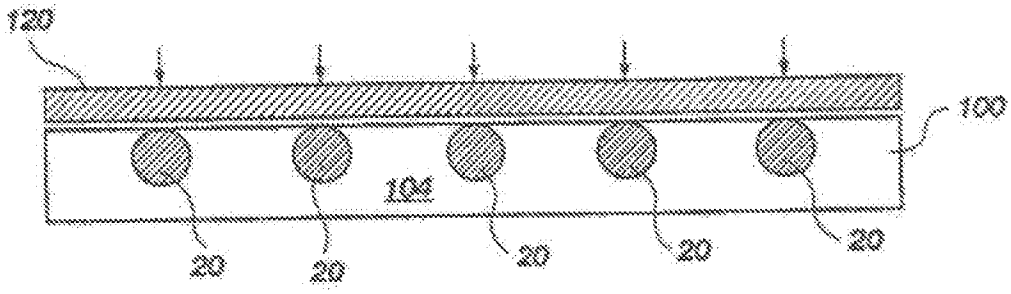


Fig. 5C

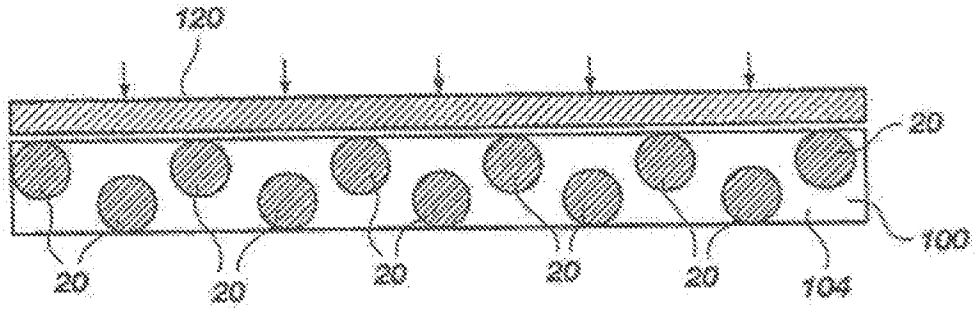


Fig. 5D

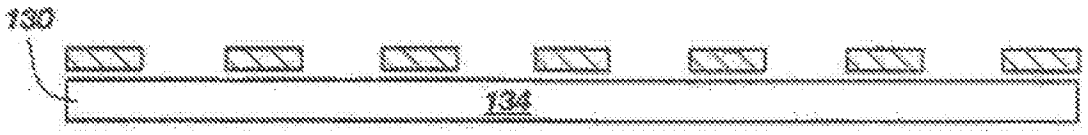


Fig. 6A

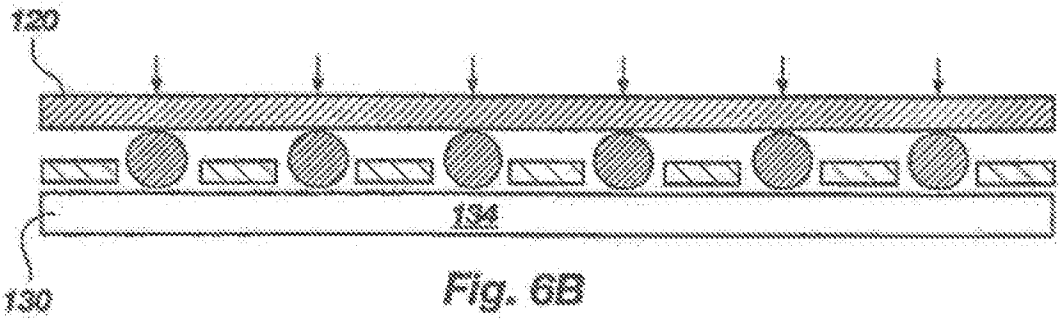


Fig. 6B

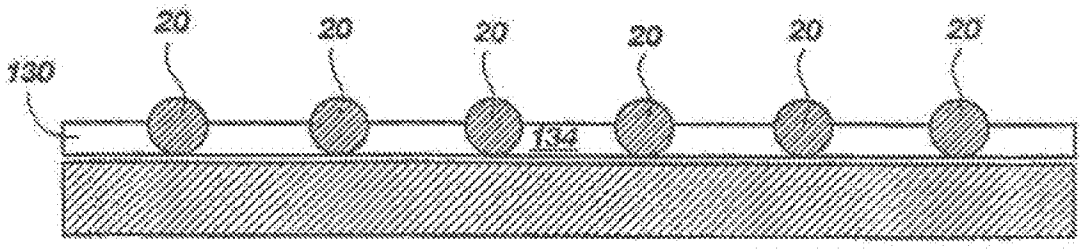


Fig. 6C

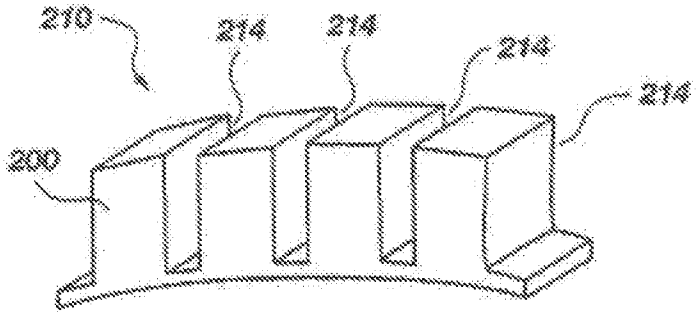


Fig. 7A

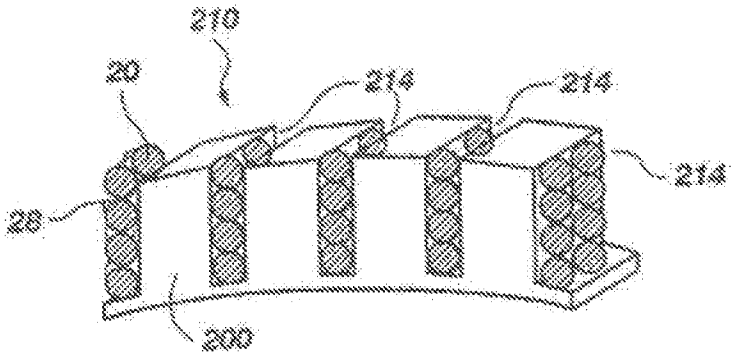


Fig. 7B

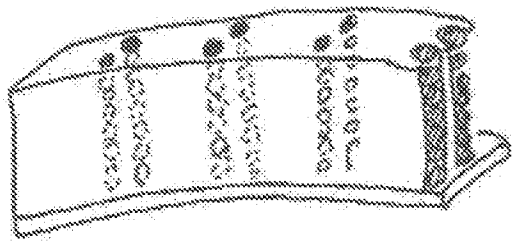


Fig. 8

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(71)(72) Applicant and Inventor: SUNG, Chien-Min [US/--]; 4, Lane 32, Chung-Cheng Road, Tamsui, Taipei County 251 (TW).

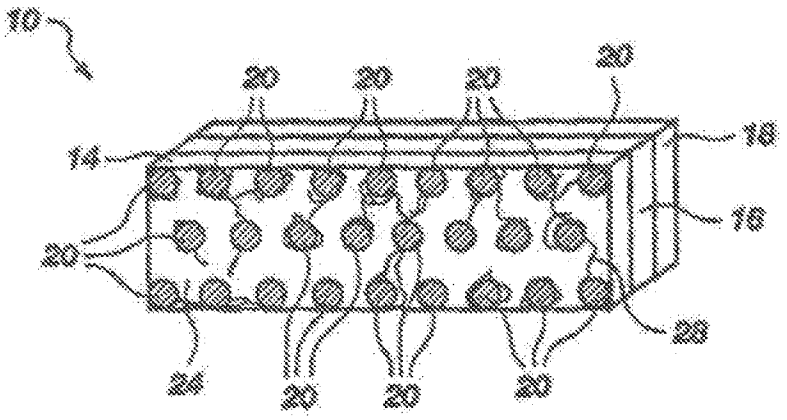
(74) Agents: BATEMAN, Randall, R. et al.; Thorpe, North & Western, L.L.P., P.O. Box 1219, Sandy, UT 84091-1219 (US).

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(54) Title: BRAZED DIAMOND TOOLS BY INFILTRATION



(57)Abstract

The present invention describes a diamond tool (10) with diamond bonded chemically by a braze (28) that contains either Cr, Mn, Si, or Al or mixtures or alloys thereof. The diamond tool (10) is made by infiltrating the braze (28) into a matrix metal (24) that contains diamond (20) in either form of grits or polycrystalline bodies.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
APS
search terms: infiltration, alloy, diamond, matrix, braze, compact,

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 4,669,522 A (GRIFFIN) 02 JUNE 1987	1, 23
A	US 4,780,274 A (BARR) 25 OCTOBER 1988	1, 23
A	US 5,518,443 A (FISHER) 21 MAY 1996	7, 21

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Date of the actual completion of the international search
24 NOVEMBER 1998

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(71)(72) Applicant and Inventor: SUNG, Chien-Min [US/-]; 4 Lane 32, Chung-Cheng Road, Tamsui, Taipei County 251 (TW).

(74) Agents: BATEMAN, Randall, B. et al.; Thorpe, North & Western, L.L.P., P.O. Box 1219, Sandy, UT 84091-1219 (US).

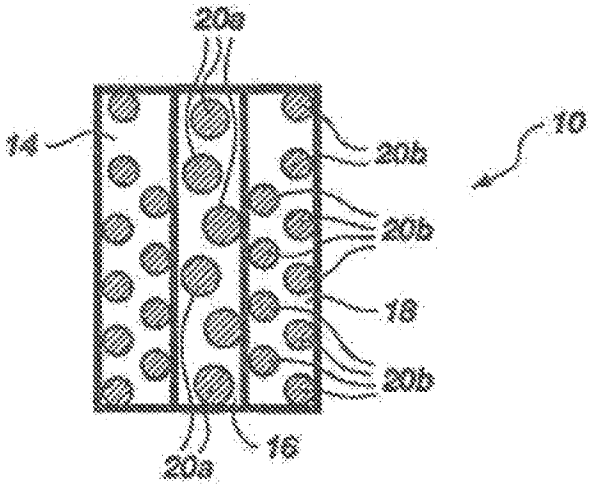
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Published
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(54) Title: ABRASIVE TOOLS WITH PATTERNED GRIT DISTRIBUTION AND METHOD OF MANUFACTURE

(57) Abstract

An abrasive tool (10) that contains abrasive particles (20) distributed in a predetermined pattern. Such a pattern is produced by fabricating two-dimensional slices (14, 16, 18) and assembling them. Abrasive particles (20) may be incorporated during the process of making these slices, or they may be planted afterwards into these slices which contain matrix powder. The planting may be guided by a template with openings laid in a specific pattern.



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ABRASIVE TOOLS WITH PATTERNED GRIT DISTRIBUTION AND METHOD OF MANUFACTURE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to improved abrasive tools used for cutting, grinding and the like. More particularly, the present invention relates to improved abrasive tools wherein abrasive particles are distributed in a predetermined pattern in a matrix powder in order to decrease cost and/or increase the useful life of the tool.

2. State of the Art

Abrasive tools have long been used in numerous applications, including cutting, drilling, sawing, grinding, lapping and polishing materials. Because diamond is the hardest abrasive material and cubic boron nitride is the second hardest, the two materials have been widely used as superabrasives on saws, drills, and other tools which utilize the abrasive to cut, form or polish other hard materials. It is estimated that the total value of superabrasive tools now consumed world wide is over is over 5 billion U.S. dollars per year. More than half of the superabrasive tools are believed to be consumed in sawing and

drilling application such as cutting stones, concretes, asphalts, etc.

Superabrasive tools are particularly indispensable for applications where other tools lack the strength and durability to be practical substitutes. For example, in the stone industry where rocks are cut, drilled, or sawed, diamond tools are the type which are sufficiently hard and durable to make the cutting, etc., economical. If superabrasives were not used, many such industries would be economically infeasible. Likewise, in the precision grinding industry, superabrasive tools, due to their superior wear resistance, are uniquely capable of developing the tight tolerances required, while simultaneously withstanding wear sufficiently to be practical.

Despite the tremendous improvements which diamond and cubic boron nitride have provided for cutting, drilling and grinding tools, there are still several disadvantages which, if overcome, would greatly improve performance of the tools, and/or reduce their cost. For example, the abrasive diamond or cubic boron nitride particles are not distributed uniformly in the matrix that holds them in place. As a result, the abrasive particles are not positioned to maximize efficiency for cutting, drilling, etc., and for production costs of the tools. In some instances, the abrasive particles are disposed too close together.

In other instances, the abrasive particles are disposed to far apart from one another.

In all applications, the separation between abrasive particles determines the work load each particle will perform. Improper spacing of the abrasive particles typically leads to premature failure of the abrasive surface or structure. Thus, if the abrasive particles are too close to one another, some of the particles are redundant. The particles are present, but provide little or no assistance in the cutting, grinding, etc., application. Of course, excess particles add to the expense of the abrasive, due the high cost of diamond and boron nitride. Moreover, these non-performing particles can block the passage of debris, thereby reducing the cutting efficiency. Thus, having abrasive particles disposed too close to one another adds to the cost, while decreasing the cutting efficiency of the tool.

On the other hand, if abrasive particles are separated too far, the work load (e.g., the impact force exerted by the work piece) for each particle becomes excessive. The sparsely distributed particles may be crushed, or even dislodged from the matrix into which they are disposed. The damaged or missing abrasive particles are unable to fully assist in the work load. Thus, the work load is transferred to the surviving abrasive particles. The failure of each

abrasive particle causes a chain reaction which soon renders the tool ineffective to cut, drill, grind, etc.

A typical superabrasive tool, such as a diamond saw blade, is manufactured by mixing diamond particles (e.g., 40/50 U.S. mesh saw grit) with a suitable matrix (bond) powder (e.g., cobalt powder of 1.5 micrometer in size). The mixture is then compressed in a mold to form the right shape (e.g., a saw segment). The "green" form is then consolidated by sintering at a temperature between 700-1200 °C to form a single body with a plurality of abrasive particles disposed therein. Finally, the consolidated body is attached (e.g., by brazing) to a tool body, such a round blade of a saw, to form the final product.

Different applications, however, require different combinations of diamond (or cubic boron nitride) and matrix powder. For example, for drilling and sawing applications, a large sized (anywhere from 20 to 60 U.S. mesh) diamond grit is mixed with a metal powder. The metal powder is typically selected from cobalt, nickel, iron, copper, bronze, alloys thereof, and/or mixtures thereof. For grinding applications, a small sized (anywhere from 60 to 400 U.S. mesh) diamond grit (or cubic boron nitride) is mixed with either metal (typically bronze), ceramic/glass (typically a mixture of oxides of sodium, potassium, silicon, and aluminum) or resin (typically phenolic),

Because diamond or cubic boron nitride is much larger than the matrix powder (300 times in the above example for making saw segments), and it is much lighter than the latter (about 1/3 in density for making saw segments), it is very difficult to mix the two to achieve uniformity. Moreover, even when the mixing is thorough, diamond can still segregate from metal in the subsequent treatments such as pouring the mixture into a mold, or when the mixture is subjected to vibrations. This diamond distribution problem is particularly troublesome for metal matrix tools. Metal matrix tools may account for more than 60% of the total value of all diamond tools. Within metal matrix tools, diamond saws (circular saws, straight blades, wire saws, etc.) comprise about 80% of the value. Thus, finding a method for increasing life of the abrasive material, and/or decreasing the amount of abrasive which is needed is highly desirable. Such has been accomplished by the invention set forth herein. The invention is applicable to all superabrasive tools, and is particularly effective for diamond saws, the largest value category of all diamond tools.

Over the decades, there have been numerous attempts to solve the diamond distribution problem. Unfortunately, none of the attempted methods have proven effective and, as of today, the distribution of diamond particles in diamond tools is still random and

irregular, except for some special cases such as drillers or dressers, where large diamond particles are individually set by hand in the surface to provide a single layer.

One method used in an attempt to make the diamond distribution uniform is to wrap diamond particles with a thick coating of matrix powder. The concentration of diamond particles in each diamond tool is tailored for a particular application. The concentration determines the average distance between diamond particles. For example, the concentration of a typical saw segment is 25 (100 means 25% by volume) or 6.25% by volume. Such a concentration makes the average diamond to diamond distance about 2.5 times of the particle size. Thus, if one coats the diamond to 0.75 times of its diameter and mix the coated particle together, the distribution of diamond would be controlled by the thickness of coating and may become relatively uniform. Additional metal powder may be added as interstitial filler between these coated particles to increase the packing efficiency so the consolidation of the matrix powder in subsequent sintering would be easier.

Although the above described coating method has certain merit, in practice, the uniformity of coating is very difficult to achieve. There are many chemical methods to coat diamond grit and its aggregates (polycrystalline diamond). For example, Chen and Sung

(U.S. Patent Nos. 5,024,680 or 5,062,865) described a CVD method for coating diamond grit using a fluidized bed. Sung et al (U.S. Patent Nos. 4,943,488 or 5,116,568) described another CVD method for coating polycrystalline diamond by fluidized bed. However, most of these methods can only produce thin coatings (e.g. a few micrometers) that do not affect the diamond distribution. Moreover, chemical coating methods typically require treatment at high temperatures (e.g. greater than 900 °C) that may cause damage to diamond. It is well known that synthetic diamond grit tends to form microcracks above this temperature. These microcracks are formed by the back-conversion of diamond to graphite at high temperature. The back-conversion is induced by the catalytic action of metal inclusions that diamond incorporated during its synthesis. CVD treatments cannot readily make thick coatings, and those which are formulated are often cost prohibitive. Thus, CVD treatments are not practical methods to make diamond distribution uniform in the tool.

There are, however, less expensive mechanical methods (e.g., by tumbling diamond particles with metal powder) that can build up a thick coating on diamond grit, typically at a low temperature that would not cause the degradation of diamond. However, it is very difficult to achieve a thick coating with uniform thickness using such methods.

For example, in attempts to practice the invention described in U.S. Patent No. 4,770,907 C.M. Sung performed "Metal Coating of Saw Diamond Grit by Fluidized Bed" (see p 267-273 of Fabrication and Characterization of Advanced Materials, edited by S. W. Kim and S. J. Park of The Materials Research Society of Korea 1995). It was found that the thickness of coated diamond particles varied considerably. Moreover, only extremely fine (i.e. less than 5 micrometers) metal powders can be coated on diamond effectively. Furthermore, the reproducibility of this method is poor. Hence, although such coating may improve the diamond distribution in the tool, its effect is limited.

Furthermore, in mechanical coating, metal powder is held loosely by an organic binder (e.g., PVA, PEG). The coating may be easily rubbed off during the subsequent mixing process, and thereby losing its intended benefit. Although heat treatment may increase the mechanical strength of the coating, nonetheless, it is an additional step with cost.

There is yet another limitation associated with the current methods of coating diamond particles. Many times a diamond tool requires different sizes of diamond grit and/or different diamond concentrations to be disposed at different parts of the same diamond tool. For example, saw segments tend to wear faster on the edge or front than the middle. Therefore,

higher concentrations and smaller diamond grit are preferred in these locations to prevent uneven wear, and thus premature failure of the saw segment. These segments with different concentration/size combinations (known as "sandwich" segments) are difficult to fabricate by mixing coated diamond with metal powder to achieve a controlled distribution of the abrasive particles in the segment. Thus, despite the known advantages of having varied diamond grit sizes and concentration levels, such configurations are seldom used because of the lack of a practical method.

In summary, current arts are incapable of efficiently controlling the uniformity of diamond distribution in the tool. Likewise, the current methods are inadequate to provide effective control of size variations and/or concentration variations on different parts of the same tool. Moreover, even when the distribution is made relatively uniform, current arts cannot tailor the pattern of the distribution to overcome or compensate for typical wear patterns for the abrasive material, when used for a particular purpose. By resolving these problems, the performance of a diamond and other superabrasive tools can be effectively optimized.

It is estimated that less than 10% of abrasives are actually consumed at work. Most of remainder is wasted due to the low efficiency of using these tools.

Among the various causes of this low efficiency, the inability to place every abrasive at the desired location is a major factor. This invention is aimed to make a revolutionary improvement to overcome the deficiency by eliminating random distribution of abrasive particles. The result would be an abrasive tool with every abrasive particle positively planted at desired positions to achieve the maximum utility. Hence, the performance of the abrasive tool can be optimized.

By making the distribution of abrasive particles uniform or tailored to the particular applications of the tool, then the work load can be evenly distributed to each particle. As a result, the abrasive tool will cut faster and its working life be extended a considerable amount of time. Moreover, by eliminating the redundancy, less abrasive may be needed, thereby reducing the cost of the tool manufacture. Additionally, if the distribution can be controlled, abrasive tools utilizing diamond or cubic boron nitride can be configured to provide the most efficient wear profile possible.

The present invention resolves these problems and provides the advantages set forth above by providing a method for forming such tools wherein the abrasive particle distribution can be controlled to provide either uniform grit placement, or to provide grit placement which is tailored to the particular wear

characteristics of the tool. Because the distribution of the diamond particles is controlled, the particles can be disposed in patterns which provide for relatively even wear of the abrasive surface, rather than having portions of the surface wear prematurely. As each particle is more fully utilized, there is no need for redundant particles as a back up. Therefore, the cost of making the abrasive tools can be reduced by decreasing the overall amount of superabrasive which is used. For example, the cost of superabrasives (diamond or cubic boron nitride) is so high that it often accounts for about half of the total manufacturing cost of the tool. By maintaining the performance of a superabrasive tool with a substantially lower concentration used in a controlled distribution, significant cost saving may be realized due to the decreased use of the expensive abrasive.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method for forming superabrasive tools, wherein the distribution of the superabrasive grit is controlled to provide improved cutting, grinding, etc., characteristics without requiring an increase in the amount of superabrasive grit used to form the tool.

It is another object of the invention to provide such a method wherein the distribution of the

superabrasive grit is controlled to promote more even wear of the abrasive surface, and thereby lengthen the useful life of the tool.

It is yet another object of the present invention to provide tools with minimal amount of superabrasive required to perform the task for which the tool is designed, thereby reducing the cost of making the tool.

The above and other objects of the invention are achieved by the use of a novel method of forming the superabrasive surface. While the distribution of the diamond or cubic boron nitride particles has always been viewed as a complex, three dimensional problem, the present invention reduces the distribution of the superabrasive to a substantially two-dimensional process that is easy to manipulate and control, and which can be repeated with a high degree of accuracy. More specifically, the desired distribution of abrasive particles in a matrix body is achieved by assembling layers of matrix material that contain a controlled, preset pattern of abrasive particles. Each layer is formed by distributing the superabrasive grit into a layer of bonding matrix in a predetermined pattern. Each layer which is assembled to form a superabrasive impregnated segment can be of the same distribution pattern and concentration, or the distribution pattern and/or concentration may vary from layer to layer.

In accordance with one aspect of the present invention, each layer is assembled by disposing a layer of matrix material so that it may be used as a precursor. The superabrasive grit is then disposed in the matrix material in a desire pattern. After the diamond particles are planted into the matrix material layer in a predetermined pattern, the process is repeated until a desired number of layers have been formed. These layers are then assembled to form the desired three-dimensional body. Subsequently, the diamond tool is consolidated (e.g., by sintering or infiltration as described above) to form the final product.

By reducing the three-dimensional problem to a two-dimensional solution through the use of the layers, the present invention can not only achieve the desirable diamond distribution pattern in the tool body, but can also provide the flexibility for possible manipulation of diamond concentration at different parts of the same tool body. Thus, for example, diamond particles can be disposed in denser concentrations in some layers than others, and the layers with the greater diamond concentrations can be disposed within the three-dimensional structure created in such a manner to prevent the uneven wear patterns that are typical in many prior art abrasive tools.

In accordance with another aspect of the present invention, each superabrasive layer is created by first forming a thin layer of bonding matrix. A template is then disposed on the bonding matrix. The template has a plurality of apertures formed therein which are sized to receive superabrasive grit of a particular size, with one particle being disposed in each aperture. As the superabrasive grit fills the apertures, it may subjected to pressure or otherwise moved into the bonding matrix. Because of the template, the superabrasive grit which enters the bonding matrix is disposed in a predetermined pattern. A plurality of such superabrasive layers can then be bonded together and attached to the tool by brazing, or some other process, to provide a three-dimensional superabrasive cutting or grinding member on the tool.

In accordance with another aspect of the present invention, the pattern in which the superabrasive grit is disposed may be uniform, or may be calculated to provide superabrasive members with particular cutting abilities. For example, the superabrasive particles may be disposed in varied concentrations to compensate for uneven wear patterns. Thus, the diamond distribution for the cutting edge of a saw may have a greater distribution of diamond particles on the lead edge and sides than on the middle portion which is generally subjected to less wear. Likewise, the sizes of the superabrasive particles can be

controlled to provide a cutting, grinding, etc., surface which is tailored to the particular purpose, such as to prevent chipping of the workpiece.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the invention will become apparent from a consideration of the following detailed description presented in connection with the accompanying drawings in which:

FIG. 1A shows a segment from a superabrasive tool formed by a plurality of linear, longitudinal layers disposed adjacent one another to form a three-dimensional superabrasive member;

FIG. 1B shows a cross-sectional view of one likely configuration of the tool segment shown in FIG. 1A, wherein a layer formed by a matrix material and a relatively large superabrasive is sandwiched between two layers of matrix materials which have smaller grit and higher concentration of the abrasive;

FIG. 2A shows a segment from a superabrasive tool formed by a plurality of arcuate, longitudinal layers which are attached to one another to form a three-dimensional superabrasive member;

FIG. 2B shows a cross-sectional view of a plurality of layers matrix material as may be used with the segment shown in FIG. 2A;

FIG. 3 shows another possible layout of a segment of a cutting tool with transverse layers configured with a denser concentration of abrasive material disposed, e.g., at a forward, cutting end of the three-dimensional superabrasive member;

FIG. 4 shows yet another layout of a segment wherein a three-dimensional superabrasive member is formed with progressively denser abrasive distribution toward, e.g., the upper surface of a tool with horizontal layers;

FIGs. 5A through 5D show one possible method for forming layers with controlled superabrasive distribution within the layer;

FIGs. 6A through 6C show an alternate method for forming one or more layers with controlled superabrasive distribution.

DETAILED DESCRIPTION

Reference will now be made to the drawings in which the various elements of the present invention will be given numeral designations and in which the invention will be discussed so as to enable one skilled in the art to make and use the invention. It is to be understood that the following description is only exemplary of the principles of the present invention, and should not be viewed as narrowing the pending claims.

Referring to FIG. 1A, there is shown a perspective view of a segment, generally indicated at 10, from a superabrasive tool (the remainder of which is not shown). The segment 10 is formed by a plurality of layers, 14, 16 and 18, which are impregnated with superabrasive particles, indicated by the circles 20. The plurality of layers 14, 16 and 18 are disposed adjacent to one another in a linear, longitudinal array so that the layers form the three-dimensional superabrasive segment 10.

As will be discussed in additional detail below, forming the segment 10 in a plurality of thin layers provides remarkably improved control over the distribution of the superabrasive particles. By controlling the distribution of the superabrasive particles within each layer and then combining layers, a three-dimensional segment can be formed in which distribution of the superabrasive particles is controlled in each dimension. This, in turn, enables the formation of segments which are particularly adapted to the likely use of the segment, be it for cutting, sawing, grinding, etc. By tailoring the distribution and concentration of the superabrasive particles within the segment 10, more precise control is given over performance of the tool under actual working conditions.

For example, when using a diamond saw blade to cut a rock (e.g., granite), the two sides of diamond

saw segments are cutting more materials than the center. As a result of the uneven wear, the cross section of the saw segment becomes convex in shape with the center bulging above both sides. This configuration typically slows the cutting rate of the saw blade. Moreover, the protruding profile may also cause the saw blade to deflect sideways in the cut slot. In order to maintain a straight cutting path, it is sometimes desirable to make a "sandwiched diamond segment" to reinforce both sides of the segment with layers impregnated with more superabrasive particles. Such a "sandwich segment" is difficult to manufacture by mixing diamond grit with metal powder by conventional means, but it can be easily accomplished by first planting diamond particles with desirable patterns in layered metal matrix and then assembling these layers together to form the sandwich segment.

In accordance with the present invention, a cutting segment can be formed to resist premature wear to the sides of the segment, thereby extending the cutting segment's useful life. Referring specifically to FIG. 1B, there is shown a cross-sectional view of the cutting segment 10 of FIG. 1A. Unlike the cutting segments of the prior art, the cutting segment 10 is formed of, for example, three layers, 14, 16 and 18 respectively. The middle layer 16 has a plurality of superabrasive particles 20a

which are of a first size (typically 40/50 U.S. mesh) and a first concentration (e.g. 20). The outer layers 14 and 18, in contrast, have a plurality of superabrasive particles 20b, which are of a second size (typically 50/60 mesh), smaller than the first size, and in a second concentration greater than that present in the middle layer 16 (e.g. 23). The smaller, more densely distributed superabrasive particles 20b provide the outer layers 14 and 18 with a greater resistance to wear as they cut through concrete, rock, asphalt, etc. Because the outer layers 14 and 18 are more resistant to wear, the cutting segment 10 resists formation of a convex outer surface, as has traditionally occurred with conventional tools. By maintaining a more planar cutting surface or even a concave profile, the cutting segment can maintain a straighter cutting path with a longer useful life. Moreover, by using a smaller grit on the flank of the saw, the finish of cut surface is more smooth. Furthermore, the chipping of the workpiece can be avoided.

Another advantage to the use of multiple layers of matrix with diamond or cubic boron nitride disposed therein is that the layers are easily formed into other desirable shapes for cutting, drilling, grinding, etc. For example, FIG. 2A shows a perspective view of a saw segment, generally indicate at 30, of a superabrasive tool formed by a plurality

(e.g., 3) of arcuate, longitudinal layers which are attached to one another to form a three-dimensional tool member. In this example, the segment 30 is formed from first, second and third layers, 34, 36 and 38, which are each arcuate. When the three are joined together, an arcuate segment 30 is created. Such a segment, of course, may be used on cutting tools which are non linear (e.g, circular saw blades), and on other types of tools for which a nonlinear superabrasive segment is desired. Because the layers 34, 36 and 38 are initially formed independent of one another, they are much easier to conform to a desired shape, and are able to do so while the superabrasive particles 20 disposed therein are held in their predetermined positions.

Each of the layers is impregnated with a plurality of superabrasive particles 20, typically diamond or cubic boron nitride. Because each layer is formed as a substantially two-dimensional unit (i.e., the matrix will usually be no more than two times the thickness of the diameter of the particles) superior control is provided over placement of the superabrasive particles. As discussed above, the random placement of the prior art often led to ineffective use of superabrasive particles. However, the controlled distribution of the present invention enables either even distribution designed to prevent under or over spacing, or controlled distribution so

that different portions of the segment have different sizes and concentrations which are matched to prevent traditional wear patterns.

Referring now to FIG. 2B, there is shown a cross-sectional view of a plurality of the layers 34, 36 and 38 of the segment 30. Of course, the superabrasive particle as may be used with the segment shown in FIG. 1A or that shown in FIG. 2A. Unlike the embodiment of FIG. 1B, the layers are each provided with the same size and concentration of the superabrasive particles 20. However, because the spacing is substantially uniform, there is no underspacing or overspacing between the superabrasive particles, and the segment 30 wears more evenly than the segments of the prior art with randomly spaced particles. The more even wear prevents premature failure of the segment 30, and thus extends the life of the tool while keeping the amount of superabrasive used to a minimum.

FIG. 3 shows another possible embodiment of a segment 50 made in accordance with the teachings of the present invention. The layered structure in a diamond segment may also be assembled transversely or horizontally. Thus, the segment 50 in FIG. 3 is formed from a plurality of transverse layers. A first plurality of layers, indicated at 56 are provided with a first concentration of superabrasive particles 20 (represented by four layers, that contain superabrasive particles 20 distributed within an

offset pattern). A second plurality of layers, indicated at 58, are provided with a second concentration, less than the first concentration (represented by nine layers with an offset pattern of superabrasive particles 20).

Many cutting tools are configured such that the cutting segment 50 is provided with a lead edge which performs a majority of the cutting and which receives most of the impact force when contacting the workpiece to be cut. For example, a circular saw blade will usually have a plurality of teeth (saw segments), each tooth having a leading edge which takes the force of the cutting. Because the leading edge preforms a significant portion of the cutting, it is much more susceptible to wear than are rotationally trailing portions of the tooth. When formed in accordance with the prior art, the teeth, however, often had similar concentrations of abrasive particles disposed therein. Over time the leading edge wears significantly, but the trailing layers 58 remain with minimal wear. Eventually, the abrasive of the saw tooth is worn off the leading edge, while significant amounts remain on the tail end. Thus, a considerable amount of superabrasive is wasted when the blade is discarded.

The embodiment of FIG. 3 is specifically configured to overcome such concerns. The layers 56 and 58 are configured to provide substantially even wear across the cutting segment 50 by placing a larger

percentage of the superabrasive particles 20 near the leading edge, than on rotationally distal portions. Thus, by the time the leading edge has reached the end of its useful life, the remaining portions of the cutting segment 50 have also been worn out. Such controlled distribution of the superabrasive particles 20 decreases the use of the expensive material and lowers the cost for making the cutting segment 50 without hurting performance. Additionally, by providing more even wear, the cutting segment 50 will often be able to maintain most of its cutting speed until shortly before ending its useful life.

FIG. 4 shows yet another layout of a segment wherein a three-dimensional superabrasive member is formed with progressively denser abrasive distribution toward the upper surface of a tool with horizontal layers. It is often found that the speed of cutting tends to decrease with the wear of the tool. Thus, with a reduced concentration of superabrasive particles, the tool can maintain its current cutting speed at a constant power of the machine. Thus, as with the embodiment of FIG. 3, the controlled distribution of the superabrasive particles 20 forms an improved abrasive segment 70, while at the same time decreasing the cost of abrasive tools by saving those superabrasive particles which are not needed.

With routine experimentation and the teachings of the method of the present invention, those skilled in

the art will be able to customize cutting, drilling, grinding, polishing and other types of abrasive segments which are specifically formed to maximize their performance (i.e. cutting, drilling, grinding, etc.) over an extended useful life, while simultaneously decreasing the amount of expensive superabrasive which is used to form the tool.

Referring now to FIGs. 5A through 5D, there is shown one method for forming layers in accordance with the principles of the present invention. The first step of the method is to form a sheet 100 of matrix material 104 which will be bonded to the superabrasive particles 20. The sheet 100 of matrix material 104 can be formed from conventional metal powders as discussed above, or other bonding agents which have yet to be discovered.

There are many ways that a matrix powder can be made into the sheets 100. For example, the powder can first be mixed with a suitable binder (typically organic) and a solvent that can dissolve the binder. This mixture is then blended to form a slurry with a proper viscosity. In order to prevent the powder from agglomeration during the processing, a suitable wetting agent (e.g., menhaden oil, phosphate ester) may also be added. The slurry can then be poured onto a plastic tape and pulled underneath a blade or leveling device. By adjusting the gap between the blade and the tape, the slurry can be cast into a

sheet with the right thickness. The tape casting method is a well known method for making thin sheets out of powdered materials and it works well with the method of the present invention.

Alternatively, the powder can be mixed with a suitable binder and its solvent to form a deformable cake. The cake can then be extruded through a die with a slit opening. The gap in the opening determines the thickness of the extruded plate. Alternatively, the material can also be drawn between two rollers with adjustable gap to form sheets with the right thickness.

It is desirable to make the sheets pliable for subsequent treatments (e.g., bending over a tool substrate which has a curvature). Therefore, a suitable organic plasticizer may also be added to provide the desired characteristics.

The use of organic agents for powder (metal, plastics, or ceramics) processing is documented in many text books and it is well known by those skilled in the art. Typical binders include polyvinyl alcohol (PVA), polyvinyl butyral (PVB), polyethylene glycol (PEG), paraffin, phenolic resin, wax emulsions, and acrylic resins. Typical binder solvents include methanol, ethanol, acetone, trichlorethylene, toluene, etc. Typical plasticizers are polyethylene glycol, diethyl oxalate, triethylene glycol dihydroabietate, glycerine, octyl phthalate. The organic agents so

introduced are to facilitate the fabrication of metal layers. They must be removed before the consolidation of metal powders. The binder removal process (e.g., by heating in a furnace with atmospheric control) is also well known to those skilled in the art.

Once the sheet 100 of matrix material 104 is formed, a template 110 is laid on the top of the sheet. The template 110 contains apertures 114 that are larger than one abrasive particle 20, but smaller than two abrasive particles, thereby allowing a single particle of the abrasive to be disposed at each specific location.

In this example, the thickness of the template is preferably between 1/3 to 2/3 of the height of the average abrasive particle 20. However, other thicknesses may be used if appropriate accommodations are made for seating the abrasive particles in the desired locations.

After the template 110 is properly positioned, a layer of abrasive particles 20 is then spread over the template so that each aperture 114 receives an abrasive particle. Those particles not falling into the apertures 114 in the template 110 are removed by tilting the substrate, sweeping the template with a broom, or some other similar method.

As shown in FIG. 5B, a generally flat surface 130, such as a steel plate) is then laid over the particles 20 which rest in the apertures 114 in the

template 110. The flat surface 120 presses the abrasive particles 20 at least partially into the pliable sheet 100 of matrix material 104 to seat the particles.

After removing the template 110, the flat surface 120 is used again to press the abrasive particles 120 firmly into the sheet 100 of matrix material 104 as shown in FIG. 5C. While the flat surface 120 is preferable, those skilled in the art will appreciate that there may be occasions when it is desirable to have abrasive particles protruding above the metal sheet 100 with equal height. Alternatively, some of the abrasive particles 20 may be wanted to extend outwardly from the sheet 100 of matrix material more than that of other abrasive particles. In such situations, a contoured or otherwise shaped surface could be used to seat some of the abrasive particles 20 deeper into the sheet 100 of matrix material 104, than other particles.

If desired, the process shown in FIGs. 5A through 5C can be repeated on the other side of the sheet 100 of matrix material 104 (as shown in FIG. 5D), to form an impregnated layer having abrasive particles 20 distributed throughout the layer in some predetermined, desired pattern. The process is typically repeated several times to obtain multiple thin layers or sheets 100 which are impregnated with the abrasive particles 20. Of course, each sheet 100

needs not have the same distribution pattern for the abrasive particles 20, nor does it need the concentration of the abrasive particles be the same.

The abrasive impregnated sheets 100 are next cut to any desired size and shape. The sheets 100 are then assembled to form the tool segment or the entire tool body where appropriate. Typically, the assembly of the sheets 100 is accomplished by a known method such as cold compaction with a press. The "green" body so formed can then be consolidated to form a final tool product by conventional method of sintering or infiltration as described by following the examples.

While the method described in FIGs. 5A through 5D is preferred for many applications, there are instances where it is desirable to have the abrasive particles 20 extend outwardly from the sheet 100 of matrix material. For example, some tools may only have one layer of abrasive. This can be accomplished simply by leaving the template 110 in place when performing the steps shown in FIG. 5A and 5B, and not further pressing the particles 20 into the matrix material once the template has been removed.

In the alternative, FIGs. 6A through 6C show a side view of an alternate to the method discussed in FIGs. 5A through 5D. The sheet 130 of matrix material in FIGs. 6A through 6C is thinner than the height of the superabrasive particles 20. Thus, in this

procedure, when the particles are pressed into the sheet 130, the particles 20 would protrude above the matrix material 134.

Although the present invention is intended for making three-dimensional abrasive tools, the teachings contained in the present application can readily be applied to two-dimensional tools as well. For example, U.S. Patent Nos. 3,894,673 and 4,100,576 describe certain brazed diamond tools that contain a single layer of diamond particles. These particles are brazed onto a tool shank by a chromium containing alloy. Such diamond tools are widely marketed (e.g., by Abrasives Technology of U.S.A.) for cutting and grinding non-ferrous materials (e.g., stones or glass).

However, the distribution of diamond particles on these tools are typically random and non-uniform. The methods illustrated in FIGs. 5A through 6C can readily be applied to such tools to improve the diamond distribution. In this case, the method offers several advantages over the conventional technology as described by these patents. For example, by making diamond particles distributed in a desirable pattern, the load of cutting can be evenly distributed to all diamond particles. As a result, the tool can cut faster with a longer life.

The performance may be further improved by having a braze layer of uniform thickness. This uniformity

can allow a better diamond retention and easier debris removal. Moreover, by fully utilizing each diamond particle for cutting, the concentration of diamond can be reduced. As discussed, diamond cost often accounts for about half of the total manufacturing cost of a diamond tool. Hence, by practicing this invention, manufacturing cost can be reduced substantially.

Also shown in FIG. 6A through 6C is the principle that the spacings of the apertures in the template 130 need not be uniform. Rather, variations in spacing can be provided to facilitate different concentrations on various portions of the sheet 130 of matrix material 134. Likewise, by controlling the size of the apertures 138 and the order in which the diamond particles are placed in the apertures, a single layer could be provided with particles of different sizes.

In addition to being able to improve the performance of the tool and to reduce the cost of the manufacturing, this invention also provides a easier method for making thin bladed tools. For example, the electronic industry requires using larger and larger silicon wafers (now 12 inches in diameter). Hence, thinner saw blades for slicing silicon crystals with lower kurf loss, and thinner dicing wheels for grooving silicon chips with tighter partitions have been in demand.

Prior to the present invention, it has been extremely difficult to make very thin tools that

contain evenly distributed diamond particles. The present invention provides an alternative method for making such tools. For example, it has been discovered that by mixing micron powders of diamond, a blend of metal powders (e.g., bronze and cobalt) and a suitable binder, the material can be rolled to a thickness thinner than 0.1 mm. By firing this thin sheet and mounting it on a tool holder, a thin dicing wheel can be made.

In the alternative to the above, it has been found in accordance with the present invention that some of the advantages of the controlled distribution, multilayered superabrasive configurations described above can be achieved without the use of a template. More specifically, the abrasive particles can also be mixed in with the matrix powder and made as an ingredient of the layered sheet. In this case, the distributions of abrasive particles are still somewhat random. Even so, their distribution is typically more uniform than that in a conventional abrasive body. The segregation of abrasive particles and matrix powders discussed in the background section is less extensive in a substantially two-dimensional sheet than in a three-dimensional body. This is particularly true for sheets made by a deforming process (e.g., by rolling). In this case, abrasive particles are further spread out in the matrix by the shearing action of the rollers.

This invention may also be applicable to other applications not related to making abrasive tools. For example, graphite or metal sheets planted with diamond particles may be used as seeds for diamond growth under high pressure and temperature. Industrial diamonds are typically produced by compressing alternative layers of graphite and metal catalyst (e.g., Fe, Co, or Ni alloy) to high pressure and heated above the melting point of the catalyst. Diamond will then nucleate randomly on the interface of these layers. The quality of the diamond crystal formed often suffers by the impingement of growing crystals that are distributed unevenly. Hence, the yield and cost of diamond synthesis can be substantially improved by making the nuclei distributed uniformly. This invention can provide layers of either graphite or metal catalyst with a pre-determined pattern of diamond seeds. If organic binders are introduced during the fabrication of these layers, they can be removed by heating in a furnace before loading into the press.

Example 1

40/50 mesh diamond grit (SDA-85' made by De Beers Company) were mixed with metal powder to form a mixture with diamond concentration of 20 (5% of total volume). Five different proportion of cobalt (about 1.5 micrometer in size) and bronze (about 20

micrometers in size) were used for the matrix powder. An acrylic binder was added (8% by weight) to the mixture and the charge was blended to form a cake. The cake was then rolled between two stainless steel rollers to form sheets with a thickness of 1 mm. These sheets were cut in the shape of saw segments with a length of 40 mm and width of 15 mm. Three each of such segments were assembled and placed into a typical graphite mold for making conventional diamond saw segments. The assembled segments were pressed and heated by passing electric current through the graphite mold. After sintering for three minutes, the segments were consolidated to a height of 9 mm with less than 1% porosity. Twenty-four segments for each composition were fabricated. They were brazed onto a circular saw of 14 inches in diameter. These five blades were used for cutting granites and found to perform equal or better than those with higher diamond concentrations (e.g. 23) made by conventional methods. Microscopic examination of the worn segment indicated that although diamond particles were not planted into the layered matrix, they were distributed more evenly than segments prepared by the traditional method. The segregation of particles in layered matrix was considerably less than that in a thick body of conventional segments.

Example 2

The same procedures were followed as Example 1, but with 8 thinner layers (0.4 mm) for each segment. The diamond concentration was reduced to 15 and particles were planted according to the illustration as shown in FIGs. 5A through 5D. The diamond distribution was much improved. As a result, the performance of these blades were equal or better than those made by conventional methods with diamond concentration of 20.

Example 3

Iron powders of about 100 mesh were mixed with an S-binder made by Wall Colmonoy Company to form a cake. The cake was then rolled to form sheets of 0.4 mm in thickness. 40/50 mesh SDA-100' diamond grit was planted into these sheets to attain a concentration of 15. These diamond containing sheets were cut in the shape of saw segments with a length of 40 mm and width of 9 mm. Eight of such segments were assembled as a group and placed in a graphite mold. Twenty-four groups were placed horizontally, and another twenty-four groups were placed vertically in the graphite mold. Nicrobraz LM powder (-140 mesh) (made by Wall Colmonoy Company) was added on the top of these segments. These samples were heated in a vacuum furnace (10^{-5} torr) to 1050 °C for 20 minutes for horizontally placed segments, and 30 minutes for

vertically placed segments. The melted LM alloy (Ni-Cr-B-Si with a liquidus point at 1000 °C) infiltrated into these segments and filled the porosity. The excess LM braze on these segments were ground by electrode discharge (EDG). Each of the 24 segments so fabricated were brazed onto a 14 inch (diameter) circular saw blade. These blades were used to cut granite and showed marked improvement over conventional saw blades.

Example 4

Microbrax LM powder was mixed with an acrylic binder and rolled to form layers of about 0.25 mm. 40/50 mesh MBS-960 diamond grit manufactured by General Electric Company was planted into these metal layers according to the method as illustrated in Figure 5. These diamond planted metal layers were cut in proper size and wrapped around 2,000 beads (pearls) of wire saw. The beads preferably have a taper angle between 3 and 5 degrees. These beads (10 mm in diameter by 10 mm long) were divided into two groups, one contains 280 crystals (about 0.2 carat) per bead; and the other, 400 crystals (about 0.3 carat). These beads were heated in a vacuum furnace to a temperature of 1,000 °C for 8 minutes. These beads were mounted on several wire saws and used to cut marble, serpentine and granite. The performance of these beads was found to be superior to conventional beads.

The latter beads were typically made by either hot pressing or electroplating. These conventional beads may contain a much higher amount of diamond (up to 1 carat) per bead.

Example 5

The same method as described by Example 4, but applied to other products, e.g., circular saws, thin-wall core bits, and curvature grounder. Each of these products shows superior performance over conventional electro-plated diamond tools having a similar or higher superabrasive concentrations.

The above description and examples are intended only to illustrate certain potential uses of this invention. It will be readily understood by those persons skilled in the art that the present invention is susceptible of a broad utility and applications. Many embodiments and adaptations of the present invention other than those herein described, as well as many variations, modifications and equivalent arrangements will be apparent from or reasonably suggested by the present invention and the forgoing description thereof without departing from the substance for scope of the present invention. Accordingly, while the present invention has been described herein in detail in relation to its preferred embodiment, it is to be understood that this disclosure is only illustrative and exemplary of the present invention and is made merely for the purpose

of providing a full and enabling disclosure of the invention. The forgoing disclosure is not intended to be construed to limit the present invention or otherwise to exclude any such other embodiment, adaptations, variations, modifications and equivalent arrangements, the present invention being limited only by the claims appended hereto and the equivalents thereof.

CLAIMS

What is claimed is:

1. An abrasive tool having an abrasive impregnated segment comprising:

a matrix material configured for bonding abrasive particles; and

a plurality of abrasive particles distributed in the matrix material in a predetermined pattern.

2. The abtasive tool according to claim 1, wherein the plurality of abrasive particles are selected from the group consisting essentially of diamond, cubic boron nitride, alumina and silicon carbide.

3. The abrasive tool according to claim 1, wherein the abrasive impregnated segment is formed by a plurality of matrix material layers, each layer being impregnated with abrasive particles, and wherein the plurality of layers are disposed adjacent one another.

4. The abrasive tool according to claim 3, wherein the abrasive particles in one of the layers are larger than the abrasive particles in at least one of the other layers.

5. The abrasive tool according to claim 4, wherein the plurality of layers includes at least one outer layer and at least one inner layer, and wherein the abrasive particles of the at least one inner layer

are larger than the abrasive particles of the at least one outer layer.

6. The abrasive tool according to claim 5, wherein the abrasive segment is configured with two outer layers and at least one inner layer disposed between the outer layers, wherein each of the outer layers and the at least one inner layer has abrasive particles disposed therein, and wherein the abrasive particles disposed in the at least one inner layer are larger than those disposed in the outer layers.

7. The abrasive tool according to claim 3, wherein at least one of the layers has a greater concentration of abrasive particles than at least one of the other layers.

8. The abrasive tool according to claim 7, wherein the plurality of layers includes at least one outer layer and at least one inner layer, and wherein the at least one outer layer has a greater concentration of abrasive particles than the at least one inner layer.

9. The abrasive tool according to claim 8, wherein the abrasive segment is configured with two outer layers and at least one inner layer disposed between the outer layers, wherein each of the outer layers and the at least one inner layer has abrasive particles disposed therein, and wherein the abrasive particles disposed in the outer layers are disposed in

greater concentration than the abrasive particles in the at least one inner layer.

10. The abrasive tool according to claim 7, wherein the plurality of layers includes at least one first layer having a first concentration of abrasive particles, at least one second layer having a second concentration less than the first concentration, and at least one third layer having a third concentration less than the second concentration.

11. The abrasive tool according to claim 7, wherein the abrasive impregnated segment has a leading edge configured to initially impact a surface to be cut, wherein the segment is formed by a plurality of layers and wherein the layers adjacent the leading edge having a higher concentration of abrasive particles than layers remote from the leading edge.

12. The abrasive tool according to claim 1, wherein the abrasive particles are distributed in a uniform pattern throughout the impregnated segment.

13. The abrasive tool according to claim 12, wherein the abrasive particles are uniformly distributed throughout the tool.

14. The abrasive tool according to claim 1, wherein the tool has abrasive particles distributed therethrough, and wherein the tool has an outer

portion having a higher concentration of abrasive particles disposed therein.

15. The abrasive tool according to claim 1, wherein the segment has an impacting surface formed thereon and wherein the abrasive particles are distributed in higher concentration adjacent the impacting surface.

16. The abrasive tool according to claim 1, wherein the segment is formed by a plurality of two-dimensional layers assembled together to form a three-dimensional segment.

17. An abrasive tool comprising a plurality of layers formed from a matrix material for holding abrasive particles, and a plurality of abrasive particles distributed in the layers of matrix material, the layers being attached to one another to form a three-dimensional tool abrasive segment.

18. The abrasive tool of claim 17, wherein at least one of the layers is 1 millimeter thick or less.

19. The abrasive tool of claim 17, wherein the layers have been consolidated together by a method selected from the group consisting of brazing, sintering or infiltration.

20. The abrasive tool of claim 17, wherein the abrasive particles are distributed within the layers in predetermined patterns.

21. The abrasive tool of claim 20, wherein the distribution of the abrasive particles if uniform in at least one of the layers.

22. An abrasive tool comprising at least one layer of matrix material with abrasive particles formed therein, the layer being 1 millimeter or less in thickness and formed by rolling the matrix material and abrasive particles between rollers to improve uniformity in the distribution of the abrasive particles.

23. A method for forming an abrasive tool body, the method comprising:

(a) forming a sheet of matrix material configured for bonding to abrasive particles; and

(b) disposing a plurality of abrasive particles in the sheet of matrix material in a predetermined pattern.

24. The method according to claim 23, wherein the method comprises, more specifically, placing a template with a plurality of apertures formed therein on the sheet of matrix material prior to disposition of the plurality of abrasive particles so that placement of the abrasive particles is controlled by the position of the apertures, thereby selectively limiting placement of the abrasive particles in the sheet of matrix material to the positions of the apertures.

25. The method according to claim 24, wherein the method comprises, more specifically, using a template formed from a sieve.

26. The method according to claim 24, wherein the template is formed by a plate having a plurality of apertures formed therein, the apertures being configured in a predetermined pattern.

27. The method according to claim 26, wherein each aperture has a diameter which is greater than a diameter of the abrasive particles to be positioned thereby, but less than twice the diameter of the abrasive particles.

28. The method according to claim 23, wherein the method comprises, more specifically, forming the sheet of matrix material by tape casting.

29. The method according to claim 23, wherein the method comprises, more specifically, forming the sheet of matrix material by rolling.

30. The method according to claim 23, wherein the method comprises, more specifically, forming the sheet of matrix material by extrusion.

31. The method according to claim 23, wherein the method comprises, more specifically, forming a plurality of layers of matrix material having abrasive particles disposed therein, and attaching the layers together to form a three-dimensional abrasive segment.

32. A method for forming a layer of abrasive impregnated matrix material having improved abrasive distribution, the method comprising:

(a) forming a layer having a mixture of matrix material and abrasive particles; and

(b) rolling the layer of mixture to form a layer no greater than 1 millimeter thick.

33. A method of making layers catalyst for diamond synthesis, the method comprising:

(a) forming at least one layer of a catalyst; and

(b) planting a plurality of diamond particles in the catalyst in a predetermined pattern.

34. The method according to claim 33, therein the method further comprises disposing organic binders in the catalyst prior to planting the plurality of diamond particles, and removing the heating in a furnace before pressing the catalyst and diamond particles.

35. A method of making a source material for diamond synthesis, the method comprising:

(a) providing a layer of graphite; and

(b) planting a plurality of diamond particles in the layer of graphite in a predetermined pattern.

36. The abrasive tool according to claim 1, wherein the abrasive impregnated segment is formed by at least one layer of matrix material.

37. The abrasive tool according to claim 36, wherein the at least one layer of matrix material contains at least one layer of abrasive particles.

38. The abrasive tool according to claim 37, wherein the tool is a wire saw that it at least partially surrounded by the matrix material that contains the abrasive particles.

39. The abrasive tool according to claim 38, wherein the tool is a wire saw that contains diamond beads overcoated with diamond.

40. The abrasive tool according to claim 39, wherein the diamond bead has a taper angle of 3 to 5 degrees.

41. The abrasive tool according to claim 36, wherein the matrix material is consolidated by a method selected from the group consisting of brazing, sintering and infiltration.

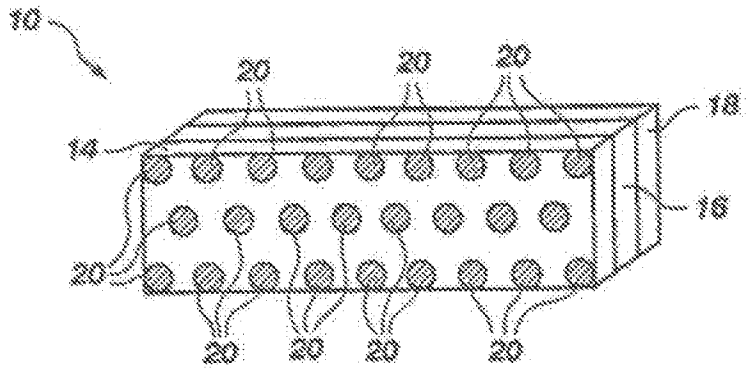


Fig. 1A

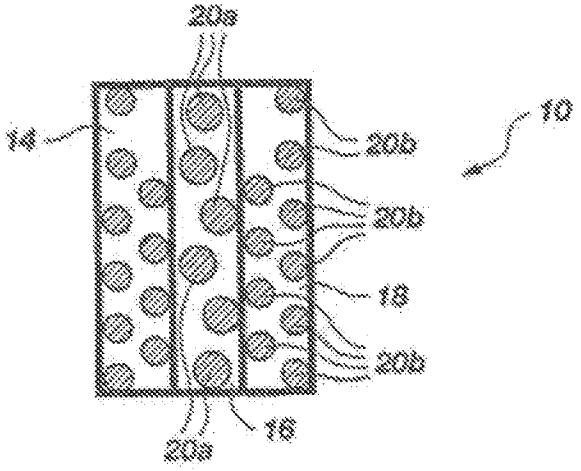


Fig. 1B

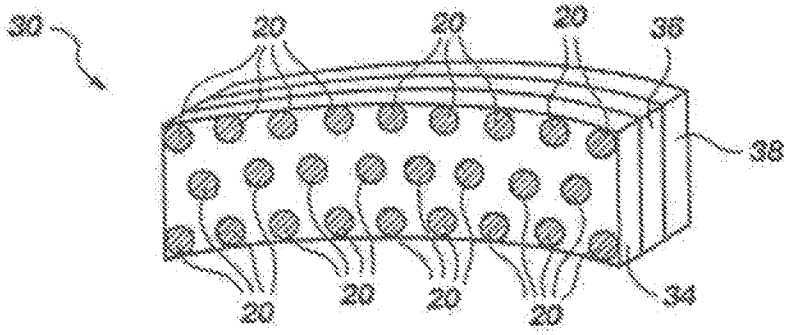


Fig. 2A

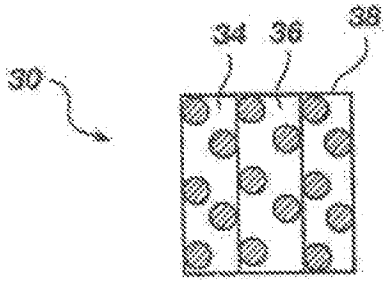


Fig. 2B

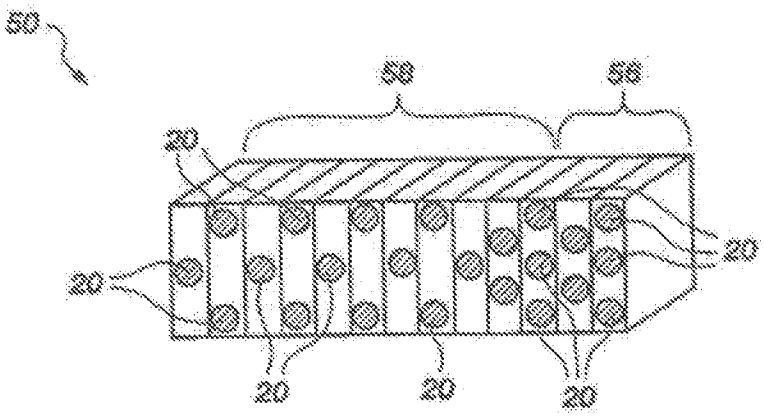


Fig. 3

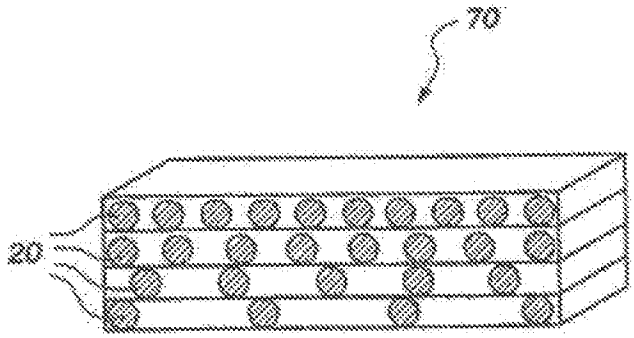


Fig. 4

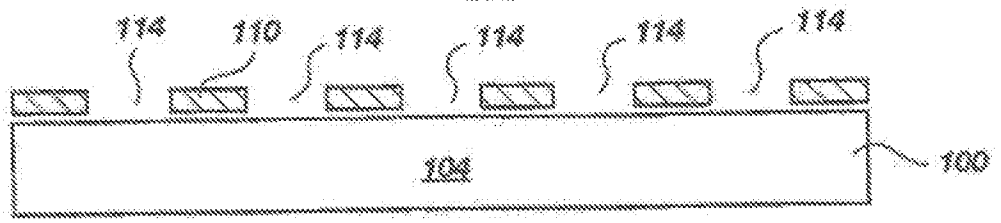


Fig. 5A

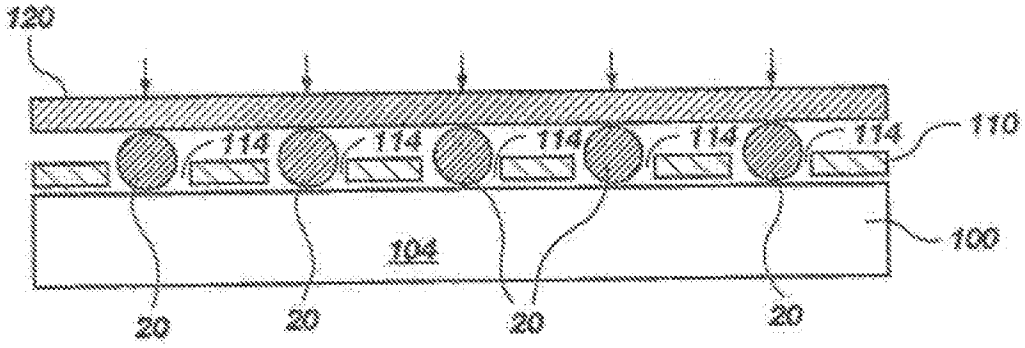


Fig. 5B

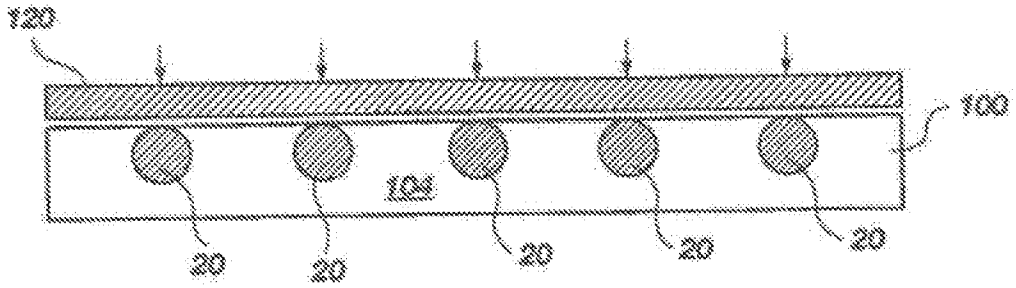


Fig. 5C

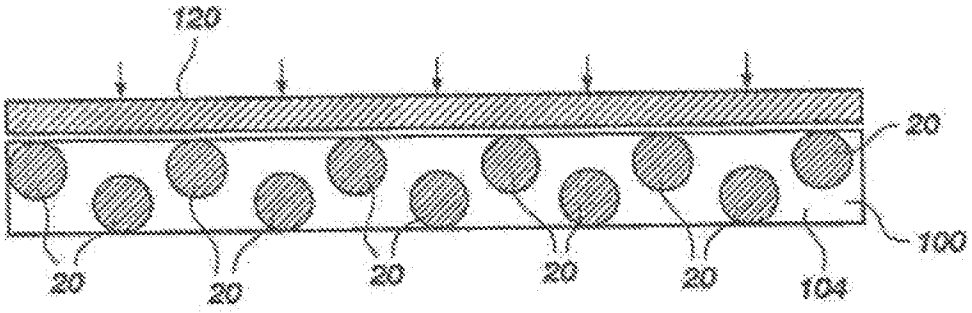


Fig. 5D

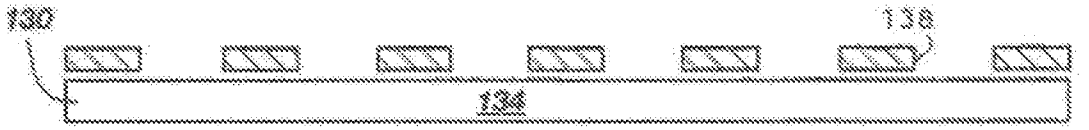


Fig. 6A

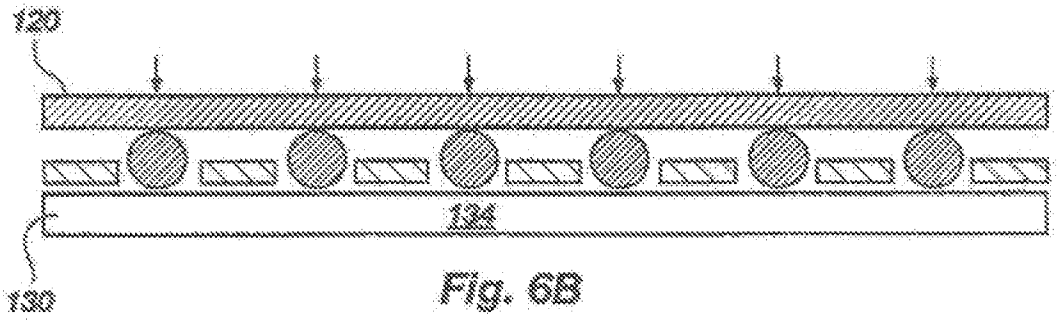


Fig. 6B

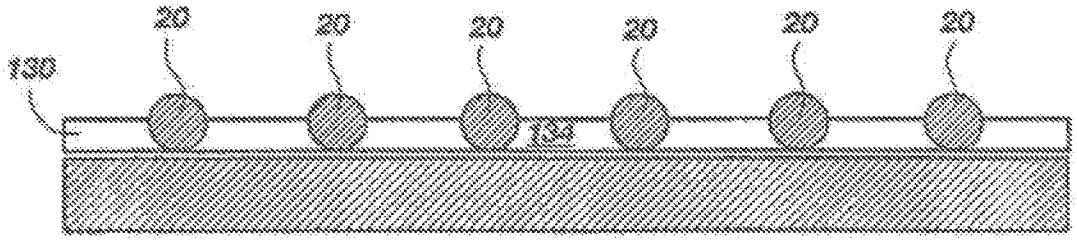


Fig. 6C

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/05931

A. CLASSIFICATION OF SUBJECT MATTER

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US CL :451/540

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)

U.S. : 451/527,529,533,540; 51/297; 125/16.02,21,22

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, 2,725,693 A (SMITH) 06 December 1955	1-41
Y	US, 2,952,951 A (SIMPSON) 20 September 1960, see entire document, specifically figure 2	1-41
Y	US, 3,146,560 A (HURST) 01 September 1964, see entire document.	1-41
Y	US 4,712,552 A (PANGBURN) 15 December 1987, see entire document, specifically figures 9 and 10.	1-41
A	US, 4,866,888 A (MURAI et al) 19 September 1989.	1-41
A	US 5,176,155 A (RUDOLPH, JR.) 05 January 1993.	1-41.

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

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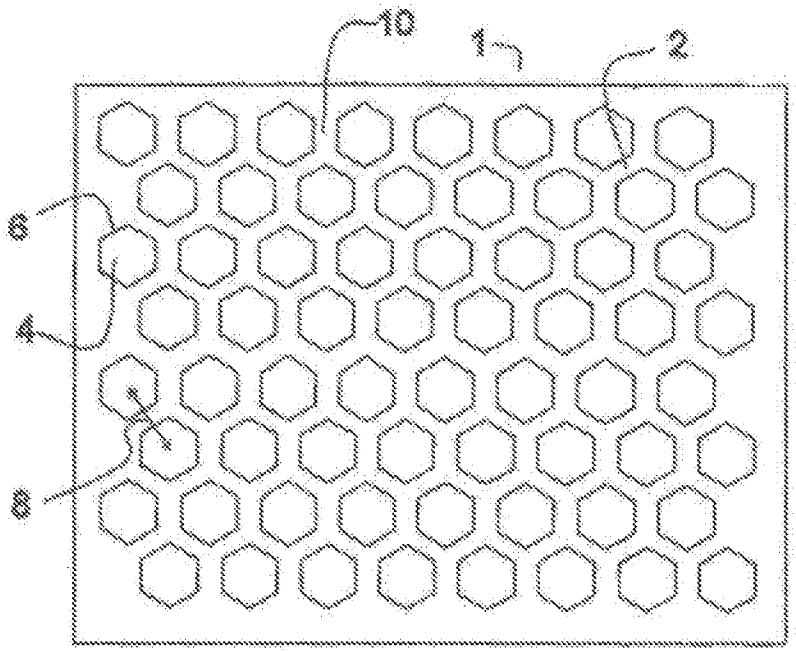
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Published
With international search report.

(54) Title: PATTERNED ABRASIVE TOOLS

(57) Abstract

A method of making a metal bonded, abrasive tool uses a perforated stencil to place abrasive parcels in a pattern on the cutting surface of the tool. The stencil is placed against the tool preform so that the perforations define cavities. Metal brazing composition in the form of a paste is packed into the cavities and the stencil is removed to leave discrete parcels of brazing paste tacked to the cutting surface. Abrasive grains are deposited onto the paste particles and fixed in place by firing the preform at brazing conditions. The abrasive grains thus are precisely positioned and spaced apart on the cutting surface by abrasive free channels which are defined by the web of the stencil. The abrasive free channels provide paths to facilitate flow of coolant material and swarf particles at the cutting zone. The method can include initially placing the brazing paste parcels onto a resilient, transfer medium and subsequently transferring the parcels onto the preform cutting surface. This method is particularly useful for depositing an abrasive pattern on a non-planar or highly curved tool surface. In another contemplated variation of the invention, the abrasive grains are premixed with the brazing paste prior to filling the cavities.



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Patterned Abrasive Tools

This invention relates to the manufacture of abrasive tools. More specifically, it relates to making tools with abrasive grains disposed in discrete parcels separated from neighboring parcels on the cutting surface by open channels. The invention further relates to self-sharpening abrasive tools in which the abrasive parcels are formed from multiple, ultrafine abrasive grains embedded therein.

In certain abrasive tools for industrial applications abrasive grains are affixed to a metal preform. The grains are attached to the preform by brazing a metal bonding composition at temperatures above about 600°C.

Removing swarf from the cutting zone during grinding improves performance. Among other things, swarf removal reduces wear of the brazed bonding composition and premature dulling of the abrasive grains. Cooling the work piece is another way abrasive tool users obtain improved grinding performance. Often cooling is accomplished by bathing the work piece in a cool, liquid lubricant. By providing open spaces on the abrasive tool, manufacturers can enhance swarf removal and cooling efficiency. These open spaces provide paths for swarf to leave the cutting zone and conduct coolant to and from the work piece.

A typical method of creating swarf removal and coolant spaces involves cutting grooves or drilling holes through the preform. This technique is widely used in abrasive wheel manufacture. In segmented abrasive tool fabrication, channels can be created by placing gaps between abrasive segments. Normally, such segments are molded from mixtures of abrasive grains and bonding composition and then attached as units to the tool. These methods add to the complexity of the manufacturing operation, are time consuming, and add to product cost.

It is desirable to provide an efficient method of making an abrasive tool with swarf removal and cooling space. Some methods for placing abrasive grains in discrete locations separated by open space on an abrasive tool have been suggested.

U.S. 5,389,119 (Ferronato et al.) discloses a method of making a nonwoven fabric with discrete islands of abrasive bound to a porous fabric layer. The islands are created by

masking portions of a conductive fabric layer and electro-depositing or electroplating a metal structure which contains abrasive material in isolated, unmasked spots.

U.S. 4,826,508 (Schwartz et al.) teaches a method of forming a flexible abrasive member which includes applying a flexible mask of non-electrically conductive material having a multitude of discrete openings therein to one side of a flexible fabric, placing the fabric with the mask applied in a metal deposition bath, and depositing metal directly in the discrete openings in the presence of particulate abrasive material such that the metal adheres directly to the fabric and the abrasive material becomes embedded in the metal deposits.

U.S. 4,047,902 (Wiand) discloses a method of manufacturing a metal-plated abrasive product which entails providing a conductive or metallic backing member, masking off predetermined desired surface portions thereof to leave exposed, spaced-apart portions on the backing, and bonding abrasive grit particles to the exposed portions. The bonding is carried out by a metal plating process.

U.S. 4,863,573 (Moore et al.) teaches a method of making an abrasive article by screen printing a non-conductive mesh with non-electrically conductive ink. The mesh is passed through an electroplating bath while in contact with an electrically conductive cylinder or metal band. A first, nearly complete thickness of metal is electrodeposited onto the non-printed areas of the mesh. Then abrasive particles are deposited on the metal and a second, outer layer of metal is electrodeposited onto the first thickness of metal. The abrasive particles thus are captured by the outer layer of metal and lie at the surface of the metal.

U.S. 4,874,478 (Ishak et al.) provides a method of making an abrasive member comprising attaching a metal film to one surface of a flexible sheet, applying a mask of plating resistant material having a multitude of discrete openings to the exposed surface of the film and depositing metal directly through the openings into the metal film in the presence of particulate abrasive so that the metal adheres to the film and embeds the abrasive in the metal deposits.

Each of the foregoing references relates to manufacture of flexible abrasive fabric or film. Although these abrasive articles might be laminated to supporting substrates to form coated abrasive products, they generally cannot be used by themselves in many industrial grinding applications. Fabric or film-borne abrasive tools will not hold up in aggressive

grinding of construction materials, such as steel and concrete. Additionally, each referenced method employs electro-deposition or electroplating to attach the abrasive to the fabric. Such methods of attachment do not usually provide sufficient thickness of bond material to endure in demanding, industrial grinding applications.

Other approaches to incorporating open space in an abrasive matrix have been disclosed. U.S. 4,882,878 (Benner) describes a grinding wheel having a rigid, continuous abrasive-bearing matrix. The matrix has a plurality of spaced apertures extending into the wheel from the grinding surface. Preferably the matrix is of an organic binding material.

International Patent Application WO 96/26811 (Ferronato) discloses a flexible abrasive member having a backing layer on one side and deposits of abrasive particles and bonding material on the other side. The article further includes a permanent one way mold substantially encircling the deposits and extending along at least part of the height of the deposits. The deposits are placed in holes of the flexible abrasive member.

U.S. 5,152,917 (Pieper et al.) teaches the method of making a structured, coated abrasive article comprising a backing bearing a plurality of abrasive composites having precise shape and disposed in a non-random array. The method includes introducing a slurry of binder precursor and abrasive grains into cavities on the outer surface of a production tool. A backing is placed over the outer surface such that the slurry wets one major surface of the backing to form an intermediate article. The binder precursor is then cured before the intermediate article departs from the outer surface of the production tool. The binder precursor is a quick setting, curable or thermoplastic organic resin.

The prior art does not satisfy the need for a metal preform abrasive tool for aggressive grinding applications in which discretely spaced apart abrasive elements are strongly attached to the preform with a brazeable metal bonding composition. Accordingly, there is provided a process for making an abrasive tool comprising the steps of:

(A) providing a stencil having a plurality of perforations of selected shape;

(B) contacting a cutting surface on the abrasive tool with the stencil whereby the perforations define cavities adjacent the cutting surface;

(C) providing a brazing paste including a metal braze composition and a binder component;

(D) filling the cavities with brazing paste;

(E) removing the stencil to form parcels of brazing paste on the cutting surface, each parcel being separated from neighboring parcels by paste-free channels;

(F) depositing abrasive grains onto the parcels; and

(G) thermally processing the abrasive tool to braze the abrasive grains to the cutting surface.

In another aspect, the present invention provides a process for making a metal preform abrasive tool in which selectively shaped and spaced apart parcels of brazing paste are first formed on a transfer medium. The brazing paste parcels are then transferred to the cutting surface of a metal preform where abrasive grains are added and brazing is accomplished. This method facilitates the manufacture of riddly-shaped and curved cutting surface abrasive tools. There is thus provided a process for making an abrasive tool comprising the steps of:

(A) providing a stencil having a plurality of perforations of selected shape;

(B) contacting a transfer medium with the stencil whereby the perforations define cavities adjacent the transfer medium;

(C) providing a brazing paste including a braze composition and a binder component;

(D) filling the cavities with brazing paste;

(E) removing the stencil to form a patterned face of parcels of brazing paste on the transfer medium, each parcel being separated from neighboring parcels by paste-free channels;

(F) forcing the patterned face against a cutting surface of the abrasive tool;

(G) peeling the transfer medium away to leave the parcels on the cutting surface;

(H) depositing abrasive grains onto the parcels; and

(I) thermally processing the abrasive tool to braze the abrasive grains to the cutting surface.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view of a mask for creating a stencil useful in the practice of the present invention.

DETAILED DESCRIPTION

The present invention is useful for fabricating abrasive tools in which abrasive grains are metal-bonded onto metal, primarily ferrous metal, preforms. The method can be used with a diverse variety of preform shapes. Representative preforms include flat disks, drill bit cores, abrasive wheel rims, saw blades and many specialty tool bodies, such as spherical, conical, and frustoconical-shaped preforms. The abrasive tools made according to this invention thus will be rugged and suitable for demanding industrial and construction material grinding and cutting applications.

The abrasive grains will be of a substance that is harder than the substance being cut. Very hard abrasive substances generally known as superabrasives, such as diamond, cubic boron nitride and mixtures of them can be used. Among these, diamond is preferred, primarily for cutting nonferrous materials. Many non-superabrasive substances also can be employed. Representative non-superabrasives which can be used in this invention include aluminum oxide, silicon carbide, tungsten carbide, and the like. Aluminum oxide encompasses standard alumina abrasive as well as seeded and unseeded sol-gel microcrystalline alumina, described in greater detail, below.

A preferred non-superabrasive is a microcrystalline alumina. Also preferred are the sol-gel alumina filamentary abrasive particles described in U.S. Pat. Nos. 5,194,072 and 5,201,916, incorporated herein by reference. "Microcrystalline alumina" means sintered sol-gel alumina in which the crystals of alpha alumina are of a basically uniform size which is generally smaller than about 10 μm, and more preferably less than about 5 μm, and most preferably less than about 1 μm in diameter. Crystals are areas of essentially uniform crystallographic orientation separated from contiguous crystals by high angle grain boundaries.

Sol-gel alumina abrasives are conventionally produced by drying a sol or gel of an alpha alumina precursor which is usually but not essentially, boehmite; forming the dried gel into particles of the desired size and shape; then firing the pieces to a temperature sufficiently high to convert them to the alpha alumina form. Simple sol-gel processes for making grain suitable for use in accordance with the present invention are described, for example, in U.S. Patent Nos. 4,314,827; 4,518,397 and 5,132,789 ; and British Patent Application 2,099,012, the disclosures of which are incorporated herein by reference.

In one form of sol-gel process, the alpha alumina precursor is "seeded" with a material having the same crystal structure as, and lattice parameters as close as possible to, those of alpha alumina itself. The "seed" is added in as finely divided form as possible and is dispersed uniformly throughout the sol or gel. It can be added *ab initio* or it can be formed *in situ*. The function of the seed is to cause the transformation to the alpha form to occur uniformly throughout the precursor at a much lower temperature than is needed in the absence of the seed. This process produces a crystalline structure in which the individual crystals of alpha alumina are very uniform in size and are essentially all sub-micron in diameter. Suitable seeds include alpha alumina itself but also other compounds such as alpha ferric oxide, chromium suboxide, nickel titanate and a plurality of other compounds that have lattice parameters sufficiently similar to those of alpha alumina to be effective to cause the generation of alpha alumina from a precursor at a temperature below that at which the conversion normally occurs in the absence of such seed. Examples of such seeded sol-gel processes are described in U.S. Patent Nos. 4,623,364; 4,744,802; 4,788,167; 4,881,971; 4,954,462; 4,964,883; 5,192,339; 5,215,551; 5,219,806; and 5,453,104, the disclosures of which are incorporated herein by reference, and many others.

Preferably the abrasive grains are attached to the metal preform by a bond containing metal. The bond is formed from a metal braze composition which is thermally treated according to a conventional, high temperature brazing process. Metal braze compositions for uniting abrasive to a metal tool preform are well known. Illustrative metal braze compositions include silver, nickel, zinc, lead, copper, tin and mixtures of these metals alloyed with other metals, such as phosphorous, cadmium, vanadium and the like. Generally minor amounts of additional components can be included in the braze composition to modify the properties of the bond during and after brazing, such as to modify melting temperature, melt viscosity, abrasive surface wetting and bond strength. Copper/tin bronze-based alloys are preferred for bonding abrasives, especially superabrasives to metal. Certain so-called "active metals" or "reactive metals" including titanium, tantalum, chromium,
and zirconium, for example, can be added to the braze composition particularly for bonding diamond. These metals react with the carbon to form carbides and thereby improve the wetting of the braze composition on the superabrasive particle. Hybrid bond

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material such as a metal filled resinoid braze composition containing a major fraction of metal can also be used with the present invention.

Brazing is performed at elevated temperatures selected with consideration to numerous system parameters such as solidus-liquidus temperature range of the metal brazing composition, geometry and material of construction of the preform and physical properties of the abrasive. For example, diamond can graphitize at temperatures above about 1000°C in air and above about 1200°C under vacuum or inert atmosphere. Hence, it is often desirable to braze at the lowest possible temperatures. The metal brazing composition should be selected to braze preferably at about 800-1025°C, and more preferably, at about 850-950°C.

The metal braze composition is usually employed in fine particulate form. The components of the metal braze composition can be present as prealloyed particles, as a mixture of separate component powders or a combination of both forms. The metal braze composition can be conveniently delivered to the braze site in paste form by mixing a liquid binder with the dry particulate components. The liquid binder facilitates blending of the dry particulate components to uniform composition and provides a vehicle for dispensing precise amounts of metal braze composition.

The liquid binder should be sufficiently volatile to evaporate or pyrolize below the melting temperature of the metal braze composition so as not to interfere with the formation of a secure bond between abrasive and preform. However, the volatility should not be so great that the paste dries too quickly. The paste should remain fluid for a reasonable time to permit assembly of the abrasive tool. Preferably, the paste should be fluid for at least several minutes and up to about an hour at ambient temperature and humidity conditions. Liquid binders are well known in the industry. Representative paste-forming binders suitable for use in the present invention include Braz™-Binder Gel from Vitta Company; "S" binder from Wall Colmonoy Corporation, Madison Heights, Michigan; and Cusil-ABA, Cusin-ABA, and Incusil-ABA pastes from Wesgo, Belmont, California. Active metal braze composition pastes including binder premixed with metal braze composition components can be obtained from Lucas-Milhaupt Company, Cudahy, Wisconsin under the Lucanex ™ tradename, such as Lucanex 721.

The present invention uses a stencil to place abrasive parcels in a pattern on the abrasive tool. Generally, the stencil is a flat sheet structure. The sheet can be flexible

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which permits it to conform to a curved cutting surface and to be rolled up for storage or for deployment in an endless belt configuration.

The stencil material should be capable of being perforated with a plurality of precisely positioned, selectively shaped holes. Perforating can be done by any well known technique, such as stamping with a die, photoetching, drilling and cutting. Stainless steel sheet can be reused repeatedly, is wear resistant, is generally not affected by a wide range of chemicals, and therefore, is a preferred stencil material. For one-time or limited reuse stencils, disposable material, such as plastic film and fiberboard sheeting, also is contemplated to fall within the scope of this invention.

The perforations will extend completely through the stencil. Shape and placement of the perforations determine the size and location of abrasive parcels on the tool. Any regular or non-regular geometric, area-enclosing shape can be employed. Uncut regions of the stencil correspond to open channels on the tool between abrasive parcels.

In use, one side of the stencil is brought in contact with the tool preform adjacent the cutting surface. The other side of the stencil remains exposed. The interior walls of the perforations and the cutting surface within the perimeters of the perforations define vacant cavities. On the exposed side of the stencils, the cavities are open.

The cavities are filled with brazing paste. Filling preferably is accomplished by forcing the paste into the cavities with a squeegee-like tool. That is, a thick bead of brazing paste is dispensed on the exposed side of the stencil, generally at one end of the cutting surface. The bead length extends slightly beyond the width of the cutting surface. A straight edged blade longer than the bead length is drawn with slight pressure from behind the bead across the exposed side of the stencil. The blade forces the paste into the cavities and removes the excess paste above the cavities flush with the exposed side of the stencil. The blade also wipes away excess paste from the exposed side of the stencil for reuse or disposal.

It is seen that the thickness of the stencil sheet will determine the height of the abrasive parcels on the tool. The thickness can vary widely to suit the needs of a particular grinding application. Generally, the thickness will be about equal to the maximum cross section dimension of the abrasive particles, although a different thickness can be used, especially if the binder concentration of the brazing paste varies outside the range of about 20-25 wt%. One can also appreciate that the size of the metal braze

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composition particles should be small enough to form a smooth paste that will flow into the cavities. Particle size of 325 U.S. standard mesh or smaller, *i.e.*, at most 44 μm, is generally suitable.

The stencil is peeled away from the cutting surface. The parcels of brazing paste remain stuck to the cutting surface. Thus the brazing paste is disposed on the cutting surface in discrete islands separated from neighboring parcels by paste-free channels.

In one aspect, abrasive grains are deposited onto the still soft parcels of abrasive paste. Grains can be placed individually or dusted over the whole surface. In an embodiment, abrasive grains are at least about 100 μm and only one abrasive grain is deposited onto each of most parcels. A feeding apparatus can be used to facilitate individual placement of a single abrasive grain in each parcel of paste. Such feeding apparatus also advantageously may orient grain placement to optimize exposure of each grain's cutting facet relative to the workpiece. The fabricator thus can control the tool at the individual grain level to provide maximum cutting speed, minimum energy consumption, minimum grain fracture, or combinations of these parameters. The metal brazing composition will liquefy during brazing. Consequently, it may be necessary to provide means to preserve the orientation of individually placed grains until a permanent bond is formed at the conclusion of brazing. For example, this may be achieved by utilizing a stencil or feeding apparatus of a thermally stable composition, such as graphite or ceramic. The thermally stable stencil or feeding apparatus may be left in place during all or part of the brazing step.

In another embodiment the abrasive grains have a particle size of at most 10 μm. Preferably, the small grains are dusted onto the cutting surface to embed the grains in the parcels. Excess grains which dust into the paste-free channels are not embedded in the parcels. They can be removed by inverting the preform, by vacuum, by blowing with gas jets or like procedures. After removing excess grains, loosely embedded grains can be further buried in the parcels of paste. The grains can be deeply planted by placing a flexible release film over the parcel-populated cutting surface and applying pressure with a manual or automated roller, for example.

In yet another embodiment, the abrasive grains are premixed with the brazing paste prior to filling the cavities. The premixed grains should be smaller than the cross section

dimension of the perforations to permit the grains to enter the cavities. Preferably the premixed grains should be smaller than 75% of the stencil thickness.

Premixing of small grains with the paste can provide a uniform concentration throughout the paste. This technique will embed grains over the complete depth of the parcel. Moreover, the small grains can impart self-sharpening behavior to the premixed parcels. That is, each parcel on the tool will constitute a plurality of abrasive grains bonded within a matrix of metallic braze. Such parcels tend to wear by dislodging the most exposed abrasive grains. This will expose underlying fresh, sharp grains to continue grinding. Consequently, tools fabricated in this manner generally provide consistent, superior grinding performance as the parcels wear away over time in service.

Once the abrasive grains are embedded in the parcels of brazing paste, the preform can be fired by traditional methods. A brazing treatment causes the residual liquid binder to dissipate or burn off at intermediate temperature. At high temperature the metal braze composition components permanently unite the abrasive grains to the preform. Control of the thermal cycle variables permits the braze composition components to sinter without significantly changing the shape or placement of the parcels. One of ordinary skill in the art can select appropriate brazing time and temperature parameter to optimize parcel shape retention.

It is sometimes desirable to create a patterned abrasive on a tool exhibiting non-planar or extreme surface curvatures. Deployment of a stencil directly against such a cutting surface may be problematic. In another aspect of this invention, this problem is solved by forming parcels of brazing paste on a transfer medium, and subsequently transferring the parcels to the cutting surface of a metal preform. The transfer medium can be a resilient, rubbery pad that is capable of conforming to the shape of the preform cutting surface. The operative face of the transfer medium preferably has a closed cell, smooth surface structure to facilitate transfer of paste parcels.

According to this variation of the invention, a stencil is provided with a plurality of perforations. Each perforation has a precise shape and is placed apart from neighboring perforations. One side of the stencil is brought in contact with a generally flat sheet of transfer medium while the other side of the stencil remains exposed. The interior walls of the perforations and the transfer medium within the perimeters of the perforations define vacant cavities. On the exposed side of the stencils, the cavities are open.

The cavities are filled with brazing paste. Filling preferably is accomplished by forcing the paste into the cavities, as explained above. The stencil is peeled away leaving the parcels of brazing paste stuck to the transfer medium. The parcel-bearing side of the transfer medium is pressed against the cutting surface of a tool preform. This can be accomplished to some advantage by first placing the parcel-free side of the transfer medium on a stable working surface, such as a table top or similar holding structure. The parcel-bearing side of the medium is held stationary and exposed. Then the cutting surface of the preform is forced against the stationary transfer medium. The parcels transfer to the cutting surface. Thereafter, abrasive particles can be added and the tool can be fired to permanently attach the abrasives.

EXAMPLES

EXAMPLE 1

The example can be better understood with reference to Fig. 1. Mask the surface of a 15 inch long by 15 inch wide by 0.010 inch thick stainless steel sheet with a U.V. impenetrable coating. The mask 1 is a continuous network 2 with exposed regular hexagonal areas 4 of 0.115 inches length on each side 6 and center-to-center distance 8 of 0.32 inches. The gap 10 between neighboring hexagons is 0.12 inches. Photoetch the sheet to open hexagonal perforations at the exposed areas and remove the mask.

Mount the perforated stainless steel stencil to a sturdy, rigid rectangular frame to maintain flatness. Place a 0.030 inch thick, 9.875 inch diameter, flat, circular steel preform for an abrasive disk on a table with the cutting surface facing up. Align the stencil centrally over the disk and clamp the frame to the preform so that the face of the disk contacts one side of the stencil. Maintain the exposed side of the stencil facing up in a horizontal plane.

Dispense an approximately 0.5 inch diameter, 12 inch long bead of Lucanex™ 721 braze paste just inside one edge of the rectangular frame. Use a 14 inch long, hard rubber squeegee, to draw the bead in a steady speed stroke across the exposed face of the stencil with slight downward pressure and to force the braze paste into the hexagonal cross-section cavities to a depth flush with the exposed surface of the stencil, *i.e.*, approximately 0.010 inch. Use only a single pass to prevent braze paste from bleeding under the stencil between perforations.

Unclamp the frame from the preform and lift the stencil vertically away from the disk face. Sprinkle 120/140 U.S. mesh type PDA 989 diamond abrasive grains from DAC Company, New York, New York to evenly dust grains over the disk face. Lift the preform from the table and invert to drop excess abrasive grains into a collection pan. Place the abrasive bearing preform cutting surface side up on a horizontal work surface. Align a 0.25 inch thick, 14 inch diameter circular rigid acrylic plastic sheet to overlay the preform and push down evenly to embed the abrasive grains into the braze paste parcels.

Remove the acrylic sheet and fire the preform in a vacuum furnace at about 15°C per minute to a maximum temperature of about 900°C, while maintaining pressure within the furnace below 10^{-4} Torr. Hold the preform at 900°C for 10 minutes and allow to cool to room temperature. This example demonstrates the manufacture of a flat, single diamond layer metal abrasive disk.

EXAMPLE 2

Drill 2.0 mm diameter circular holes on 5 mm centers in a 60° isometric pattern through a 0.2 inch thick by 12 inch wide by 12 inch long stainless steel sheet to form a stencil. Mount the stencil in a sturdy, rigid frame to maintain stencil flatness. Align the stencil over a 1 inch thick by 12 inch wide by 12 inch long pad of smooth-faced urethane rubber. Bring the stencil and rubber pad in laminating contact. Maintain the exposed side of the stencil facing up in a horizontal plane.

Dispense an approximately 0.5 inch diameter, 12 inch long bead of Incusil™ ABA braze paste along one edge of the stencil. Use a 14 inch long, hard rubber squeegee, to draw the bead in a steady speed stroke across the exposed face of the stencil with slight downward pressure and to force the braze paste into the cylindrical cavities to a depth flush with the exposed surface of the stencil, *i.e.*, approximately 0.2 inch. Use only a single pass to prevent braze paste from bleeding under the stencil between perforations.

Lift the stencil vertically away from the face of the rubber pad. Sprinkle a 50/50 vol/vol mixture of 60/80 U.S. mesh diamond and cubic boron nitride abrasive grains from General Electric Company, Columbus, Ohio to evenly dust grains over the rubber pad. Lift the pad from the table and invert to drop excess abrasive grains into a collection pan. Replace the pad with abrasive/paste side up on a horizontal work surface.

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Place a spherical steel preform firmly in a manual jig to expose the convex cutting surface of the preform. Press the preform vertically downward against the pad. Apply a slight rolling motion to the sphere to evenly transfer the parcels of abrasive laden brazing paste onto the cutting surface of the preform. Remove the manual jig and fire the preform as in Example 1. This example demonstrates the manufacture of an abrasive tool with a transfer medium according to the present invention. The abrasive tool is useful for grinding concave ball joints.

What is claimed is

1.A process for making an abrasive tool comprising the steps of:

(A) providing a stencil having a plurality of perforations of selected shape;

(B) contacting a cutting surface on the abrasive tool with the stencil whereby the perforations define cavities adjacent the cutting surface;

(C) providing a brazing paste including a metal braze composition and a binder component;

(D) filling the cavities with brazing paste;

(E) removing the stencil to form parcels of brazing paste on the cutting surface, each parcel being separated from neighboring parcels by paste-free channels;

(F) depositing abrasive grains onto the parcels; and

(G) thermally processing the abrasive tool to braze the abrasive grains to the cutting surface.

2. The invention of claim 1 wherein the filling step includes forcing the brazing paste into the cavities with a straight-edged blade.

3. The invention of claim 2 wherein the abrasive grains are mixed with the brazing paste prior to filling the cavities.

4. The invention of claim 3 wherein the abrasive grains have a particle size of at most 10 μm.

5. The invention of claim 2 wherein the depositing step includes:

(i) dusting grains onto the cutting surface to embed grains into the parcels; and

(ii) removing non-embedded grains.

6. The invention of claim 5 wherein the depositing step further includes pressing the embedded grains into the parcels.

7. The invention of claim 1 wherein the abrasive grains have a particle size of at least about 100 μm and only one abrasive grain is deposited onto each of most parcels.

8. A process for making an abrasive tool comprising the steps of:

(A) providing a stencil having a plurality of perforations of selected shape;

(B) contacting a transfer medium with the stencil whereby the perforations define cavities adjacent the transfer medium;

(C) providing a brazing paste including a braze composition and a binder component;

(D) filling the cavities with brazing paste;

(E) removing the stencil to form a patterned face of parcels of brazing paste on the transfer medium, each parcel being separated from neighboring parcels by paste-free channels;

(F) forcing the patterned face against a cutting surface of the abrasive tool;

(G) peeling the transfer medium away to leave the parcels on the cutting surface;

(H) depositing abrasive grains onto the parcels; and

(I) thermally processing the abrasive tool to braze the abrasive grains to the cutting surface.

9. The invention of claim 8 wherein the filling step includes forcing the brazing paste into the cavities with a straight-edged blade.

10. The invention of claim 9 wherein the abrasive grains are mixed with the brazing paste prior to filling the cavities.

11. The invention of claim 10 wherein the abrasive grains have a particle size of at most 10 μm.

12. The invention of claim 9 wherein the depositing step includes:

(i) dusting grains onto the cutting surface to embed grains into the parcels; and

(ii) removing non-embedded grains.

13. The invention of claim 12 wherein the depositing step further includes pressing the embedded grains into the parcels.

14. The invention of claim 8 wherein the abrasive grains have a particle size of at least about 100 μm and only one abrasive grain is deposited onto each of most parcels.

15. The invention of claim 8 wherein the cutting surface is a three dimensional, curvilinear surface and the transfer medium is a flexible, resilient pad.

16. An abrasive tool fabricated by a process comprising the steps of:

(A) providing a stencil having a plurality of perforations of selected shape;

(B) contacting a cutting surface on the abrasive tool with the stencil whereby the perforations define cavities adjacent the cutting surface;

(C) providing a brazing paste including a braze composition and a binder component;

(D) filling the cavities with brazing paste;

(E) removing the stencil to form parcels of brazing paste on the cutting surface, each parcel being separated from neighboring parcels by paste-free channels;

(F) depositing abrasive grains onto the parcels; and

(G) thermally processing the abrasive tool to braze the abrasive grains to the cutting surface.

17. An abrasive tool fabricated by a process comprising the steps of:

(A) providing a stencil having a plurality of perforations of selected shape;

(B) contacting a transfer medium with the stencil whereby the perforations define cavities adjacent the transfer medium;

(C) providing a brazing paste including a braze composition and a binder component;

(D) filling the cavities with brazing paste;

(E) removing the stencil to form a patterned face of parcels of brazing paste on the transfer medium, each parcel being separated from neighboring parcels by paste-free channels;

(F) forcing the patterned face against a cutting surface of the abrasive tool;

(G) peeling the transfer medium away to leave the parcels on the cutting surface;

(H) depositing abrasive grains onto the parcels; and

(I) thermally processing the abrasive tool to braze the abrasive grains to the cutting surface.

18. The invention of claim 17 wherein the cutting surface includes a convex, spherical portion.

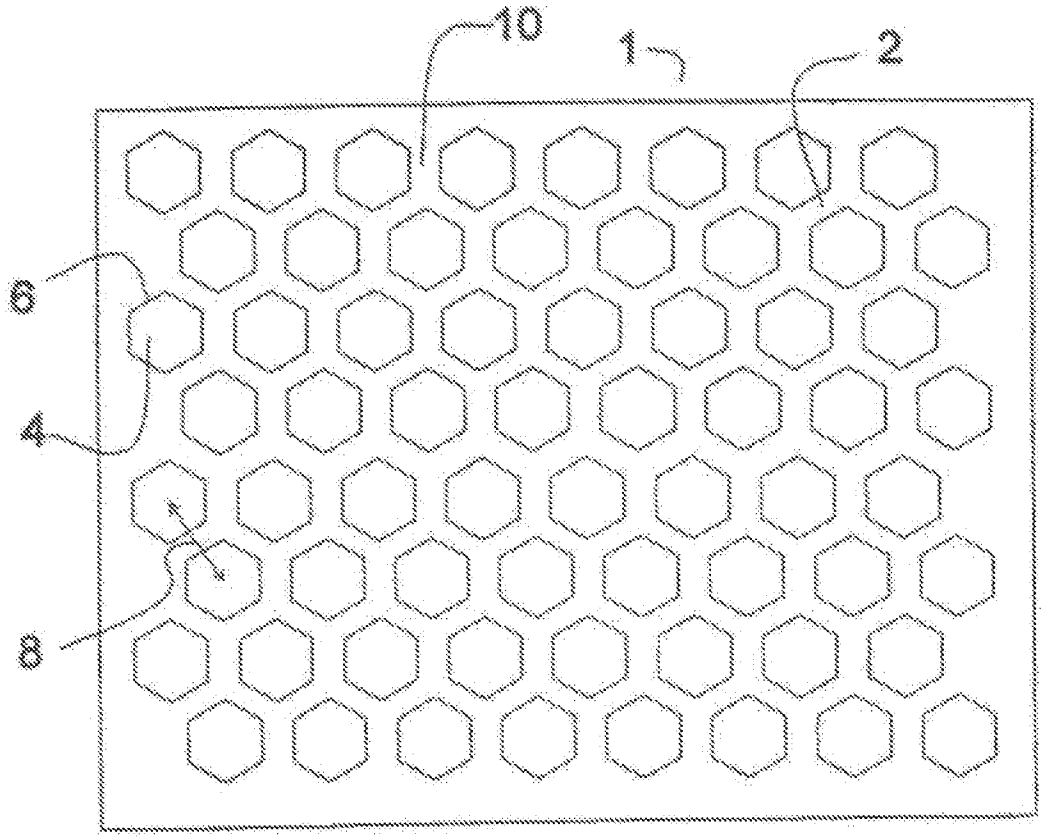


FIG. 1

INTERNATIONAL SEARCH REPORT

Inter national Application No
PCT/US 98/05537

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B24B11/00 B24B19/00

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 6 B24D

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 380 390 A (TSELESIN NAUM H) 10 January 1995	1,16
A	see column 3, line 13 - column 5, line 6; figures 1-4	8,17
A	US 3 774 355 A (DAWSON C ET AL) 27 November 1973 see column 2, line 32 - line 58; figures 1-6,11	1,8,16, 17
A	US 4 010 583 A (HIGHBERG CARLE W) 8 March 1977 see column 8, line 38 - line 63; figures 4-6	1,16
A	US 5 219 462 A (BRUXVOORT WESLEY J ET AL) 15 June 1993 see column 3, line 62 - line 68; figure 2	2,3,9,10

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in 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 document 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 another 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	Date of mailing of the international search report
24 June 1998	02/07/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Eschbach, O

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter national Application No
PCT/US 98/05537

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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MANUFACTURE OF DIAMOND CUTTER AND DIAMOND CUTTER AND DIAMOND CUTTER MANUFACTURING JIG

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Classification: - **international:*B24D3/00; B24D5/12;*** (IPC1-7): B24D3/00; B24D3/00; B24D5/12
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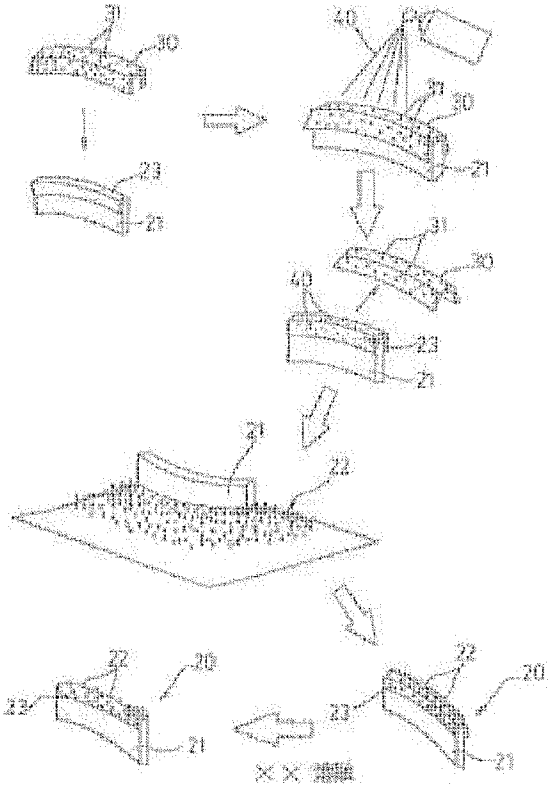
Priority number (s): JP19980301722 19981009

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Abstract of JP2000167774 (A)

PROBLEM TO BE SOLVED: To increase fixation strength of diamond particles to prevent diamond particles from falling out by fixing diamond particles forming a diamond layer on the diamond layer at a predetermined interval mutually. SOLUTION: A manufacturing method of a diamond cutter includes a bond paste fixation process in which bond (registered trademark) paste in which binder and bond powders are blended is attached on a substrate, a screen covering process in which a screen 30 in which holes are drilled to a desired manner after the bond paste fixation process is covered in a bond paste fixation scope, an application process in which viscous substance 40 is applied from above the screen 30 on which the bond paste is covered, a screen removing process in which the screen 30 is removed after the application process,; and a diamond abrasive grain adhesion process in which diamond abrasive grains 22 come into contact with a bond paste face on which the viscous substance 40 adheres from a hole drilled part 31 of the screen 30 to form the substrate and the diamond layer integrally with each other by melting the bond after binder removing treatment.

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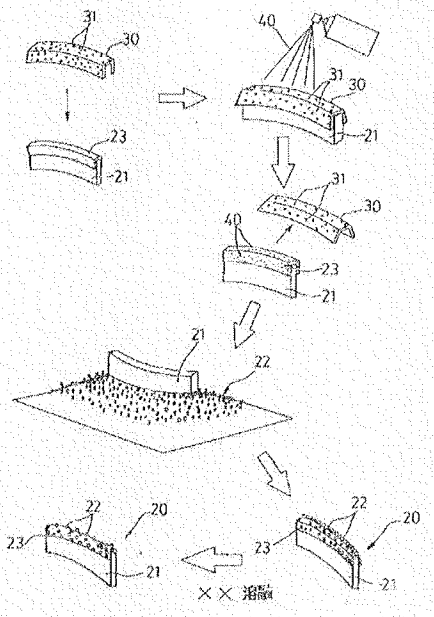
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(54)【発明の名称】　ダイヤモンドカッターの製造方法及びダイヤモンドカッター並びにダイヤモンドカッター製造治具

(57)【要約】

【課題】　本発明の目的はダイヤモンド層を形成するダイヤモンド粒子が互いに所定間隔をもってダイヤモンド層に固着され、ダイヤモンド粒子の固着強度を高めてダイヤモンド粒子の脱落を防止できるダイヤモンドカッターの製造方法及びダイヤモンドカッター並びにダイヤモンドカッター製造治具を提供する。

【解決手段】　ダイヤモンドカッターＣの製造方法は、基板１０にバインダとボンド粉とを混練したボンド（登録商標）ペーストを取着させるボンドペースト取着工程と、ボンドペースト取着工程の後で所望に穿孔されたスクリーン３０をボンドペースト取着範囲に被覆するスクリーン被覆工程と、ボンドペーストを被覆したスクリーン３０上から粘性物質４０を塗布する塗布工程と、塗布工程の後でスクリーン３０を取り除くスクリーン除去工程と、スクリーン３０の穿孔部分３１から粘性物質４０が付着したボンドペースト面にダイヤモンド砥粒２２を接触させるダイヤモンド砥粒付着工程と、脱バインダ処理後ボンドを溶融させることによって基板１０とダイヤモンド層を一体に形成する。



【特許請求の範囲】
【請求項１】　取付部が形成された基板と、該基板の外周端面に取着されたダイヤモンド層と、を備えたダイヤモンドカッターの製造方法において、前記基板にバインダとボンド粉とを混練したボンドペーストを取着させるボンドペースト取着工程と、該ボンドペースト取着工程の後で所望に穿孔されたスクリーンを前記ボンドペースト取着範囲に被覆するスクリーン被覆工程と、前記ボンドペーストを被覆したスクリーン上から粘性物質を塗布する塗布工程と、該塗布工程の後で前記スクリーンを取り除くスクリーン除去工程と、前記スクリーンの穿孔部分から粘性物質が付着した前記ボンドペースト面にダイヤモンド砥粒を接触させるダイヤモンド砥粒付着工程と、脱バインダ処理後前記ボンドを溶融させることによって基板とダイヤモンド層を一体に形成してなることを特徴とするダイヤモンドカッターの製造方法。
【請求項２】　取付部が形成された基板と、該基板の外周端面に取着されたダイヤモンド層と、を備えたダイヤモンドカッターであって、前記ダイヤモンド層はボンド材料により所定間隔でダイヤモンド砥粒が配列されて前記基板に固定されていることを特徴とするダイヤモンドカッター。
【請求項３】　取付部が形成された基板と、該基板の外周端面に取着されたダイヤモンド層と、を備えたダイヤモンドカッターの製造過程で用いられるダイヤモンドカッター製造治具であって、ダイヤモンド層となる部分を被覆するカバー部材と、該カバー部材に所望間隔で形成された多数の小孔とから形成されていることを特徴とするダイヤモンドカッター製造治具。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明はダイヤモンドカッターの製造方法及びダイヤモンドカッター並びにダイヤモンドカッター製造治具に係り、特に石材、コンクリートなどの切断に用いるのに好適なダイヤモンドカッターの製造方法及びダイヤモンドカッター並びにダイヤモンドカッター製造治具に関するものである。
【０００２】
【従来の技術】従来、取り付け部を有する基板の外周にダイヤモンド層が形成されたダイヤモンドカッターは公知である。そして、このようなダイヤモンドカッターとしては、例えば特公昭５５－２２１９４号公報で示されているように、「一時的な結合剤を使用して金属基材表面にダイヤモンド結晶とろう付け用合金の粒子を附着させて組立てたものを造る工程と、該組合せを還元性雰囲気または真空中で約１３００℃以下の温度迄に加熱してろう付け用合金を熔融する工程、該組合せを冷却して該ろう付け用合金を固化させダイヤモンドを基材に結合する工程よりなり、ここに該ろう付け用合金はニッケルおよびコバルトからなる群から選ばれた１種または２種の金属の少なくとも５０重量％、クロムの２～２６重量％、および硼素、珪素、燐より成る群より選ばれた１種または２種以上の元素の合計１２重量％以下よりなる、金属基材にダイヤモンド結晶を結合する」技術が知られている。
【０００３】また特開平９－２７２０６０号公報で示されているように、「化学的または物理的に表面処理された前記砥石刃取付部に、有機糊剤と結合材として自溶合金粉末の混合物を塗布し、その後乾燥させ、さらに有機糊剤を塗布し、砥粒を散布し、乾燥させ次いで、非酸化性雰囲気中において９００～１１５０°Ｃの加熱温度に加熱し、前記自溶合金の融着により前記砥石刃取付部に前記砥粒を固定し、前記加熱温度から徐々に冷却する」技術が知られている。
【０００４】上記従来技術では、基板等に取着させたボンドペーストにダイヤモンド砥粒を附着させるときに篩を利用したり、直接散布することにより、ダイヤモンド層を形成している。
【０００５】
【発明が解決しようとする課題】上述のように、ダイヤモンド砥粒を篩や散布することによっているため、ダイヤモンド層を形成するボンドペーストにダイヤモンド粒子が、一部分に団塊となって附着したり、ダイヤモンド粒子同士が隣接して結合することになり、ダイヤモンド粒子の固着が弱くなるという不都合があった。すなわち、このようにダイヤモンド粒子が団塊になったり、ダイヤモンド粒子が隣接した状態は、ダイヤモンド粒子を固定するためのボンドペーストが、ダイヤモンド粒子の周りに少ない状態となり、ダイヤモンド粒子の固着力の低下を意味するものである。
【０００６】本発明の目的は、ダイヤモンド層を形成するダイヤモンド粒子が互いに所定間隔をもってダイヤモンド層に固着され、ダイヤモンド粒子の固着強度を高めてダイヤモンド粒子の脱落を防止できるダイヤモンドカッターの製造方法及びダイヤモンドカッター並びにダイヤモンドカッター製造治具を提供することにある。
【０００７】
【課題を解決するための手段】上記課題は、請求項１のダイヤモンドカッターの製造方法によれば、取付部が形成された基板と、該基板の外周端面に取着されたダイヤモンド層と、を備えたダイヤモンドカッターの製造方法において、前記基板にバインダとボンド粉とを混練したボンドペーストを取着させるボンドペースト取着工程と、該ボンドペースト取着工程の後で所望に穿孔されたスクリーンを前記ボンドペースト取着範囲に被覆するスクリーン被覆工程と、前記ボンドペーストを被覆したスクリーン上から粘性物質を塗布する塗布工程と、該塗布工程の後で前記スクリーンを取り除くスクリーン除去工程と、前記スクリーンの穿孔部分から粘性物質が付着した前記ボンドペースト面にダイヤモンド砥粒を接触させ

るダイヤモンド砥粒付着工程と、脱バインダ処理後前記ボンドを溶融させることによって基板とダイヤモンド層を一体に形成してなる構成とすることにより、解決される。

【０００８】上記のように、ボンドペースト取着工程の後で所望に穿孔されたスクリーンを前記ボンドペースト取着範囲に被覆するスクリーン被覆工程と、前記ボンドペーストを被覆したスクリーン上から粘性物質を塗布する塗布工程を行なうことにより、ボンドペーストに塗布される粘性物質は、スクリーンを除去すると、スクリーンの小孔が形成された範囲だけとなる。したがって、スクリーンを除去した後でダイヤモンド砥粒を接触させると、ダイヤモンド粒子は、粘性物質が塗布された個所、すなわちスクリーンに形成された小孔の位置に付着することになる。このようにしてスクリーンに形成された小孔にしたがって、ダイヤモンド粒子を所定間隔で付着させたダイヤモンド層を形成することができる。

【０００９】また、上記課題は、請求項２に係るダイヤモンドカッターによれば、取付部が形成された基板と、該基板の外周端面に取着されたダイヤモンド層と、を備えたダイヤモンドカッターであって、前記ダイヤモンド層はボンドペーストにより所定間隔でダイヤモンド砥粒が配列されて前記基板に固定されている構成とすることにより、解決される。

【００１０】このようなダイヤモンド層はボンドペーストにより所定間隔でダイヤモンド砥粒が配列されて前記基板に固定されているダイヤモンドカッターによれば、ダイヤモンド粒子が所定間隔で配置されているために、ダイヤモンド粒子の固着強度が高まる。そして、ダイヤモンド層に均一にダイヤモンド粒子を配置して固着されているために、被切削材に対して均一な切り口となり、切削がスムーズに行なわれることになる。

【００１１】さらに、上記課題は、請求項３に係るダイヤモンドカッター製造治具によれば、取付部が形成された基板と、該基板の外周端面に取着されたダイヤモンド層と、を備えたダイヤモンドカッターの製造過程で用いられるダイヤモンドカッター製造治具であって、ダイヤモンド層となる部分を被覆するスクリーン部材と、該スクリーン部材に所望間隔で形成された多数の小孔とから形成されている構成とすることにより、解決される。

【００１２】このようなスクリーン部材によれば、スクリーン部材に形成する小孔の間隔や数を調整することにより、ダイヤモンド粒子を一定間隔で所望数配置することが可能となり、ダイヤモンドカッターにおけるダイヤモンド粒子の配置調整が可能となる。またダイヤモンド粒子が団塊になったり、隣接して配置されることがないために、各ダイヤモンド粒子が溶融ボンドによって確実に基板に固定できることになる。

【００１３】

【発明の実施の形態】ここでは、ダイヤモンドカッターとしてダイヤモンドチップを用いた例を示すが、これに限定されるものではなく、基板に直接ダイヤモンド層を形成してもよい。本発明のダイヤモンドカッターＣは、基板１０にダイヤモンドチップ２０を取着しており、このダイヤモンドチップは、基台にバインダペーストとボンド粉とを混練したボンドペーストを取着させ、ボンドペースト取着範囲に所望に穿孔されたスクリーンを被覆し、このスクリーン上から粘性物質を塗布し、塗布工程の後でスクリーンを取り除き、スクリーンの穿孔部分から粘性物質が付着したボンドペースト面にダイヤモンド砥粒を接触させ、脱バインダ処理後ボンドを溶融させることによって基板とダイヤモンド層を一体に形成することにより製造することが可能となる。

【００１４】以上のように、ダイヤモンド砥粒のばらつきがなく、均等に配置することが可能となり、ダイヤモンド層の全ての部分で切削が均等に行うことが可能となる。

【００１５】

【実施例】以下、本発明の一実施形態について、図を参照して説明する。なお、以下に説明する部材、配置等は、本発明を限定するものではなく、本発明の趣旨に沿って各種改変することができることは勿論である。

【００１６】図１乃至図６は本発明に係る実施例を示すものであり、図１はダイヤモンドカッターの一例としてダイヤモンドチップとして適用したときの製造工程を示す説明図、図２乃至図４は製造工程の拡大説明図、図５は製造工程のブロック図、図６はダイヤモンドカッターの一例を示す正面図である。また図７はダイヤモンドカッター製造治具としてのスクリーンの例を示す説明図である。

【００１７】本例のダイヤモンドカッターＣは、図６で示すように、基板１０と、ダイヤモンドチップ２０と、ダイヤモンド粒子（砥粒）２２と、を主要構成要素としており、ダイヤモンドチップ２０は、基台２１とダイヤモンド粒子（砥粒）２２とを固定するボンドペースト層２３から構成されている。そして上記円形基板１０の外周に、ダイヤモンド粒子（砥粒）２２が取着されたダイヤモンドチップ２０を焼結等により固着している。

【００１８】本例の基板１０は、鋼製であり、この鋼製基板１０は中心に取付孔１１が形成され、円形形状として形成されている。本例の基板１０は、冷間プレスで成形されている。また、本例の基板１０は、外周端面が同一円の面に形成され、所定間隔で冷却用溝等が形成されているものを用いている。このとき、基板１０の外周端面に若干の凹凸等が形成されている場合には、基台２１を基板外周端面と整合するような形状に成形する。しかし、外周端面に若干の凹凸等が形成されたり、溝を設けていないものを用いても良い。

【００１９】次に本発明に係るダイヤモンドカッターＣの製造方法について、図１乃至５を参照して説明する。

本発明のダイヤモンドカッターCは、基板１０にダイヤモンドチップ２０を取着しており、このダイヤモンドチップ２０は、基台２１にバインダペーストとボンド粉とを混練したボンドペースト２３を取着させ、ボンドペースト取着範囲に所望に穿孔されたスクリーン３０を被覆し、このスクリーン３０上から粘性物質４０を塗布し、塗布工程の後でスクリーン３０を取り除き、スクリーン３０の穿孔部分から粘性物質４０が付着したボンドペースト面にダイヤモンド砥粒２２を接触させ、少なくともボンドペースト２３中のバインダを除去した後、ダイヤモンド砥粒２２の周辺部分のボンドを溶融させて基板１０とダイヤモンド層を一体に形成することにより製造する。これをさらに詳細に説明する。

【００２０】はじめにペースト用バインダとボンド粉とを混練してボンドペースト２３を作成する。ボンドペースト２３を構成するペースト用バインダとボンド粉は、公知の材料を使用するものであり、本例で使用するボンドペースト２３としては、ダイヤとの化学的親和力の高いＴｉ、Ｃｒ等を含むボンドであり、ダイヤに対するボンドの濡れが良く、ダイヤ保持力がかなり強化されている。基台２１（基板１０）との接着力は、ボンドと基台２１（基板１０）が化学的に結合され、溶融に伴う拡散もあるので、接着力は比較的強固となる。具体的にはＣｕ－Ｓｎ－Ｔｉ系や、Ｎｉロウ系のボンドと、各種のバインダ用ペーストを用いてボンドペーストを形成している。

【００２１】本例で用いる粘性物質４０としては、例えば、市販の水溶性メチルセルロースを約３．３倍量の水で希釈した有機糊剤、その他糊材等の粘着のある物質を使用する。

【００２２】なお溶融のボンド合金化は９４０℃～９８０℃が適正温度範囲であり、ボンドとダイヤの濡れ具合が良好となる。また適正脱脂条件について説明すると、脱脂の昇温速度が速すぎると急激なバインダの分解ガスでボンドとダイヤの飛散が生じる。そこで、真空脱脂はバインダ熱分解温度まで５℃／ｍｉｎで昇温し２０ｍｉｎ保持の条件が有効である。使用金属粉としては、ブロンズ粉が溶融温度が低めで溶融状態が安定している。またＣｕＰの添加をすることにより、濡れ性を改善することができる。

【００２３】次に図１に示すように、上記混練されたペースト用バインダとボンド粉からなるボンドペースト２３を、ディスペンサなどの射出機や刷毛を使用して、ダイヤモンドチップ２０を構成する基台２１に塗布等により取着する。そして、次に述べるスクリーン３０を固着させないように、若干の所定時間を経過させて、乾燥させる。

【００２４】次いで、基台２１のボンドペースト２３の取着範囲にスクリーン３０を被覆する。本例のスクリーン３０は、断面コ字状の枠体であり、ボンドペースト２３が取着された基台端部に嵌合可能に形成されている。スクリーン３０はボンドペースト２３の取り付けを考慮して、基台２１より若干大き目で基台２１と略同形状に形成されている。そして、基台２１にスクリーン３０を被覆するように嵌合させる。

【００２５】なおスクリーン３０は基台端部を連続して被覆するように形成しても良く、或いは所定長さに形成し、この所定長さに形成された複数のスクリーン３０を用いて基台端部を被覆するように構成しても良い。スクリーン３０には、所望箇所に多数の小孔３１が穿孔されており、この小孔３１を介して、粘性物質４０が基台２１に塗布されるように構成されている。

【００２６】本例のスクリーン３０は、アルミ等の金属から形成されている。このようにスクリーン３０を金属製とすることにより、表面や小孔３１に付着した粘性物質４０を取り除いて再使用することが可能となり、低コスト化を実現するとともに、廃棄物を減少させて環境への影響を抑えることができる。またスクリーン３０を単一金属で形成することにより、リサイクルが可能となり資源の有効利用を図ることが可能となる。

【００２７】上記スクリーン３０の形状は、上記形状に限定されるものではなく、基台２１（基板１０）の端部形状に合わせて、各種形成するものである。例えば図７（ａ）に示すスクリーン３０は、端部側が薄く中心部に向けて厚みが増した形状の基台２１（基板１０）に用いられるものであり、図７（ｂ）に示すスクリーン３０は、端部がアール形状の基台２１（基板１０）に用いられるものである。さらに図７（ｃ）に示すスクリーン３０は端部側が薄く、且つ端部がアール形状の基台２１（基板１０）に用いられるものである。

【００２８】また、スクリーン３０は上記金属製に限らず、紙製或いは樹脂フィルム製とすることもできる。紙製や樹脂フィルム製のスクリーン３０とすれば、製造時において、各基台２１（基板１０）に常に新しいスクリーン３０を使用することが可能となり、生産効率の向上を図ることができる。

【００２９】そして基台２１に配設されたスクリーン３０に、粘性物質４０をディスペンサなどの射出機や刷毛を使用して塗布する。塗布された粘性物質４０は、スクリーン３０の小孔３１を介して基台２１に付着する。

【００３０】粘性物質４０を塗布後、基台２１からスクリーン３０を取り外す。スクリーン３０が取り外された基台２１表面には、図３に示すように、スクリーン３０の小孔３１と同様のパターンで粘性物質４０が付着している。

【００３１】次に基台２１にダイヤモンド砥粒２２を付着させる。ダイヤモンド砥粒２２としては通常４０～５０メッシュのダイヤモンド粒子を使用する。ダイヤモンド砥粒２２は、図１及び図３に示すように、予め作業台等の上に所定量が載せられており、このダイヤモンド砥

粒２２中に前記基台２１の粘性物質４０が付着した側を接触させ、基台２１にダイヤモンド砥粒２２を付着させる。

【００３２】次に基台２１にダイヤモンド砥粒２２を一体に形成するため、加熱炉の炉内にセットし、排気を行う。処理は、乾燥、昇温、減圧脱脂、溶融、炉冷（真空冷却）、取り出しの順で行なう。なお製造における加熱条件としては、温度１２０℃で乾燥し、５℃／ｍｉｎで昇温し、脱脂は、１８０℃２０ｍｉｎ保持～３８０℃２０ｍｉｎ保持で行なうと好適である。次に溶融について昇温を３０℃／ｍｉｎで行い、９００℃～１１００℃で１５ｍｉｎ保持する。次に、炉冷（真空冷却）を行なうが、約7℃／ｍｉｎで行なう。さらに外熱炉体移動を６００℃で行ない、その後取り出す。なお上記では、溶融接合時の炉内真空度１０－５～１０－６Ｔｏｒｒとしている。

【００３３】上記製造工程により、基台２１にダイヤモンド粒子を単一層に保持したダイヤモンドチップ２０を得ることができる。そしてこのダイヤモンドチップ２０を基板１０に取着してダイヤモンドカッターＣが形成される。なお上記実施例では複数の基台２１にダイヤモンド砥粒２２を取着させ、基台２１を基板１０に貼着した構成例を示したが、基板１０に直接ダイヤモンド砥粒２２を取着させた構成としても良い。またダイヤモンドカッターＣとしては、円形基板の外周にダイヤモンド層が形成されたダイヤモンドホイール、筒状の一方端面側にダイヤモンドチップを取りつけたコアビット、皿状のダイヤモンドカッター等各種形態のものとすることが可能である。

【００３４】上記各種形態のダイヤモンドカッターを製造するときも、スクリーンとしては、上記各ダイヤモンド層を形成する構成に合わせて、各種形成するものである。スクリーンの形状をダイヤモンドチップの形状に合わせて構成することにより、所望形状のダイヤモンド砥粒層を取着することができる。

【００３５】

【発明の効果】以上のように本発明に係るダイヤモンドカッターの製造方法によれば、ボンドペースト取着工程の後で所望に穿孔されたスクリーンを前記ボンドペースト取着範囲に被覆するスクリーン被覆工程と、前記ボンドペーストを被覆したスクリーン上から粘性物質を塗布する塗布工程を行なうことにより、ボンドペーストに塗布される粘性物質は、スクリーンを除去すると、スクリーンの小孔が形成された範囲だけとなる。したがって、スクリーンを除去した後でダイヤモンド砥粒を接触させると、ダイヤモンド粒子は、粘性物質が塗布された個所、すなわちスクリーンに形成された小孔の位置に付着することになる。このようにしてスクリーンに形成された小孔にしたがって、ダイヤモンド粒子を所定間隔で付着させたダイヤモンド層を形成することができる。

【００３６】また、本発明のダイヤモンドカッターによれば、ダイヤモンド粒子が所定間隔で配置されているために、ダイヤモンド粒子の固着強度が高まる。そして、ダイヤモンド層に均一にダイヤモンド粒子を配置して固着されているために、被切削材に対して均一な切り口となり、切削がスムーズに行なわれることになる。

【００３７】さらに、本発明のダイヤモンドカッター製造治具としてのスクリーン部材によれば、スクリーン部材に形成する小孔の間隔や数を調整することにより、ダイヤモンド粒子を一定間隔で所望数配置することが可能となり、ダイヤモンドカッターにおけるダイヤモンド粒子の配置調整が可能となる。またダイヤモンド粒子が団塊になったり、隣接して配置されることがないために、各ダイヤモンド粒子が溶融ボンドによって確実に基板に固定できることになる。

【図面の簡単な説明】

【図１】本発明をダイヤモンドカッターの一例としてダイヤモンドチップとして適用したときの製造工程を示す説明図である。

【図２】図１の製造工程の拡大説明図である。

【図３】図１の製造工程の拡大説明図である。

【図４】図１の製造工程の拡大説明図である。

【図５】製造工程のブロック図である。

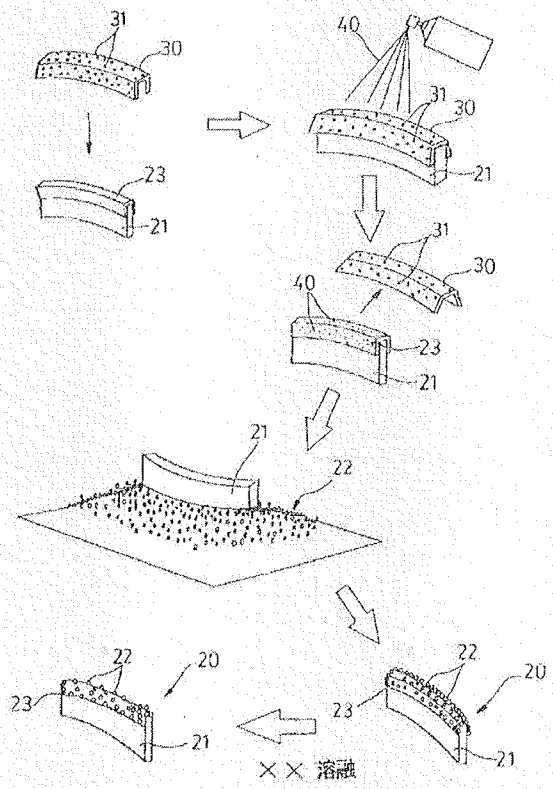
【図６】ダイヤモンドカッターの一例を示す正面図である。

【図７】ダイヤモンドカッター製造治具としてのスクリーンの例を示す説明図である。

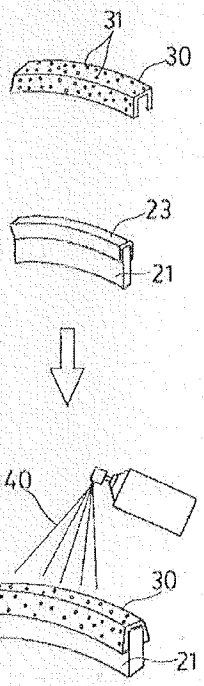
【符号の説明】

１０　基板
１１　取付孔
２０　ダイヤモンドチップ
２１　基台
２２　ダイヤモンド砥粒
２３　ボンドペースト
３０　スクリーン
３１　小孔
４０　粘性物質
Ｃ　ダイヤモンドカッター

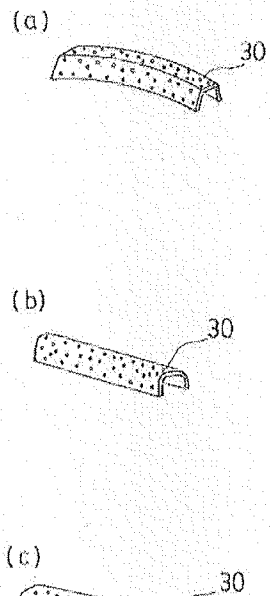
【図1】


31
30
40
23
21
22
20
××溶融

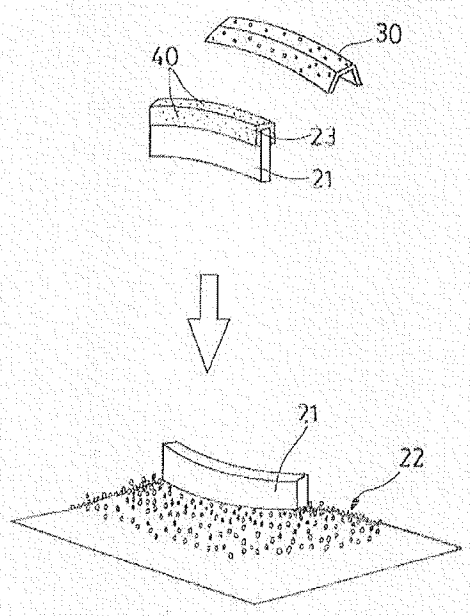
【図2】


31
30
23
21
40

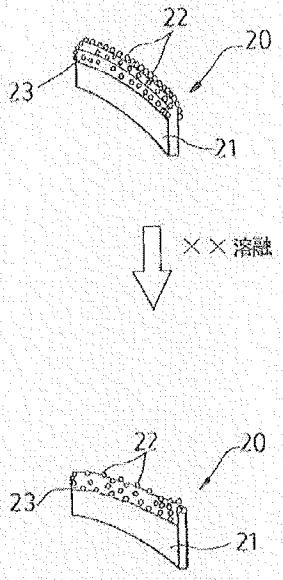
【図7】


(a)
30
(b)
30
(c)
30

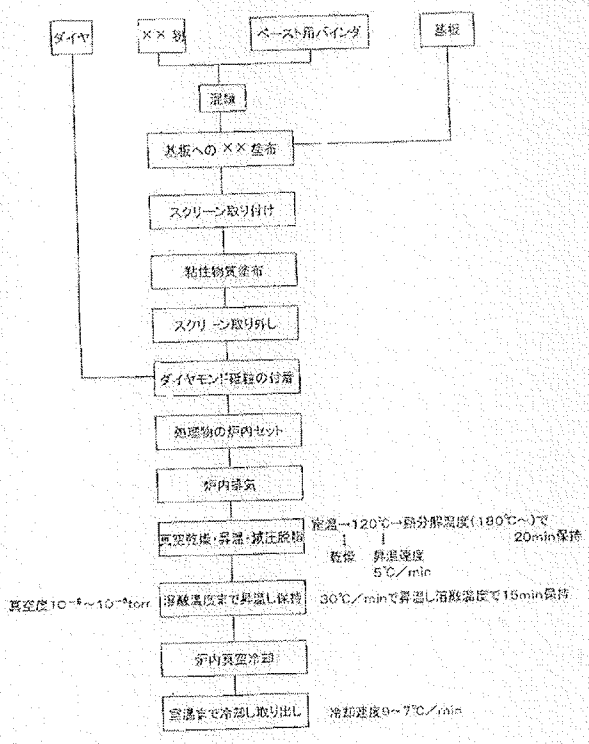
【図3】


30
40
23
21
22

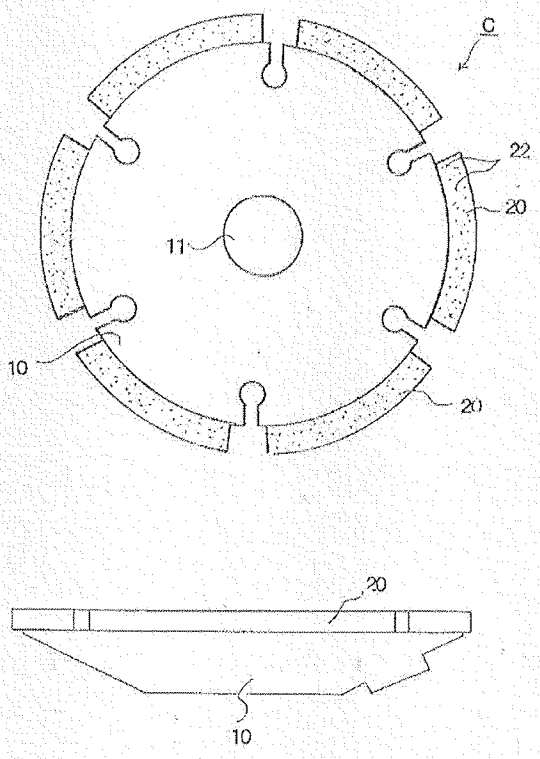
【図4】


22
20
23
21
××溶融

【図5】


ダイヤ
××剤
ペースト用バインダ
基板
混練
基板への××塗布
スクリーン取り付け
粘性物質塗布
スクリーン取り外し
ダイヤモンド粒粒の付着
処理物の炉内セット
炉内排気
真空乾燥・昇温・減圧脱脂
室温→120℃→脱分解温度(180℃～)で20min保持
乾燥
昇温速度5℃/min
真空度10⁻⁶～10⁻⁵torr
溶融温度まで昇温し保持
30℃/minで昇温し溶融温度で15min保持
炉内真空冷却
室温まで冷却し取り出し
冷却速度5～7℃/min

【図6】



フロントページの続き

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GRINDING WHEEL AND MANUFACTURE THEREOF

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Classification: - **international:** ***B24D3/00; B24D3/02; B24D3/06; B24D3/28; B24D5/00;*** (IPC1-7): B24D3/00; B24D3/00; B24D3/02; B24D3/06; B24D3/28; B24D5/00

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Abstract of JP2000343436 (A)

PROBLEM TO BE SOLVED: To obtain long-term stable cutting quality through the excellent supply of a polishing solution and discharge of chips while obtaining the holding force and necessary protruding height of abrasive grains by setting wax material thickness to be specific times as large as an abrasive grain diameter, and forming a chip pocket with base metal matrix exposed with a width specific times as large as the abrasive grain diameter between the abrasive grains. SOLUTION: In arranging abrasive grains 2 in one layer on a base metal 2 for brazing, the abrasive grains 2 are held with a wax material thickness W of about 1/3-1/2 times as large as an abrasive grain diameter (d),and a chip pocket T with the matrix of the base metal 1 exposed with a width about 2/3-2.5 times as large as the abrasive grain diameter(d) between the adjacent abrasive grains 2 is regularly formed.; Such a wax material thickness W can ensure the protruding height of the abrasive grains 2 required to exhibit excellent cutting quality while ensuring the holding force of the abrasive grains 2, and the regular formation of the chip pocket T with the exposed matrix of the base metal 1 permits the uniform distribution of the abrasive grains 2 and excellent supply of a polishing solution and discharge of chips.

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			３１０Ｂ
	３２０		３２０Ｂ
	３４０		３４０
3/02		3/02	Ａ

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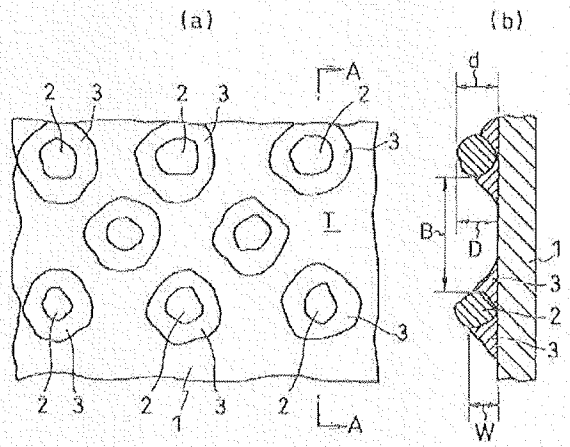
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最終頁に続く

(54)【発明の名称】　研削砥石およびその製造方法

(57)【要約】
【課題】　超砥粒を台金に一層配列してろう付けした研削砥石において、砥粒層の全面に砥粒を均一に分布させ、良好な切れ味と切粉の排出を安定的に維持する。
【解決手段】　砥粒粒径dの１／３～１／２倍の厚さのろう材３で砥粒２を保持するとともに、隣り合う砥粒２との間に砥粒粒径の２／３～２．５倍の幅で台金１の素地を露出させた部分を含むチップポケットＴを規則的に形成した。



【特許請求の範囲】
【請求項１】　ダイヤモンド、ＣＢＮなどの超砥粒を台金に一層配列してろう付けした研削砥石において、砥粒粒径の１／３～１／２倍のろう材厚さで砥粒を保持するとともに、隣り合う砥粒との間に砥粒粒径の２／３～２．５倍の幅で台金素地を露出させた部分を含むチップポケットを規則的に形成した研削砥石。
【請求項２】　前記チップポケットの深さを砥粒粒径の２／３～１倍の深さとした請求項１記載の研削砥石。
【請求項３】　ダイヤモンド、ＣＢＮなどの超砥粒を台金に一層配列してろう付けする研削砥石の製造方法において、所定の間隔で規則的に孔を開けたスクリーンを用いて台金上に有機接着剤を塗布し、この有機接着剤の上に砥粒を配置した状態で乾燥炉中で乾燥させた後、接着部にのみろう材とバインダーの混合物を塗布し加熱、ろう付けすることにより、砥粒を台金上に所定の間隔で配列させることを特徴とする研削砥石の製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明はダイヤモンド、ＣＢＮなどの超砥粒を用いた研削砥石にかかり、とくに砥石の切れ味を向上させた研削砥石およびその製造方法に関する。
【０００２】
【従来の技術】従来より、ダイヤモンド砥粒やＣＢＮ砥粒などの超砥粒をろう付け法により単層に固着した研削砥石が研削・研磨用砥石として使用されている。このような研削砥石には、切れ味に優れ、しかもその切れ味が長期にわたって安定的に持続することが要求される。ところが、ダイヤモンド砥粒にしろ、ＣＢＮ砥粒にしろ、研削作業の進行に伴い切れ味と寿命が低下する。
【０００３】その主な原因として、台金への砥粒の固着状態が不安定で砥粒が脱落しやすいこと、チップポケットが小さいこと、砥粒間隔のコントロールが不十分なために研削作業中に切粉によって目詰まりが生じることが挙げられる。とくに砥粒間隔に関しては、台金の表面に砥粒を均一に分散させるのが難しく、砥粒どうしが近接した状態にある部分においては、研削液が充分に供給されにくく、また切粉が排出されにくく、切れ味の低下につながる。
【０００４】ろう付け法による砥石の製造において、砥粒を均一に分散させるための方策として、特開平９－１９８６７号公報には、金属被覆したダイヤモンド砥粒を砥石台金と金型の間隙に充填し、砥石台金と金型を加熱しながら銀ろうを間隙に溶浸させる砥石の製造方法が開示されている。また特開平１０－３４５４０号公報には、台金の表面に複数本のＶ溝を平行にかつ等間隔に設け、このＶ溝に砥粒をろう付けする方法が開示されている。
【０００５】
【発明が解決しようとする課題】上記の公開公報に記載の方法によれば、砥粒が所定の間隔をもって一様に分布した砥石が得られる。しかし、特開平９－１９８６７号公報に記載の方法により製造された砥石は、台金と金型の間隙によって決まる一定厚さの砥粒層が形成され、砥粒と砥粒の間に砥粒の金属被覆成分と銀ろうとが充填されたかたちであるので、いわゆるチップポケットが形成されず、充分な切れ味と切粉の排出が得られないという欠点がある。
【０００６】また特開平１０－３４５４０号公報に記載の方法により製造された砥石は、砥粒の一部がＶ溝に埋設されたかたちであるので、砥粒の突出量が小さく、切れ味が不十分となり、また、Ｖ溝内に配列される個々の砥粒どうしの間隔をコントロールすることができないため、Ｖ溝内の砥粒間隔が小さい部分では部分的に目詰まりが生じるという欠点がある。
【０００７】本発明が解決すべき課題は、超砥粒を台金に一層配列してろう付けした研削砥石において、砥粒層の全面に砥粒を均一に分布させ、良好な切れ味と切粉の排出を安定的に維持することにある。
【０００８】
【課題を解決するための手段】本発明の研削砥石は、ダイヤモンド、ＣＢＮなどの超砥粒を台金に一層配列してろう付けした研削砥石であって、砥粒粒径の１／３～１／２倍のろう材厚さで砥粒を保持するとともに、隣り合う砥粒との間に砥粒粒径の２／３～２．５倍の幅で台金素地を露出させた部分を含むチップポケットを規則的に形成したことを特徴とする。
【０００９】本発明の研削砥石においては、ろう材の厚さを砥粒粒径の１／３～１／２倍とすることによって、砥粒の保持力を確保したうえで、良好な切れ味を発揮するのに必要な砥粒の突出高さを確保することができる。ろう材の厚さが砥粒粒径の１／３倍より小さいと、ろう材による砥粒の保持力が低下し、砥粒が脱落しやすくなる。砥粒粒径の１／２倍より大きくなると、砥粒の切削に寄与する部分が小さいため切削量が少なく、切れ味が悪くなり、また、切粉が排出されにくく、ろう材が磨耗しやすくなる。ろう材の厚さが上記の範囲内にあるとき、砥粒が被研削材に十分に食い込んで研削され、また、切粉が効率よく排出され、目詰まりや焼付きが発生せず、安定した切れ味が得られる。
【００１０】また、個々の砥粒どうしの間に砥粒粒径の２／３～２．５倍の幅で台金素地を露出させた部分を含むチップポケットを規則的に形成させることによって、砥粒層の全面にわたって砥粒の分布を均一にするとともに、研削液の供給と切粉の排出を良好にして切れ味を向上させることができる。チップポケットの幅が砥粒粒径の２／３倍より小さいと、研削液の供給と切粉の排出が不十分となり、砥粒粒径の２．５倍より大きくすると、砥粒の総量が少なくなって砥石全体としての研削能力が

低下し、砥石の寿命も短くなる。

【0011】ここで、前記チップポケットの深さを砥粒粒径の2／3～1倍の深さとするのが望ましい。チップポケットの深さをこの範囲とすることにより、研削液の供給と切粉の排出がより良好となり、切れ味がより向上する。

【0012】上記のように個々の砥粒どうしの間に所定の範囲内の幅のチップポケットが形成されるように砥粒を配列させた砥石は、つぎのいずれかの方法により製造することができる。第1の方法は、所定の間隔で規則的に孔を開けたスクリーンを用いて、台金上に有機接着剤を塗布し、この有機接着剤の上に砥粒を配置した状態で乾燥炉中で乾燥させて砥粒を仮固定した後、接着部にのみろう材とバインダーの混合物を塗布し、加熱、ろう付けして本固定することにより、砥粒を台金上に所定の間隔で配列させる方法である。第2の方法は、スクリーンを用いてろう材とバインダーの混合体を塗布し、砥粒を配置した状態で加熱することにより、仮固定なしで本固定する方法である。砥粒の確実な保持と所定の範囲内の幅のチップポケットの形成のためにろう材とバインダーの混合物の塗布量をコントロールするという点からは、砥粒の仮固定後に砥粒一粒ずつに対して確実に塗布することのできる前記第1の方法が適している。

【0013】

【発明の実施の形態】図1は本発明の実施形態における研削砥石の台金上の砥粒の配列を示す模式図であり、（a）は平面図，（b）はA－A線断面図である。

【0014】本実施形態は、ADC（アルミダイキャスト）合金、鋳鉄などの粗研削用の砥石に本発明を適用した例である。図1は砥石の砥粒層形成部分の一部を示す図であり、1は台金、2は砥粒、3はろう材である。この砥石の製造手順はつぎの通りである。

① 台金1として外径100mm、厚さ10mmの鉄製台金を準備する。

② 砥粒2として平均粒径約400μmのダイヤモンド砥粒を準備する。

③ 直径0．2mmの孔を1．2mm間隔で千鳥状に配列したスクリーンを用いて、台金1上に有機接着剤を塗布する。

④ この有機接着剤の上に砥粒を配置する。この状態で砥粒は台金上に1．2mm間隔で千鳥状に配列されたかたちとなる。

⑤ これを乾燥炉中で120℃、1時間乾燥させ、砥粒を仮固定する。

⑥ 三次元移動が可能なアプリケータ（吐出機）を用いて、接着部にろう材とバインダーの混合物を砥粒粒径の1／2の高さに塗布する。

⑦ これを非酸化性雰囲気中で1000℃、1時間加熱し、砥粒を台金に本固定する。

【0015】このようにして、ろう材3の厚さWが砥粒粒径d（400μm）の1／2で、砥粒2のまわりに幅B、深さDともに砥粒粒径dに相当するチップポケットTを形成した研削砥石を製造した。この砥石（発明品）と、同じ砥粒と台金を用いて前述した特開平10－345540号公報記載の方法によって製造した砥石（比較品）について研削試験を行った。両砥石の仕様のうち数値の異なる項目を表1に示す。

【0016】

【表1】

	発明品	比較品
砥粒ピッチ	1．2mm	溝間隔0．8mm、溝内ピッチ不定
砥粒突出高さ	0．4mm	0．2mm
チップポケット幅	0．4mm	0～0．4mm
チップポケット深さ	0．4mm	0．2mm

【0017】〔試験条件〕

研削機械　：工具研削盤

砥石周速度：1200m／min

被研削材　：ハイシリコンアルミ（ADC－14）

切り込み量：0．1mm／pass

【0018】図2に試験結果を示す。同図は、比較品の砥石の切断速度および砥石寿命を100としたときの本発明品の切断速度および砥石寿命を示すものである。同図からわかるように、V溝に砥粒を配列した比較品の砥石に比べて、全面に砥粒を一様に分布させ、かつ適正なチップポケットを形成した発明品は、切断速度は1．5倍程度、砥石寿命は1．7倍程度向上している。

【0019】

【発明の効果】本発明によって以下の効果を奏する。

【0020】（1）ろう材の厚さを砥粒粒径の1／3～1／2倍とし、さらに個々の砥粒どうしの間に砥粒粒径の2／3～2．5倍の幅で台金素地を露出させた部分を含むチップポケットを形成させることによって、砥粒の保持力を確保したうえで、良好な切れ味を発揮するのに必要な砥粒の突出高さを確保することができ、また、研削液の供給と切粉の排出を良好にして目詰まりや焼付きが発生せず、長期にわたって安定した切れ味が得られ、砥石の寿命も延長する。

【0021】（2）チップポケットの深さを砥粒粒径の2／3～1倍の深さとすることにより、研削液の供給と切粉の排出がより良好となり、切れ味がより向上する。

【0022】（3）所定の間隔で規則的に孔を開けたスクリーンを用いて台金上に有機接着剤を塗布し、この有

機接着剤の上に砥粒を配置した状態で乾燥炉中で乾燥させた後、接着部にのみろう材とバインダーの混合物を塗布し加熱、ろう付けすることにより、砥粒を台金上に所定の間隔で配列させることができる。

【図面の簡単な説明】

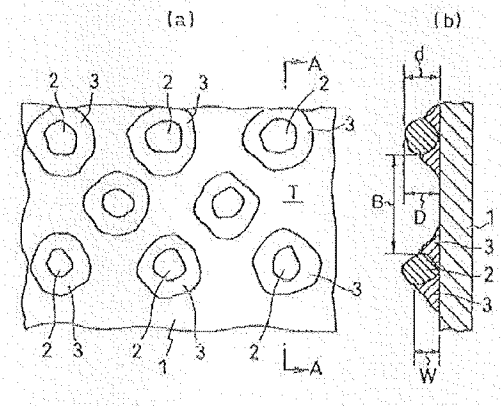
【図１】　発明の実施形態における研削砥石の台金上の砥粒の配列を示す模式図であり、（ａ）は平面図，（ｂ）はＡ－Ａ線断面図である。

【図２】　研削試験結果を示すグラフである。

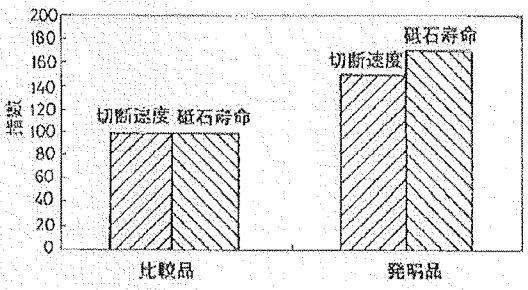
【符号の説明】

1　台金
2　砥粒
3　ろう材
d　砥粒粒径
W　ろう材厚さ
T　チップポケット
B　チップポケット幅
D　チップポケット深さ

【図１】



【図２】



フロントページの続き

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	3/28			3/28	
	5/00			5/00	Ｐ

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BB07 BC03 BG01 BG07 BG30
CC09 CC16 FF23 FF30

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EFS ID:	13940543
Application Number:	12726786
International Application Number:	
Confirmation Number:	1959
Title of Invention:	CMP Pad Dressers with Hybridized Abrasive Surface and Related Methods
First Named Inventor/Applicant Name:	Chien-Min Sung
Customer Number:	20551
Filer:	David William Osborne
Filer Authorized By:	
Attorney Docket Number:	00802-32779.NP.CIP2
Receipt Date:	09-OCT-2012
Filing Date:	18-MAR-2010
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Application Type:	Utility under 35 USC 111(a)

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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Information:	

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This is not an USPTO supplied IDS fillable form					
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6	Foreign Reference	cn1351922.pdf	3773582 98546530fd4539b9af79cd7c16ae09fed78024b3	no	18
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8	Foreign Reference	ep0264674.pdf	8397148 e4f93539f1ad6083e3c8b4c47185cb70ee61f733	no	25
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9	Foreign Reference	ep0331344.pdf	2978401 b4c991378b8fbd88a0237950d6c871ac834a7506	no	12
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10	Foreign Reference	ep0712941.pdf	20841107 39485f2b3de5608f57bbdeda2ade560e84416932	no	86
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33	Non Patent Literature	noa2.pdf	683476 959ce99d1845833a8d4fb82c9a699d57fa71c180	no	13
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41	Non Patent Literature	syndite_elementsisx.pdf	546013 ab4aa94460ac101b6c3e495bd73e7ec44ca4c844	no	1
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42	Non Patent Literature	yasinaga_advances.pdf	144771 49b0f550fce739e914405c3b7db22ca5d15702a9	no	3
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43	Foreign Reference	jp1.pdf	1561975 3bcdfda7135cb9ad69cf5eb0c41d13b2c34b432c	no	10
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44	Foreign Reference	jp2.pdf	897944 08a77b6640ca46e2b05c1a837e5aa3d49481e6ec	no	6
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			Total Files Size (in bytes):	132368253	

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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: EXAMINER: FIRST NAMED INVENTOR: Chien-Min Sung SERIAL NO.: 12/726,786 FILED: 3/18/2010 CONF. NO.: 1959 FOR: CMP PAD DRESSERS WITH HYBRIDIZED ABRASIVE SURFACE AND RELATED METHODS DOCKET NO.: 00802-32779.NP.CIP2	**CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8** DATE OF DEPOSIT: 10/09/2012 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. /Kelley Warner/ Kelley Warner

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.

☐ 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 9th day of October, 2012.

Respectfully submitted,

/David W. Osborne/

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Complete if Known	
Application Number	12/726,786
Filing Date	3/18/2010
First Named Inventor	Chien-Min Sung
Art Unit	
Examiner Name	
Attorney Docket Number	00802-32779.NP.CIP2

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
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Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]- Number[4] – Kind Code[5] (if known)	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]
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		WO96/06732	03/07/1996	Roberts		
		WO98/10897	03/1998	Norton Co.		
		WO98/45091	03/1998	Sung		
		WO98/45092	10/15/1998	Sung		
		WO98/51448	03/1998	Norton Co.		

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. Confidentially 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.
12/726,786	03/18/2010	Chien-Min Sung	02074-32779.NP.CIP2	1959

20551 7590 10/29/2012

THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

EXAMINER	
RACHUBA, MAURINA T	
ART UNIT	PAPER NUMBER
3727	

NOTIFICATION DATE	DELIVERY MODE
10/29/2012	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):

causse@tnw.com
patentdocket@tnw.com
rich@tnw.com

Office Action Summary	Application No.	Applicant(s)	
	12/726,786	SUNG, CHIEN-MIN	
	Examiner	Art Unit	
	MAURINA RACHUBA	3727	

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

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *1* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ 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.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *1-19* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☐ Claim(s) _____ is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☒ Claim(s) *1-19* are subject to restriction and/or election requirement.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

12)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

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)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. This application contains claims directed to the following patentably distinct species: Species 1, the blade has a shape, subspecies A, the shape is serrated, subspecies B, the shape is flat. Species 2, the alternating pattern, subspecies A, a single blade element alternates between regions of particle elements, subspecies B, groups of two or more blade elements alternate between regions of particle elements. Species 3, the matrix material, subspecies A, the matrix is an epoxy resin, subspecies B, the matrix is a polyimide resin, subspecies C, the matrix is a polyurethane resin. Applicant may elect one subspecies from each species group (for example applicant may elect 1B, 2A, 3C. The species are independent or distinct because none of the claimed species require the structure of the other species to function. In addition, these species are not obvious variants of each other based on the current record.

Applicant is required under 35 U.S.C. 121 to elect a single disclosed species, or a single grouping of patentably indistinct species, for prosecution on the merits to which the claims shall be restricted if no generic claim is finally held to be allowable. Currently, s 1 and 5 are generic.

There is a search and/or examination burden for the patentably distinct species as set forth above because at least the following reason(s) apply:

The search for each of the various shapes, patterns and materials requires separate individual searches and is a burden on the examiner.

Applicant is advised that the reply to this requirement to be complete must include (i) an election of a species or a grouping of patentably indistinct species to be examined even though the requirement may be traversed (37 CFR 1.143) **and (ii) identification of the claims encompassing the elected species or grouping of patentably indistinct species**, including any claims subsequently added. An argument that a claim is allowable or that all claims are generic is considered nonresponsive unless accompanied by an election.

The election may be made with or without traverse. To preserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the election of species requirement, the election shall be treated as an election without traverse. Traversal must be presented at the time of election in order to be considered timely. Failure to timely traverse the requirement will result in the loss of right to petition under 37 CFR 1.144. If claims are added after the election, applicant must indicate which of these claims are readable on the elected species or grouping of patentably indistinct species.

Should applicant traverse on the ground that the species, or groupings of patentably indistinct species from which election is required, are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing them to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the species unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103(a) of the other species.

Upon the allowance of a generic claim, applicant will be entitled to consideration of claims to additional species which depend from or otherwise require all the limitations of an allowable generic claim as provided by 37 CFR 1.141.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAURINA RACHUBA whose telephone number is (571)272-4493. The examiner can normally be reached on Monday-Thursday, 6:00AM-4:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Monica Carter can be reached on 571 272 4475. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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.

/M. Rachuba/
Primary Examiner, Art Unit 3727

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

ART UNIT: 3727 EXAMINER: Maurina T. Rachuba FIRST NAMED INVENTOR: Chien-Min Sung SERIAL NO.: 12/726,786 FILED: 03/18/2010 CONF. NO.: 1959 FOR: CMP Pad Dressers with Hybridized Abrasive Surface and Related Methods DOCKET NO.: 02074-32779.NP.CIP2	**CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8** DATE OF DEPOSIT: **December 31, 2012** 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

ELECTION AND RESPONSE UNDER 37 C.F.R. § 1.121

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313

Dear Sir:

In response to the communication mailed October 29, 2012, please reconsider this application in view of the election and remarks provided below. A petition for a 1-month extension and the required fee are enclosed.

ELECTION

Applicants elect without traverse, the following: Species 1B, Species 2A, and Species 3A, as outlined in the office action mailed October 29, 2012.

REMARKS

Applicants thank the Examiner for consideration of the subject patent application. In the office action mailed October 29, 2012, Claims 1-19 were pending, and made subject to an election of species requirement under 35 U.S.C. § 121. Particularly, the Examiner indicated the following distinct species:

Species 1- the blade has a shape

Subspecies A- the shape is serrated;

Subspecies B- the shape is flat

Species 2- the alternating pattern

Subspecies A- a single blade element alternates between regions of particle elements;

Subspecies B- groups of two or more blade elements alternate between regions of particle elements;

Species 3- the matrix material

Subspecies A- the matrix is an epoxy resin;

Subspecies B- the matrix is a polyimide resin;

Subspecies C- the matrix is a polyurethane resin;

The Examiner further indicated that Claims 1 and 5 were generic.

By the present election, Applicants have elected Species 1B, 2A, and 3A. Therefore, pursuant to the present election Claims 1-7, 9-14, and 16-17 read on the elected species and remain pending for consideration while Claims 8, 15, and 18-19 are withdrawn.

CONCLUSION

If any impediment remains to examination after consideration of the above-recited remarks, which could be removed during a telephone interview, the Examiner is invited to telephone the undersigned attorney, at (801) 566-6633 so that such issues may be resolved as expeditiously as possible.

The Commissioner is hereby authorized to charge any additional fees associated with this communication or credit any overpayment to Deposit Account No. 20-0100.

DATED this 31st day of December, 2012.

Respectfully submitted,

THORPE, NORTH & WESTERN, LLP

/David W. Osborne/

David W. Osborne
Reg. No. 44,989
8180 South 700 East, Suite 350
Sandy, UT 84070
Telephone: (801) 566-6633
Facsimile: (801) 566-0750

PTO/SB/22 (09-11)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARMENT OF COMMERCE
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) 02074-32779.NP.CIP2
Application Number 12/726,786	Filed 3/18/2010
For CMP Pad Dressers with Hybridized Abrasive Surface and Related Methods	
Art Unit 3727	Examiner Maurina T. Rachuba

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):

		Fee	Small Entity Fee	
☑	One month (37 CFR 1.17(a)(1))	$150	$75	$150
☐	Two months (37 CFR 1.17(a)(2))	$560	$280	$
☐	Three months (37 CFR 1.17(a)(3))	$1270	$635	$
☐	Four months (37 CFR 1.17(a)(4))	$1980	$990	$
☐	Five months (37 CFR 1.17(a)(5))	$2690	$1345	$

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ 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~~ deficiencies only, or credit any overpayment, to Deposit Account Number 20-0100.

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/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed (Form PTO/SB/96).

☑ attorney or agent of record. Registration Number 44989

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

/David W. Osborne/	December 31, 2012
Signature	Date
David W. Osborne	801-566-6633
Typed or printed name	Telephone Number

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below.

☑ Total of 1 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: 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.

Electronic Patent Application Fee Transmittal

Application Number:	12726786
Filing Date:	18-Mar-2010
Title of Invention:	CMP Pad Dressers with Hybridized Abrasive Surface and Related Methods
First Named Inventor/Applicant Name:	Chien-Min Sung
Filer:	David William Osborne/Nicole Solomon
Attorney Docket Number:	02074-32779.NP.CIP2

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

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:				
Extension - 1 month with $0 paid	1251	1	150	150

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
			Total in USD ($)	**150**

Electronic Acknowledgement Receipt

EFS ID:	14590840
Application Number:	12726786
International Application Number:	
Confirmation Number:	1959
Title of Invention:	CMP Pad Dressers with Hybridized Abrasive Surface and Related 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:	02074-32779.NP.CIP2
Receipt Date:	31-DEC-2012
Filing Date:	18-MAR-2010
Time Stamp:	18:01:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$150
RAM confirmation Number	3913
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1		32779NPCIP2restriction.pdf	64179 c010a8d10739ba445f150fcdfe644ca0c197a5f7	yes	4

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Response to Election / Restriction Filed	2	2
Applicant Arguments/Remarks Made in an Amendment	3	4

Warnings:

Information:

2	Extension of Time	32779NPCIP2extension.pdf	666821 debddd05671e6a426d9a2892f9f870020b620bea	no	1

Warnings:

Information:

3	Fee Worksheet (SB06)	fee-info.pdf	30589 8a87ad7d31671a4aef5f639b485fd509a0252433	no	2

Warnings:

Information:

Total Files Size (in bytes):	761589

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.

PTO/SB/08B (08-03)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet | | of |

Complete if Known	
Application Number	12/726,786
Filing Date	3/18/2010
First Named Inventor	Chien-Min Sung
Art Unit	3727
Examiner Name	Maurina Rachuba
Attorney Docket Number	02074-32779.NP.CIP2

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 12/715,583; filed 03/02/2010; Chien-Min Sung; notice of allowance dated 12/07/2012	
		PCT/US2012/039199; filed 05/23/2012; Chien-Min Sung; International Search Report dated 12/18/2012	
		U.S. Application 12/255,823; filed 10/22/2008; Chien-Min Sung; notice of allowance dated 12/16/2012	
		U.S. Application 13/362,917; filed 01/13/2012; Chien-Min Sung; office action dated 12/31/2012	
		U.S. Application 12/267,172; filed 11/07/2008; Chien-Min Sung; notice of allowance dated 01/07/2013	
		U.S. Application 12/168,110; filed 07/05/2008; Chien-Min Sung; notice of allowance dated 01/18/2013	

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]Applicant 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. Confidentially 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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PTO/SB/08A (08-03)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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(Use as many sheets as necessary)

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Complete if Known	
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First Named Inventor	Chien-Min Sung
Art Unit	3727
Examiner Name	Maurina Rachuba
Attorney Docket Number	02074-32779.NP.CIP2

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		2010/0261419	10/14/2010	Chien-Min Sung	
		2007-0266639	11/22/2007	Chein-Min Sung	
		2010/0248595	09/30/2010	Dinh-Ngoc	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]- Number[4] – Kind Code[5] (if known)	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]
		JP 2007-044823	02/22/2007	Soken		

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.

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

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:

OSBORNE DAVID W.

P.O. BOX 1219 SANDY UT 84091-1219 USA

RECEIVED
DEC 26 2012
TROP, PRUNER & HU, P.C.

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 02074-24012PCT	Date of mailing *(day/month/year)* 18 DECEMBER 2012 (18.12.2012) **FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. **PCT/US2012/039199**	International filing date *(day/month/year)* **23 MAY 2012 (23.05.2012)**
Applicant **SUNG CHIEN-MIN**	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:

   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 . 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. Following the expiration of 30 months from the priority date, these comments will also be made available to the public.

Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90bis.1 and 90bis.3).

Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19months.

For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the PCT Applicant's Guide, National Chapters.

Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea	Authorized officer COMMISSIONER
Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-8754

Form PCT/ISA/220 (July 2010)

(over)

DOCKETED
DEC 30 2012
TNW

* Attention

Copies of the documents cited in the international search report can be searched in the following Korean Intellectual Property Office English website for three months from the date of mailing of the international search report.

http://www.kipo.go.kr/en/ => PCT Services => PCT Services

ID : PCT international application number
PW : **XW34DDSW**

Inquiries related to PCT International Search Report or Written Opinion prepared by KIPO as an International Searching Authority can be answered not only by KIPO but also through IPKC (Intellectual Property Korea Center), located in Vienna, VA, which functions as a PCT Help Desk for PCT applicants.

Homepage: http://www.ipkcenter.com
Email: ipkc@ipkcenter.com
Phone: +1 703 388 1066
Fax: +1 703 388 1084

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
02074-24012P		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2012/039199	**23 MAY 2012 (23.05.2012)**	23 MAY 2011 (23.05.2011)

Applicant

SUNG CHIEN-MIN

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 43.6*bis*(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.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/039199

A. CLASSIFICATION OF SUBJECT MATTER

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)

H01L 21/304; B05D 3/02; B24B 53/02; B24B 53/00; C09K 3/14; B24B 53/12

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: "CMP, pad, grain, abrasive particle, protruding"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010-0261419 A1 (CHIEN-MIN SUNG) 14 October 2010 See paragraphs [0033] - [0054]; and claims 1 - 2; and figure 2.	1-27
A	US 2007-0266639 A1 (CHIEN-MIN SUNG) 22 November 2007 See paragraphs [0053] - [0055]; and claims 22 - 35; and figures 1 - 3.	1-27
X A	US 2010-0248595 A1 (DINH-NGOC CHARLES et al.) 30 September 2010 See paragraphs [0071] - [0096]; and claim 1; and figures 1 - 2.	10 1-9,11-27
A	JP 2007-044823 A (SOKEN:KK) 22 February 2007 See paragraphs [0001] - [0034]; and claims 1 - 6; and figures 1 - 3.	1-27

☐ 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	Date of mailing of the international search report
17 DECEMBER 2012 (17.12.2012)	**18 DECEMBER 2012 (18.12.2012)**

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

Lee, Myoung Jin

Telephone No. 82-42-481-8364

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2012/039199

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010-0261419 A1	14.10.2010	CN 101856806 A	13.10.2010
		TW 201036762 A	16.10.2010
US 2007-0266639 A1	22.11.2007	TW 200806432 A	01.02.2008
		TW I331066B	01.10.2010
		US 7771498 B2	10.08.2010
		WO 2007-136864 A2	29.11.2007
US 2010-0248595 A1	30.09.2010	CA 2764358 A1	09.12.2010
		CN 102341215 A	01.02.2012
		CN 102484054 A	30.05.2012
		EP 2411181 A1	01.02.2012
		EP 2438609 A2	11.04.2012
		IL 215146D0	29.12.2011
		JP 2012-521309 A	13.09.2012
		KR 10-2011-0124370 A	16.11.2011
		KR 10-2012-0027449 A	21.03.2012
		SG 174351A1	28.10.2011
		US 2010-0330886 A1	30.12.2010
		WO 2010-110834 A1	30.09.2010
		WO 2010-141464 A2	09.12.2010
JP 2007-044823 A	22.02.2007	None	

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
OSBORNE DAVID W.

P.O. 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)*	**18 DECEMBER 2012 (18.12.2012)**
Applicant's or agent's file reference: 02074-24012P	**FOR FURTHER ACTION**: See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2012/039199	**23 MAY 2012 (23.05.2012)**	23 MAY 2011 (23.05.2011)

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

H01L 21/304(2006.01)i

DOCKETED
Description | Due Date | Initials
Response | 3-23-13 | KW

Applicant

SUNG CHIEN-MIN

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

KR INITIAL

- [X] 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
- [X] 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
- [X] 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.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. 82-42-472-7140	17 DECEMBER 2012 (17.12.2012)	Lee, Myoung Jin Telephone No.82-42-481-8364

Form PCT/ISA/237 (cover sheet) (July 2011)

DOCKETED DEC 30 2012 TNW

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2012/039199

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. a sequence listing filed or furnished
      ☐ on paper
      ☐ in electronic form

   b. time of filing or 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 has been filed or furnished, the required statements that the information in the subsequent or additioanl 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:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2012/039199

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	1-9,11-27	YES
	Claims	10	NO
Inventive step (IS)	Claims	1-9,11-27	YES
	Claims	10	NO
Industrial applicability (IA)	Claims	1-27	YES
	Claims	NONE	NO

2. Citations and explanations :
Reference is made to the following documents:

D1: US 2010-0261419 A1 (CHIEN-MIN SUNG) 14 October 2010
D2: US 2007-0266639 A1 (CHIEN-MIN SUNG) 22 November 2007
D3: US 2010-0248595 A1 (DINH-NGOC CHARLES et al.) 30 September 2010
D4: JP 2007-044823 A (SOKEN:KK) 22 February 2007

1. Novelty and Inventive Step

1.1. Claims [1-9]

1.1.1. Independent Claim [1]

The subject matter of claim [1] differs from these prior art documents in that a CMP pad dresser comprises the superabrasive particles, wherein the difference in protrusion distance 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 and the difference in protrusion distance between the highest 1% of the protruding tips of the monolayer of superabrasive particles are within about 80 microns or less. Therefore, claim [1] meets the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

1.1.2. Dependent Claims [2-9]

Claims [2-9] are dependent on claim [1]. Therefore, claims [2-9] meet the requirements of PCT Article 33(2) and (3).

Continued on Supplemental Box

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/US2012/039199

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Box VIII

The term "The dresser claim 1" used in claim 8 is unclear since "the dresser claim 1" is typo of "the dresser of claim 1" shown in claim 8, thereby resulting in lack of clarity (PCT Article 6).

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of :
Box V

1.2. Claims [10-13]
1.2.1. Independent Claim [10]

D3, which is considered to be the closest prior art to the subject matter of claim [10], discloses the abrasive tool comprising (a) a first layer of abrasive grains attached to the first major surface, wherein a substrate having a first major surface and a second major surface opposite the first major surface, and (b) a second layer of abrasive grains attached to the second major surface, wherein the second layer of abrasive grains are arranged in a same distribution as the first layer of abrasive grains, and (c) a protective layer(261) providing a layer of material overlying the abrasive grains to safeguard the grains from damage. Thus, claim [10] lacks novelty under PCT Article 33(2).

1.2.2. Dependent Claims [11-13]

The subject matter of claims [11-13] differ from these prior art documents in that a CMP pad dresser comprises the superabrasive particles, wherein the differences in protrusion distance (a) between the highest protruding tip and the second highest protruding tip, / (b) between the highest protruding tip and the 10^{th} highest protruding tip, / (c) between the highest protruding tip and the 100^{th} highest protruding tip, are definitely specified. Therefore, claims [11-13] meet the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

Continued on Supplemental Box

Supplemental Box

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

Supplemental Box

1.3. Claims [14-24]
1.3.1. Independent Claim [14]

The subject matter of claim [14] differs from these prior art documents in that a method of making a CMP pad dresser comprises 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 preclude substantial warping of the metal support layer. Therefore, claim [14] meets the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

1.3.2. Dependent Claims [15-24]
Claims [15-24] are dependent on claim [14]. Therefore, claims [15-24] meet the requirements of PCT Article 33(2) and (3).

1.4. Claims [25-26]
1.4.1. Independent Claim [25]

The subject matter of claim [25] differs from these prior art documents in that a method of minimizing warpage of a CMP pad dresser comprises substantially eaualizing warping forces on opposing sides of a metal support layer, wherein warpage of the support layer is minimized. Therefore, claim [25] meets the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

1.4.2. Dependent Claim [26]
Claim [26] is dependent on claim [25]. Therefore, claim [26] meets the requirements of PCT Article 33(2) and (3).

Continued on Supplemental Box

Supplemental Box

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

Supplemental Box

1.5. Claim [27]

1.5.1. Independent Claim [27]

The subject matter of claim [27] differs from these prior art documents in that a CMP pad dresser comprises the superabrasive particles, wherein the differences in protrusion distance (a) between the highest protruding tip and the second highest protruding tip, / (b) between the highest protruding tip and the 10^{th} highest protruding tip, / (c) between the highest protruding tip and the 100^{th} highest protruding tip, and the protrusion distance of the highest protruding tip are definitely specified. Therefore, claim [27] meets the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

2. Industrial Applicability

Claims [1-27] are industrially applicable under PCT Article 33(4), because they are closely related to semiconductor technology.

No documents available for this priority number.

Europäisches Patentamt
European Patent Office
Office européen des brevets

Espacenet

Bibliographic data: JP2007044823 (A) — 2007-02-22

CMP PAD CONDITIONER IN SEMICONDUCTOR PLANARIZATION CMP PROCESS (CHEMICAL-MECHANICAL POLISHING)

Inventor(s): TANI KAZUNORI; IWASAKI HIDEKAZU ± (TANI KAZUNORI, ; IWASAKI HIDEKAZU)

Applicant(s): SOKEN KK ± (SOKEN:KK)

Classification: **- international:** ***B24B37/00; B24B53/12; B24D3/00; H01L21/304***
- cooperative:

Application number: JP20050232524 20050810

Priority number (s): JP20050232524 20050810

Abstract of JP2007044823 (A)

PROBLEM TO BE SOLVED: To reduce the time and trouble for replacing a CMP pad conditioner, and the down time and loss time of a CMP device by preventing abrasion, wearing and alteration of abrasive grains and fallout and defective of the abrasive grains to achieve long-time conditioning of the polishing pad. ; SOLUTION: This pad conditioner includes abrasive grains for pad polishing and grinding used in a semiconductor planarization CMP process, a bond layer holding the abrasive grains; and a bed to which the bond layer is fixed, wherein the abrasive grains or coating material coating the abrasive grains is a material having durability against CMP slurry. The material having durability is silicon carbide (SiC), diamond-like carbon, sapphire, alumina, TiO<SB>2</SB>, stabilized zirconia, ZrN, ZrC, WC, WC-Co, TiC, TiAlN, Tin-Ni, LiNbO<SB>3</SB>, NbC, LiTaO<SB>3</SB>, TaC or HfC. ; COPYRIGHT: (C) 2007,JPO&INPIT

Last updated: 19.12.2012 Worldwide Database 5.8.4; 93p

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2007-44823
(P2007-44823A)
(43)公開日　平成19年2月22日(2007.2.22)

(51) Int.Cl.		F I			テーマコード（参考）
B24B 53/12	(2006.01)	B24B	53/12	Z	3C047
H01L 21/304	(2006.01)	H01L	21/304	622M	3C058
B24B 37/00	(2006.01)	B24B	37/00	A	3C063
B24D 3/00	(2006.01)	B24D	3/00	320A	
		B24D	3/00	330D	

審査請求 未請求　請求項の数 8　OL　（全 9 頁）　最終頁に続く

(21)出願番号　特願2005-232524 (P2005-232524)
(22)出願日　平成17年8月10日 (2005.8.10)

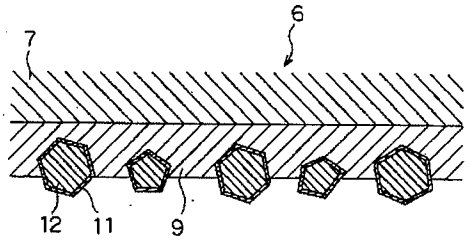
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Fターム(参考)　3C047 AA12　AA34　EE18　EE19　FF08

最終頁に続く

(54)【発明の名称】半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナー

(57)【要約】　（修正有）
【課題】砥粒の磨耗、磨滅、変質や砥粒の脱落、欠損を防止できるので、長時間研磨パッドのコンディショニングを行うことができ、ＣＭＰパッドコンディショナーの交換の手間やＣＭＰ装置のダウンタイムならびにロス時間を減らすこと。
【解決手段】パッドコンディショナーは、半導体平坦化ＣＭＰプロセスに用いるパッド研磨研削用の砥粒と、この砥粒を保持するボンド層と、このボンド層を固着した台とよりなり、砥粒あるいは砥粒を被覆する被膜物質がＣＭＰスラリーに対して耐久性を持つ物質である。耐久性を持つ物質は、炭化珪素（ＳｉＣ）、ダイヤモンドライクカーボン、サファイア、アルミナ、TiO_2、安定化ジルコニア、ＺｒＮ、ＺｒＣ、ＷＣ、ＷＣ－Ｃｏ、ＴｉＣ、ＴｉＡｌＮ、Ｔｉｎ－Ｎｉ、$LiNbO_3$、ＮｂＣ、$LiTaO_3$、ＴａＣあるいはＨｆＣである。
【選択図】　図２



【特許請求の範囲】
【請求項1】
半導体平坦化ＣＭＰプロセスに用いるＣＭＰパッド研磨研削用の砥粒と、この砥粒を保持するボンド層と、このボンド層を固着した台とよりなり、上記砥粒はダイヤモンドよりＣＭＰスラリーに対して耐久性を持つ物質であることを特徴とする半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナー。
【請求項2】
半導体平坦化ＣＭＰプロセスに用いるＣＭＰパッド研磨研削用の砥粒と、この砥粒を保持するボンド層と、このボンド層を固着した台とよりなり、上記砥粒の表面にＣＭＰスラリーに対して耐久性を持つ物質が被覆されていることを特徴とする半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナー。
【請求項3】
半導体平坦化ＣＭＰプロセスに用いるＣＭＰパッド研磨研削用の砥粒と、この砥粒を保持するボンド層と、このボンド層を固着した台とよりなり、ＣＭＰスラリーに対して耐久性を持つ物質を上記砥粒表面及び上記ボンド層表面に被覆せしめたことを特徴とする半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナー。
【請求項4】
上記被覆した物質の膜厚が１０ｎｍ～９００μｍであることを特徴とする請求項２又は３記載の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナー。
【請求項5】
上記各砥粒は夫々離間しており、上記砥粒のうち上記台からの高さが一番低い砥粒の高さと、上記台からの高さが一番高い砥粒の高さとの差が１００μｍ以内であることを特徴とする請求項１、２、３又は４記載の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナー。
【請求項6】
上記各砥粒は夫々離間しており、上記被覆した砥粒のうち上記台からの高さが一番低い砥粒の高さと、上記台からの高さが一番高い砥粒の高さとの差が１００μｍ以内であることを特徴とする請求項２、３又は４記載の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナー。
【請求項7】
上記ダイヤモンドよりＣＭＰスラリーに対して耐久性を持つ物質が、炭化珪素（ＳｉＣ）、ダイヤモンドライクカーボン、サファイア、アルミナ、安定化ジルコニアであることを特徴とする請求項１又は５記載の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナー。
【請求項8】
上記ＣＭＰスラリーに対して耐久性を持つ物質が、炭化珪素（ＳｉＣ）、ダイヤモンドライクカーボン、サファイア、アルミナ、TiO_2、安定化ジルコニア、ＺｒＮ、ＺｒＣ、ＷＣ、ＷＣ－Ｃｏ、ＴｉＣ、ＴｉＡｌＮ、Ｔｉｎ－Ｎｉ、$LiNbO_3$、ＮｂＣ、$LiTaO_3$、ＴａＣあるいはＨｆＣであることを特徴とする請求項２、３、４、５又は６記載の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナー。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナー、特に、化学機械的研磨（ＣＭＰ）装置に用いるＣＭＰパッドのコンディショナーに関するものである。
【背景技術】
【0002】

コンピュータのＣＰＵ能力向上の為には回路の集積度を上げる必要があり、これを実現する為に配線の多層化が行なわれているが、この時、シリコン基板上の各層間絶縁膜を平坦化するＣＭＰ（Chemical Mechanical Polishing）加工技術がキーテクノロジーとなる。半導体デバイスの多層配線化プロセスにおいては、半導体ウェハ表面の凹凸を極力平坦化することが重要であり、この半導体ウェハ表面の平坦化装置として化学的エッチングと研磨剤による機械的研磨とを組み合わせた研磨加工を行うＣＭＰ装置がある。

【0003】

図４は従来のＣＭＰ装置のコンセプトの一例を示す。１は回転自在な直径３００ｍｍの円板状の定盤、２は上記定盤１の略全面に設けたＣＭＰ研磨パッド、３は上記定盤１の回転中心軸に対して偏心した位置に設けた円板状の半導体ウェハ、４は上記半導体ウェハ３を保持し、上記半導体ウェハ３を上記研磨パッド２に押圧せしめる回転自在の半導体ウェハ押圧具、５は上記研磨パッド２上にコロイダルシリカ系、ヒュームドシリカ系、セリア系またはアルミナ系などのＣＭＰスラリーを供給するＣＭＰスラリー供給部、６は上記研磨パッド２の表面を再研磨または再研削（コンディショニング）するため上記半導体ウェハ３とは異なる位置で上記研磨パッド２上に載置した回転自在のＣＭＰパッドコンディショナーを示す。

【0004】

上記研磨パッド２は一般に大別して発泡ウレタンを基材としたパッドと無発泡のウレタンを基材としたパッドが使用されている。前者の発泡ウレタンを基材とする研磨パッドは弾力性があり後者の無発泡のウレタンを基材とするものに比べ平坦性が劣るという報告もある。発泡性ウレタン研磨パッドのＣＭＰパッドコンディショナーにはブラシ状の繊維を埋めこんだもの、あるいはダイヤモンド砥粒をメタルボンドした砥石状のＣＭＰパッドコンディショナーが使用される。一方、無発泡のウレタンの基材を用いたＣＭＰパッドコンディショナーにはダイヤモンド砥粒をメタルボンドした砥石状のＣＭＰパッドコンディショナーが用いられる。

【0005】

上記砥石状のＣＭＰパッドコンディショナー６は図４及び図５に示すように、円板状の金属製台金７と、この台金７の下面に設けた粒径５０μｍ～２００μｍのダイヤモンド砥粒８と、上記ダイヤモンド砥粒８を保持するための上記金属製台金７の下面あるいは台金表面全体を被覆するＮｉメッキボンド層等のボンド層９とよりなる。

【0006】

上記のような従来のＣＭＰ装置においては、上記ＣＭＰ研磨パッド２上にＣＭＰスラリーを供給し、上記定盤１と上記半導体ウェハ押圧具４とを相対的に回転せしめて、上記半導体ウェハ押圧具４により上記半導体ウェハ３を上記ＣＭＰ研磨パッド２上に押圧せしめれば、上記半導体ウェハ３の表面が研磨される。また、上記ＣＭＰパッドコンディショナー６を常時又は定期的に回転せしめれば、上記研磨パッド２の平坦度を維持、修復し、また目詰まりを防止せしめ、また、ＣＭＰ研磨パッド表面の面粗さを維持することによりＣＭＰスラリーの研磨特性を維持、回復せしめることができる。

【0007】

また、上記ＣＭＰパッドコンディショナー６におけるボンド層９により上記台金７を被覆しているので、上記ＣＭＰスラリーにより台金が溶出することがなく、ダイヤモンド砥粒８の脱落を防止できる。このようなＣＭＰ装置は特許文献１に記載されている。

【特許文献1】特開２００１－２３９４４９号

【発明の開示】

【発明が解決しようとする課題】

【0008】

しかしながら、上記従来のＣＭＰ装置においては、ある程度ＣＭＰ研磨パッド２のコンディショニングを続ければ、ＣＭＰパッドコンディショナー上の砥粒の切刃が研磨、磨滅、平坦化され、切れ味が鈍ることにより上記ＣＭＰ研磨パッド２の平坦度の修復が遅くなる。またダイヤモンド砥粒８等がＣＭＰパッドコンディショナー６のボンド層９から脱落

、欠損し、脱落したダイヤモンド砥粒８等がＣＭＰ研磨パッド２の表面に落下、固定され、あるいは転動してウェハ表面に傷をつけてしまうという欠点があった。

【0009】

本発明者は種々実験研究の結果、ダイヤモンド砥粒はコロイダルシリカ系、ヒュームドシリカ系、セリア系またはアルミナ系などのＣＭＰスラリーにより磨耗、磨滅、変質すること、また、この磨耗等により砥粒にかかる力が増大しダイヤモンド砥粒が脱落、欠損することを見出した。また、ＣＭＰスラリーに対して耐久性のある物質、例えば炭化珪素（ＳｉＣ）、ダイヤモンドライクカーボン、サファイア、アルミナ、TiO_2、安定化ジルコニア、ＺｒＮ、ＺｒＣ、ＷＣ、ＷＣ－Ｃｏ、ＴｉＣ、ＴｉＡｌＮ、Ｔｉｎ－Ｎｉ、$LiNbO_3$、ＮｂＣ、$LiTaO_3$、ＴａＣあるいはＨｆＣで砥粒あるいはＣＭＰコンディショナーの加工部表面を被覆すれば砥粒の磨耗等を少なくでき、研磨パッドの平坦度ならびに面粗さを維持し、砥粒の脱落等を防止できることを見出した。また、安価な砥粒にＣＭＰスラリーに対して耐久性のある物質を被覆すれば、安価で高品質のＣＭＰコンディショナーを提供できることを見出した。本発明はかかる知見をもとになされたものである。

【課題を解決するための手段】

【0010】

本発明の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナーは、半導体平坦化ＣＭＰプロセスに用いるＣＭＰパッド研磨研削用の砥粒と、この砥粒を保持するボンド層と、このボンド層を固着した台とよりなり、上記砥粒はダイヤモンドよりＣＭＰスラリーに対して耐久性を持つ物質であることを特徴とする。

【0011】

本発明の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナーは、半導体平坦化ＣＭＰプロセスに用いるＣＭＰパッド研磨研削用の砥粒と、この砥粒を保持するボンド層と、このボンド層を固着した台とよりなり、上記砥粒の表面にＣＭＰスラリーに対して耐久性を持つ物質が被覆されていることを特徴とする。

【0012】

本発明の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナーは、半導体平坦化ＣＭＰプロセスに用いるＣＭＰパッド研磨研削用の砥粒と、この砥粒を保持するボンド層と、このボンド層を固着した台とよりなり、ＣＭＰスラリーに対して耐久性を持つ物質を上記砥粒表面及び上記ボンド層表面に被覆せしめたことを特徴とする。

【0013】

上記被覆した物質の膜厚は１０ｎｍ～９００μｍであることを特徴とする。

【0014】

上記各砥粒は夫々離間しており、上記砥粒のうち上記台からの高さが一番低い砥粒の高さと、上記台からの高さが一番高い砥粒の高さとの差が１００μｍ以内であることを特徴とする。

【0015】

上記各砥粒は夫々離間しており、上記被覆した砥粒のうち上記台からの高さが一番低い砥粒の高さと、上記台からの高さが一番高い砥粒の高さとの差が１００μｍ以内であることを特徴とする。

【0016】

上記ダイヤモンドよりＣＭＰスラリーに対して耐久性を持つ物質は、炭化珪素（ＳｉＣ）、ダイヤモンドライクカーボン、サファイア、アルミナ、安定化ジルコニアであることを特徴とする。

【0017】

上記ＣＭＰスラリーに対して耐久性を持つ物質は、炭化珪素（ＳｉＣ）、ダイヤモンドライクカーボン、サファイア、アルミナ、TiO_2、安定化ジルコニア、ＺｒＮ、ＺｒＣ、ＷＣ、ＷＣ－Ｃｏ、ＴｉＣ、ＴｉＡｌＮ、Ｔｉｎ－Ｎｉ、$LiNbO_3$、ＮｂＣ、$LiTaO_3$、ＴａＣあるいはＨｆＣであることを特徴とする。

【発明の効果】
【0018】
本発明の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナーによれば、砥粒の磨耗、磨滅、変質や砥粒の脱落、欠損を防止できるので、長時間研磨パッドのコンディショニングを行うことができ、ＣＭＰパッドコンディショナーの交換の手間やＣＭＰ装置のダウンタイムならびにロス時間を減らすことができ、また、半導体ウェハ表面に傷が付くのを防止することができるという大きな利益がある。また、安価で高品質のＣＭＰコンディショナーを提供できる。
【発明を実施するための最良の形態】
【0019】
以下図面によって本発明の実施例を説明する。
【実施例】
【0020】
本発明のＣＭＰ装置用のＣＭＰパッドコンディショナー６においては、図１に示すように、ＣＭＰ研磨パッドのＣＭＰコンディショニング用砥粒としてダイヤモンド砥粒８を用いる代わりに、例えば粒径１００μｍ±４０μｍの、ダイヤモンドよりＣＭＰスラリーに対して耐磨耗性、耐磨滅性、耐変質性等の耐久性を持つ化学的に安定した結晶構造を持った例えば炭化珪素（ＳｉＣ）、ダイヤモンドライクカーボン、サファイア、アルミナ、安定化ジルコニアなどの物質からなる砥粒などの物質からなる砥粒１０を用いる。パッドコンディショナー用の台金７に形成せしめたＮｉメッキボンド層等のボンド層９の厚さは、上記砥粒１０の粒径のおよそ三分の一を突出せしめて固着せしめることができる程度が好適である。なお、各砥粒間隔は例えば約１０μｍ～１０ｍｍとし、ＣＭＰコンディショナーにかかる加圧力と相関してひとつの砥粒にかかる加圧力でＣＭＰコンディショナー全体の砥粒の数を決定することが望ましい。
【0021】
本発明によれば、上記砥粒１０はＣＭＰスラリー対して耐久性がダイヤモンドより大きいので、磨耗、磨滅、変質しづらく、砥粒の脱落、欠損を防ぐ事ができ、長期間ＣＭＰ研磨パッドのコンディショニングを続けることができるという大きな利益がある。
【0022】
なお、ＣＭＰスラリーをポリシャーとしての被研磨特性を試行したところ、ダイヤモンドは１時間程度で磨滅したが、サファイアを同じ量削るには２～３時間かかり、また、ＳｉＣを同量研磨するには１０～２０時間かかった。従って、ＣＭＰスラリーに対して耐久性のある物質としては特にＳｉＣが好ましい。
【0023】
また、上記各砥粒を夫々離間せしめ、また、上記砥粒のうち、台金からの先端高さが一番低い砥石の先端高さと、台金からの先端高さが一番高い砥粒の先端高さとの差を１００μｍ以内、例えば３μｍ以内としたＣＭＰコンディショナーを用いた場合、ＣＭＰパッドの面粗さを均一化することができ、ＣＭＰ加工品質を向上させ、半導体ウェハの品質を高めることができる。
【0024】
また、上記台金７は金属系の他に樹脂系、粉末冶金系であってもよい。
【実施例】
【0025】
本発明の第２の実施例においては、図２に示すように研磨パッドのコンディショニング用の砥粒として、その表面にスパッタリング、イオンプレーティング、真空蒸着法又は化学蒸着（ＣＶＤ）法等により、ＣＭＰスラリーに対して耐久性のある、例えば炭化珪素（ＳｉＣ）、ダイヤモンドライクカーボン、サファイア、アルミナ、TiO_2、安定化ジルコニア、ＺｒＮ、ＺｒＣ、ＷＣ、ＷＣ－Ｃｏ、ＴｉＣ、ＴｉＡｌＮ、Ｔｉｎ－Ｎｉ、$LiNbO_3$、ＮｂＣ、$LiTaO_3$、ＴａＣあるいはＨｆＣなどの物質１１を例えば約１０ｎｍ～９００μｍ被覆したダイヤモンド砥粒、ＳｉＣ砥粒、アルミナ砥粒あるいは立方晶窒

化ホウ素（ＣＢＮ）砥粒などの砥粒１２を用い、パッドコンディショナー用の台金７に形成せしめたＮｉメッキボンド層等のボンド層９に、上記砥粒１２の全部あるいは一部を上記ボンド層９で固着せしめる。

【0026】

この第２の実施例においては、上記物質１１はＣＭＰスラリーに対して耐久性があるので、磨耗等しづらく、砥粒の脱落等を防ぐ事ができ、長期間ＣＭＰ研磨パッドのコンディショニングを続けることができる。また、安価な砥粒にＣＭＰスラリーに対して耐久性のある物質を被覆すれば、安価で高品質のＣＭＰコンディショナーを提供できる。

【0027】

なお、上記物質１１を被覆する部分は、上記砥粒１２の切刃となる部分の表面だけであってもよい。

【0028】

また、各砥粒を夫々離間せしめ、また、上記被覆した砥粒のうち、台金からの先端高さが一番低い砥石の先端高さと、台金からの先端高さが一番高い砥粒の先端高さとの差を１００μｍ以内、例えば３μｍ以内としたＣＭＰコンディショナーを用いた場合、ＣＭＰパッドの面粗さを均一化することができ、ＣＭＰ加工品質を向上させ、半導体ウェハの品質を高めることができる。

【0029】

また、上記台金は金属系の他に樹脂系、粉末冶金系であってもよい。

【0030】

また、上記ＣＭＰスラリーに対して耐久性のある物質は炭化珪素（ＳｉＣ）、ダイヤモンドライクカーボン、サファイア、アルミナ、安定化ジルコニアなどのダイヤモンドよりＣＭＰスラリーに対して耐久性のある物質であることが好ましい。

【実施例】

【0031】

本発明の第３の実施例においては、図３に示すようにＣＭＰ研磨パッドのコンディショニング用の砥粒としてダイヤモンド砥粒、ＳｉＣ砥粒、アルミナ砥粒あるいは立方晶窒化ホウ素（ＣＢＮ）砥粒などの砥粒１２を用い、パッドコンディショナー用の台金７に形成せしめたＮｉメッキボンド層等のボンド層９に、上記砥粒１２の全部あるいは一部を上記ボンド層９の表面から突出せしめて固着せしめる。また加えて上記ボンド層９の表面から突出した砥粒１２の表面及び上記ボンド層９の表面にスパッタリング又はＣＶＤ法等により、ＣＭＰスラリーに対する耐久性のある、例えば炭化珪素（ＳｉＣ）、ダイヤモンドライクカーボン、サファイア、アルミナ、TiO_2、安定化ジルコニア、ＺｒＮ、ＺｒＣ、ＷＣ、ＷＣ－Ｃｏ、ＴｉＣ、ＴｉＡｌＮ、Ｔｉｎ－Ｎｉ、$LiNbO_3$、ＮｂＣ、$LiTaO_3$、ＴａＣあるいはＨｆＣなどの物質１１を例えば厚さ約１０ｎｍ～９００μｍで被覆せしめる。

【0032】

この第３の実施例においても、上記物質１１はＣＭＰスラリーに対して耐久性があるので、磨耗等しづらく、砥粒の脱落等を防ぐ事ができ、長期間ＣＭＰ研磨パッドのコンディショニングを続けることができる。また、安価な砥粒にＣＭＰスラリーに対して耐久性のある物質を被覆すれば、安価で高品質のＣＭＰコンディショナーを提供できる。

【0033】

なお、上記砥粒１２を被覆する部分は、上記砥粒１２の切刃となる部分の表面だけであってもよい。

【0034】

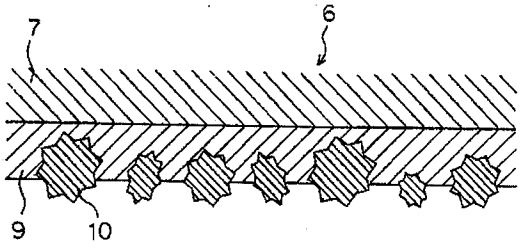
また、上記ＣＭＰスラリーに対して耐久性のある物質は炭化珪素（ＳｉＣ）、ダイヤモンドライクカーボン、サファイア、アルミナ、安定化ジルコニアなどのダイヤモンドよりＣＭＰスラリーに対して耐久性のある物質であることが好ましい。

【図面の簡単な説明】

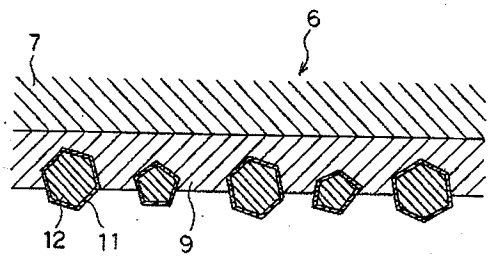
【0035】

【図1】本発明の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナーの第１の実施例の要部を拡大した縦断側面図である。
【図2】本発明の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナーの第２の実施例の要部を拡大した縦断側面図である。
【図3】本発明の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナーの第３の実施例の要部を拡大した縦断側面図である。
【図4】従来の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰ装置の斜視図である。
【図5】従来の半導体平坦化ＣＭＰプロセス（化学機械的研磨）におけるＣＭＰパッドコンディショナーの要部を拡大した縦断側面図である。
【符号の説明】
【0036】
１　定盤
２　ＣＭＰ研磨パッド
３　半導体ウェハ
４　半導体ウェハ押圧具
５　ＣＭＰスラリー供給部
６　ＣＭＰパッドコンディショナー
７　金属製台金
８　砥粒
９　ボンド層
１０　砥粒
１１　被覆物質
１２　砥粒

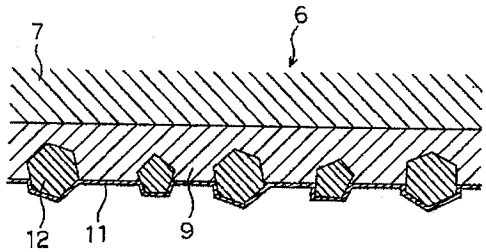
【図1】



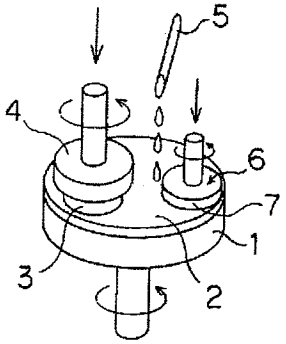
【図2】



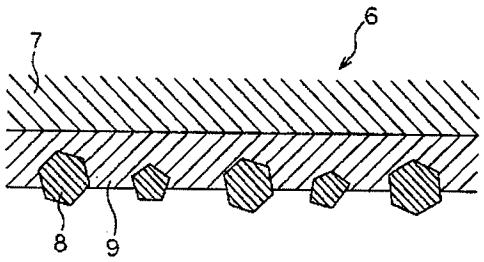
【図3】



【図4】



【図5】



(51)Int.Cl.	F I	テーマコード（参考）
	Ｂ２４Ｄ　3/00　３１０Ｄ	

Ｆターム(参考)　3C058 AA07 AA19 CB04 CB05 DA12 DA17
3C063 AB05 BA37 BB02 BB03 BB04 BB15 BC02 EE26 FF08 FF22
FF23

Electronic Acknowledgement Receipt

EFS ID:	14770142
Application Number:	12726786
International Application Number:	
Confirmation Number:	1959
Title of Invention:	CMP Pad Dressers with Hybridized Abrasive Surface and Related Methods
First Named Inventor/Applicant Name:	Chien-Min Sung
Customer Number:	20551
Filer:	David William Osborne/Eileen Fuessel
Filer Authorized By:	David William Osborne
Attorney Docket Number:	02074-32779.NP.CIP2
Receipt Date:	23-JAN-2013
Filing Date:	18-MAR-2010
Time Stamp:	14:55:35
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	trans.PDF	80306 2b0bd08f96cff603e62468c38b55242ed51056ad	no	4
Warnings:					
Information:					

2	Information Disclosure Statement (IDS) Form (SB08)	b.PDF	80414 f03900203d16591a54ef202b5bed69c7eb3ad721	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Information Disclosure Statement (IDS) Form (SB08)	a.PDF	105700 171f1b2e5122b89229475ee43b23cb829d908c5f	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
4	Non Patent Literature	ntc583.pdf	912719 524e3d68a9f801482c00e104383031bc24d1beae	no	13
Warnings:					
Information:					
5	Non Patent Literature	sungsearchreport.pdf	526584 9f31e7166acab1c7b974ead773279aecaa2a9e93	no	12
Warnings:					
Information:					
6	Non Patent Literature	ntc823.pdf	752049 5f4b1d693759db2ce1922b6d299233bbacb6eb62	no	15
Warnings:					
Information:					
7	Non Patent Literature	oa917.pdf	307976 70f7e0b383abe99e1b9fcfd853528e6a2cd7879e	no	10
Warnings:					
Information:					
8	Non Patent Literature	ntc172.pdf	170424 af5defbb81978bb06155ffa03319993ce4e5d028	no	4
Warnings:					
Information:					
9	Non Patent Literature	ntc110.pdf	773838 3d15628fa199cba5e7dad9495b4ed1e9655223cc	no	14
Warnings:					
Information:					

10	Foreign Reference	jp823.pdf	518746 de65af588f5929ef3be2ee011746241a1e1e9f6e	no	10

Warnings:	
Information:	
Total Files Size (in bytes):	4228756

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.

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

ART UNIT: 3727 EXAMINER: Maurina Rachuba FIRST NAMED INVENTOR: Chien-Min Sung SERIAL NO.: 12/726,786 FILED: 3/18/2010 CONF. NO.: 1959 FOR: CMP PAD DRESSERS WITH HYBRIDIZED ABRASIVE SURFACE AND RELATED METHODS DOCKET NO.: 02074-32779.NP.CIP2	**CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8** DATE OF DEPOSIT: January 23, 2013 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. /DavidWOsborne/ David W. Osborne

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.

☐ 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 23rd day of January, 2013.

Respectfully submitted,

/DavidWOsborne/

David W. Osborne
Attorney for Applicant
Registration No. 44989

THORPE NORTH & WESTERN, LLP
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Sandy, Utah 84091-1219
Telephone: (801) 566-6633

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.
12/726,786	03/18/2010	Chien-Min Sung	02074-32779.NP.CIP2	1959

20551 7590 03/19/2013

THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

EXAMINER	
RACHUBA, MAURINA T	
ART UNIT	PAPER NUMBER
3727	

NOTIFICATION DATE	DELIVERY MODE
03/19/2013	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):

causse@tnw.com
patentdocket@tnw.com
rich@tnw.com

Office Action Summary	Application No.	Applicant(s)	
	12/726,786	SUNG, CHIEN-MIN	
	Examiner	Art Unit	
	MAURINA RACHUBA	3727	

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

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *31 December 2012*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ 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.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *1-19* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-19* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, 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.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *18 March 2010* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

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)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *see Action*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Information Disclosure Statement

1. The information disclosure statement (IDS) submitted on 06 April 2011, 23 August 2011, 19 October 2011, 24 February 2012, 04 April 2012, 07 May 2012, 07 June 2012, 10 August 2012, 19 October 2012, 23 January 2012, have been considered by the examiner.

Election/Restrictions

2. Claim 5 is allowable, on condition that the double patenting rejection be successfully overcome. The restriction requirement, as set forth in the Office action mailed on 29 October 2012 has been reconsidered in view of the allowability of claims to the elected invention pursuant to MPEP § 821.04(a). **The restriction requirement is hereby withdrawn as to any claim that requires all the limitations of an allowable claim.** Claims 8, 15, 18 and 19, directed to species are no longer withdrawn from consideration because the claim(s) requires all the limitations of an allowable claim. In view of the above noted withdrawal of the restriction requirement, applicant is advised that if any claim presented in a continuation or divisional application is anticipated by, or includes all the limitations of, a claim that is allowable in the present application, such claim may be subject to provisional statutory and/or nonstatutory double patenting rejections over the claims of the instant application.

Once a restriction requirement is withdrawn, the provisions of 35 U.S.C. 121 are no longer applicable. See *In re Ziegler*, 443 F.2d 1211, 1215, 170 USPQ 129, 131-32 (CCPA 1971). See also MPEP § 804.01.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

4. Claims 1-4 are rejected under 35 U.S.C. 102(b) as being anticipated by Cho et al, 6,213,856. As broadly claimed, '856, figure 8, discloses a method for conditioning a CMP pad, comprising: cutting the CMP pad with superabrasive cutting elements **44**; and controlling a degree of contact between the CMP pad and the cutting elements using control elements **42**, (as the control elements are smaller than the cutting elements, the degree of contact is controlled by the smaller elements when they contact the polishing pad, compressing and cutting the pad) wherein the degree of contact is established through placement of the control elements relative to the cutting elements (the control elements alternate with the cutting elements); wherein controlling the degree of contact includes alternating regions of cutting elements with regions of control elements; wherein controlling the degree of contact includes locating the regions of control elements at a distance from the regions of cutting elements to establish the degree of contact in relation to material characteristics of the CMP pad; wherein controlling the degree of contact includes locating the regions of control elements at a distance from the regions of cutting elements to affect a degree of compression of the CMP pad along a leading edge of the regions of cutting elements.

Double Patenting

5. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

Claims 5-19 are provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-14 of copending Application No. 12/255,823. Although the conflicting claims are not identical, they are not patentably distinct from each other because the claims of the pending application are merely broader than the claims of allowed copending application 12/255,823. *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993). In essence, once the applicant has received a patent or allowed claims for a species or a more specific embodiment, he is not entitled to a patent for the generic or broader invention without maintaining common ownership and ensuring that the term of the latter issued patent will expire at the end of the original term of the earlier issued patent. This is because the more specific "anticipates" the broader.

This is a provisional obviousness-type double patenting rejection because the conflicting claims have not in fact been patented, although they are allowed.

Conclusion

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Other similar devices and methods are cited of interest.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAURINA RACHUBA whose telephone number is (571)272-4493. The examiner can normally be reached on Monday-Thursday, 6:00AM-4:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Monica Carter can be reached on 571 272 4475. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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.

/M. Rachuba/
Primary Examiner, Art Unit 3727

Notice of References Cited	Application/Control No. 12/726,786	Applicant(s)/Patent Under Reexamination SUNG, CHIEN-MIN	
	Examiner MAURINA RACHUBA	Art Unit 3727	Page 1 of 1

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/M.R./		US Application 12/255,823; filing date 10/22/2005; Chien-Min Sung; office action issued 03/07/2012	
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Examiner Signature	/Maurina Rachuba/	Date Considered	10/17/2012

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First Named Inventor	Chien-Min Sung
Art Unit	3727
Examiner Name	Maurina Rachuba
Attorney Docket Number	02074-32779.NP.CIP2

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 12/715,583; filed 03/02/2010; Chien-Min Sung; notice of allowance dated 12/07/2012	
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		JP 2007-044823	02/22/2007	Soken		

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Examiner Name	«Examiner and Art Unit Patent Examiner / Full Name: (Once)»
Attorney Docket Number	«Matter Matter ID»

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		2008/0153398	06/2008	Sung	
		7658666	02/2010	Sung	

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		EP1075898	02/2001	Tanaka et al.		

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PTO/SB/08B (08-03)
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet | | of | |

Complete if Known	
Application Number	12/726,786
Filing Date	3/18/2010
First Named Inventor	Chien-Min Sung
Art Unit	
Examiner Name	
Attorney Docket Number	00802-32779.NP.CIP2

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]
/M.R./		US Application 12/267,172; filing date 11/07/2008; Chien-Min Sung; office action issued 01/03/2012	

Examiner Signature	/Maurina Rachuba/	Date Considered	10/17/2012

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1069	451/443.ccls. 451/444.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/02/28 09:41
S2	8	S1 and (segment with blade)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/02/28 09:41
S3	145034	(cmp) (chemical adj mechanical adj polish$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/02/28 09:42
S4	85	(condition$4 with pad) and (segment with blade)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/02/28 09:45
S5	33478	(segment same blade)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/02/28 09:49
S6	36002	(condition$4 with pad)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/02/28 09:49
S7	142	S5 and S6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/02/28 09:49
S8	57	S7 not S4	US-PGPUB;	OR	ON	2012/02/28

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			09:49
S9	632	S5 same abrasive	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/02/28 09:49
S10	19	S9 and S6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/02/28 09:49
S11	4	S1 and S9	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/02/28 09:51
S12	169	S1 and blade	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/02/28 09:56
S13	35	451/548.ccls. and S5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/02/28 10:05
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S24	4	US-20080076338-$.DID. OR US-6196911-$.DID. OR US-6899592-$.DID. OR US-7150677-$.DID.	US-PGPUB; USPAT; USOCR	OR	ON	2012/09/17 09:21
S25	8	"20040180617".pn. "20100015898".pn. "20100203811".pn. "20040203325".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/09/17 09:22
S26	12	S24 S25	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/09/17 09:22
S27	6	"20020164928".pn. "20080153398".pn. "7658666".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/09/17 09:25
S31	13	(US-20100203811-$ or US-20060079160-$ or US-20040203325-$ or US-20060079162-$ or US-20020127962-$).did. or (US-6196911-$	US-PGPUB; USPAT	OR	ON	2012/10/17 07:09

		or US-7261621-$ or US-6672943-$ or US-6371842-$ or US-6213856-$ or US-5536202-$ or US-5527424-$ or US-5380390-$).did.				
S32	11	S31 and (epoxy polyimide polyurethane organic resin)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/10/17 07:10
S33	289	((CHIEN-MIN) near2 (SUNG)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/03/11 07:27

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S28	1	alternating with pattern with blade with particle with abrasive with conditioner	US-PGPUB; USPAT; UPAD	OR	ON	2012/09/17 09:05
S29	2	alternating with pattern with blade with particle with abrasive	US-PGPUB; USPAT; UPAD	OR	ON	2012/09/17 09:06
S30	1	alternating with pattern with blade with particle with abrasive with condition$4	US-PGPUB; USPAT; UPAD	OR	ON	2012/09/17 09:06

3/12/2013 7:42:52 AM
C:\Users\mrachuba\Documents\EAST\Workspaces\12726786 conditioner with blade and wedge shaped segments.wsp

PTO/SB/08A (08-03)
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First Named Inventor	Chien-Min Sung
Art Unit	
Examiner Name	
Attorney Docket Number	00802-32779.NP.CIP2

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		2004/0180617	09/2004	Goers	
		2008/0076338	03/2008	Andrews et al.	
		2010/0015898	01/2010	An et al.	
		2010/0203811	08/2010	Philipossian et al.	
		6196911	03/2001	Preston et al.	
		6899592	05/2005	Kojima et al.	
		7150677	12/2006	Yamashita et al.	
		2004/0203325	10/2004	Donohue	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]- Number[4] – Kind Code[5] (if known)	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]

Examiner Signature	/Maurina Rachuba/	Date Considered	10/17/2012

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.R./

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12726786	SUNG, CHIEN-MIN
	Examiner	Art Unit
	MAURINA RACHUBA	3727

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
update on 451	56,443,444	3/12/2013	MTR

SEARCH NOTES		
Search Notes	Date	Examiner
consulted parent cases	3/12/2013	MTR
update on East, inventor and citation searches	3/12/2013	MTR

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

	/MAURINA RACHUBA/ Primary Examiner.Art Unit 3727

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First Named Inventor	Chien-Min Sung
Art Unit	
Examiner Name	
Attorney Docket Number	3356-32779.NP.CIP2

Sheet | | of |

NON PATENT LITERATURE DOCUMENTS

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/M.R./		US Application 12/267,172; filing date 11/07/2008; Chein-Min Sung; office action issued 01/03/2012	

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/M.R./		US Application 13/021,350; filed 02/04/2011; Chien-Min Sung; office action issued 02/07/2012	

Examiner Signature	/Maurina Rachuba/	Date Considered	10/17/2012

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Filing Date	3/18/2010
First Named Inventor	Chien-Min Sung
Art Unit	3727
Examiner Name	Maurina Rachuba
Attorney Docket Number	02074-32779.NP.CIP2

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 13/021,350; filed 02/04/2011; Chien-Min Sung; office action dated 03/20/2013	
		U.S. Application 13/362,917; filed 01/31/2012; Chien-Min Sung; office action dated 04/10/2013	
		U.S. Application 13/239,189; filed 09/21/2011; Chien-Min Sung; notice of allowance dated 05/03/2013	

Examiner Signature		Date Considered	

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Electronic Acknowledgement Receipt

EFS ID:	16107545
Application Number:	12726786
International Application Number:	
Confirmation Number:	1959
Title of Invention:	CMP Pad Dressers with Hybridized Abrasive Surface and Related Methods
First Named Inventor/Applicant Name:	Chien-Min Sung
Customer Number:	20551
Filer:	David William Osborne/Eileen Fuessel
Filer Authorized By:	David William Osborne
Attorney Docket Number:	02074-32779.NP.CIP2
Receipt Date:	20-JUN-2013
Filing Date:	18-MAR-2010
Time Stamp:	18:49:25
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	tran.PDF	80371 442d7d16d2472c90ee78d17928a006bd1b0b89ec	no	4
Warnings:					
Information:					

2	Non Patent Literature	oa350.pdf	324869 fa967faad15408b579528ac07b88ce895ba81a29	no	8
Warnings:					
Information:					
3	Non Patent Literature	oa917.pdf	1011364 11eb305b41b331359bbb3db79eb10baddb6d22dc	no	24
Warnings:					
Information:					
4	Non Patent Literature	ntc189.pdf	601543 c4a6139e916a49bd56fae1a18be07852d657c4b3	no	13
Warnings:					
Information:					
5	Information Disclosure Statement (IDS) Form (SB08)	b.PDF	78320 9059157271bc94c74b369b388df4b501ccb78ea2	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
		Total Files Size (in bytes):	2096467		

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.

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

ART UNIT: 3727 EXAMINER: Maurina Rachuba FIRST NAMED INVENTOR: Chien-Min Sung SERIAL NO.: 12/726,786 FILED: 3/18/2010 CONF. NO.: 1959 FOR: CMP PAD DRESSERS WITH HYBRIDIZED ABRASIVE SURFACE AND RELATED METHODS DOCKET NO.: 02074-32779.NP.CIP2	**CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8** DATE OF DEPOSIT: June 20, 2013 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. /David W. Osborne/ David W. Osborne

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.

☐ 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 20th day of June, 2013.

Respectfully submitted,

/David W. Osborne/

David W. Osborne
Attorney for Applicant
Registration No. 44989

THORPE NORTH & WESTERN, LLP
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Telephone: (801) 566-6633

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

ART UNIT:	3727
EXAMINER:	Maurina T. Rachuba
FIRST NAMED INVENTOR:	Chien-Min Sung
SERIAL NO.:	12/726,786
FILED:	03/18/2010
CONFRM. NO.:	1959
FOR:	CMP Pad Dressers With Hybridized Abrasive Surface and Related Methods
DOCKET NO.:	02074-32779.NP.CIP2

CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8

DATE OF DEPOSIT: **August 19, 2013**

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

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 March 19, 2013, please enter this amendment and reconsider this application in view of the remarks provided below. A petition for a two-month extension of time, the associated fee, and a terminal disclaimer are enclosed herewith.

AMENDMENTS TO THE CLAIMS

1-4. (canceled)

5. (original) A CMP pad dresser, comprising:

an organic matrix;

a plurality of cutting elements partially embedded directly in the organic matrix, the cutting elements being arranged into a plurality of distinct cutting element regions;

a plurality of control elements partially embedded directly in the organic matrix, the control elements being arranged into a plurality of distinct control element regions; and

wherein the cutting element regions and the control element regions are positioned in an alternating pattern, and wherein the control element regions are spaced relative to the cutting element regions to control a degree of contact between the cutting elements and a CMP pad.

6. (original) The CMP pad dresser of claim 5, wherein the organic matrix is coupled to a CMP pad dresser support substrate.

7. (original) The CMP pad dresser of claim 5, wherein the cutting elements include a member selected from the group consisting of particle elements, blade elements, and combinations thereof.

8. (original) The CMP pad dresser of claim 7, wherein at least a portion of the blade elements have a serrated cutting edge.

9. (original) The CMP pad dresser of claim 7, wherein at least a portion of the blade elements have a flat cutting edge.

10. (original) The CMP pad dresser of claim 7, wherein the control elements include a member selected from the group consisting of particle elements, blade elements, and combinations thereof.

11. (original) The CMP pad dresser of claim 5, wherein each of the plurality of cutting elements and each of the plurality of control elements includes a CMP pad contact region, and wherein the contact regions are leveled relative to one another such that no contact region protrudes above another contact region by more than about 30 microns.

12. (original) The CMP pad dresser of claim 5, wherein the control elements are made of a member selected from the group consisting of single crystal diamond, polycrystalline diamond, and combinations thereof.

13. (original) The CMP pad dresser of claim 5, wherein the cutting elements are made of a member selected from the group consisting of single crystal diamond, polycrystalline diamond, and combinations thereof.

14. (original) The CMP pad dresser of claim 5, wherein the alternating pattern includes single blade elements alternating between regions of particle elements.

15. (original) The CMP pad dresser of claim 5, wherein the alternating pattern includes groups of two or more blade elements alternating between regions of particle elements.

16. (original) The CMP pad dresser of claim 5, wherein the organic matrix includes a member selected from the group consisting of: 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 combinations thereof.

17. (original) The CMP pad dresser of claim 16, wherein the organic matrix is an epoxy resin.

18. (original) The CMP pad dresser of claim 16, wherein the organic matrix is a polyimide resin.

19. (original) The CMP pad dresser of claim 16, wherein the organic matrix is a polyurethane resin.

REMARKS

The Applicant expresses appreciation to the Examiner for consideration of the present application. In the Office Action of March 19, 2012, claims 1-19 were pending for consideration. All of the claims were rejected on various statutory grounds, each of which is addressed in turn below. By the present amendment, claims 1-4 have been canceled. Applicant submits that no new matter is added thereby. Accordingly, claims 5-19 remain pending in the present application. The Applicant respectfully submits that the present claims are allowable.

Nonstatory Obviousness-Type Double Patenting:

The Examiner has provisionally rejected claims 5-19 under the judicially created doctrine of obviousness-type double patenting as being allegedly unpatentable over claims 1- 14 of copending U.S. Patent Application No. 12/255,823. A terminal disclaimer is filed herewith in order to expedite the present prosecution, without agreeing to the Examiner's assertions.

35 U.S.C. § 102 Rejections:

The Examiner has rejected claims 1-4 under 35 U.S.C. § 102 (b) as being allegedly anticipated by U.S. Patent No. 6,213,856 (hereinafter "Cho"). Claims 1-4 have been canceled, thus rendering this rejection moot. It should be understood, however, that the cancellation of these claim should not be seen as being in agreement with the position taken by the Examiner, and the applicant reserves the right to pursue any relinquished subject matter at a later time.

CONCLUSION

As the Examiner has indicated that claim 5 is allowable on condition that the double patenting rejection be overcome, and as claims 6-19 depend from claim 5, it is respectfully requested that claims 5-19 be allowed. 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 19th day of August, 2013.

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:	12726786
Filing Date:	18-Mar-2010
Title of Invention:	CMP Pad Dressers with Hybridized Abrasive Surface and Related Methods
First Named Inventor/Applicant Name:	Chien-Min Sung
Filer:	David William Osborne/NIcole Solomon
Attorney Docket Number:	02074-32779.NP.CIP2

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

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:				
Extension - 2 months with $0 paid	1252	1	600	600

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Statutory or Terminal Disclaimer	1814	1	160	160
		Total in USD ($)		**760**

Electronic Acknowledgement Receipt

EFS ID:	16627471
Application Number:	12726786
International Application Number:	
Confirmation Number:	1959
Title of Invention:	CMP Pad Dressers with Hybridized Abrasive Surface and Related 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:	02074-32779.NP.CIP2
Receipt Date:	19-AUG-2013
Filing Date:	18-MAR-2010
Time Stamp:	20:09:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$760
RAM confirmation Number	6047
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Extension of Time	32779NPCIP2extension.pdf	59127 9aeb029a9fd205c6677e5515cb51a2ba689dfb37	no	1
Warnings:					
Information:					
2	Terminal Disclaimer Filed	32779NPCIP2termdisc.pdf	120636 11d79bbb72f84cf53ff5ca3dc2747e9618421776	no	1
Warnings:					
Information:					
3		32779NPCIP2response.pdf	70137 54598a3ffe574cf25fd64c960dfe94a02a71af03	yes	6

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	4
	Applicant Arguments/Remarks Made in an Amendment	5	6

Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	32372 472cf33fe64101eecdd027f869edba755abc8200	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	282272		

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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.

PTO/SB/22 (03-13)
Approved for use through 3/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): 02074-32779.NP.CIP2

Application Number	Filed
12/726,786	3/18/2010

For: CMP Pad Dressers with Hybridized Abrasive Surface and Related Methods

Art Unit	Examiner
3727	Maurina T. Rachuba

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):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☑ Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$ 600
☐ 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/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. 37 CFR 3.73(b) statement is enclosed (Form PTO/SB/96).

☑ attorney or agent of record. Registration number 44989.

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

/David W. Osborne/	August 19, 2013
Signature	Date
David W. Osborne	801-566-6633
Typed or printed name	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: 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.

PTO/SB/25 (02-09)
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TERMINAL DISCLAIMER TO OBVIATE A PROVISIONAL DOUBLE PATENTING REJECTION OVER A PENDING "REFERENCE" APPLICATION

Docket Number (Optional): 02074-32779.NP.CIP2

In re Application of: Chien-Min Sung

Application No.: 12/726,786

Filed: 3/18/2010

For: CMP Pad Dressers with Hybridized Abrasive Surface and Related Methods

The owner*, Chien-Min Sung, of 100 percent interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of any patent granted on pending **reference** Application Number 12/255,823, filed on 10/22/2008, as such term is defined in 35 U.S.C. 154 and 173, and as the term of any patent granted on said **reference** application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending **reference** application. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and any patent granted on the **reference** application are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of any patent granted on the instant application that would extend to the expiration date of the full statutory term as defined in 35 U.S.C. 154 and 173 of any patent granted on said **reference** application, "as the term of any patent granted on said **reference** application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending **reference** application," in the event that: any such patent: granted on the pending **reference** application: expires for failure to pay a maintenance fee, is held unenforceable, is found invalid by a court of competent jurisdiction, is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321, has all claims canceled by a reexamination certificate, is reissued, or is in any manner terminated prior to the expiration of its full statutory term as shortened by any terminal disclaimer filed prior to its grant.

Check either box 1 or 2 below, if appropriate.

1. ☐ For submissions on behalf of a business/organization (e.g., corporation, partnership, university, government agency, etc.), the undersigned is empowered to act on behalf of the business/organization.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

2. ☑ The undersigned is an attorney or agent of record. Reg. No. 44989

/David W. Osborne/ — Signature
August 19, 2013 — Date

David W. Osborne — Typed or printed name

(801) 566-6633 — Telephone Number

☑ Terminal disclaimer fee under 37 CFR 1.20(d) is included.

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.

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this statement. See MPEP § 324.

This collection of information is required by 37 CFR 1.321. 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.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
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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.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 12/726,786	Filing Date 03/18/2010	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) 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))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	08/19/2013	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 15	Minus	** 20	= 0	X $80 =	0
	Independent (37 CFR 1.16(h))	* 1	Minus	***3	= 0	X $420 =	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

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) 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
/SHAREILL COLES/

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.

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination	
	12/726,786	SUNG, CHIEN-MIN	

Document Code - DISQ	Internal Document – DO NOT MAIL

TERMINAL DISCLAIMER	☒ APPROVED	☐ DISAPPROVED
Date Filed : August 19, 2013	**This patent is subject to a Terminal Disclaimer**	

Approved/Disapproved by:

Henry D. Jefferson

U.S. Patent and Trademark Office

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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NOTICE OF ALLOWANCE AND FEE(S) DUE

20551 7590 09/04/2013
THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

EXAMINER
RACHUBA, MAURINA T

ART UNIT	PAPER NUMBER
3727	

DATE MAILED: 09/04/2013

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/726,786	03/18/2010	Chien-Min Sung	02074-32779.NP.CIP2	1959

TITLE OF INVENTION: CMP PAD DRESSERS WITH HYBRIDIZED ABRASIVE SURFACE AND RELATED METHODS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1780	$300	$0	$2080	12/04/2013

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)

20551 7590 09/04/2013
THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

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.

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.
12/726,786	03/18/2010	Chien-Min Sung	02074-32779.NP.CIP2	1959

TITLE OF INVENTION: CMP PAD DRESSERS WITH HYBRIDIZED ABRASIVE SURFACE AND RELATED METHODS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1780	$300	$0	$2080	12/04/2013

EXAMINER	ART UNIT	CLASS-SUBCLASS
RACHUBA, MAURINA T	3727	451-056000

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 _____
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 credit 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	NOTE: Absent a valid certification of Micro Entity Status (see form PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
❑ Applicant asserting small entity status. See 37 CFR 1.27	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.
❑ Applicant changing to regular undiscounted fee 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: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

This collection of information 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.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/726,786	03/18/2010	Chien-Min Sung	02074-32779.NP.CIP2	1959

20551 7590 09/04/2013

THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

EXAMINER	
RACHUBA, MAURINA T	

ART UNIT	PAPER NUMBER
3727	

DATE MAILED: 09/04/2013

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

The Patent Term Adjustment to date is 446 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 446 day(s).

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 Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

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. 12/726,786	Applicant(s) SUNG, CHIEN-MIN	
	Examiner MAURINA RACHUBA	Art Unit 3727	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 *the amendment and terminal disclaimer filed 19 August 2013*.
   ☐ 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 *5-19*. 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 6/20/13
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 _____.

/M. Rachuba/
Primary Examiner, Art Unit 3727

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12726786	SUNG, CHIEN-MIN
	Examiner	**Art Unit**
	MAURINA RACHUBA	3727

| CPC | | |

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12726786	SUNG, CHIEN-MIN
	Examiner	**Art Unit**
	MAURINA RACHUBA	3727

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
451	443	B	2	4	B	53 / 12 (2006.01.01)						

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
451	444				

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	15	
/MAURINA RACHUBA/ Primary Examiner.Art Unit 3727	8/28/2013	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1, 2A

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12726786	SUNG, CHIEN-MIN
	Examiner	**Art Unit**
	MAURINA RACHUBA	3727

☒ 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												
	3		19												
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	5														
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	7														
	8														
	9														
	10														
	11														
	12														
	13														
	14														
	15														
	16														

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	15	
/MAURINA RACHUBA/ Primary Examiner.Art Unit 3727	8/28/2013	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1, 2A

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BIB DATA SHEET

CONFIRMATION NO. 1959

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
12/726,786	03/18/2010	451	3727	02074-32779.NP.CIP2

APPLICANTS

Chien-Min Sung, Tansui, TAIWAN;

**** CONTINUING DATA ***************************

This application is a CIP of 12/255,823 10/22/2008 PAT 8393934
which is a CIP of 12/168,110 07/05/2008 PAT 8398466
which claims benefit of 60/976,198 09/28/2007
and is a CIP of 11/560,817 11/16/2006 PAT 7762872

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

04/07/2010

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /MAURINA T RACHUBA/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		TAIWAN	4	19	2

ADDRESS

THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219
UNITED STATES

TITLE

CMP Pad Dressers with Hybridized Abrasive Surface and Related Methods

FILING FEE RECEIVED	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit
1220		

BIB (Rev. 05/07).

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12726786	SUNG, CHIEN-MIN
	Examiner	Art Unit
	MAURINA RACHUBA	3727

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
update on 451	56,443,444	3/12/2013	MTR
update		8/28/2013	MTR

SEARCH NOTES		
Search Notes	Date	Examiner
consulted parent cases	3/12/2013	MTR
update on East, inventor and citation searches	3/12/2013	MTR
update	8/2/2013	MTR

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
451	443, 444	8/28/2013	MTR

	/MAURINA RACHUBA/ Primary Examiner.Art Unit 3727

Receipt date: 06/20/2013

PTO/SB/08B (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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)

Sheet		of	

Complete if Known	
Application Number	12/726,786
Filing Date	3/18/2010
First Named Inventor	Chien-Min Sung
Art Unit	3727
Examiner Name	Maurina Rachuba
Attorney Docket Number	02074-32779.NP.CIP2

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]
/M.R./		U.S. Application 13/021,350; filed 02/04/2011; Chien-Min Sung; office action dated 03/20/2013	
/M.R./		U.S. Application 13/362,917; filed 01/31/2012; Chien-Min Sung; office action dated 04/10/2013	
/M.R./		U.S. Application 13/239,189; filed 09/21/2011; Chien-Min Sung; notice of allowance dated 05/03/2013	

Examiner Signature	/Maurina Rachuba/	Date Considered	08/28/2013

*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]Applicant 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. Confidentially 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.

PTO/SB/08A (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet | | of |

Complete if Known	
Application Number	12/726,786
Filing Date	3/18/2010
First Named Inventor	Chien-Min Sung
Art Unit	3727
Examiner Name	Maurina Rachuba
Attorney Docket Number	02074-32779.NP.CIP2

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		2001/0046835	11/2001	Wielonski et al.	
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Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]- Number[4] – Kind Code[5] (if known)	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]
		KR 10/2007/0063569	06/19/2007	Sung		
		KR 10/2002/0036138	05/16/2002	Kinik Co.		

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Application Number	12/726,786
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Examiner Name	Maurina Rachuba
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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 13/239,198; filed 09/21/2011; Chien-Min Sung; office action dated 07/23/2013	
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CONTOURED CMP PAD DRESSER AND ASSOCIATED METHODS

No documents available for this priority number.

Inventor(s): SUNG CHIEN MIN [US] ± (SUNG CHIEN MIN)

Applicant(s): SUNG CHIEN MIN [US] ± (SUNG CHIEN MIN)

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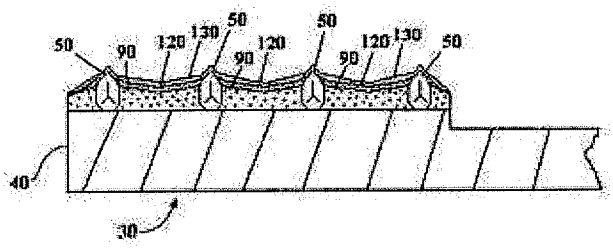
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Abstract of KR20070063569 (A)

CMP pad dressers with increased pad dressing work loads on centrally located abrasive particles (310) during dressing of a CMP pad, and methods associated therewith are disclosed and described. The increase in work loads on centrally located particles (310) improves pad dressing performance and also extends the service life of the pad dresser.



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전체 청구항 수 : 총 62 항

(54) 윤곽지어진 CMP 패드 드레서 및 관련 방법들

(57) 요약

CMP 패드의 드레싱 동안 중심에 위치한 연마 입자들(310)에 패드 드레싱 작업 부하를 증가시킨 CMP 패드 드레서, 및 이와 관계된 방법이 개시되고 설명된다. 중심에 위치한 입자들(310)에 대한 작업 부하의 증가는 패드 드레싱 성능을 개선시키고 또한 패드 드레서의 사용 수명을 연장시킨다.

대표도

도 10

특허청구의 범위

청구항 1.

둘레에 위치한 입자들의 CMP 패드 내부로의 침투를 감소시키고 중심에 위치한 입자들의 CMP 패드 내부로의 침투를 증가시키는 패턴으로 초연마 입자들을 배열하는 것을 포함하는,

CMP 패드를 드레서로 드레싱하는 동안 CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 2.

제 1항에 있어서, 상기 초연마 입자들의 패턴은 둘레에 위치한 입자들의 작업 말단으로부터 중심에 위치한 입자들의 작업 말단까지 상향의 기울기를 제공함을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 3.

제 2항에 있어서, 상기 기울기는 둘레에 위치한 입자들에서 중심에 위치한 입자들까지 드레서의 작업 표면 위의 입자 높이를 증가시킴으로써 제공됨을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 4.

제 2항에 있어서, 상기 기울기는 패드 속도(velocity) 및 가요성을 측정하여 결정됨을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 5.

제 2항에 있어서, 상기 기울기는 0.1% 내지 0.5% 임을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 6.

제 5항에 있어서, 상기 기울기는 0.2%임을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 7.

제 1항에 있어서, 상기 초연마 입자들의 패턴은 중심에 위치한 입자들의 밀도 보다 더 높은, 둘레에 위치한 입자들의 밀도를 제공함을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 8.

제 7항에 있어서, 상기 둘레에 위치한 입자들의 밀도는 중심에 위치한 입자들의 밀도보다 5배 이상 더 큼을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

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청구항 9.

제 7항에 있어서, 상기 둘레에 위치한 입자들의 밀도는 중심에 위치한 입자들의 밀도보다 2배 이상 더 큼을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 10.

제 7항에 있어서, 상기 둘레에 위치한 입자들의 밀도는 중심에 위치한 입자들의 밀도보다 1.25배 이상 더 큼을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 11.

제 7항에 있어서, 중심에 그리고 둘레에 위치한 입자들 사이의 초연마 입자들은 중심에 위치한 입자들 및 둘레에 위치한 입자들의 밀도 사이의 밀도로 배치됨을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 12.

제 7항에 있어서, 상기 초연마 입자들의 패턴은 둘레에 위치한 입자들에서는 높고 중심에 위치한 입자들에서는 낮은, 실질적으로 연속적인 밀도 구배를 제공함을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 13.

제 1항에 있어서, 상기 초연마 입자들의 패턴은 둘레에 위치한 입자들의 애티튜드에 의하여 제공되는 침투보다 CMP 패드 내부로 더 큰 입자 침투를 유발하는 애티튜드를 가지는 중심에 위치한 입자들을 제공함을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 14.

제 13항에 있어서, 상기 중심에 위치한 입자들의 애티튜드는 이들의 작업 말단에서 꼭지점(apex)이며, 둘레에 위치한 입자들의 애티튜드는 이들의 작업 말단에서 에지 또는 면임을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 15.

제 13항에 있어서, 상기 중심에 위치한 입자들의 애티튜드는 이들의 작업 말단에서 에지이며, 둘레에 위치한 입자들의 애티튜드는 이들의 작업 말단에서 면임을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 16.

제 13항에 있어서, 상기 중심에 위치한 입자들의 애티튜드는 이들의 작업 말단에서 꼭지점(apex)이며, 둘레에 위치한 입자들의 애티튜드는 이들의 작업 말단에서 면이고, 사이에 위치한 입자들은 이들의 작업 말단에서 에지의 애티튜드를 가짐을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

EX1058, Page 1292

청구항 17.

제 1항, 2항, 7항 또는 13항 중 어느 한 항에 있어서, 상기 중심에 위치한 입자들의 작업 부하는 상기 둘레에 위치한 입자들의 작업 부하의 적어도 30% 까지 이내까지 증가됨을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 18.

제 17항에 있어서, 상기 중심에 위치한 입자들의 작업 부하는 둘레에 위치한 입자들의 작업 부하의 적어도 10% 이내까지 증가됨을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 19.

제 17항에 있어서, 상기 중심에 위치한 입자들의 작업 부하는 둘레에 위치한 입자들의 작업 부하와 실질적으로 동일하게 증가됨을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 20.

제 17항에 있어서, 모든 입자들의 작업 부하는 실질적으로 동일함을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 21.

제 2항 또는 13항에 있어서, 상기 초연마 입자들은 각각 개별적으로 예정된 패턴에 따라 기판 상의 특정 위치에 배치됨을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 22.

제 21항에 있어서, 상기 패턴은 실질적으로 균일한 격자임을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 23.

제 1항, 2항, 7항 또는 13항 중 어느 한 항에 있어서, 상기 초연마 입자들은 다이아몬드, 다결정질 다이아몬드 (PCD), 입방정 질화 붕소 (cBN), 및 다결정질 입방정 질화 붕소 (PCBN)로 구성된 그룹에서 선택됨을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 24.

제 23항에 있어서, 상기 초연마 입자들은 다이아몬드임을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 25.

제 1항, 2항, 7항 또는 13항 주 어느 한 항에 있어서, 초연마 입자들이 결합되는 기판을 제공하는 단계를 더욱 포함함을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 26.

제 25항에 있어서, 상기 초연마 입자들은 브레이징, 소결, 또는 전기도금에 의하여 기판에 결합됨을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 27.

제 1항, 2항, 7항 또는 13항 중 어느 한 항에 있어서, 상기 초연마 입자들은 실질적으로 균일한 형상을 가짐을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 28.

제 27항에 있어서, 상기 균일한 형상은 자형임을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 29.

제 27항에 있어서, 상기 균일한 형상은 팔면체임을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 30.

제 25항에 있어서, 상기 기판은 가요성의 금속 또는 세라믹 물질로 제조됨을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 31.

제 30항에 있어서, 상기 금속 물질은 스테인레스 강임을 특징으로 하는, CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 작업 부하를 증가시키는 방법.

청구항 32.

다음을 포함하는 CMP 패드 드레서:

기판; 및

상기 기판에 부착된 복수의 초연마 입자들, 여기서 상기 초연마 입자들은 둘레에 위치한 입자들의 작업 말단으로부터 중심에 위치한 입자들의 작업 말단까지 상향의 기울기를 제공하는 예정된 패턴으로 배열됨.

청구항 33.

다음을 포함하는 CMP 패드 드레서:

기판; 및

상기 기판에 부착된 복수의 초연마 입자들, 여기서 상기 초연마 입자들은 중심에 위치한 입자들의 밀도 보다 더 높은, 둘레에 위치한 입자들의 밀도를 제공하는 예정된 패턴으로 배열됨.

청구항 34.

다음을 포함하는 CMP 패드 드레서:

기판; 및

상기 기판에 부착된 복수의 초연마 입자들, 여기서 상기 초연마 입자들은 중심에 위치한 입자들에, 둘레에 위치한 입자들의 애티튜드에 의하여 제공되는 침투보다, CMP 패드 내부로 더 큰 입자 침투를 유발하는 애티튜드를 제공하는 예정된 패턴으로 배열됨.

청구항 35.

제 32항에 있어서, 상기 기울기는 둘레에 위치한 입자들로부터 중심에 위치한 입자들까지 드레서의 작업 표면 위의 입자 높이를 증가시킴으로써 제공됨을 특징으로 하는, CMP 패드 드레서.

청구항 36.

제 32항에 있어서, 상기 기울기는 패드 속도(velocity) 및 가요성의 측정치로서 결정됨을 특징으로 하는, CMP 패드 드레서.

청구항 37.

제 32항에 있어서, 상기 기울기는 0.1% 내지 0.5%임을 특징으로 하는, CMP 패드 드레서.

청구항 38.

제 32항에 있어서, 상기 기울기는 0.2%임을 특징으로 하는, CMP 패드 드레서.

청구항 39.

제 33항에 있어서, 상기 둘레에 위치한 입자들의 밀도는 중심에 위치한 입자들의 밀도 보다 5배 이상임을 특징으로 하는, CMP 패드 드레서.

청구항 40.

제 33항에 있어서, 둘레에 위치한 입자들의 밀도는 중심에 위치한 입자들의 밀도 보다 2배 이상 더 큼을 특징으로 하는, CMP 패드 드레서.

청구항 41.

제 33항에 있어서, 둘레에 위치한 입자들의 밀도는 중심에 위치한 입자들의 밀도 보다 1.25배 이상 더 큼을 특징으로 하는, CMP 패드 드레서.

청구항 42.

제 33항에 있어서, 중심에 위치한 입자들과 둘레에 위치한 입자들 사이의 초연마 입자들은 중심에 위치한 입자들의 밀도와 둘레에 위치한 입자들의 밀도 사이의 밀도로 배치됨을 특징으로 하는, CMP 패드 드레서.

청구항 43.

제 33항에 있어서, 상기 초연마 입자들의 패턴은 둘레에 위치한 입자들에서는 높고 중심에 위치한 입자들에서는 낮은, 연속적 밀도 구배를 제공함을 특징으로 하는, CMP 패드 드레서.

청구항 44.

제 34항에 있어서, 중심에 위치한 입자들의 애티튜드는 이들의 작업 말단에서 꼭지점(apex)이고, 둘레에 위치한 입자들의 애티튜드는 이들의 작업 말단에서 에지 또는 면임을 특징으로 하는, CMP 패드 드레서.

청구항 45.

제 34항에 있어서, 중심에 위치한 입자들의 애티튜드는 이들의 작업 말단에서 에지이고, 둘레에 위치한 입자들의 애티튜드는 이들의 작업 말단에서 면임을 특징으로 하는, CMP 패드 드레서.

청구항 46.

제 34항에 있어서, 중심에 위치한 입자들의 애티튜드는 이들의 작업 말단에서 꼭지점(apex)이고, 둘레에 위치한 입자들의 애티튜드는 이들의 작업 말단에서 면이며, 이들 사이에 위치한 입자들은 이들의 작업 말단에서 에지의 애티튜드를 가짐을 특징으로 하는, CMP 패드 드레서.

청구항 47.

제 32항, 33항, 또는 34항 중 어느 한 항에 있어서, 상기 중심에 위치한 입자들의 작업 부하는 둘레에 위치한 입자들의 작업 부하의 적어도 30% 이내까지 증가됨을 특징으로 하는, CMP 패드 드레서.

청구항 48.

제 47항에 있어서, 상기 중심에 위치한 입자들의 작업 부하는 둘레에 위치한 입자들의 작업 부하의 적어도 10% 이내까지 증가됨을 특징으로 하는, CMP 패드 드레서.

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청구항 49.

제 47항에 있어서, 상기 중심에 위치한 입자들의 작업 부하는 둘레에 위치한 입자들의 작업 부하와 실질적으로 같아지도록 증가됨을 특징으로 하는, CMP 패드 드레서.

청구항 50.

제 47항에 있어서, 모든 입자들의 작업 부하는 실질적으로 동일함을 특징으로 하는, CMP 패드 드레서.

청구항 51.

제 32항 또는 34항에 있어서, 초연마 입자들은 각각 개별적으로 예정된 패턴에 따라 특정 위치에 배치됨을 특징으로 하는, CMP 패드 드레서.

청구항 52.

제 51항에 있어서, 상기 패턴은 실질적으로 균일한 격자임을 특징으로 하는, CMP 패드 드레서.

청구항 53.

제 32항, 33항, 또는 34항 중 어느 한 항에 있어서, 상기 초연마 입자들은 다이아몬드, 다결정질 다이아몬드 (PCD), 입방정 질화 붕소 (cBN), 및 다결정질 입방정 질화 붕소 (PCBN)로 구성되는 그룹에서 선택됨을 특징으로 하는, CMP 패드 드레서.

청구항 54.

제 53항에 있어서, 상기 초연마 입자들은 다이아몬드임을 특징으로 하는, CMP 패드 드레서.

청구항 55.

제32항, 33항, 또는 34항 중 어느 한 항에 있어서, 상기 초연마 입자들은 브레이징, 소결, 또는 전기도금에 의해 기판에 부착됨을 특징으로 하는, CMP 패드 드레서.

청구항 56.

제 32항, 33항, 또는 34항 중 어느 한 항에 있어서, 상기 초연마 입자들은 실질적으로 균일한 형상을 가짐을 특징으로 하는, CMP 패드 드레서.

청구항 57.

제 56항에 있어서, 상기 균일한 형상은 자형임을 특징으로 하는, CMP 패드 드레서.

청구항 58.

제 56항에 있어서, 상기 균일한 형상은 팔면체임을 특징으로 하는, CMP 패드 드레서.

청구항 59.

제 56항에 있어서, 상기 균일한 형상은 입방정 팔각임을 특징으로 하는, CMP 패드 드레서.

청구항 60.

제 32항, 33항 또는 34항 중 어느 한 항에 있어서, 상기 기판은 가요성의 금속 또는 세라믹 물질로 제조됨을 특징으로 하는, CMP 패드 드레서.

청구항 61.

제 60항에 있어서, 상기 금속 물질은 스테인레스 강임을 특징으로 하는, CMP 패드 드레서.

청구항 62.

다음 단계들을 포함하는, 제 32항 내지 34항 중 어느 한 항의 CMP 패드 드레서를 제조하는 방법:

기판을 제공하는 단계; 및

둘레에 위치한 입자들의 CMP 패드 내부로의 침투는 감소시키고 중심에 위치한 입자들의 CMP 패드 내부로의 침투는 증가시키는 패턴으로 기판에 복수의 초연마 입자들을 부착하는 단계.

명세서

기술분야

발명의 분야

본원 발명은 일반적으로 화학적 기계적 연마 (CMP) 패드를 드레싱 또는 컨디셔닝 하기 위한 장치 및 방법에 관계한다. 따라서, 본원 발명은 화학 및 물질 과학 분야에 관계된다.

배경기술

발명의 배경

많은 산업들은 특정 피가공물을 연마하기 위해 화학적 기계적 가공(CMP)을 사용하고 있다. 특히, 컴퓨터 제조 산업은 세라믹, 실리콘, 유리, 석영 및 이들의 금속들의 웨이퍼들을 연마하기 위하여 CMP 공정에 크게 의존하기 시작했다. 이러한 연마 공정들은 일반적으로 폴리우레탄과 같은 내구성 유기 물질로 제조된 회전식 패드에 대면하는 웨이퍼 사용을 수반한다. 패드에, 웨이퍼 물질을 손상시킬 수 있는 화학물질을 함유하는 화학물질 슬러리 및 웨이퍼 표면을 물리적으로 부식시키기 위하여 작용하는 양의 연마 입자들이 첨가된다. 슬러리는 회전하는 CMP 패드에 연속적으로 첨가되며, 웨이퍼에 가해지는 이원 화학물질 및 기계적 힘은 웨이퍼가 원하는 방식으로 연마되게 한다.

구현되는 연마의 품질에 특히 중요한 것은 패드 전체에 두루 퍼져있는 연마 입자들의 분포이다. 패드의 상부는 통상적으로 섬유, 또는 소형 공극과 같은 메커니즘으로 입자들을 지지하는데, 섬유 또는 소형 공극과 같은 메커니즘들은 패드의 회전 운동에 의해 발생되는 원심력으로 인해 패드가 이탈하는 것을 방지하기에 충분한 마찰력을 제공한다. 그러므로, 패드 상부를 가능한 한 가요성인 상태로유지하는 것, 그리고 섬유들을 가능한 한 직립으로 유지하는 것, 또는 새로운 연마 입자들을 수용할 수 있는 여분의 개구 및 공극들이 존재하도록 확보하는 것이 중요하다.

패드의 상부를 유지하는 것에 관한 문제는 피가공물, 연마 슬러리, 및 드레싱 디스크에서 생긴 연마 부스러기의 축적에 의해 야기된다. 이러한 축적은 패드 상부의 "글레이징" 또는 경화를 야기하며, 섬유질들을 헝클어 버리므로, 패드가 슬러리의 연마 입자들을 덜 지지할 수 있도록 만들고, 패드의 전체적인 연마 성능을 현저히 감소시킨다. 또한, 많은 패드들에 있어서, 슬러리를 지지하기 위하여 사용되는 공극들은 막히게 되고, 패드의 연마 표면의 전체적인 조도는 저하되어 편평해진다. 그러므로, 다양한 장치를 사용하여 패드 상부를 "코밍(combing)" 또는 "컷팅(cutting)"하여 재생시키기 위한 시도들이 이루어졌다. 이러한 공정은 CMP 패드를 "드레싱" 또는 "컨디셔닝"하는 것으로 공지되었다. 이러한 목적을 위하여 많은 유형의 장치들 및 공정들이 사용되었다. 이러한 하나의 장치는 표면에 부착된 다이아몬드 입자들과 같은 복수의 초경질 결정질 입자들을 구비한 디스크 또는 이들의 기판이다.

불행하게도, 전통적인 방법에 의하여 제조된 이러한 연마 디스크들은 여러 가지 문제점들을 보인다. 첫째, 연마 입자들은 디스크의 기판으로부터 제거되어 CMP 패드 섬유질에 붙잡힐 수 있다. 이는 연마되는 피가공물의 긁힘 및 파손을 초래한다. 둘째, 선행 기술의 제조 방법들은 기판의 표면위에 고르지 않은 간격의 그룹으로 밀집되는 연마 입자들을 가지는 디스크들을 생산하기 쉽다. 입자들 사이에 생성된 균일하지 않은 간격은 CMP 패드의 일부분을 과다하게 드레싱되게 하여 마모흔들을 생성하고, 그밖의 다른 부분들을 덜 드레싱하여, 광택있는 층들을 생성한다. 셋째, 이러한 디스크들의 연마 입자들은 패드를 균일한 깊이로 침투하도록 배열되지 않는다. 이러한 비-균일성은 CMP 패드의 고르지 않은 드레싱을 추가적으로 생성한다. 마지막으로, CMP 패드가 유연한 정도에 따라, 드레서의 처음 리딩 에지 앞부분에서는 드레서에 의하여 생성되는 하향력으로 인하여 볼록해지거나 둥글어지는 경향이 있다. 이러한 볼록함은 패드가 드레서의 잔여 부분아래서 지나갈 때, 패드의 함몰이 일어나게 할 수 있으며, 순차적으로 남아있는 연마 입자들, 특히 패드 드레서의 중심에 위치한 입자들이 패드 전체에 걸쳐 덜 깊게 침투하게 또는 심지어는 침투하지 않게 할 수 있다. 드레서 입자들에 대한 이러한 고르지 않은 작업 부하는 패드를 고르지않게 드레싱 되도록 할 수 있으며, 또한 드레서를 고르지 않게 마모되게 하거나 조기에 마모되어 닳도록 할 수 있다.

또한 현재의 CMP 패드 드레서가 가지는 또다른 결점은 패드 컨디셔너의 사용 수명 감소이다. CMP 패드 컨디셔너의 사용 효과 및 효율성은 작업하는 연마 입자들의 수 및 각 입자가 수행하는 작업의 양에 의해 결정된다. 상기 지적한 바와 같이, 패드 컨디셔너의 사용 수명은 초연마 입자들에 대한 작업 부하의 고르지 않은 분포에 의해 감소될 수 있다. 가요성 CMP 패드가 드레서의 압력하에서 함몰할 때, 패드 컨디셔너의 리딩 에지 결정들에 과다한 마모가 발생할 수 있는데, 이는 이러한 결정들이 대부분의 작업 부하를 견디게 되기 때문이다. 또한, 중심에 위치한 연마 입자들은 동일한 작업 부하를 수용하지 못하게 된다. 이러한 작업 부하의 불일치는 리딩 에지 입자들에 대한 마모 속도를 증가시키고, 중심에 위치한 입자들의 소모 이전에 드레서를 쓸모없게 만들 수 있다.

입자 보유와 관련하여, 두가지 요인들이 연마 입자들로 하여금 선행 기술의 패드 드레서 디스크로부터 제거되기 쉽게 한다. 첫째, 제거는 종종 연마 입자들이 부착되었던 열등한 방법으로 인하여 발생한다. 전기도금된 니켈 또는 그밖의 다른 기저에 놓인 물질들에 의해서만 기판에 지지된 연마 입자들은 약한 기계적 힘에 의하여만 확보되며, 어떤 형태의 화학적 결합에 의하여도 확보되지 않는다. 그러므로, 이러한 입자들은 마찰력과 같은 강한 기계적 힘에 노출될 때 용이하게 제거되게 된다. 더욱이, 입자 제거는 화학물질 슬러리에 의하여 제공되는 전기도금 물질에 대한 화학적 공격에 의해 촉진된다.

대조적으로, 연마 입자들이 기판 위에 브레이징 될 때, 화학적 결합은 입자들을 더욱 견고하게 지지한다. 그러나, 화학물질 슬러리의 산은 브레이즈-입자 결합들을 급속하게 약하게 하며, 패드 드레싱의 마찰력 하에서 연마 입자들을 제거하게 할 수 있다. 그러므로, 화학물질들에 대한 브레이즈의 노출을 최소화하고 패드 드레서의 가용 수명을 연장하기 위하여, 연마 공정들은 드레싱이 발생하는 동안 정지되어야 한다. 결과적으로 연마 및 그 이후 드레싱을 교대시키는 연쇄는 시간을 낭비시키며, 비효율적이다.

브레이징 공정 동안 패드 드레서 작업 표면의 뒤틀림 또한 종종 연마 입자들을 제거되게 한다. 브레이징 공정 동안 패드 드레서는 상당한 고온에 노출되어야 한다. 이러한 극도의 열에 대한 노출은 패드 드레서의 작업 표면을 뒤틀리게 할 수 있으므로, 패드 드레서 작업 표면의 매끄러움 및 평면성을 손상시킨다. 결과적으로, 작업 표면의 브레이즈 부분은 거칠게 되며,

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높고 낮은 지점들을 가지게 될 것이다. 이러한 지점들은 바람직하지 않은데, 왜냐하면 이들은 브레이즈를 조각조각 떨어지기 시작하도록 만들 수 있으며, 피가공물의 연마된 표면에 미세-긁힘을 만들 수 있다. 또한, 이러한 울퉁불퉁함은 드레서의 또다른 가공, 및 연마 입자 보유력과 관련하여 문제점을 유발할 수 있다.

전술한 관점에서, 최대의 효율성 및 수명을 가지며 최적의 드레싱 결과를 구현하기 위하여 제작되고 구성된 CMP 패드 드레서가 계속하여 요구되고 있다.

발명의 요약

따라서, 한 양태에서, 본원 발명은 CMP 패드를 드레싱 하는 동안 CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 대한 작업 부하를 증가시키기 위한 방법 및 CMP 패드 드레서 구조물을 제공한다. 이러한 한 방법에서, 각각이 기판 부재에 연결되고 예정된 패턴에 따라 특정 위치에 지지된 복수의 초연마 입자들을 가지는 CMP 패드 드레서가 제공된다. 초연마 입자들은 둘레에 위치한 입자들의 CMP 패드 내부로의 침투는 감소시키고 중심에 위치한 입자들의 CMP 패드 내부로의 침투는 증가시키는 패턴으로 배열될 수 있으므로, 중심에 위치한 초연마 입자들에 대하여 가해지는 작업 부하를 최적화 시킬 수 있다. 일반적으로, 입자들은 단일 결정 또는 다결정질 형태의 다이아몬드, 또는 입방정 질화 붕소 (cBN)와 같은 초경질 물질들이다.

본원 발명의 한 구체예에서, 중심에 위치한 초연마 입자들에 대한 작업 부하를 증가시키는 방법은 둘레에 위치한 입자들의 작업 말단으로부터 중심에 위치한 입자들의 작업 말단까지 상향인 기울기를 제공하는 패턴으로 배열된 초연마 입자들을 보유하는 기판을 가지는 CMP 패드 드레서의 이용을 포함한다. 또한, 이용되는 기울기의 정확한 각도는 중심에 위치한 입자들이 부담하는 작업 부하를 제어하도록 형성될 수 있다. 이러한 기울기는 다양한 방식으로 생성될 수 있다. 예를 들면, 한 양태에서, 기울기는 실질적으로 편평한 기판 위에 또는 내부에 초연마 입자들을 배치함으로써 생성될 수 있는데, 여기서 기판의 작업 표면위의 초연마 입자들의 높이는 둘레에 위치한 입자들로부터 중심에 위치한 입자들을 향하여 증가한다. 몇몇 경우에, 바람직한 기울기 각도는 패드 속도(velocity) 및 패드 가요성의 측정으로서 결정될 수 있다.

본원 발명의 또다른 바람직한 구체예에서, 중심에 위치한 입자들에 대한 작업 부하를 증가시키는 방법은 중심에 위치한 입자들보다 더 높은 밀도로 둘레에 위치한 초연마 입자들을 배치하는 패턴으로 기판에 결합된 복수의 초연마 입자들을 가지는 CMP 패드 드레서를 제공하는 것을 포함할 수 있다. 더 높은 밀도로 밀집된 입자들은 서로 더 먼 간격으로 밀집된 입자들만큼 깊게 패드 내부로 침투할 수 없음이 발견되었다. 그러므로, 기판 상의 입자들의 밀도를 변화시킴으로써 작업 부하는 한 부위에서 다른 부위로 이전될 수 있다.

또한 본원 발명의 또다른 구체예에서, 중심에 위치한 입자들에 대한 작업 부하를 증가시키는 방법은 중심에 위치한 입자들을 둘레에 위치한 입자들의 애티튜드(attitude)에 의해 제공되는 침투보다 CMP 패드 내부로 더 높은 입자 침투를 유발시키는 애티튜드로 배향시킴으로써 구현될 수 있다. 한 양태에서, 중심에 위치한 입자들의 애티튜드는 이들의 작업 말단에 꼭지점(apex)을 제공할 수 있으며, 둘레에 위치한 입자들의 애티튜드는 이들의 작업 말단에 면 또는 에지를 제공할 수 있다. 또다른 양태에서, 중심에 위치한 입자들의 애티튜드는 이들의 작업 말단에 에지를 제공할 수 있으며, 둘레에 위치한 입자들의 애티튜드는 이들의 작업 말단에 면을 제공할 수 있다. 또한 또다른 양태에서, 중심에 위치한 입자들의 애티튜드가 이들의 작업 말단에 꼭지점(apex)을 제공할 때, 둘레에 위치한 입자들의 애티튜드는 이들의 작업 말단에서 면을 제공할 수 있으며, 둘레에 위치한 입자들과 중심에 위치한 입자들 사이에 위치한 입자들의 애티튜드는 이들의 작업 말단에 에지를 제공할 수 있다. 상기 언급된 사용 방법 이외에도, 본원 발명은 또한 중심에 위치한 초연마 입자들에서 증가된 작업 부하를 보여주는 CMP 패드 드레서를 제공하는 방법을 포함한다. 일반적으로 말하면, 이러한 방법은 다음 단계들을 포함한다: 1) 기판을 제공하는 단계; 및 2) 둘레에 위치한 입자들의 CMP 패드 내부로의 침투는 감소시키고 중심에 위치한 입자들의 CMP 패드 내부로의 침투는 증가시키는 패턴으로 복수의 초연마 입자들을 기판 위에 부착하는 단계.

상기 설명된 방법을 사용하여, 상당한 이점들을 보이는 CMP 패드 드레서를 제조할 수 있다. 예를 들면, CMP 패드 드레서의 작업 표면은 외부 또는 이들의 "리딩 에지"를 지나치게 접촉하기 보다는 드레서의 중심 이하의 부분에서 CMP 패드의 접촉을 증가시키기 위하여 배열될 수 있다. 이러한 중심 접촉의 증가는 드레서의 둘레부로부터 드레서의 중심부로 작업 부하의 일부를 이전시키므로, 드레서의 사용 수명을 길게하고 드레서로 하여금 패드를 더욱 효과적으로 절삭 및 그루밍(grooming)할 수 있게 한다. 상기 배열을 결합시킨 CMP 패드 드레서는 본원 발명에 포함되며, 상기 언급된 방법들을 뒷받침하기 위하여 이루어진 특정 구조를 가지는 CMP 패드 드레서들도 포함한다.

본원 발명의 상기 언급된 특징들 및 이점들은 첨부된 도면 및 다음의 상세한 설명을 참고하면 더욱 자명해질 것이다.

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발명의 상세한 설명

발명의 상세한 설명

본원의 CMP 패드 드레서 및 수반되는 사용 및 제조 방법을 개시하고 설명하기에 앞서, 본원 발명은 본원에 개시된 특정 공정 단계들 및 물질들에 제한되는 것이 아니라, 관련 분야의 통상의 당업자가 인식하게 되는 이들의 균등물에까지 확장됨을 이해하여야 한다. 또한 본원에서 사용되는 용어는 단지 특정 구체예들을 설명하기 위하여 사용되는 것이며 제한하기 위하여 사용되되는 것이 아님을 이해하여야 한다.

본원 명세서 및 첨부된 청구항에서 사용되는, 단수형들 "하나" 및, "그것"은 명확하게 다른 언급이 없으면 복수형을 포함함을 알아두어야 한다. 그러므로, 예를 들면, 하나의 "연마 입자" 또는 "그릿"이라는 언급은 하나 또는 그 이상의 연마 입자들 또는 그릿들에 대한 언급을 포함한다.

정의

본원 발명을 설명하고 청구함에 있어서, 아래 설명된 정의에 따라 다음의 용어가 사용될 것이다.

본원에서 사용되는, "연마 입자" 또는 "그릿" 또는 유사한 용어들은 초경질의 결정질 또는 다결정질 물질, 또는 이들 물질들의 혼합물을 의미하며, 다이아몬드, 다결정질 다이아몬드 (PCD), 입방정 질화 붕소, 및 다결정질 입방정 질화 붕소 (PCBN)를 포함하나, 이에 제한되는 것은 아니다. 또한, "연마 입자", "그릿", "다이아몬드", "다결정질 다이아몬드 (PCD)", "입방정 질화 붕소" 및 "다결정질 입방정 질화 붕소(PCBN)" 의 용어들은 호환적으로 사용될 수 있다.

본원에서 사용되는, "기판"은 연마 입자들을 지지하는, 그리고 연마 입자들이 고정될 수 있는, CMP 드레서의 일부를 의미한다. 본원 발명에서 유용한 기판들은 의도한 목적에 유용한 공구를 제공하기에 충분한 방식으로 연마 입자들을 지지할 수 있는, 임의의 형상, 두께 또는 물질일 수 있다. 기판들은 고체 물질, 가공시 고체가 되는 분말 물질, 또는 가요성 물질일 수 있다. 전형적인 기판 물질들의 예에는 금속, 금속 합금, 세라믹, 및 이들의 혼합물을 포함하나, 이에 제한되는 것은 아니다. 또한 기판은 브레이징 합금 물질을 포함할 수 있다.

본원에서 사용되는, "착업 표면"은 작업하는 동안 위를 향하는, 또는 CMP 패드와 접촉하게 되는 CMP 패드 드레서의 표면을 의미한다.

본원에서 사용되는, "리딩 에지"는 CMP 패드가 움직이는 방향에 기초하여, 또는 패드가 움직이는 방향에 기초하여, 또는 이들 모두에 기초하여 전두 에지인 CMP 패드 드레서의 에지를 의미한다. 특히, 몇몇 양태에서, 리딩 에지는 특정하게 드레서의 에지 부위를 포함할 뿐만 아니라, 또한 실제 에지로부터 약간 안쪽으로 연장하는 드레서의 일부들을 포함할 수 있는 것으로 생각된다. 한 양태에서, 리딩 에지는 CMP 패드 드레서의 외부 에지를 따라 위치될 수 있다. 또다른 양태에서, CMP 패드 드레서는 CMP 패드 드레서 작업 표면의 중심 또는 내부 부분 위에 적어도 하나의 효과적인 리딩 에지를 제공하는 연마 입자들의 패턴으로 형성될 수 있다. 다시 말하면, 드레서의 중심 또는 내부 부분은 드레서의 외부 에지 위에 리딩 에지의 효과와 유사한 기능적 효과를 제공하도록 형성될 수 있다.

본원에서 사용되는, "날카로운 부분"은 결정이 올 수 있는 협소한 부분을 의미하며, 코너, 융기, 에지, 오벨리스크, 및 그밖의 다른 돌출부들을 포함하나, 이에 제한되는 것은 아니다.

본원에서 사용되는, "중심에 위치한 입자"는 통상의 드레싱 환경하에서 둘레에 위치한 입자에 비하여 감소된 작업 부하를 수용하는 드레서의 입자를 의미한다. 몇몇 양태에서, "중심" 또는 "중심에 위치한"이란 드레서의 중심 지점에서 시작하여 드레서 에지를 향해 바깥쪽으로 드레서 직경의 최대 약 90%까지 연장하는 영역을 의미한다. 몇몇 양태에서, 상기 영역은 반경의 약 20% 내지 약 90%까지 바깥쪽으로 연장할 수 있다. 그밖의 다른 양태에서, 상기 영역은 반경의 약 50%까지 연장할 수 있다. 또한 또다른 양태에서, 상기 영역은 드레서 반경의 약 33%까지 연장할 수 있다.

본원에서 사용되는, "둘레에 위치한"이란 통상적인 드레싱 환경하에서 중심에 위치한 입자들에 비하여 과다한 작업 부하를 수용하는 드레서의 입자를 의미한다. 몇몇 양태에서, "둘레의" 또는 "주변의" 또는 "둘레에 위치한"이란 드레서의 리딩 에지 또는 외부 가장자리에서 시작하여 드레서 직경의 최대 약 90%까지 중심을 향하여 안쪽으로 연장하는 영역을 의미할 수

있다. 몇몇 양태에서, 상기 영역은 반경의 약 20% 내지 90%까지 안쪽으로 연장할 수 있다. 그밖의 다른 양태에서, 상기 영역은 반경의 약 50%까지 연장할 수 있다. 또한 또다른 양태에서, 상기 영역은 드레서 직경의 약 33%까지 연장할 수 있다 (즉, 중심으로부터 66% 떨어짐).

본원에서 사용되는, "작업 부하"란 드레서를 사용하는 동안 드레서에 있는 입자들에 가해지는 작업량 또는 힘의 양을 의미한다.

본원에서 사용되는, "작업 말단"이란 CMP 패드를 향하여 배향되고 드레싱 작업을 하는 동안 패드와 접촉하는 입자의 말단을 의미한다. 거의 대부분 입자의 작업 말단은 입자가 부착되는 기판으로부터 말단이 될 것이다.

본원에서 사용되는, "비정질 브레이즈"란 비-결정질 구조를 가지는 균질의 브레이즈 조성물을 의미한다. 이러한 합금은 가열시 부조화 용융하는 공융상을 실질적으로 전혀 함유하지 않는다. 비록 간결한 합금 조성물을 확보하기 어렵지만, 본원에서 사용되는 비정질 브레이징 합금은 좁은 온도 범위에 걸쳐 실질적으로 조화용융 거동을 보여야 한다.

본원에서 사용되는, "합금"이란 제 2 물질과 금속의 고체 또는 액체 혼합물을 의미하며, 상기 제 2 물질은 탄소와 같은 비-금속, 금속, 또는 금속의 성질을 향상 또는 개선시키는 합금이 될 수 있다.

본원에서 사용되는, "금속 브레이징 합금," "브레이징 합금," "브레이즈 합금", "브레이즈 재료" 및 "브레이즈"는 호환적으로 사용될 수 있으며, 초연마 입자들, 및 매트릭스 지지 재료 또는 기판을 서로 실질적으로 결합시키기 위하여 화학적으로 결합할 수 있는 금속 합금을 의미한다. 본원에 개시된 특정 브레이즈 합금 성분들 및 조성물은 이와 관계되어 개시된 특정 구체예에 제한되는 것이 아니며, 본원에 개시된 본원 발명의 어떠한 구체예에서도 사용될 수 있다.

본원에서 사용되는, "브레이징" 공정은 초연마 입자들의 탄소 원자들과 브레이즈 재료 사이의 화학적 결합 생성을 의미하는 것으로 간주된다. 또한, "화학적 결합"이란 기계적 인력 또는 그보다 약한 원자 내부의 인력이라기 보다는, 탄화물 또는 보라이드 결합과 같은 공유 결합을 의미한다. 그러므로, "브레이징"이 초연마 입자들과 관련하여 사용되는 경우, 진정한 화학적 결합이 형성되는 것이다. 그러나, "브레이징"이 금속 대 금속 결합과 관련하여 사용되는 경우, 이 용어는 더욱 전형적인 야금학적 결합의 의미로 사용된다. 그러므로, 공구 몸체에 대한 초연마 세그먼트의 브레이징은 탄화물 형성제의 존재를 요하지 않는다.

본원에서 사용되는, "초연마 입자들" 및 "초연마 그릿들"은 호환적으로 사용될 수 있으며, 천연 또는 인공 다이아몬드, 초경질 결정질, 또는 다결정질 물질, 또는 물질들의 혼합물의 입자들을 의미하며, 다이아몬드, 다결정질 다이아몬드 (PCD), 입방정 질화 붕소 (CBN), 및 다결정질 입방정 질화 붕소 (PCBN)를 포함하나, 이에 제한되는 것은 아니다. 또한, "연마 입자", "그릿", "다이아몬드", "PCD", "CBN" 및 "PCBN"이란 용어들은 호환적으로 사용될 수 있다.

브레이징 공정과 관련하여 본원에서 사용되는, "직접적으로"란 결합 매질로서 단일 브레이징 금속 또는 합금을 사용하여 초연마 입자들 및 동일한 재료 사이에 화학적 결합의 형성을 의미하는 것으로 간주된다.

본원에서 사용되는, "돌기"란 다양한 표면 분석의 특성들에 의하여 평가된 표면의 거칠음을 의미한다. 다양한 측정들은 피크 높이 또는 그 위의 돌출, 및 밸리의 깊이 또는 그 내부에 함몰하는 함몰부와 같은 표면 돌기의 지표로서 사용될 수 있다. 더욱이, 돌기의 측정치에는 주어진 표면 영역 내부의 피크 또는 밸리의 수 (즉, 피크 또는 밸리 밀도), 및 피크들 또는 밸리들 사이의 거리가 포함될 수 있다.

본원에서 사용되는, "세라믹"이란 비-금속 물질, 때때로 금속 물질과 함께 연소함에 의해 제조될 수 있는, 상당히 내열성이며 내식성인, 경질의, 때때로 결정질의 재료를 의미한다. 세라믹으로 고려되는 수많은 산화물, 질화물, 및 탄화물 재료들이 당해 분야에 잘 알려져 있으며, 산화 알루미늄, 산화 알루미늄, 산화 규소, 질화 붕소, 질화 규소, 및 탄화 규소, 탄화 텅스텐, 등이 포함되나, 이에 제한되는 것은 아니다.

본원에서 사용되는, "금속성"이란 임의의 타입의 금속, 금속 합금, 또는 이들의 혼합물을 의미하며, 구체적으로는 강(스틸), 철, 및 스테인레스 강이 포함되나, 이에 제한되는 것은 아니다.

본원에서 사용되는, "격자"는 복수의 사각형을 형성하는 선들의 패턴을 의미한다.

거리 및 크기와 관련하여 본원에서 사용되는, "균일한"이란 전체 약 75 마이크로미터 미만으로 상이한 크기를 의미한다.

본원에서 사용되는, "Ra"란 피크 및 이웃하는 밸리 사이의 높이차로 결정되는 표면 조도의 측정치를 의미한다. 또한, "Rmax"는 표면 위에서 가장 높은 피크와 표면에서 가장 낮은 밸리 간의 높이차로 결정되는 표면 조도의 측정치이다.

콘센트레이션, 양, 및 그밖의 다른 수치 데이타는 본원에서 범위 형식으로 표현되거나 나타내어질 수 있다. 이러한 범위 형식은 단순히 편의 및 간결함을 위해 사용되는 것이므로, 범위의 한계로 명확히 언급되는 수치 값들 뿐만 아니라, 그 범위 내에 포함되는 모든 개개의 수치 값들 또는 하위-범위들도 마치 각각의 수치 값 및 하위-범위가 명확히 언급된 것처럼 포함되는 것으로 해석되어야 함을 이해하여야 한다.

설명하자면, "약 1 마이크로미터 내지 약 5 마이크로미터"의 수치 범위는 약 1 마이크로미터 내지 약 5 마이크로미터 중 명확히 언급된 수치들 뿐만 아니라, 지시된 범위에 속하는 개별적인 수치들 및 하위-범위들도 포함되는 것으로 해석되어야 한다. 그러므로, 상기 수치 범위에는 2, 3, 및 4와 같은 개개의 수치들 및 1-3, 2-4, 및 3-5, 등과 같은 하위-범위까지도 포함된다. 이와 동일한 원리가 단 하나의 수치 값을 언급하는 범위들에도 적용된다. 더욱이, 이러한 해석은 설명되는 범위의 폭 및 특성들에 관계없이 적용되어야 한다.

발명

출원인은 CMP 패드 컨디셔닝 또는 드레싱의 효율성과 품질을 개선하기 위한 장치 및 방법들을 발견하였다. CMP 패드를 컨디셔닝 또는 드레싱 하기 위한 장치를 사용함으로써, 패드 수명이 연장될 뿐만 아니라, 또한 패드가 사용될 수 있는 항구성, 및 그리하여 장치가 구현하는 장치의 작업 속도가 개선된다.

이제 도 1을 참고하면, 선행 기술의 CMP 패드 드레서(10)이 도시되는데, 이것은 기판 (40)에 전기도금된 복수의 연마 입자들(50)을 가진다. 전기도금 재료(60)는 일반적으로 산 용액으로부터 침전된 니켈이다.

기판에 연마 입자들 (50)을 부착하기 위하여 전기도금 재료(60)만을 사용하는 CMP 패드 드레서는 도 1에 도시된 바와 같이 자명한 많은 결점들을 가진다. 첫째, 전기도금 재료는 연마 입자들과 화학적 결합을 형성할 수 없다. 그러므로, 단지 약한 기계적 힘들이 기판(40) 상에서 연마 입자들을 지지한다. 패드 드레서가 CMP 패드를 대면하여 회전되는 경우, 이러한 기계적 힘들은 연마 입자들에 작용하는 마찰력에 의해 신속하게 극복된다. 결과적으로 연마 입자들은 전기도금 재료로부터 쉽게 헐거워져서, 전기도금 재료에 공간(70)과 같은 공극들을 남긴다. 이러한 공극들은 피가공물에서 연마되어 나온 잔여물 뿐만 아니라, 슬러리로부터 화학물질 및 연마 입자들로 신속히 채워진다. 이러한 물질들은 전기도금 재료를 화학적으로 공격하며 더욱 약화시킨다.

전기도금 재료(60)에 의해 생성된 기계적 힘은 기판(40) 위에 연마 입자들(50)을 지지시키는 단 하나의 수단이기 때문에, 연마 입자들 above the 전기도금 재료 위의 연마 입자들의 노출은 최소로 유지되어야 한다. 그럼에도 불구하고, 전기도금 재료와 CMP 패드 사이의 접촉은 필연적이다. 이러한 접촉은 전기도금 재료를 마모시키며, 연마 입자들의 방출을 더욱 촉진시킨다. 추가적으로, 제조하는 동안, 전기도금 재료는 볼록한 부분(80)과 같은 공간에서 연마 입자들 주위에 쌓이기 쉽다. 불가능한 것이 아니라면, 이미 낮은 노출 및 연마 입자들의 빽빽한 공간 이외에도 이러한 볼록한 부분들은 연마 입자들의 CMP 패드 섬유질 내부로의 상당한 침투를 어렵게 한다. 이러한 침투가 없다면, 드레싱 공정의 효과는 불리하다.

이제 도 2를 보면, 브레이징 재료(90) 및 전통적인 진공로 브레이징 기술을 사용하여 기판에 브레이즈된 연마 입자들(50)을 가지는 기판(40)을 구비한 선행 기술의 CMP 패드 드레서가 도시된다. 브레이징 재료(90)은 일반적으로 탄화물 형성제와 혼합된 금속 합금을 포함한다. 이러한 탄화물 형성제는 연마 입자들을 브레이징 재료에 화학적으로 결합할 수 있게 하여 순차적으로 기판과 결합할 수 있게 한다. 이러한 결합 배열은 CMP 드레서의 전체 강도를 현저히 증가시키지만, 몇가지 바람직하지 않은 부작용을 수반한다.

브레이징 재료(90)는 연마 입자들(50)을 완전히 커버하지 않도록 하기 위하여 최소로 유지되어야 한다. 그러므로, 연마 입자들은 브레이징 재료의 얇은 코팅만으로 감싸진다. 이러한 문제는 전형적인 브레이징 재료들이 기계적으로 너무 약하다는 사실에 의해 사화된다. 이러한 기계적 결함은 연마 입자들과 브레이징 재료 사이에 생성되는 화학 결합의 강도를 상쇄시킨다. 사실상, 연마 입자들과 브레이징 재료 사이의 화학 결합들은 떨어져 나간 연마 입자들과 함께 브레이징 재료 자체가 종종 전단되어 나가기에 충분히 강하다.

브레이징 재료(90)는 또한 연마 슬러리에 의한 화학적 공격에 매우 민감하다. 이는 연마 입자들(50)의 탈착에 기여하는데, 왜냐하면 연마 입자들의 탈착은 브레이징 재료를 더욱 약화시키기 때문이다. 화학물질 슬러리에 대한 CMP 패드 드레서

(20)의 노출을 감소시키기 위하여, 피가공물의 연마는 중단되어야 하며, 화학물질 슬러리는 패드 드레서에 도포되기 전에 패드에서 제거되게 하여야 한다. 연마 공정에서 이러한 중단은 패드가 사용될수 있는 항구성을 현저히 감소시키고, 완제품을 제조하는데 필요한 시간을 증가시키므로, 비효율적이다.

연마 입자들(50)을 전통적인 브레이징만을 사용하여 기판(40)에 결합시키는 것에 대한 또다른 결점은 용융 금속 합금이 기판에 사용될 경우 연마 입자들의 "밀집"을 유발하기 쉽다는 것이다. 이러한 밀집은 (100)에 도시되는데, 의도하지 않은 공백(110)을 남긴다. 전체적인 효과는 연마 입자들의 비-균일한 분포이며, 이것은 그루밍(grooming)을 비효율적이게 한다. 또한, 공백들은 패드의 고르지않은 컨디셔닝을 유발하며, 이는 궁극적으로 CMP 패드의 특정 영역을 그밖의 다른 영역보다 더 빠르게 마모시키며, 전체적으로는, 마모된 영역들이 적절히 컨디셔닝된 영역 보다 덜 효과적으로 연마되기 때문에 피가공물이 고르지 않은 연마를 수용하게 되는 결과를 가져온다.

연마 입자들의 밀집은 브레이징 재료(90)에 둑을 형성함으로써 또다른 손실을 만든다. 둑 형성은 일부 연마 입자들을 기판(40) 위의 높이까지 상승하여 형성되며, 이것은 그밖의 다른 연마 입자들의 높이보다 더 높다. 그러므로, 가장 높이 돌출한 연마 입자들은 CMP 패드의 섬유질 내부로 매우 깊이 침투할 수 있으며, 그보다 덜 돌출한 연마 입자들이 CMP 패드를 접촉하지 못하게 하거나 유용한 그루밍 효과를 가지지 못하게 할 것이다.

선행 기술의 CMP 패드 드레서와 대조적으로, 본원 발명은 CMP 패드의 고른 드레싱을 가능하게 한다. 이제 도 3을 보면, 본원 발명의 원리에 따라 제조된 CMP 패드 드레서(30)이 도시되어 있다. CMP 패드 드레서는 브레이징 재료(90)을 가진 기판(40)에 결합된 복수의 연마 입자들(50)을 가진다.

연마 입자들(50)은 다양한 초경질 재료로 이루어질 수 있다. 이러한 재료의 예에는 다이아몬드, 다결정질 다이아몬드(PCD), 입방정 질화 붕소 (CBN) 및 다결정질 입방정 질화 붕소 (PCBN)가 포함되나, 이에 제한되는 것은 아니다.

추가적으로 도 3에는 최종 브레이징 공정 후에 처리되는 오버레이 재료층(120)이 도시된다. 상기 언급한 바와 같이, 오버레이는 브레이징 합금의 작업 표면보다 실질적으로 더 매끄러운 작업 표면을 제공한다. 이러한 매끄러움 및 평면성은 수많은 이점들을 제공하는데, 이 이점들에는 브레이즈를 조각조각 떨어뜨리는 것으로부터 미세-긁힘의 발생 감소 및 내식층이 포함되는 경우 내식층과 더 우수한 결합이 포함된다. 한 양태에서, 오버레이 재료의 작업 표면은 약 1 마이크로미터 미만의 Ra 값을 가질수 있다.

수많은 적절한 오버레이 재료가 사용될 수 있다. 그러나, 한 양태에서, 오버레이 재료들에는 주석, 니켈, 텅스텐, 코발트, 크롬, 및 지르코늄 니켈 합금과 같은 이들의 합금이 포함되나, 이에 제한되는 것은 아니다. 오버레이 재료는 다양한 방법들에 의해 처리될 수 있다. 오버레이 재료를 처리하는 방법들의 예에는 전기도금 및 물리적 증기 증착 (PVD)이 포함된다. 오버레이 재료층은 특수한 결과를 달성하기 위하여 필요한 두께일 수 있으나, 본원 발명의 한 양태에서, 오버레이 재료층은 약 0.1 내지 50 마이크로미터 두께의 두께를 가질 수 있다. 또다른 양태에서, 오버레이의 두께는 약 0.1 내지 약 5 마이크로미터일 수 있다.

또한 도 3에는 내식성 층(130)이 도시되어 있다. 선택적인 내식성 층은 연마 입자들(50)이 기판(40)에 고정된 후 CMP 패드 드레서의 표면 위에 형성된다. 한 양태에서, 내식성 층은 다이아몬드-형 탄소 (DLC), 또는 비정질 다이아몬드와 같은 초연마 재료일 수 있다. 한 구체예에서, 내식성 층은 약 80% 이상의 원자 탄소 함량을 가진다. 추가적으로, 내식성 층은 특수한 결과를 달성하기 위하여 필요한 다양한 두께를 가질 수 있으나, 일반적으로 그 두께는 0.5 내지 5 마이크로미터 범위이다. 한 양태에서, 내식성 층은 3 마이크로미터 미만의 두께를 가진다. 이러한 얇은 내식성 층은 CMP 패드 드레서의 작업 표면이 CMP 패드를 드레싱하는 연마 입자들의 능력을 감소시키지 않고 보호되는 것을 보장한다. 내식성 층은 일반적으로 물리적 증기 증착(PVD)법을 사용하여 제조된다. 흑연 양극과 함께 양극 아크를 사용하는 것과 같은 PVD 법은 일반적으로 당해 분야에 공지이다.

내식성 층(130)에 의해 제공되는 하나의 이점은 내식성 층이 작업 표면을 효과적으로 "밀폐"한다는 점이며, 또한 화학적 공격에 약할 수 있는, CMP 패드 드레서(30)의 그밖의 다른 표면들을 밀폐할 수 있다는 점이다. 밀폐제로서, 내식성 층은 CMP 패드 내부에 지지된 연마성 화학물질 슬러리에 의한 화학적 공격으로부터 브레이징 재료(90)를 보호한다. 이러한 보호는 CMP 패드 드레서로 하여금 즉석에서 CMP 패드를 드레싱할 수 있게 하며, 선행 기술의 CMP 패드 드레서의 가용 수명을 연장시키기 위하여 사용되는 제조 정지를 제거할 수 있게 한다. CMP 패드의 연속적이고 고른 드레싱은 더욱 많은 제조 작업 산출량을 가능하게 하며, CMP 패드의 수명 및 효율성을 연장시킨다.

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내식성 층(130)이 본원 발명의 몇몇 구체예에서 사용될 수 있으나, 오버레이 재료(120)는 그 자체로써 그리고 자연히 상당한 내식성을 가진다는 점이 두드러진다. 오버레이 재료만이 사용되고, 내식성 층이 사용되지 않는 경우, 이와 같은 많은 제조 이점들을 상당한 정도로 얻을 수 있다.

연마 입자들(180)을 기판에 고정시키는 한 가지 방법이 도 4-6에 도시된다. 먼저, 개구들(150)을 가지는 형판(140)이 브레이징 합금(190) 쉬트 위에 배치된다. 본원 발명의 한 양태에서, 브레이징 합금 쉬트는 연속적 비정질 브레이징 합금의 압연 쉬트일 수 있다. 또다른 양태에서, 브레이징 합금 쉬트는 결합제 재료와 함께 지지되는 브레이징 합금 분말일 수 있다. 또다른 양태에서, 브레이징 합금 분말에는 그밖의 다른 금속성 분말들이 포함될 수 있으며, 이러한 그밖의 다른 분말들은 브레이징 쉬트에서 재료의 대부분을 구성할 수 있다. 또한 또다른 양태에서, 쉬트는 기판으로서 기능하기에 충분할 수 있다. 형판의 사용은 개구들을 가지는 형판을 원하는 패턴으로 디자인함으로써 특정 위치에 각 연마 입자를 제어하여 배치할 수 있게 한다.

형판(140)이 브레이징 합금 쉬트(190) 위에 배치된 후, 개구들(150)은 연마 입자들(180)로 채워진다. 개구들은 오직 하나의 연마 입자 만이 각 개구에 채워지도록 예정된 크기를 가진다. 어떠한 크기의 연마 입자 또는 그릿이라도 사용할 수 있으나, 본원 발명의 한 양태에서, 입자 크기는 약 100 내지 약 350 마이크로미터 직경일 수 있다.

본원 발명의 또다른 양태에서, 형판에 있는 개구들의 크기는 균일한 크기 범위에 속하는 크기를 가지는 연마 입자들의 패턴을 얻기 위하여 주문제작될 수 있다. 한 구체예에서, 형판의 개구들은 50 마이크로미터 이하의 변화량을 가지는 크기 범위에 속하는 그릿들만을 선택하기에 충분하다. 이러한 그릿 크기의 균일성은 CMP 패드 그루밍의 균일성에 기여하는데, 이는 각각의 연마 입자의 작업 부하가 고르게 분포되기 때문이다. 순차적으로, 고른 작업 부하 분포는 개별적인 연마 입자들에 대한 응력(stress)을 감소시키고, CMP 패드 드레서의 유효 수명을 연장시킨다.

형판(150)의 개구들이 그릿들(180)로 모두 채워진 후, 과량의 연마 입자들이 제거되고, 편평한 표면(160)이 연마 입자들에 처리된다. 편평한 표면(160)은 브레이징 합금 쉬트(190) 내부로 연마 입자들을 내리누를 수 있도록 극히 강하고 단단한 재료여야 한다. 이러한 재료들에는 전형적으로 스틸, 철, 이들의 합금 등이 포함되나, 이에 제한되는 것은 아니다.

연마 입자들(180)은 도 6에서 브레이징 합금 쉬트(190)에 묻혀 있는 것으로 도시된다. 표면(160)이 편평하기 때문에, 연마 입자들은 기판으로부터, 예정된 균일한 높이까지 확장될 것이다. 이러한 균일한 높이는 T형판(140)의 두께에 의해 결정될 것이며, 바람직한 구체예에서, 각각의 연마 입자는 상기 거리의 50 마이크로미터 이내까지 확장할 것이다. 이와 같이, 각각의 연마 입자는 CMP 패드 상에서 실질적으로 동일한 깊이로 그루밍된다. 그러나, 어떠한 응용예에서는, 그릿 높이가 균일한 것이 바람직하지 않을 수도 있음을 알아두어야 한다. 이와 같이, 다양한 높이의 그릿 패턴들은 그러한 디자인을 제공하기 위해 형판(140) 및 표면(160)을 다양한 높이로 형성함으로써 제공될 수 있음을 당해 분야의 통상의 당업자들은 알고 있을 것이다. 예를 들면, 한 양태에서, 표면(160)은 둘레에 위치한 입자들을 중심에 위치한 입자들보다 더 아래로 가압하기 위하여 오목한 형상을 가질 수도 있다. 알 수 있는 바와 같이, 이러한 오목한 형상은, 둘레의 입자들의 작업 말단에서의 낮은 지점에서 시작하여 중심에 위치한 입자들의 작업 말단에서의 높은 지점까지 기울어지는, 연마 입자들을 위한 기울기를 제공할 것이다.

도 4-6에 도시된 연마 입자들(180)은 둥글다. 그러나, 도 3에서, 이들은 뾰족하다. 자형, 팔면체, 입방정 팔면체, 또는 천연적으로 형성된 입자들을 포함하여, 어떠한 형상의 연마 입자들이라도 본원 발명의 범위에 포함된다. 그러나, 한 구체예에서, 연마 입자들은 기판(40)으로부터 한 방향으로 뻗어나가는 뾰족한 지점 또는 꼭지점(apex)을 보유한 예정된 형상을 가진다.

다른 구체예에서, 연마 입자들(180)을 브레이징 합금 쉬트(190) 내부로 가압하기 보다는, 연마 입자들은 브레이징 합금 쉬트 표면 위에 접착제를 도포하여 형판에서와 같은 위치에 고정될 수 있다. 이러한 방식에서, 입자들은 형판이 제거되고 열처리되는 동안 제 위치에 고정된 채로 남는다. 또한 본원 발명의 또다른 구체예에서, 형판(140)은 그 위에 얇은 접착제를 보유한 전달 쉬트(도시되지 않음) 위에 놓일 수도 있다. 이러한 경우, 입자들은 상기 설명한 형판 절차를 사용하여 전달 쉬트에 부착되게 된다. 이후 형판은 제거되고, 전달 쉬트는 쉬트를 대면하는 연마 입자들과 함께 브레이징 쉬트(190) 위에 놓인다. 브레이징 쉬트위에 도포된 상기 접착제 층은 전달 쉬트 위의 접착제보다 훨씬 더 강한 접착제이다. 그러므로, 연마 입자들은 형판에 의해 지정된 패턴으로 브레이징 합금의 쉬트로 전달된다.

연마 입자들(180)이 브레이징 합금 쉬트(190) 내부에 적어도 부분적으로 묻히거나, 쉬트에 부착된 후, 쉬트는 도 3에 도시된 바와 같이 기판에 고정된다. 대안적으로 몇몇 구체예에서, 브레이징 합금 쉬트는 기판에 먼저 고정될 수 있으며, 연마 입자들은 본원에 설명된 형판 절차를 사용하여 후속적으로 브레이징 합금 쉬트에 추가된다. 사용되는 브레이징 합금은 당

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해 분야에 공지된 어떠한 브레이징 재료일 수도 있으나, 한 양태에서, 2 중량% 이상의 크롬 함량을 가지는 니켈 합금일 수 있다. 이러한 조성의 브레이징 합금은 그 자체로 그리고 자연적으로 거의 초경질이 될 것이며, 연마제를 함유하는 슬러리로부터의 화학적 공격에 덜 민감할 것이다. 그러므로, 내식성 층(130), 및 오버레이 재료(120)는 선택적이다.

연마 입자들(50)이 브레이징 합금 쉬트(90) 안에 또는 위에 단단히 지지되기 때문에, 액체 브레이징 합금의 표면 장력은 도 2에서 도시된 바와 같은 입자 밀집을 유발하기에 불충분하다. 게다가, 브레이즈 농축은 훨씬 적은 정도로 발생하며, "둑(mound)"이 거의 또는 전혀 형성되지 않는다. 그보다, 브레이즈는 각 연마 입자 사이에 약간 오목한 표면을 형성하는데, 이는 추가적인 구조적 지지를 제공한다. 한 구체예에서, 브레이징 합금 쉬트(90)의 두께는 각 연마 입자의 적어도 약 10 내지 90%를 브레이징 재료(90)의 외부 또는 작업 표면 위로 돌출될 수 있도록 예정된다. 또다른 양태에서, 오버레이 재료(120)가 사용될 때, 연마 입자들은 각 연마 입자의 적어도 약 10 내지 약 90%가 오버레이 재료(120)의 외부 또는 작업 표면 위로 돌출될 수 있도록 선택되거나 배치될 수 있다.

가공하는 동안 연마 입자들(50)을 고정된 위치에 유지시키는 방법의 결과로서, 연마 입자들 사이에 고른 간격들이 형성될 수 있다. 게다가, 연마 그릿들은 기판(40) 위의 균일한 높이 또는 거리까지 확장할 수 있는데, 이는 CMP 패드에 적용될 때, 연마 그릿들은 패드 섬유질 내의 균일한 깊이까지 돌출하게 되는 것을 의미한다. 고른 간격 및 균일한 돌출은 CMP가 고르게 드레싱 또는 그루밍될 수 있게 하며, 이는 순차적으로 CMP 패드의 연마 효율성을 증가시키고, CMP 패드의 가용 수명을 연장시킨다. 연마 입자들을 브레이징 합금에 묻거나 부착시키는 상기 설명한 방법 이외에도, 당업자들은 연마 입자들을 기판에 고정시킨 후, 브레이즈를 그 위에 배치하는 것과 같은 적절한 대안 절차들을 알고 있을 것이다. 이러한 경우, 입자들은 상기 언급된 형판 방법을 사용하여 기판 위에 배치될 수 있으며, 아교, 또는 그밖의 다른 결합제에 의하여 제 위치에 지지될 수 있다. 이후 브레이즈 재료는 헹궈지거나, 연마 입자들 주위의 기판 위에 배치되고, 오버레이 재료가 첨가된다.

본원 발명은 상기 설명한 방법을 사용하여 생성될 수 있는 연마 입자 배치를 위한 널리 다양한 패턴들을 포함하지만, 본원 발명의 한 양태는 CMP 패드 드레서가 사용되는 특수한 필요성 및 조건들을 더욱 적절하게 충족시키는 특수한 예정 패턴의 인식물이다. 상기 패턴들을 구현하기 위하여, 각각의 그릿은 패턴 디자인에 따라 특수 위치에 배치되고 지지된다. 이러한 패턴들은 특수한 CMP 패드 드레싱 결과를 달성하기 위해 실제로 유용하며, 알 수 있는 바와 같이 특수한 그루밍 결과를 달성하기 위하여 다양해질 수 있다.

예를 들면, 많은 공지된 패드의 그루밍 결과는 그릿들을 특정한 배열로 배치함으로써 개선될 수 있다. 특히, CMP 패드가 가요성이기 때문에, 드레서에 의해 발생되는 하향 압력은 주어진 방향으로 움직이는 드레서의 리딩 에지와 패드가 접촉될 때 패드를 상승하게 또는 올려지게 한다. 상승하는 작용은 연마 입자들과 더 최대의 접촉을 가능하게 하기 때문에 드레서의 리딩에지에서 패드의 드레싱을 개선시킬 수 있지만, 이는 또한 드레서의 리딩 에지 아래 이미 통과된 패드 부분에서는 침적 작용을 유발할 수 있다. 심지어 어떠한 침적도 전혀 발생하지 않는다 하더라도, 패드는 일단 드레서 아래에서 다시 한 번 상승할 수 있게 되지 않기 때문에, 일반적으로 리딩 에지 후방에 있는 드레서 잔여 부분의 드레싱 작용은 리딩 에지의 드레싱 작용보다 덜 효과적이다 (즉, 연마 입자들의 첫번째 열은 드레서, 또는 회전하는 CMP 패드, 또는 모두의 방향성 거동에 의해 지정된 바에 따라 패드와 직면됨). 이와 같이, 드레싱 작업 부담의 대부분이 드레서의 리딩 에지에 있는 연마 입자들에 배치되며, 고르지 않은 입자 마모가 발생한다.

각 입자의 침투 깊이는 주로 두 개의 요인, 즉, 다른 입자들로부터의 분리 거리 및 돌출 높이에 의해 제어된다. 성긴 간격의 입자들은 빽빽하게 밀집된 입자들보다 더욱 공격적으로 드레싱 할 것이다. 그러므로, 본원 발명의 한 양태에서, 연마 입자들의 패턴은 내부 또는 중심 위치(즉, 리딩 에지에 후속하는 위치)에서 드레서 아래에 있는 동안 CMP 패드를 상승하게 하고, 그리하여 입자들이 리딩 에지의 연마 입자들에 후속하는 연마 입자들에 의해 드레싱되도록 배열될 수 있다. 실제로, 이러한 배열은 드레서의 작업 표면을 따라 리딩 에지의 다양성을 제공한다. 다시 말하면, 둘레에 있는 입자들은 중심에 위치한 입자들의 밀도 보다 더 큰 밀도를 가진다. 둘레의 입자들의 밀도는 중심 입자들의 밀도보다 적어도 약 1.25, 2, 또는 5배 더 클 수 있다. 또한 밀도는 둘레의 입자들에서 높고 중심 입자들에서 낮은 구배가 될 수 있다. 이러한 방식에서, 다양한 밀도들은 CMP 패드가 패드 드레서의 중심 부분 아래에 있는 동안 CMP 패드를 상승하게 하고, 드레싱 효율을 증가시킨다. 알게 되는 바와 같이, 다양한 입자 배열 또는 패턴들은 상기 작용들을 구현하는데 필요한 연마 입자들의 간격을 제공할 수 있으며 특수하게 필요로하는 드레싱 결과를 달성하기 위하여 사용될 수 있다.

도 7에서 실시예로서 설명되는 바와 같이, 본원 발명의 한 양태에서, 연마 입자들은 패드 드레서(30)의 리딩 에지(200)를 따라서만 배치된 연마 입자들을 가지기 위하여 배열될 수 있다. 이제 도 8을 보면, 본원 발명의 또다른 양태에서, 연마 입자들은 중심(210)에서 보다 리딩 에지(200)을 따라 더 고도로 밀집되도록 (즉 더 큰 밀도를 가지도록) 배열될 수 있다. 대조적으로, 본원 발명의 또다른 양태에서, 연마 입자들은 리딩 에지를 따라서 보다는 중심에 더 많이 밀집되도록 배열될 수 있다 (도시되지 않음). 또한 또다른 양태에서, 입자들은 둘레에 있는 입자들 보다는 패드 드레서의 중심 부분에서 더 많은 밀집도로 배열되어 분포될 수 있다. 또한, 중심 및 둘레 부분들 사이에 위치한 입자들은 중심 부분과 둘레 부분의 밀도 사이

의 밀도를 가지도록 배열된다. 이제 도 9를 보면, 본원 발명의 또다른 양태에서, 연마 입자들은 전술한 패드 상승을 가능하게 하기에 충분한, 각 입자들 사이의 간격으로 균일하게 분포되도록 배열될 수 있다. 한 양태에서, 균일하게 분포된 입자들은 격자를 형성할 수 있으며, 각 개별적인 그릿 크기의 약 1.5 내지 약 10배의 거리로 고르게 간격지어 질 수 있다. 당업자가 알게 되는 바와 같이, 연마 입자들은 또한 콘센트레이션에 있어서 리딩 에지로부터 CMP 패드 드레서의 중심을 향하여 증가하거나 감소하는 다양한 콘센트레이션 구배로 배열될 수 있다 (도시되지 않음).

또다른 구체예에서, 본원 발명은 드레서를 구비한 CMP 패드의 드레싱을 하는 동안 CMP 패드 드레서에서 중심에 위치한 초연마 입자들에 대한 작업 부하를 증가시키는 방법을 제공한다. 상기 방법은 둘레에 위치한 입자들의 CMP 패드 내부로의 침투는 감소시키고 중심에 위치한 입자들의 CMP 패드 드레서 내부로의 침투는 증가시키는 패턴으로 초연마 입자들을 배열한다. 몇몇 양태에서, 초연마 입자들은 예정된 패턴에 따라 CMP 패드 기판위의 특수한 위치에 각각 개별적으로 배치된다. 중심에 위치한 입자들에 대한 작업 부하는 둘레에 위치한 입자들의 작업 부하의 적어도 약 10% 내지 약 30% 이내까지 증가될 수 있다. 또한 작업 부하는 둘레의 입자들 또는 모든 입자들의 작업 부하와 실질적으로 동일할 수 있다.

중심에 위치한 입자들에 대한 작업 부하를 증가시키는 것은 여러가지 방식으로 구현될 수 있다. 예를 들면, 초연마 입자들은, 도 10에 도시된 바와 같이, 둘레의 입자들의 작업 말단으로부터 중심 입자들의 작업 말단을 향하여 상향의 기울기를 제공하는 패턴으로 배열될 수 있다. 작업 부하를 증가시키는 또다른 방법은, 상기 설명한 바와 같이, 중심에 위치한 입자들의 밀도보다 더 높은, 둘레에 위치한 입자들의 밀도를 제공하는 패턴으로 초연마 입자들을 고정시키는 것이다. 마지막으로, 도 11에 도시된 바와 같이, 상기 패턴은 둘레에 위치한 입자들의 애티튜드에 의해 제공되는 침투보다 CMP 패드 내부로 더 큰 입자 침투를 유발하는 애티튜드를 중심에 위치한 입자들에 제공하도록 배열될 수 있다.

도 10을 참고하면, 본원 발명은 둘레의 초연마 입자들(320)로부터 중심에 위치한 입자들(310)을 향하여 상향의 기울기(305)를 가지는 초연마 입자들에 결합된 기판(300)을 제공함으로써 중심에 위치한 초연마 입자들에 대한 작업 부하를 증가시키는 CMP 패드 드레서를 제공한다. 상향의 기울기는 둘레에 위치한 입자들로부터 중심에 위치한 입자들 쪽으로 입자 높이를 증가시킴으로써 생성될 수 있다. 결과적으로, 상향의 기울기는 중심의 입자들과 CMP 패드에 더욱 큰 접촉을 제공함으로써 작업 부하를 둘레의 입자들로부터 중심의 입자들로 전달한다. 증가된 접촉은 CMP 패드의 드레싱 및 패드 컨디셔너의 총 마모를 개선시킨다. 기울기는 패드 속도(velocity) 및 패드 가요성의 측정으로서 결정된다. 일반적으로, 패드는 패드가 리딩 에지 입자들과 접촉될 때 함몰하는 변형가능한 매질이다. 통상적으로, 패드의 함몰은 패드의 가요성 및 패드의 회전속도에 따라 증대될 것이다. 본원 발명의 바람직한 구체예에서, 기울기는 약 0.1% 내지 0.5%이며, 바람직하게는 기울기는 0.2%이다.

대안으로서, 기울기는 기판의 배열을 변형시킴으로써 얻어질 수 있다. 도 10에 도시된 바와 같이, CMP 패드 드레서의 기판은 실질적으로 편평하나, 몇몇 양태에서, 기판은 회전하는 CMP 패드의 함몰에 맞게 변형하기 위해 윤곽지어질 수 있다. 이러한 윤곽은 연마 입자들(310 및 320)의 작업 말단에 필요한 기울기를 제공할 수 있다. 이러한 경우, 기판 작업 표면 위의 입자들의 높이는 실질적으로 균일할 것이다. 기판은 통상적으로 금속성, 세라믹, 또는 가요성 재료로 제조된다. 한 구체예에서, 기판은 스테인레스 강일 수 있다. 몇몇 양태에서, 기판은 가공시에 고체로 되는 분말화된 재료일 수 있다. 또다른 양태에서, 분말은 크롬과 같은, 약 2 중량% 이상의 양의 탄화물 형성 원소와 조합된 니켈과 같은 금속의 브레이징 합금을 포함할 수 있다. 몇몇 양태에서, 기판은 본질적으로 브레이징 재료로 구성될 수 있다.

도 11은 CMP 패드를 드레싱하는 동안 CMP 패드 드레서의 중심에 위치한 입자들에 대한 작업 부하를 증가시키는 CMP 패드 드레서의 도시이다. 연마 입자들은 입자들의 애티튜드에 따라 상이한 속도로 마모한다. 일반적으로, 꼭지점(apex)의 애티튜드는 CMP 패드 내부로 더 많은 침투를 제공할 것이며 그밖의 다른 애티튜드 보다 더욱 공격적으로 그루밍할 것이다. 면의 애티튜드를 가지는 입자는 최소량의 침투를 제공하며, 패드를 드레싱함에 있어서 가장 적은 공격성을 띤다. 애티튜드로서 에지를 가지는 입자는 중간 정도의 그루밍 및 침투 특성을 제공한다. 도 11을 참고하면, 기판(400)은 복수의 초연마 입자들(410, 420, 430)을 예정된 패턴으로 수용한다. 패턴은 패드 드레서의 둘레에 위치한 입자들의 애티튜드에 의해 제공되는 침투보다 더 높은 입자 침투를 CMP 패드 내부로 유발하는 애티튜드를 중심에 위치한 입자들에 제공하도록 배열된다. 중심에 위치한 초연마 입자들(410)은 입자들의 작업 말단(405)에 꼭지점(apex)을 제공하는 애티튜드로 배향된다. 이러한 입자들은 패드를 더욱 공격적으로 다듬으며, 그밖의 다른 입자들에 의해 제공되는 애티튜드보다 더 큰 정도의 침투를 가진다. 둘레의 입자들(420)은 이들의 작업 말단에서 에지 또는 면(430)을 제공하는 애티튜드로 배향될 수 있다. 특히, 도 11의 구체예에서 도시된 바와 같이, 중심에 위치한 입자들은 이들의 작업 말단(405)에서 꼭지점(apex)을 제공하는 애티튜드로 배향되고, 둘레의 입자들의 애티튜드(430)는 이들의 작업 말단(405)에서 면이며, 이들 사이의 입자들(420)은 이들의 작업 말단에서 에지를 제공하는 애티튜드로 배향될 수 있다. 그러나, 그밖의 다른 전형적인 구체예에서, 둘레의 입자들과 중심의 입자들 사이에 위치한 입자들은 다른 유형 중 하나와 동일할 것이다. 하나의 추가 구체예에서 (도시되지 않음), 중심에 위치한 입자들은 이들의 작업 말단에 에지를 제공하는 애티튜드로 배향될 수 있으며, 둘레에 위치한 입자들은 이들의 작업 말단에 면을 제공하는 애티튜드로 배향될 수 있다.

상기 언급한 방법 및 장치들 이외에도, 본원 발명은 본원에 설명된 CMP 패드 드레서의 제조 방법을 제공한다. 한 양태에서, 이러한 방법은 기판을 제공하는 단계 및 둘레에 위치한 입자들의 CMP 패드 내부로의 침투를 감소시키고 중심에 위치한 입자들의 CMP 패드 내부로의 침투를 증가시키는 패턴으로 초연마 입자들을 기판에 부착하는 단계를 포함한다.

산업상 이용 가능성

수많은 변형 및 수정이 본원 발명의 원리 및 범위에서 벗어나지 않고 당업자에 의하여 고안될 수 잇으며, 첨부된 청구항들은 이러한 변형 및 배열을 뒷받침하는 것으로 간주된다. 그러므로, 가장 실용적이고 바람직한 본원 발명의 구체예로 생각되는 것과 관련하여 본원 발명을 특수하고 상세하게 상기와 같이 설명하였으나, 본원에 설명된 원리 및 개념에서 벗어나지 않고 크기, 재료, 형상, 형태, 기능, 작업 방식, 조합, 및 용도의 변화(이에 제한되는 것은 아님)를 포함한, 수많은 변형이 이루어질 수 있음이 당업자에게는 자명할 것이다.

도면의 간단한 설명

도면의 간단한 설명

도 1은 본원 발명의 한 구체예에 따른 디스크 기판에 연마 입자들을 고정시키기 위하여 전기도금법을 사용하는 선행 기술의 CMP 패드 드레서의 측면도이다.

도 2는 디스크 기판에 연마 입자들을 고정시키기 위하여 전통적인 브레이징법을 사용하여 제조된 선행 기술의 CMP 패드 드레서의 측면도이다.

도 3은 본원 발명의 한 구체예에 따라 제조된 CMP 패드 드레서의 측면도이다.

도 4는 본원 발명의 한 구체예에 따라, 브레이징 합금 쉬트의 표면위에 연마 입자들을 배치하기 위한 형판을 구비한 브레이징 합금 쉬트의 측면도이다.

도 5는 브레이징 합금 쉬트의 표면에 형판을 구비한 브레이징 합금 쉬트의 측면도이며, 연마 입자들이 형판의 개구들을 채우고 있다. 본원 발명의 한 구체예에 따라 편평한 표면은 브레이징 합금 쉬트 내부로 연마 입자들을 가압하는데 사용하기 위하여 도시되어 있다.

도 6은 본원 발명의 한 구체예에 따라 브레이징 합금 쉬트 내부로 가압된 연마 입자들을 가지는 브레이징 합금 쉬트의 측면도이다.

도 7은 본원 발명의 한 구체예에 따라, 실질적으로 오직 드레서의 리딩 에지를 따라서 연마 입자들이 존재하도록 기판에 결합된 연마 입자들을 가지는 CMP 패드 드레서의 작업 표면의 평면도이다.

도 8은 본원 발명의 한 구체예에 따라, 중심에서 보다 리딩 에지에서 더 많은 입자들이 존재하도록 기판에 결합된 연마 입자들을 가지는 CMP 패드 드레서의 작업 표면의 평면도이다.

도 9는 본원 발명의 한 구체예에 따라, 입자들이 두루 균일하게 분포되도록 기판에 결합된 연마 입자들을 가지는 CMP 패드 드레서의 작업 표면의 평면도이다.

도 10은 본원 발명의 한 구체예에 따라 제조된 CMP 패드 드레서의 측면도이다.

도 11은 본원 발명의 한 구체예에 따라 제조된 CMP 패드 드레서의 측면도이다.

도면

도면1

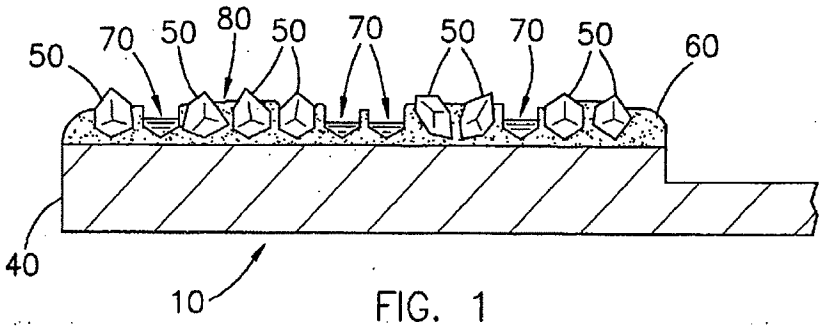


FIG. 1
(PRIOR ART)

도면2

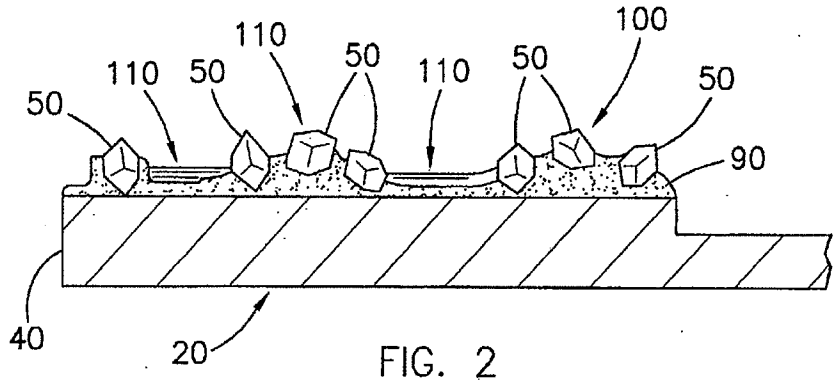


FIG. 2
(PRIOR ART)

도면3

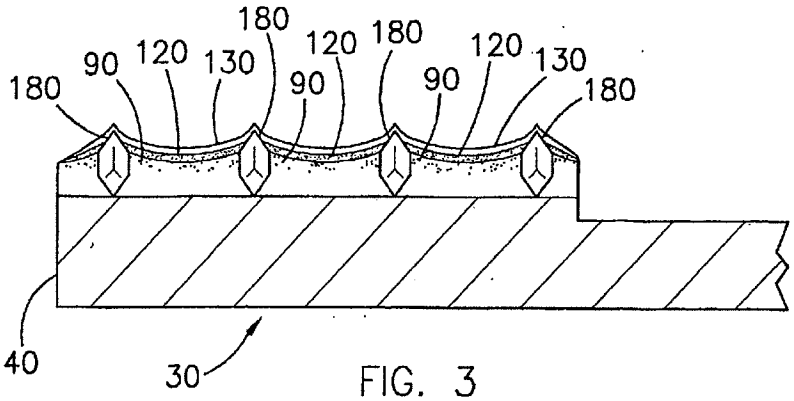
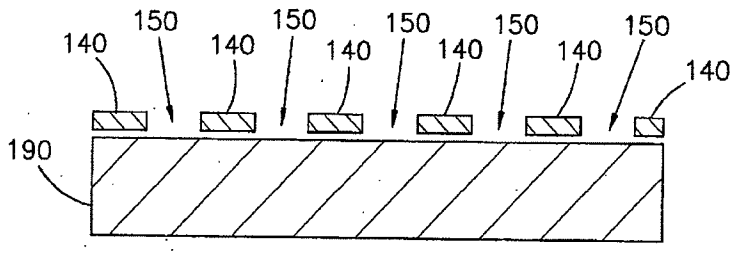


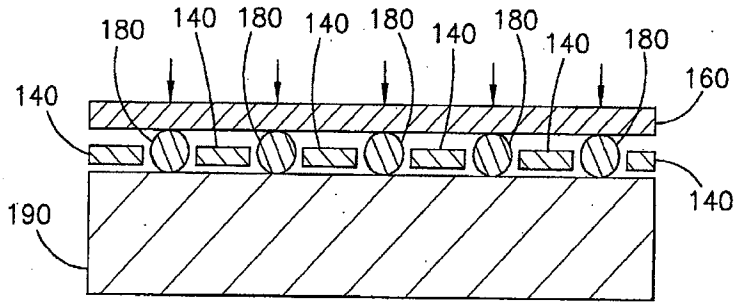
FIG. 3

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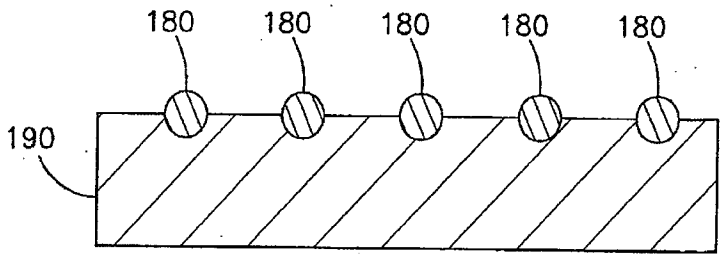
도면4



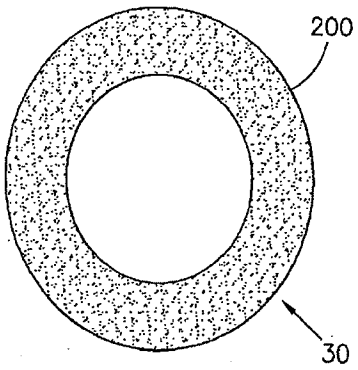
도면5



도면6



도면7



도면8

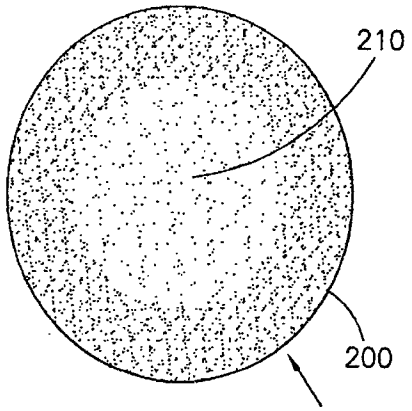


FIG. 8

도면9

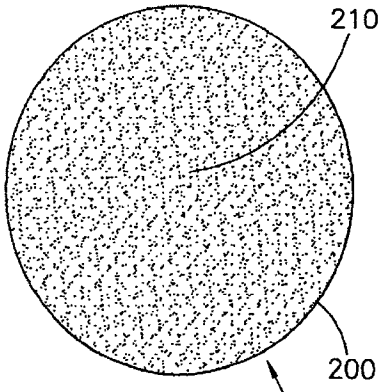


FIG. 9

도면10

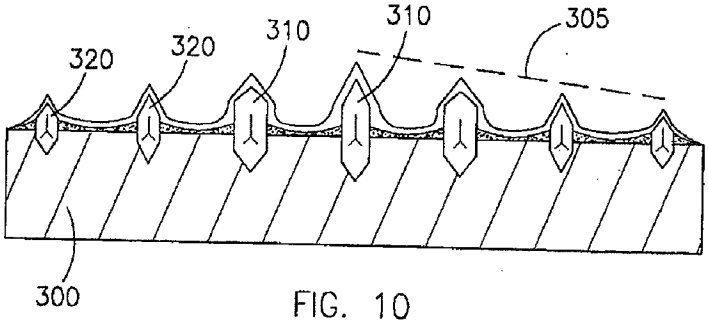
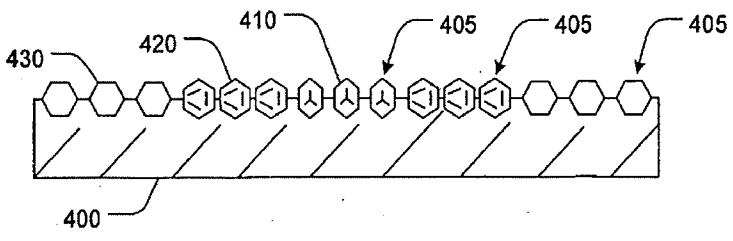


FIG. 10

도면11



Espacenet

Bibliographic data: KR20020036138 (A) — 2002-05-16

DIAMOND GRID-CHEMICAL MECHANICAL POLISH PAD DRESSER

No documents available for this priority number.

Inventor(s): LIN FRANK S; SUNG CHIEN-MIN ± (LIN FRANK S, ; SUNG CHIEN-MIN)

Applicant(s): KINIK CO ± (KINIK COMPANY)

Classification: **- international:** ***B24B1/00;*** (IPC1-7): B24B1/00
- cooperative:

Application number: KR20000066159 20001108

Priority number(s): KR20000066159 20001108

Abstract of KR20020036138 (A)

PURPOSE: A diamond grid-chemical mechanical polish pad dresser is provided to improve polishing efficiency of a CMP(Chemical Mechanical Polish) pad and prolong the service life. CONSTITUTION: A diamond grid-chemical mechanical polish pad dresser (30) constitutes plural abrasive grains(180) of desirable size attached to a plate member. The abrasive grains are extended on the plate member in predetermined height, at regular intervals. The abrasive grains are crystal grains of diamond or cubic boron nitride of a single crystal or poly-crystal type. The crystal grains are placed on a plate(40) coated with an anticorrosion layer(130). The anticorrosion layer is diamond or diamond carbon coated on the surface of a disk to prevent corrosion of brazing alloy(90) by chemical slurry used relatively to the CMP pad.

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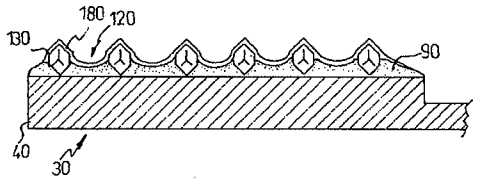
전체 청구항 수 : 총 48 항

(54) 다이아몬드 그리드 화학 기계적 연마 패드 드레서

(57) 요 약

본 발명은 돌출하는 균일하게 일정한 간격을 이룬 다수의 연마 입자들(180)을 가진 CMP 패드 드레서를 나타낸다. 상기 연마 입자들(180)은 우수한 경질 재료로, 일반적으로 다이아몬드, 다결정 다이아몬드(PCD), 입방 보론 질화물(cBN), 또는 다결정 입방 보론 질화물(PcBN)이다. 연마 입자들(180)은 부가 내식 층(130)으로 코팅된 기판(40)에 착지된다. 상기 내식층(130)은 보통 CMP 패드와 연관되어 사용된 화학 슬러리에 의해 경납 합금(90)의 부식을 방지하기 위해 디스크의 표면위로 코팅되는 다이아몬드 또는 다이아몬드형 카본이다. 화학 부식에 대한 상기 면역은 작업편을 연마하는 동안 패드를 드레싱하기 위한 CMP 패드 드레서를 허용한다. 기판(40)상의 평탄한 일정한 간격에 더하여, 연마 입자들(180)은 수직과 수평방향으로 CMP 패드의 손질 또는 드레싱을 위해 허용하는 기판(40)으로부터 떨어진 균일한 거리로 연장한다. 또한 그러한 CMP 패드 드레서를 제조하는 방법이 나타내어졌다.

대 표 도 - 도 3



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청구의 범위

청구항 1

기판 부재에 부착된 바람직한 크기 범위내에 크기를 가진 다수의 연마 입자를 구성하고,

상기 연마 입자들은 균일하게 일정한 간격을 이루고 및 기판 부재위에서 미리 결정된 높이로 연장되는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 2

제 1 항에 있어서,

상기 연마 입자들은 단결정 또는 다결정 형태로써 다이아몬드 또는 입방 보론 질화물의 결정 입자들인 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 3

제 1 항에 있어서,

상기 크기 범위는 50 내지 250 마이크로미터인 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 4

제 1 항에 있어서,

상기 연마 입자들은 크기에 있어서 실질적으로 균일하고, 모든 연마 입자들은 서로 10%내 크기를 가지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드
레서.

청구항 5

제 1 항에 있어서,

상기 다수의 균일하게 일정한 간격을 이룬 연마 입자들은 미리 결정된 형태에 따라서 분포되고, 미리 결정된 거리는 두 개의 입자들사이에 유지되는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 6

제 5 항에 있어서,

각 입자 사이의 미리 결정된 거리는 입자들의 평균 크기의 1.5 내지 10 배인 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 7

제 5 항에 있어서,

상기 미리 결정된 형태는 그리드(grid)인 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 8

제 1 항에 있어서,

기판위의 미리 결정된 높이는 모든 연마 입자들이 50 마이크로미터내로 연장하는 균일한 높이인 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 9

제 1 항에 있어서,

상기 기판위의 미리 결정된 높이는 평균 70μm 이상인 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 10

제 1 항에 있어서,

상기 연마 입자들은 자형(euhedral) 결정 형상을 가지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 11

제 1 항에 있어서,

상기 연마 입자들은 미리 결정된 형상을 가지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 12

제 1 항에 있어서,

상기 연마 입자들은 기판으로부터 떨어져 방향지어진 가장자리 또는 예리한 지점을 구비하는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 13

제 1 항에 있어서,

상기 기판은 금속 재료로 만들어진 것을 특징으로 하는 화학 기계적 연마 (CMP) 패드 드레서.

청구항 14

제 12 항에 있어서,

상기 금속 재료는 스테인레스강인 것을 특징으로 하는 화학 기계적 연마 (CMP) 패드 드레서.

청구항 15

제 1 항에 있어서,

상기 연마 입자들은 경납 합금에 의해 기판에 부착되는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 16

제 14 항에 있어서,

추가로 상기 경납 합금은 1 wt% 이상의 크롬 량을 가진 니켈 합금을 구성하는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 17

제 14 항에 있어서,

상기 경납 합금은 기판의 표면위에 미리 결정된 두께이고, 각 연마 입자의 10 내지 90%가 노출되는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 18

내식층으로 코팅되는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 19

제 18 항에 있어서,

연마 입자들의 층은 전기 도금 니켈에 의해 기판에 결합되는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 20

제 18 항에 있어서,

상기 내식층은 다이아몬드형 카본으로 구성되는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 21

제 18 항에 있어서,

상기 다이아몬드형 카본은 다이아몬드 결합에 있어서 70% 이상을 함유한 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 22

제 18 항에 있어서,

상기 내식층은 3 마이크로미터 이하의 두께를 가지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 23

제 18 항에 있어서,

상기 다이아몬드형 카본은 95% 이상의 원자 탄소 함량을 가지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서.

청구항 24

a) 기판 부재를 제공하는 단계,

b) 상기 기판의 표면위에 다수의 연마 입자들을 균일하게 일정한 간격으로 유지하는 단계, 및

c) 각 연마 입자들이 기판 부재위에 미리 결정된 높이로 연장하도록 기판에 상기 연마 입자들을 부착하는 단계를 구성하는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 25

제 24 항에 있어서,

상기 연마 입자들은 단결정 또는 다결정 형태로써 다이아몬드 또는 입방 보론 질화물의 결정 입자들인 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 26

제 24 항에 있어서,

단계 b) 및 c)는 추가로,

a) 연마 입자의 배치가 구멍들의 위치에 의해 제어되도록 경납 합금의 시트상에 그 안에 형성된 구멍들의 미리 결정된 형태를 가지는 형판을 놓는 단계,

b) 연마 입자들로 상기 형판의 구멍을 채우는 단계,

c) 형판 구멍내에 있지않은 연마 입자들을 제거하는 단계,

d) 상기 연마 입자들이 경납 합금으로 부분적으로 애워싸여지게 되도록 경납 합금의 시트내부 구멍에 함유된 연마 입자들을 가압하는 단계,

e) 연마 입자들이 경납 합금의 시트상에 놓인 상태로 유지하도록 형판을 제거하는 단계,

f) 기판에 연마 입자들을 함유하는 경납 합금의 시트를 부착하는 단계, 및

g) 진공로에서 제품을 경납하는 단계를 구성하는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 27

제 26 항에 있어서,

상기 구멍들은 단지 하나의 연마 입자를 수용하기에 충분한 크기를 가지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 28

제 27 항에 있어서,

상기 구멍들은 미리 결정된 범위의 연마 입자들을 수용하기 위해 선택된 미리 결정된 크기를 가지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 29

제 24 항에 있어서,

상기 연마 입자들은 50 내지 250 마이크로미터의 범위인 평균 크기를 가지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 30

제 24 항에 있어서,

상기 연마 입자들은 모든 연마 입자들이 서로의 10%내 크기를 가지도록 크기에 있어서 실질적으로 균일한 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드
레서 제조 방법.

청구항 31

제 26 항에 있어서,

미리 결정된 형태의 상기 구멍들은 두 개의 입자들 사이에 미리 결정된 거리를 만들기 위해 충분한 방법내에서 일정한 간격으로 유지되는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 32

제 31 항에 있어서,

상기 각 입자사이의 미리 결정된 거리는 입자들 크기의 1.5 내지 10배인 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 33

제 26 항에 있어서,

상기 미리 결정된 입자의 형태는 그리드인 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 34

제 24 항에 있어서,

기판으로부터 미리 결정된 높이는 모든 연마 입자들이 50 마이크로미터내로 연장하는 균일한 높이인 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 35

제 24 항에 있어서,

상기 연마 입자들은 자형 형상을 가지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 36

제 24 항에 있어서,

상기 연마 입자들은 미리 결정된 형상인 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 37

제 24 항에 있어서,

상기 연마 입자들은 상기 기판으로부터 떨어져 방향지어진 가장자리 또는 예리한 지점을 가지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 38

제 24 항에 있어서,

상기 기판 부재는 금속 재료로 만들어진 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 39

제 38 항에 있어서,

상기 금속 재료는 스테인레스강인 것을 특징으로 하는 화학 기계적 연마 (CMP) 패드 드레서 제조 방법.

청구항 40

제 26 항에 있어서,

상기 경납 합금의 시트는 유기 결합제로 서로 경납 합금 입자들을 결합하는 단계, 및

바람직한 두께의 시트로 상기 결합된 입자들을 형성하는 단계에 의해 제조되는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 41

제 40 항에 있어서,

상기 시트로 경납 합금 입자들을 형성하는 단계는 압연, 압출 또는 테이프 케스팅에 의해 이루어지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 42

제 26 항에 있어서,

상기 경납 합금은 1wt% 이상의 크롬 양을 가지는 니켈 합금을 구성하는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 43

제 26 항에 있어서,

상기 경납 합금의 시트는 경납 합금위의 각 연마 입자의 10 내지 90% 사이의 노출을 허용하기 위해 충분한 경납 두께를 가지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 44

제 24 항에 있어서,

추가로 내식층을 가진 상기 경납 합금과 상기 연마 입자들을 코팅하는 단계를 구성하는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 45

제 44 항에 있어서,

상기 내식층은 다이아몬드, 또는 다이아몬드형 카본으로 구성되는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 46

제 44 항에 있어서,

상기 내식층은 3 마이크로미터 이하의 두께를 가지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 47

제 44 항에 있어서,

상기 다이아몬드형 카본은 90% 이상의 원자 탄소 함량을 가지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

청구항 48

제 47 항에 있어서,

상기 코팅 단계는 음극 아크 방법을 사용하여 이루어지는 것을 특징으로 하는 화학 기계적 연마(CMP) 패드 드레서 제조 방법.

명세서

발명의 명칭

다이아몬드 그리드 화학 기계적 연마 패드 드레서{A DIAMOND GRID CMP PAD DRESSER}

도면의 간단한 설명

[0001] 도 1은 디스크 기판에 다이아몬드를 고정하기 위해 전기 도금 방법을 사용한 종래 기술의 CMP 패드 드레서의 측면도이고,

[0002] 도 2는 디스크 기판에 다이아몬드 입자들을 고정하기 위한 종래 경납 방법을 사용하여 만들어진 종래 기술의 CMP 패드 드레서의 측면도이고,

[0003] 도 3은 본 발명의 원리에 따라 만들어진 CMP 패드 드레서의 측면도이고,

[0004] 도 4는 본 발명의 원리에 따라 만들어진 그의 표면위에 연마 입자들을 놓기 위한 형판을 가진 경납 합금의 시트에 대한 측면도이고,

[0005] 도 5는 그의 표면위에 형판과 상기 형판의 구멍들을 채우는 연마 입자들을 가진 경납 합금 시트의 측면도로, 평평한 표면은 본 발명의 원리에 따라서 경납 합금의 시트내부로 연마 입자들을 가압하여 사용하기 위한 것을 나타내었고,

[0006] 도 6은 본 발명의 원리에 따라서 상기 내부로 가압된 연마 입자들을 가진 경납 합금 시트의 측면도이다.

발명의 상세한 설명

[0007] 본 발명은 일반적으로 CMP(화학기계적 연마) 패드(pad)를 조절하고 또는 드레싱(dressing)하기 위한 장치 및 그의 제조 방법에 관한 것이다. 특히, 본 발명은 CMP 패드를 조절하고 또는 드레싱하기 위해 다이아몬드 또는 입방 보론 질화물과 같은 우수한 경질재료를 함유한 드레싱 디스크에 관한 것이다. 더욱 특이하게, 본 발명은 화학적 침식으로부터 보호하기 위해 탄소와 같은 다이아몬드의 얇은 피막으로 코팅될 수 있는, 평탄하게 일정한 간격을 이룬 연마 입자들을 가진 드레싱 디스크에 관한 것이다.

[0008] 많은 산업체에서는 현재 어떠한 작업편을 연마하기 위해 화학기계적 평탄화 (CMP) 방법을 사용하고 있다. 특히, 제조 산업은 세라믹, 실리콘, 유리, 석영 및 금속의 웨이퍼들을 연마하기 위해 대부분이 CMP 방법에 의존하고 있다. 일반적으로 그러한 연마공정은 폴리우레탄과 같은 내구성 유기물로 만들어진 회전 패드에 대항하여 웨이퍼 부착을 수반한다. 패드에 대하여, 웨이퍼 기판을 파괴시킬 수 있는 화학물질을 함유한 화학 슬러리 및 웨이퍼 표면을 물리적으로 침식시키기 위해 작용하는 많은 양의 연마 입자들이 첨가된다. 슬러리는 회전 CMP 패드에 연속적으로 첨가되고, 및 웨이퍼상에 발휘된 이중의 화학적 및 기계적 작용들은 바람직한 방법을 통해 연마되도록 한다.

[0009] 제조된 연마 품질에 대해 특별한 중요성의 하나는, 전체 패드를 통한 연마 입자들의 분포에 있다. 패드의 최상부는 보통 폴리우레탄내에 공공과 같은 수단에 의해 입자들을 지지하고 및 패드의 최상부상에 거친 조직을 유지한다. 추가로 유연한 패드 최상부는 웨이퍼상에서 연마를 허용하기 위해 필요한 지지물을 제공한다.

[0010] 패드의 최상부의 조직을 유지하는 것에 대한 문제는 작업편, 연마 슬러리 및 드레싱 디스크로부터 나오는 연마 부스러기(debris)의 축적때문이다. 상기 축적은 패드가 슬러리의 연마 입자들을 유지할 수 없게 만드는 패드의 최상부의 "글레이징 (glazing)" 또는 경화를 일으킨다.

[0011] 따라서, 시도들이 다양한 장치들로 상기를 "빗질"하므로써 패드 최상부의 재생을 만든다. 상기 공정이 CMP 패드를 "드레싱" 또는 "조절"하는 것으로써 공지되어 왔다. 많은 형태의 장치들 및 공정들은 상기 목적을 위해 사용되었다. 그러한 장치중 하나는 그의 기판 또는 표면에 부착된 다이아몬드 입자들과 같은 매우 단단한 결정질 입자들을 가진 디스크(disk)이다.

[0012] 불행이도, 종래 방법에 의해 만들어진 그러한 다이아몬드 디스크들은 몇 가지 문제점들을 나타내었다. 첫 번째, 다이아몬드들은 디스크의 기판으로부터 박리되어졌고 및 CMP 패드 표면에 포착되었다. 상기는 연마되는 작업편에 대하여 스크래치(scratch)를 유발한다. 두 번째, 종래 디스크들은 그룹으로 덩어리지고, 또는 기판의 표면위에 평탄하지 않게 일정한 간격을 이룬 다이아몬드를 가지기 쉬워진다. 상기 평탄하지 않은 그룹은 마모 영역을 발생하는 과다하게 드레싱될 CMP 패드의 약간의 부분들을 일으키고, 한편 다른 것들은 글레이징 층을 유발하는 드레이싱 결핍이 유발된다. 어느 경우에나, 패드 연마 효율은 감소되고, 및 평탄하지 않은 연마를 일으킨다. 마지막으로, 상기 디스크들의 다이아몬드들은 디스크의 기판 표면위의 균일한 높이로 연장하지 못한다. 상기 불균일함은 또한 단지 드레서로부터 충분한 높이로 돌출하는 상기 입자들이 패드에 접촉하기 때문에 CMP 패드의 평탄하
지 않은 드레싱을 일으킨다. 패드 최상부의 평탄하지 않은 드레싱은 웨이퍼의 불균일함을 초래할 수 있다.

[0013] 디스크 기판으부터 다이아몬드의 박리는 그들이 부착되어지는 열등한 방법 때문이다. 다이아몬드들이 기판에 전기도금된 니켈에 의해 유지될 때, 강력한 결합이 아닌 다이아몬드의 기계적 체결이 있게 된다. 따라서, 상기 입자들은 그들이 요동하여 느슨하게되자마자 박리되어질 것이다. 상기 박리 공정은 전기 도금재료상에 화학 슬러리의 화학적 침식에 의해 실행된다.

[0014] 한편, 다이아몬드들이 기판위로 경납(brazing)될 때, 화학 작용력은 더욱 확고하게 다이아몬드를 지탱한다. 그러나, 화학 슬러리내 산은 입혀진 물질을 빠르게 용해시키고 및 다이아몬드를 박리시킨다. 따라서, 화학작용으로 경납의 노출을 최소화하기 위해, 연마 공정은 드레이싱이 발생하는 동안 중지되고, 및 그 후에 다시 시작되어야 한다. 상기는 다른 연마가 뒤따르고 및 그 후 드레싱은 시간을 소비하게 때문에 비효율적이다.

[0015] 전술된 관점에서, CMP 패드의 평탄한 손질(grooming)을 제공하는 CMP 패드 드레서가 바람직할 수 있다. 또한, 평탄한 깊이로 CMP 패드를 손질하는 CMP 패드 드레서가 매우 바람직할 수 있다. 추가로, 다이아몬드 입자 박리에 덜 민감한 CMP 패드 드레서가 매우 바람직할 수 있다. 마지막으로, 화학 슬러리의 산 침식에 저항하고, 및 연속적으로 CMP 패드를 드레싱할 수 있고, 심지어 산 슬러리에서 연마가 수행되어지는 CMP 패드 드레서가 극히 바람직할 수 있다.

[0016] 본 발명의 목적은 평탄하게 드레스 또는 조절을 위한 연마 입자들을 사용할 수 있는 CMP 패드 드레서, CMP 패드를 제공하는 것이 본 발명의 목적이다.

[0017] 본 발명의 다른 목적은 연마 입자 박리에 덜 민감한 CMP 패드 드레서를 제공하기 위한 것이다.

[0018] 본 발명의 또 다른 목적은 CMP 패드를 일정하게 드레싱할 수 있고, 심지어는 패드가 산 슬러리내에서 연마 작용으로 체결되도록 내식성이 있는 CMP 패드 드레서를 제공하기 위한 것이다.

[0019] 또한 본 발명의 목적은 연마되어진 웨이퍼를 오염시키는 디스크로부터 성분들의 용해를 방지하는 화학 베리어를 제공하기 위한 것이다.

[0020] 추가로 본 발명의 목적은 평탄하게 CMP 패드를 드레싱하고 또는 조절하는 방법을 제공하기 위한 것이다.

[0021] 또한 본 발명의 목적은 패드가 산 슬러지에 담궈질 때 연마 입자 박리에 대하여 CMP 패드 드레서의 민감성을 감소시키는 방법을 제공하기 위한 것이다.

[0022] 상기 목적들 및 특별하게 인용되지 않은 다른 것들은 많은 평평하게 일정한 간격을 이룬 기판에 부착된 연마 입자들을 가지는 CMP 패드 드레서의 특별하게 설명된 실시예를 통해 이루어졌다. 일반적으로, 상기 입자들은 단결정 또는 다결정 형태에서, 다이아몬드, 또는 입방형 보론 질화물(cBN)과 같은 매우 단단한 기판중의 하나이다.

[0023] 본 발명의 CMP 패드 드레서를 형성하는 하나의 방법에서, 브레이징 파우다 와 유기 결합제가 첫 번째 반죽(dough)을 형성하기 위해 완전히 혼합된다. 그 후
상기 반죽은 경납 합금의 유연한 시트를 형성하기 위해 두 개의 롤러 사이를 통해 압연된다. 그 후 연마 입자들은 다수의 평평하게 일정한 간격을 이룬 구멍들을 포함하는 형판의 사용에 의해 경납 합금의 시트상에 평평하게 놓여진다. 상기 형판의 구멍들은 하나의 연마 입자 또는 "그리트(grit)"의 크기보다 크지만, 두 개의 크기보다 작다. 모든 구멍들이 연마 입자들로 채워질 때, 어느 과도한 연마 입자들은 제거되고, 및 연마 입자들은 강판과 같은 일반적으로 평평한 표면을 사용하므로써 그 안에 그들이 묻히도록 경납 합금 시트내부로 가압된다. 그 후 상기 형판은 제거되고, 및 연마 입자를 함유한 경납 합금은 아크릴 아교를 가진 기판에 부착된다. 마지막으로, 전체 조립체는 경납 공정을 완성하고 및 확고하게 기판에 연마 입자들을 고정시키기 위해 진공로에서 경납된다.

[0024] 다른 방편으로, 연마 입자들은 상기에 기술된 것 처럼 형판을 사용하여 아크릴 아교를 가진 기판에 부착될 수 있다. 다음, 경납 합금 입자들은 연마 입자들과 기판위로 나타내어진다. 마지막으로, 전체 조립체는 경납 공정을 완성하고 및 확고하게 기판에 연마 입자들을 부착하기 위해 진공 경납로에서 가열된다.

[0025] 제어된 방법에서 연마 입자들을 위치시키기 위해 형판을 사용하므로써, 어떠한 바람직한 형태의 배치는 이루어질 수 있다. 상기 패턴은 거의 어떠한 상상할 수 있는 패턴일 수 있지만, 그러나 대부분이 상당히 기판위에 연마 입자들을 평평하게 일정한 간격을 유지시킬 수 있는 능력을 제공한다. 또한, 균일한 크기인 구멍들을 가진 형판을 사용하므로써, 각 연마 입자의 균일한 크기가 확보된다. 마지막으로, 기판 내부로 연마 입자들을 가압하기 위한 평평한 표면의 사용은 기판 표면위로 돌
출하는 연마 입자들의 균일한 높이를 만든다. 상기 균일한 높이의 연마 입자들은 균일한 깊이로 CMP 패드의 드레싱 또는 홈파기(plowing)를 확보한다. 추가로, 기판을 가로지른 연마 입자들의 균일한 분포는 그의 표면을 가로지른 패드의 균일한 드레싱을 위해 허용한다.

[0026] 기판에 연마 입자들을 부착한 후, 부가적인 내식 재료의 얇은 코팅이 CMP 패드 드레이서에 적용될 수 있다. 그러한 코팅은 효과적으로 CMP 패드 드레서의 표면을 밀봉한다. 그러한 밀봉제는 연마 입자 및 경납을 보호하고, 또는 다른 정착제는 연마 슬러리, 특히 산을 함유한 상기 슬러리들의 화학물질로부터 화학 침식에 대한 그들의 민감성을 감소시킨다. CMP 패드 드레서의 표면이 화학 분해로 덜 민감하게 되는 것 처럼, 또한 연마 입자 박리에 대한 그의 민감성은 줄어든다. 따라서, CMP 패드 드레서는 기판에 대하여 연마 입자들을 결합하는 작용제가 화학 박리로부터 보호되기 때문에 연마 작용동안에도 CMP 패드를 연속적으로 드레서할 수 있다.

[0027] 본 발명의 상기 및 다른 목적, 형태 및 장점들이 첨부된 도면들과 관련하여 나태내어진 다음의 상세한 설명으로부터 더욱 명백히 나타내어질 것이다.

[0028] 현재 CMP 패드 드레서 및 수반된 사용 방법 및 제조가 나타내어지고 및 기술되어지기전, 상기는 본 발명이 여기에서 나타내어진 특별한 공정 단계 및 재료에 제한을 두지 않았지만, 관계 기술에서 보통 기술된 것들에 의해 인식되어진 것 처럼 그의 대등한 연장으로 이해되어질 것이다. 또한 상기는 여기에서 사용된 용어는 단지 특별한 실시를 기술하기 위한 목적으로 사용되었고 및 제한되길 의도되지 않
은 것으로 이해되어져야 한다.

[0029] 상기 상기 명세서 및 첨부된 청구범위에서 사용된 것 처럼, 단일 형태들 "a", "and", "the"는 문맥이 분명하게 다른 것으로 규정되지 않는 한 복수의 지지 대상을 포함하는 것으로 주목되어야 한다. 따라서, 예를 들면, "연마 입자" 또는 "그리트"로 인용은 하나 이상의 그러한 연마 입자들 또는 그리트들에 대한 인용을 포함한다.

[0030] 본 발명을 기술하고 및 청구함에 있어서, 다음의 용어는 아래 설명된 정의에 따라서 사용될 것이다.

[0031] 여기에서 사용된 것으로, "연마 입자", 또는 "그리트", 또는 유사한 말들은 어떤 우수한 단단한 결정질, 또는 다결정 물질, 또는 물질의 혼합물을 의미하고 및 포함하지만 다이아몬드, 다결정 다이아몬드(PCD), 입방 보론 질화물, 및 다결정 입방 보론 질화물(PCBN)로 제한되지 않는다. 추가로, "연마 입자", "그리트", "다이아몬드", "다결정 다이아몬드(PCD)", "입방 보론 질화물" 및 "다결정 입방 보론 질화물(PCBN)"의 용어들은 서로 교환하여 사용될 수 있다.

[0032] 여기에서 사용된 것으로써, "기판"은 연마 입자들이 부착될 수 있는 표면을 가진 CMP 드레서의 기부(基部)를 의미한다. 상기 기부는 어떠한 형상, 두께 또는 재료일 수 있고 및 포함하지만, 그러나 금속, 합금, 세라믹 및 그의 혼합물로 제한되지 않는다.

[0033] 여기에서 사용된 것으로써, "자형(euhedral)"은 고유 형태를 가짐을 의미하고, 또는 성장된 결정학적면을 가진 변경되지 않은 자연 형상을 가짐을 의미한다.

[0034] 여기에서 사용된 것으로써, "끝이 뾰족한(sharp point)"은 결정으로 되는 어떠한 협소한 정점을 의미하고, 포함하지만 모서리들, 융기들, 오벨리스크(obelisk)들, 및 다른 돌출부들로 제한되지 않는다.

[0035] 여기에서 사용된 것으로써, "금속"은 어떠한 금속의 형태, 금속 합금 또는 그의 혼합물을 의미하고 및 특별하게 포함하지만 강, 철, 및 스테인레스강으로 제한되지 않는다.

[0036] 발명자는 CMP 패드를 조절 또는 드레싱의 효율성 및 품질을 개선하기 위한 장치를 발견하였다. 장치를 사용하고 및 제조하기 위한 방법이 여기에 포함되었다. CMP 패드를 조절하고 드레싱하기 위한 장치를 사용하므로써, 디스크 수명 및 패드 수명이 연장될 뿐만 아니라 패드가 사용될 수 있는 동일성이 연장되었고, 따라서 작업이 완성되는 처리량이 향상되었다. 또한, 연마된 웨이퍼의 균일성 및 결함율이 개선되었다.

[0037] 도 1을 참고로, 거기에는 다수의 다이아몬드 입자들(50), 전기 도금된 기판 (40)을 구비한 CMP 패드 드레서가 나타내어져있다. 전기 도금 재료(60)는 일반적으로 산 용액으로부터 석출된 니켈이다. 그러한 전기 도금 방법은 고가이고 및 시간이 소모될 뿐만 아니라, 공정에 의해 발생된 폐기물 때문에 환경적으로 위험하다.

[0038] 전기 도금된 CMP 패드 드레서(10)는 도 1에 나타낸 것 처럼 나타내어진 많은 단점을 가지고 있다. 첫 번째, 전기 도금 재료(60)는 다이아몬드 입자(50)로 어떠한 화학 결합을 형성할 수 없다. 따라서, 단지 약한 가공력은 기판(60)위로 다이아몬드 입자들(50)을 유지한다. 그러한 가공력은 패드 드레서가 CMP 패드에 대항하여
문질러질 때 공간(70)과 같은 전기 도금 재료(60)내에 공공들을 남겨 전기 도금 재료(60)로부터 쉽게 느슨해지는 다이아몬드 입자들(50)에 작용하는 큰 마찰력에 의해 빠르게 극복된다. 그러한 공공들은 슬러리로부터 화학 제품 및 연마 입자들 뿐만 아니라 작업편의 연마된 잔유물로 빠르게 채워지게된다. 그러나, 그러한 증착된 잔유물은 경화되고 및 떨어질 때, 종종 미세 스크래치를 발생시키고, 연마된 웨이퍼의 생산량을 감소시킨다.

[0039] 전기 도금 재료(60)에 의해 생산된 가공력이 기판(40)상에서 다이아몬드 입자들(50)을 지지하고, 다이아몬드 입자(50)를 노출하는 유일한 수단이고, 상기 전기도금 재료가 최소로 유지되어야 한다. 따라서, 전기 도금 재료(60)와 CMP 패드사이의 접촉은 피할 수 없다. 그러한 접촉은 전기 도금 재료를 마모시키고 및 다이아몬드 입자(50)들의 방출을 촉진시킨다.

[0040] 또한, 전기 도금 재료(60)는 볼록한 부분(80)과 같은 장소에서 다이아몬드 (50)위로 성장하는 경향이 있다. 상기 과도한 성장은 이미 낮은 노출 및 다이아몬드 입자(50)들의 빽빽한 간격에 더하여, 만약 불가능하지 않다면, 어려운 CMP 패드 내부로 다이아몬드 입자(50)의 상당한 관통을 만든다. 그러한 관통없이, 드레싱 공정은 심하게 방해를 받는다.

[0041] 도 2를 참고로, 거기에는 경납 재료(90) 및 종래 경납 기술을 사용하여 기판(40)에 경납된 다이아몬드 입자(50)들을 가지고, 기판(40)을 가진 종래 기술의 CMP 드레서 패드를 나타내었다. 경납 재료들은 일반적으로 탄화물 형성자와 혼합된 금속 합금을 구성한다. 그러한 탄화물 형성자들은 차례로 기판과 결합하여, 재료
(90)를 경납하기 위해 화학적 결합으로 다이아몬드 입자(50)들을 허용한다. 상기 결합 장치는 그리트 부착 강도를 상당히 증가시키지만, 약간의 바람직하지 않은 부작용에 의해 수반되어진다.

[0042] 경납 재료(90)는 다이아몬드 입자(50)들을 완전히 덮는 것으로부터 유지하기 위해서 최소로 유지되어야 한다. 따라서, 다이아몬드 입자(50)들은 단지 경납 재료 (90)의 얇은 코팅으로 감싸진다. 상기 문제는 일반적인 경납 재료들이 기계적으로 약하다는 사실에 의해 혼합된다. 상기 기계적 약함은 경납 재료 그 자체가 분리된 다이아몬드 입자로 잘리워질 수 있기 때문에 다이아몬드 입자(50)들과 경납 재료 (90)사이의 화학 결합의 강도를 상쇄시킨다.

[0043] 경납 재료(90)를 가진 부가적인 문제는, 상기에 언급된 전기 도금 니켈과 같이 연마 슬러리에 의해 화학 침식에 매우 민감하다는 것이다. 그러한 화학 침식은 경납 재료(90)를 약하게 하는 것과 같이 다이아몬드 입자(50)들의 분리에 기여한다. 따라서, 화학 슬러리에 CMP 패드 드레서(20)의 노출을 감소시키기 위해서, 작업편의 연마가 중지되어야 하고, 및 화학 슬러리는 패드 드레서(20)가 적용되기전 패드를 떠나는 것을 허용한다. 그러한 연마 공정에서 중지는 마무리 제품을 제조하기 위해 요구된 시간을 증가시키고, 및 따라서 비효율적이다.

[0044] 종래 경납에 대한 다른 결점은 용융 금속 합금의 표면 장력이 기판(40)에 적용될 때 "덩어리"로 연마 입자(50)들을 발생시키는 경향이 있다는 것이다. 그러한 덩어리는 100으로 설명되었고, 틈(110)을 남긴다. 전체 효과는 비효율적이 손질을 만드는 다이아몬드 입자(20)들의 고르지 않은 분포를 남긴다. 상기 비효율성은 틈
(110) 때문이고, 조절되지 않고 남아 있는 CMP 패드의 영역을 발생시킨다.

[0045] 상기 고르지 않은 조절은 작업편의 마모 영역이 적당하게 조절된 영역보다 덜 효과적으로 연마되기 때문에 고르지 않은 연마를 받는 전체 결과로 다른 것 보다 빠르게 마모되는 CMP 패드의 영역을 발생시킨다.

[0046] 연마 입자들의 덩어리를 만드는 다른 효과는 경납 재료(90)내에 작은 무더기 (mound)의 형성이다. 작은 무더기 형성은 약간의 다이아몬드 입자들을 다른 연마 입자들의 것보다 큰 기판(40)위로 높게 상승시킨다. 따라서, 높아진 돌출 입자들은 CMP 패드 내부로 깊게 관통하고, 그들은 어떠한 손질 효과에 의해 연마 입자들이 돌출하는 것을 더 적게 방지할 것이다. 상기는 또한 비효율성 및 부적합한 조절을 발생시킨다.

[0047] 종래 기술의 CMP 패드 드레서와 대조적으로, 본 발명은 CMP 패드의 고른 드레싱을 허용한다. 도 3을 참고로, 거기에는 본 발명의 원리에 따라서 만들어진 CMP 패드 드레서를 나타낸다. 상기 CMP 패드 드레서는 경납 재료(90)로 기판(40)에 부착된 다수의 연마 입자(180)를 가진다. 연마 입자(180)들은 어떠한 우수한 경질 재료일 수 있다. 바람직한 재료들은 다이아몬드로 제한되지 않은 다결정질 다이아몬드(PCD), 입방 보론 질화물(CBN) 및 다결정 입방 보론 질화물(PCBN)을 포함한다.

[0048] 또한 도 3에 나타내어진 것 처럼, 내식 층(130)이다. 상기 내식 층은 연마 입자(180)들이 아래에 기술된 방법을 통해 기판(40)에 부착되어진 후 CMP 패드 드레서의 표면위에 형성된다. 내식 층(130)은 다이아몬드, 또는 다이아몬드형 카본과 같은 다른 우수한 경질 재료이다. 바람직한 실시예에서, 내식 층(130)은 비다이아
몬드 카본의 메트릭스내에 약 70% 이상의 다이아몬드로 구성되었다. 내식 층(130)은 임의의 두께일 수 있으나, 일반적으로 0.5 내지 3μm의 범위이다. 바람직한 실시예에서, 내식 층(130)은 약 1의 두께를 가진다. 그러한 얇은 내식 층(130)은 물리 증기 증착(PVD)방법에 의해 제조될 수 있다. 흑연 음극을 가진 음극 아크의 사용과 같은 PVD 방법은 기술내에서 공지되었고 및 내식 층(130)을 제조하기 위해 사용될 수 있다.

[0049] 내식 층(130)에 의해 제공된 장점은 효과적으로 가공 표면을 "밀봉"하는 것이고, 및 또한 화학 침식에 취약할 수 있는 CMP 패드 드레서의 다른 바람직한 표면들을 밀봉할 수 있다. 밀봉제로써, 내식 층(130)은 CMP 패드내에 유지된 연마 화학 슬러리에 의해 화학 침식으로부터 경납 재료(90)를 보호한다. 상기 보호는 패드가 작업편을 연마할 때에도 CMP 패드 드레서(30)가 연속적으로 CMP 패드를 드레싱하는 것을 허용하고, 및 종래 기술의 CMP 패드 드레서의 수명을 연장하기 위해 사용된 제조 중지를 제거한다. CMP 패드의 연속적이고 및 고른 드레싱은 더 많은 제품 생산을 허용하고, 및 CMP 패드의 수명 및 효과를 연장한다.

[0050] 기판(40)에 연마 입자(180)들을 부착하는 하나의 방법이 도 4-6에 나타내어졌다. 첫 번째, 구멍(150)을 가진 형판(140)은 경납 합금(90)의 시트위에 놓인다. 형판의 사용은 바람직한 형태로 구멍들을 가진 형판을 디자인하므로써 제어될 연마 입자(180)들의 배치를 허용한다. 연마 입자 배치를 위한 형태들은 CMP 패드 드레서가 사용될 특별하게 필요한 조건들을 맞추기 위한 기술에서 보통 기술된 하나에 의해 선택될 수 있다.

[0051] 본 발명의 하나의 양상에서, 구멍들의 분포는 경납 합금(90)에 의해 결합된 연마 그리트(180)들 사이에 바람직한 양의 공간을 만들기 위해 미리 결정된 구멍들 사이에 공간을 가진 그리드(grid) 형태이다. 바람직한 실시예에서, 상기 그리트는 각 그리트 크기의 약 1.5 내지 약 10배의 거리로 고르게 일정한 간격을 이룬다.

[0052] 형판(140)이 경납 합금 시트(90)에 놓인 후, 구멍(150)들은 연마 입자 (180)들로 채워진다. 구멍(150)들은 단지 하나의 연마 입자가 각 구멍에 채워지도록 바람직한 크기를 가진다.

어떠한 크기의 연마 입자, 또는 그리트는 수용할 수 있지만, 그러나 본 발명의 양상에서, 입자들 크기는 직경으로 약 100 내지 350 마이크로미터이다.

[0053] 본 발명의 다른 양상에서, 형판내에 구멍들의 크기는 크기에서 변하거나 또는 실질적으로 균일한 크기인 연마 입자들의 형태를 얻기 위해서 요구되어질 수 있다. 바람직한 실시예에서, 형판의 구멍들은 서로의 크기에서 50 마이크로미터내에 있는 그리트를 단지 선택하기 위해 충분하다. 상기 그리트 크기의 균일성은 각 연마 입자의 가공 하중이 고르게 분포되는 것 처럼, CMP 패드 손질의 균일성에 기인한다. 차례로, 고른 가공 하중 분포는 개개의 연마 입자들상에 응력을 감소시키고, 및 CMP 패드 드레서(30)의 효과적인 수명을 연장한다.

[0054] 형판(150)의 구멍들이 그리트(180)로 채워진 후, 어떤 과도한 연마 입자들은 제거되고, 및 평평한 표면(160)이 연마 입자(180)에 적용된다. 평평한 표면(160)은 경납 합금 시트(90)내부로 내려오는 연마 입자(180)들을 밀어낼 수 있는 것과 같은 강하고 단단한 재료로 이루어져야 한다. 그러한 재료들은 일반적으로 포함되지만,
강, 철, 그의 합금등에 제한되지 않는다.

[0055] 연마 입자(180)들은 도 6에서 경납 합금 시트(90)내에 포함되는 것으로 나타내어졌다. 표면(160)이 평평하기 때문에, 연마 입자(180)들은 기판(40)으로부터 균일한 거리로 떨어져 연장할 것이다. 상기 거리는 형판(140)의 두께에 의해 결정될 것이고, 및 바람직한 실시예에서, 각 연마 입자는 상기 거리의 50 마이크로미터내로 연장할 것이다.

[0056] 도 4-6에서 나타내어진 것과 같이 연마 입자(180)들은 둥글다. 그러나, 도 3에서 그들은 뾰족하였다. 본 발명의 범위는 자형을 포함한 어떠한 형상, 또는 자연적으로 형상을 이룬 입자들의 연마 입자들을 포함한다. 그러나, 바람직한 실시예에서, 연마 입자(180)들은 기판(40)으로부터 떨어진 방향으로 연장하는 뾰족한 포인트 또는 가장자리를 가진다.

[0057] 연마 입자(180)들이 경납 합금 시트(90)내에 포함되어진 후, 상기 시트는 도 3에 나타내어진 것 처럼, 기판(40)에 부착된다. 사용된 경납 합금은 기술내에서 공지된 어떠한 경납 재료일 수 있지만, 그러나 바람직하게 중량 %로 2% 이상의 크롬을 함유한 니켈 합금이다.

[0058] 연마 입자(180)들이 경납 합금 시트(90)내에 포함되었기 때문에, 액체 경납 합금의 표면 장력은 입자 덩어리를 발생시키기에는 불충분하다. 또한, 경납의 두께는 훨씬 낮은 수준으로 발생하고 및 "무더기"가 형성되지 않는다. 반대로, 경납은 상당한 지지물과 슬러리 틈을 제공하는 각 연마 입자사이의 오목한 표면을 형성한다. 마지막으로, 바람직한 실시예에서, 경납 합금 시트(90)의 두께는 경납 재료
(90)의 외부 표면위로 돌출하기 위한 각 연마 입자의 약 10 내지 약 90%를 허용하기 위해 선택되어진다.

[0059] 경납 합금 시트(90)내에 연마 입자(180)를 포함하기 위한 방법의 결과로써, 고른 공간(120)이 만들어진다. 또한, 연마 그리트(180)들은 CMP 패드에 적용될 때를 의미하는 기판(40)위의 거리 또는 균일한 높이로 연장하고, 그들은 패드 섬유내부 균일한 깊이로 돌출할 것이다. 상기 고른 공간 및 균일한 돌출은 CMP가 고르게 드레싱되고 손질되는 것을 발생시키는 것으로, CMP 패드의 연마 효율성을 증가시키고 및 그의 사용 수명을 연장시킨다.

[0060] 본 발명의 더 많은 이해를 위해서, 실시예들이 아래에 제공되어졌다. 이러한 실시예들은 본 발명의 범위의 제한내에서 사용됨을 의미하지는 않는다.

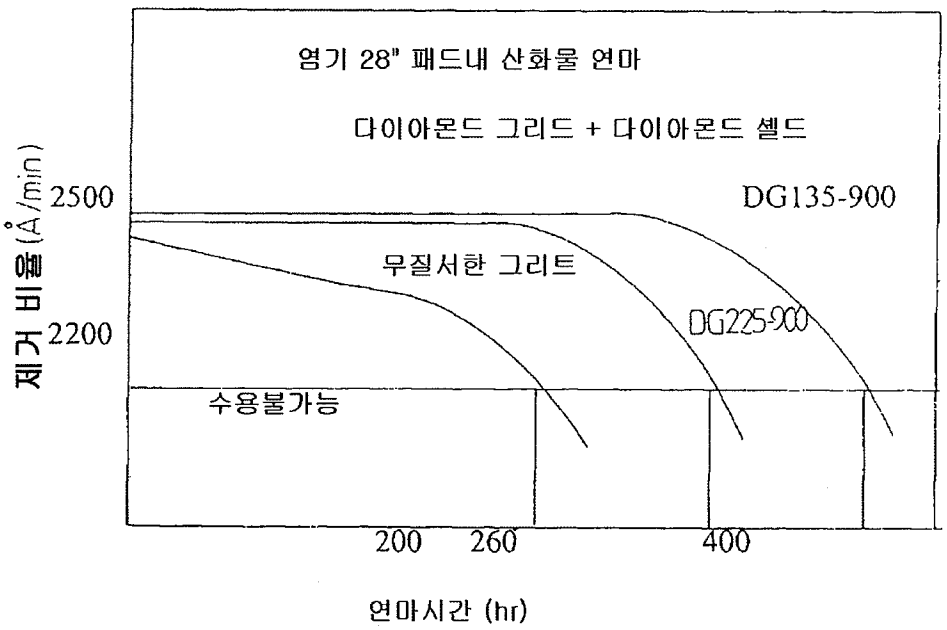
[0061] 실시예 1

[0062] 두 개의 CMP 패드 드레서 디스크들이 다음과 같이 제조되었다. 경납 합금 시트는 두개의 롤러사이에서 금속 파우다와 유기 결합체의 혼합물로 만들어진다. 135 및 225 마이크로미터의 평균 크기를 가진 제네럴 일렉트릭사에 의해 제조된 MBS970의 다이아몬드 그리트들은 경납 합금 시트내부로 형판의 도움에 의해 포함된다. 사용된 형판은 각 다이아몬드 그리트사이의 900 마이크로미터의 거리로 그리드 패턴 내부로 다이아몬드 그리트를 형성하였다.

[0063] 경납 합금 시트내부에 다이아몬드 그리트 입자들의 배치 후, 상기 시트는 아크릴 아교를 사용하여 금속 기판에 부착된다. 그 후 상기 조립체는 1000℃의 온도
로 진공로에서 경납된다. 얻어진 제품들은 약 100 밀리미터의 직경 및 약 6.5 밀리미터의 두께를 가진 두 개의 평평한 디스크이다.

[0064] 그 후 상기 디스크들은 무질서한 형상으로 배치된 다이아몬드 입자들의 양을 5배 이상 가진 디스크에 대항하여 시험되어졌다. 상기 디스크들은 스트라우스바우 (STRAUSBOUGH) 기계상에 장착된 28 인치 CMP 패드를 드레싱하기 위해 사용되었다. 상기 패드는 알칼리성 슬러리내에 8 인치 실리콘 웨이퍼를 연마하기 위해 사용되었다. 시험 결과가 아래 표 1에 나타내어졌다. DG 135-900은 900μm의 거리로 분리된 135 마이크로미터 입자들을 가진 디스크이고, 및 DG 225는 900μm의 거리로 분리된 225 마이크로미터 입자들을 가진 디스크이다.

[0065]



[0066] 나타내어진 것 처럼, 균일한 입자 배치를 가진 두 개의 디스크들은 무질서하게 배치된 다이아몬드를 가진 디스크를 상당히 능가하였다. 또한, 135 마이크로미
터 입자들을 가진 디스크는 거의 무질서한 입자 디스크의 수행력의 두배였다.

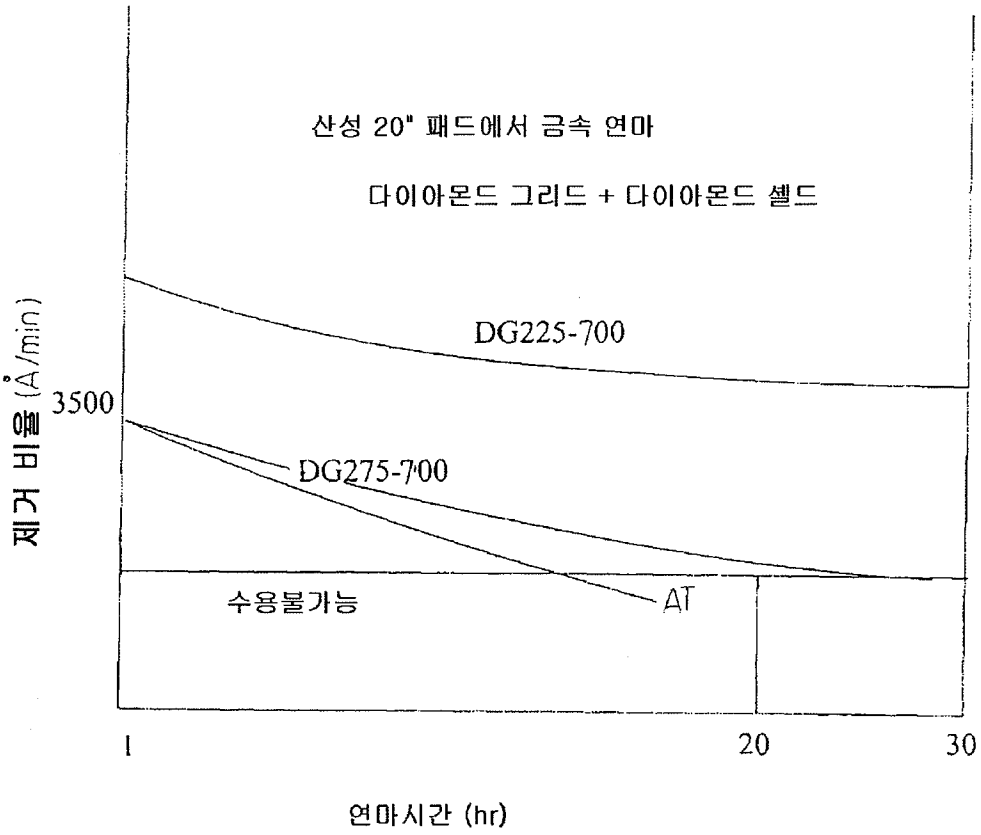
[0067] 실시예 2

[0068] 두 개의 부가 다이아몬드 디스크들은 실시예 1의 방법에 의해 제조되었다. 그러나, 225 마이크로미터 및 275 마이크로미터 크기의 다이아몬드가 사용되었다. 또한, 각 디스크는 경납 합금을 보화하기 위해 1 마이크로미터 두께 다이아몬드형 탄소 코팅으로 코팅되었다. 상기 다이아몬드형 탄소 피막은 음극 아크 방법에 의해 증착되었다.

[0069] 그 후 상기 디스크들은 8 인치 실리콘 웨이퍼를 연마하기 위한 적용된 재료 기계(Mirra)상에 장착된 CMP 패드를 드레싱하므로써 종래 다이아몬드 디스크와 비교되었다. 상기 패드는 3.0 pH의 산성 슬러리에 담궈졌다. 상기 드레싱은 연마가 발생되는 동안 동시에 수행되었다.

결과가 아래 표 2에 나타내어졌다. DG 275-700은 고르게 간격을 유지한 크기에 있어서 275 마이크로미터의 700μm 그리트를 함유한 디스크이다. DG 225-700은 고르게 간격을 유지한 크기에 있어서 225 마이크로미터의 700μm 그리트를 함유한 디스크이고, 및 AT는 보호 코팅없이 무질서하게 분포된 그리트를 함유하는 종래 다이아몬드 디스크이다.

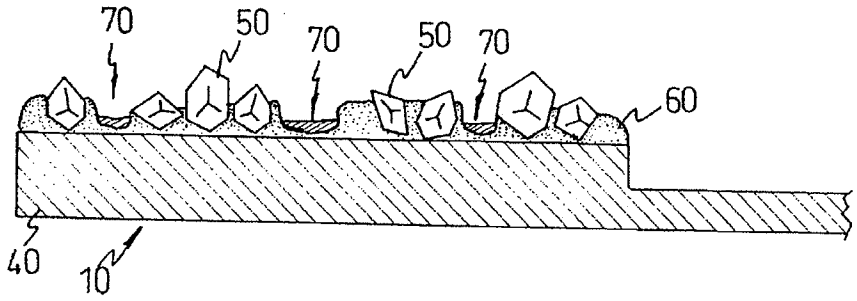
[0070]

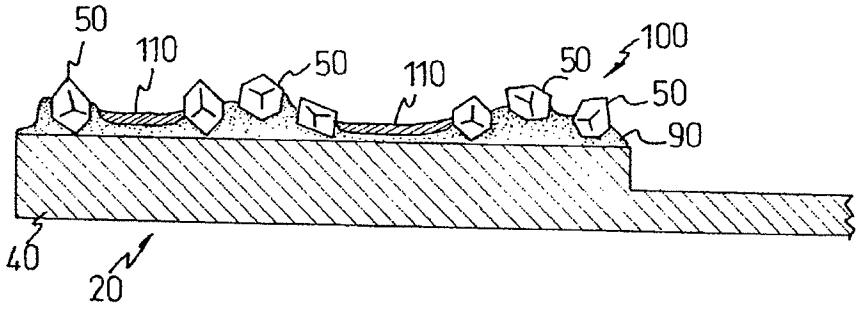


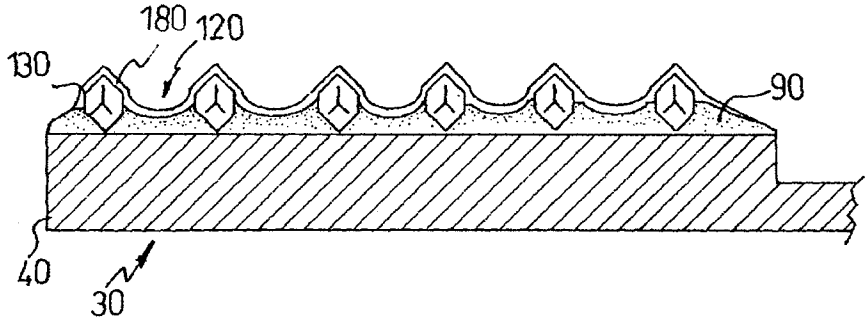
[0071] 표 2로부터 볼 수 있는 것 처럼, 종래 제조된 다이아몬드 디스크는 연마된 웨이퍼의 제거 비율을 유지할 수 없다. 또한, 금속 결합은 단지 1.5 시간동안 연마 슬러리의 산성 분위기에서 유지된다. 그 후, 다이아몬드는 떨어지기 시작하고 및 고가의 웨이퍼상에 많은 스크래치를 발생시킨다. 그러나, 본 발명의 디스크들은 산성 분위기에서 30 시간이상동안 유지되었다. 그러한 수명의 범위는 더 나은 CMP 패드 드레싱 결과를 얻을 수 있고, 및 종래 기술보다 상당히 개선된 웨이퍼 제조의 전체 비용 및 생산량을 구성한다. 물론, 상기는 상기 기술된 실시예가 본 발명의 원리의 적용으로 단지 설명되는 것으로 이해되어졌다.

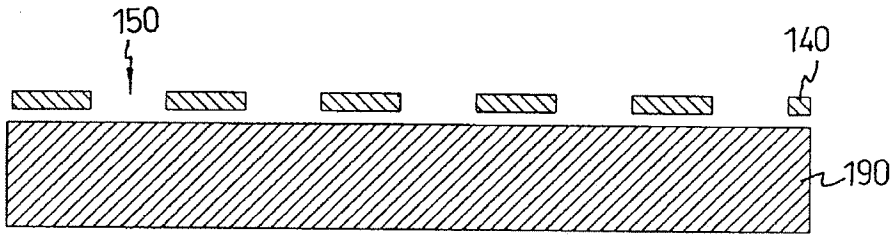
[0072] 많은 변경 및 다른 장치들이 본 발명의 범위 및 범주로부터 벗어남 없이 본 기술내에서 기술된 것들에 의해 발명되어졌고 및 첨부된 청구범위는 그러한 변경 및 장치들을 보호하기 위해 의도되어졌다. 따라서, 본 발명이 본 발명의 가장 실질적이고 및 바람직한 실시예로 간주되는 것과 관련하여 특별하고 및 상세하게 상기에 기술되어졌지만, 상기는 크기의 다양함, 재료, 형상, 형태, 기능, 작동 방법, 조립체, 및 용도에 제한을 두지 않고 포함된 많은 변경이 여기에서 설명된 개념 및 원리로부터 벗어남 없이 만들어질 수 있는 기술내에서 보통 기술의 것들로 명백해질 것이다.

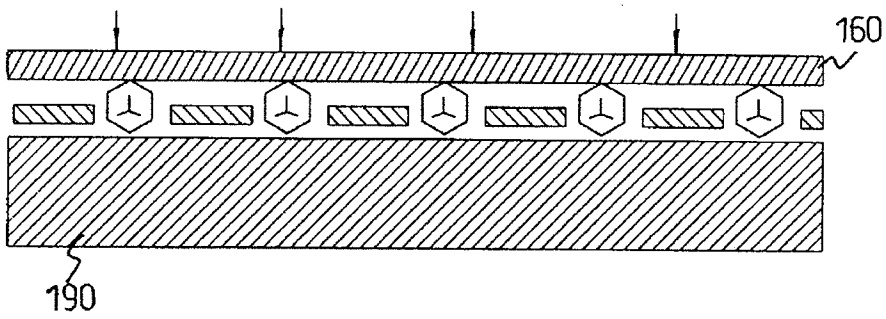
[0073] 상기한 바와 같이, 본 발명은 경납 합금 시트내에 연마 입자를 포함하기 위한 방법의 결과로써, 고른 공간이 만들어지고, 연마 그리트들은 CMP 패드에 적용될 때를 의미하는 기판 위의 거리 또는 균일한 높이로 연장하고, 그들은 패드 섬유내부 균일한 깊이로 돌출함에 따라, 상기 고른 공간 및 균일한 돌출로 CMP가 고르게 드레싱되고 손질되어 CMP 패드의 연마 효율성을 증가키고 및 그의 사용 수명을 연장시킨다.

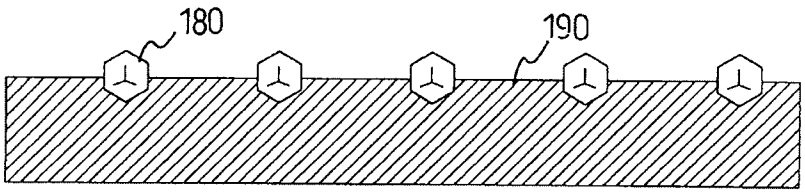

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PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:
OSBORNE DAVID W.

P.O. BOX 1219 SANDY UT 84091-1219 USA

RECEIVED
SEP - 3 2013
THORPE NORTH & WESTERN

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Date of mailing *(day/month/year)*	27 August 2013 (27.08.2013)
Applicant's or agent's file reference 02074 - 24012NPCIPPC T	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. **PCT/US2013/042538**	International filing date *(day/month/year)* **23 May 2013 (23.05.2013)**
Applicant **SUNG CHIEN-MIN**	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:

   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 . 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. Following the expiration of 30 months from the priority date, these comments will also be made available to the public.

Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90bis.1 and 90bis.3).

Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19months.

For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the PCT Applicant's Guide, National Chapters.

Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea	Authorized officer COMMISSIONER
Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-8755

Form PCT/ISA/220 (July 2010)

DOCKETED

	Description	Due Date	Initials
00802-T5100.CIP11	IDS	11-27-13	
" " .CIP3.CON.ACN2	IDS	11-27-13	
" T5100.CIP6	IDS	11-27-13	
" " " 7	IDS	11-27-13	
" " " 8	IDS	11-27-13	
" " " 9			

INITIAL

DOCKETED

	Description	Due Date	Initials
	Modify Abstract	9-27-13	
	Article 19	10-27-13	
	Chpt II Demand	3-23-14	
24012-NP	IDS	11-27-13	
" .CIP	IDS	11-27-13	

INITIAL

DOCKETED

	Description	Due Date	Initials
32979.NP.CIP.CON	IDS	11-27-13	
" " CIP2	IDS	11-27-13	
" " .CON	IDS	11-27-13	
3356-32820.NP2	IDS	11-27-13	
00802-T5110.CIP10	IDS	11-27-13	

INITIAL

* Attention

Copies of the documents cited in the international search report can be searched in the following Korean Intellectual Property Office English website for three months from the date of mailing of the international search report.

http://www.kipo.go.kr/en/ => PCT Services => PCT Services

ID : PCT international application number
PW : **6GGTL9PA**

Inquiries related to PCT International Search Report or Written Opinion prepared by KIPO as an International Searching Authority can be answered not only by KIPO but also through IPKC (Intellectual Property Korea Center), located in Vienna, VA, which functions as a PCT Help Desk for PCT applicants.

Homepage: http://www.ipkcenter.com

Email: ipkc@ipkcenter.com

DOCKETED SEP - 6

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 24012NPCIPPC	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. **PCT/US2013/042538**	International filing date *(day/month/year)* **23 May 2013 (23.05.2013)**	(Earliest) Priority Date *(day/month/year)* 23 May 2012 (23.05.2012)
Applicant **SUNG CHIEN-MIN**		

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 5 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 43.6*bis*(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.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/042538

A. CLASSIFICATION OF SUBJECT MATTER

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)
H01L 21/304; B24B 53/02; B24B 53/017; B05D 3/02; C09K 3/14; B24B 53/12; B24B 1/00

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: CMP, dresser, pad, protrusion, distance

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010-0248595 A1 (CHARLES DINH-NGOC et al.) 30 September 2010 See abstract; paragraphs [0065], [0075]-[0076], [0167] and figures 2A, 24B, 24D.	1-20
A	KR 10-2007-0063569 A (CHIEN-MIN SUNG) 19 June 2007 See abstract; pages 2-4, 6-8 and figures 5-6, 10.	1-20
A	WO 2012-040374 A2 (RITEDIA CORPORATION et al.) 29 March 2012 See abstract; page 9, line 31 - page 17, line 2 and figures 1-4.	1-20
A	KR 10-2002-0036138 A (KINIK COMPANY) 16 May 2002 See abstract; pages 3-5 and figures 1-6.	1-20
A	US 2007-0266639 A1 (CHIEN-MIN SUNG) 22 November 2007 See abstract; paragraphs [0054]-[0061] and figures 1-7.	1-20

☐ 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	Date of mailing of the international search report
27 August 2013 (27.08.2013)	**27 August 2013 (27.08.2013)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. +82-42-472-7140	CHOI Sang Won Telephone No. +82-42-481-8291

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2013/042538

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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KR 10-2007-0063569 A	19/06/2007	AU 2003-288917 A1	19/04/2004
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		US 2005-0136667 A1	23/06/2005
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WO 2012-040374 A2	29/03/2012	CN 102593277 A	18/07/2012
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2013/042538

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		WO 2007-136864 A2	29/11/2007
		WO 2007-136864 A3	31/01/2008

Electronic Patent Application Fee Transmittal

Application Number:	12726786
Filing Date:	18-Mar-2010
Title of Invention:	CMP PAD DRESSERS WITH HYBRIDIZED ABRASIVE SURFACE AND RELATED METHODS
First Named Inventor/Applicant Name:	Chien-Min Sung
Filer:	David William Osborne/Eileen Fuessel
Attorney Docket Number:	02074-32779.NP.CIP2

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

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($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	17039416
Application Number:	12726786
International Application Number:	
Confirmation Number:	1959
Title of Invention:	CMP PAD DRESSERS WITH HYBRIDIZED ABRASIVE SURFACE AND RELATED METHODS
First Named Inventor/Applicant Name:	Chien-Min Sung
Customer Number:	20551
Filer:	David William Osborne/Eileen Fuessel
Filer Authorized By:	David William Osborne
Attorney Docket Number:	02074-32779.NP.CIP2
Receipt Date:	04-OCT-2013
Filing Date:	18-MAR-2010
Time Stamp:	10:57:06
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$180
RAM confirmation Number	8790
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Transmittal Letter	trans.PDF	80204 ee905baa076375719c9eceed0be9c3f420ae254b	no	4
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Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	a.PDF	107320 f261f52b2241c69a8ac455ade32eda3551a426b3	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Information Disclosure Statement (IDS) Form (SB08)	b.PDF	77789 da6d4085db634eeaf4148ff8e3b82df5486fabdc	no	1
Warnings:					
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This is not an USPTO supplied IDS fillable form					
4	Foreign Reference	kr569.pdf	1373578 e2e093d38bfbf5d187e5223b20afa6ac42a8208f	no	23
Warnings:					
Information:					
5	Foreign Reference	kr138.pdf	1099615 839367cfa03ad84f74e9abd48d79f30434980d5d	no	23
Warnings:					
Information:					
6	Non Patent Literature	oa198.pdf	1216275 9334c1e12aa5fa5fb70b000a11b123086bc6a739	no	25
Warnings:					
Information:					
7	Non Patent Literature	Searchreport538.pdf	360731 e26c0cdcfa73a5833a96852f843eb2cbe6c7f93d	no	7
Warnings:					
Information:					
8	Fee Worksheet (SB06)	fee-info.pdf	30566 0b833a55da53df2630071af19cc1ca81c06e500d	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	4346078		

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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: 3727 EXAMINER: Maurina Rachuba FIRST NAMED INVENTOR: Chien-Min Sung SERIAL NO.: 12/726,786 FILED: 3/18/2010 CONF. NO.: 1959 FOR: CMP PAD DRESSERS WITH HYBRIDIZED ABRASIVE SURFACE AND RELATED METHODS DOCKET NO.: 02074-32779.NP.CIP2	**CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8** DATE OF DEPOSIT: October 4, 2013 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. /David W. Osborne/ David W. Osborne

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 $180.00 (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 4th day of October, 2013.

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

Receipt date: 10/04/2013

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet		of	

Complete if Known	
Application Number	12/726,786
Filing Date	3/18/2010
First Named Inventor	Chien-Min Sung
Art Unit	3727
Examiner Name	Maurina Rachuba
Attorney Docket Number	02074-32779.NP.CIP2

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]
/M.R./		U.S. Application 13/239,198; filed 09/21/2011; Chien-Min Sung; office action dated 07/23/2013	
/M.R./		PCT/US2013/042538; filed 05/23/2013; Chien-Min Sung; international search report dated 08/27/2013	

Examiner Signature	/Maurina Rachuba/	Date Considered	10/07/2013

*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]Applicant 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. Confidentially 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	
Examiner Name	
Attorney Docket Number	00802-32779.NP.CIP2

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	US 2008/0292869	11/27/2008	Sung	
	2	US 2007/0264918	11/2007	Sung	
	3	US 2005/0260939	11/24/2005	Andrews et al.	
	4	US 2006/0258276	11/16/2006	Sung	
	5	US 2006/0254154	11/2006	Huang et al.	
	6	US 2007/0249270	10/2007	Sung	
	7	US 2005/0227590	10/13/2005	Sung	
	8	US 2010/0221990	09/02/2010	Sung	
	9	US 2010/0221988	09/02/2010	Sung	
	10	US 2003/0207659	11/06/2003	Annen et al.	
	11	US 2002/0173234	11/2002	Sung et al.	
	12	US 2008/0171503	07/2008	Sung	
	13	US 2002/0164928	11/07/2002	Tolles	
	14	US 2009/0145045	06/11/2009	Sung	
	15	US 2006/0143991	07/2006	Sung	
	16	US 2007/0128994	06/07/2007	Sung	
	17	US 2006/0128288	06/15/2006	An et al.	
	18	US 2002/0127962	09/2002	Cho et al.	
	19	US 2009/0123705	05/14/2009	Sung	
	20	US 2005/0118939	06/02/2005	Duescher	
	21	US 2003/0114094	06/19/2003	Myoung et al.	
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	23	US 2005/0095959	05/05/2005	Sung	
	24	US 2007/0093181	04/26/2007	Lugg et al.	
	25	US 2009/0093195	04/09/2009	Sung	
	26	US 2003/0092357	05/2003	Yoon et al.	
	27	US 2003/0084894	05/2003	Sung	
	28	US 2006/0079162	04/13/2006	Yamashita et al.	
	29	US 2006/0079160	04/2006	Balagani et al.	
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	33	US 2005/0060941	03/24/2005	Provow	
	34	US 2007/0060026	03/15/2007	Sung	
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	36	US 2007/0051355	03/2007	Sung	
	37	US 2002/0042200	04/11/2002	Fawcett	
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	41	US 2001/0009844	07/2001	Cho et al.	
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	43	US RE 20,660	02/22/1938	Schacht	
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	45	US 2027087	01/07/1936	Buckner	

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First Named Inventor	Chien-Min Sung
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Examiner Name	
Attorney Docket Number	00802-32779.NP.CIP2

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	86	US	5453106	09/26/1995	Roberts	
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	92	US	5560745	10/1996	Roberts	
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	99	US	6001008	12/14/1999	Fujimori et al.	
	100	US	6024824	02/15/2000	Krech	
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	125	US	6672943	01/06/2004	Vogtmann et al.	
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	137	US	7021995	04/04/2006	Toge et al.	
	138	US	7033408	04/25/2006	Fries et al.	
	139	US	7044990	05/2006	Ishizaki et al.	
	140	US	7066795	06/2006	Balagani et al.	
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	144	US 7261621	08/2007	Moon et al.		
	145	US 7465217	12/2008	Kinoshita et al.		
	146	US 7651368	01/26/2010	Kendall et al.		
	147	US 7651386	01/26/2010	Sung		
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	149	US 7690971	04/06/2010	Sung		
	150	US 7762872	07/27/2010	Sung		
	151	US 790127				

FOR/EIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.	Foreign Patent Document Country Code[3]- Number[4] – Kind Code[5] (if known)	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]
	152	EP 1 075 898	02/14/2001	Mitsubishi		
	153	GB 2239011	06/1991	Anthony et al.		
	154	GB 2366804	03/02/2002	Kinik Company		
	155	JP 2003/071718	03/12/2003	Nippon Steel Corp.		
	156	KR 20/0339181	01/31/2004	Sung Man Jang		
	157	WO 02/31078	04/2002	Fries et al.		
	158	WO 2004/094106	11/04/2004	Intel Corp.		
	159	WO 2006/039413	04/13/2006	Sung		
	160	WO 2006/124792	11/23/2006	Sung		
	161	WO 2007/032946	03/22/2007	Sung		
	162	WO 2008/063599	05/29/2008	Sung		
	163	WO 2009/043058	04/02/2009	Sung et al.		
	164	WO 2009/064677	05/22/2009	Sung		
	165	WO 95/31006	11/16/1995	Siliconix Incorporated		

Examiner Signature	/Maurina Rachuba/	Date Considered	10/07/2013

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Art Unit	3727
Examiner Name	Maurina Rachuba
Attorney Docket Number	02074-32779.NP.CIP2

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		2001/0046835	11/2001	Wielonski et al.	
		2002/0139680	10/2002	George	
		2010/0022174	01/2010	Chou et al.	
		2010/0248595	09/30/2010	Dinh-Ngoc et al	
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		2307461	01/1943	Ogden	
		6692547	02/2004	Kim	
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Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]- Number[4] – Kind Code[5] (if known)	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]
		KR 10/2007/0063569	06/19/2007	Sung		
		KR 10/2002/0036138	05/16/2002	Kinik Co.		

Examiner Signature	/Maurina Rachuba/	Date Considered	10/07/2013

*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. Confidentially 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. /M.R./

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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.
12/726,786	03/18/2010	Chien-Min Sung	02074-32779.NP.CIP2	1959

20551 7590 10/11/2013

THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

EXAMINER	
RACHUBA, MAURINA T	

ART UNIT	PAPER NUMBER
3727	

NOTIFICATION DATE	DELIVERY MODE
10/11/2013	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):

causse@tnw.com
patentdocket@tnw.com
rich@tnw.com

Corrected Notice of Allowability	Application No. 12/726,786	Applicant(s) SUNG, CHIEN-MIN	
	Examiner MAURINA RACHUBA	Art Unit 3727	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 *the IDS filed 04 October 2013*.
   ☐ 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 *5-19*. 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 4/6/11, 10/4/13
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 _____.

/M. Rachuba/
Primary Examiner, Art Unit 3727

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)

20551
THORPE NORTH & WESTERN, LLP.
P.O. Box 1219
SANDY, UT 84091-1219

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.

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)
December 4, 2013	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/726,786	3/18/2010	Chien-Min Sung	02074-32779.NP.CIP2	1959

TITLE OF INVENTION: CMP Pad Dressers with Hybridized Abrasive Surface and Related Methods

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1780	$300	$0	$2080	12/04/2013

EXAMINER	ART UNIT	CLASS-SUBCLASS
RACHUBA, MAURINA T	3727	451-056000

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 credit 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	NOTE: Absent a valid certification of Micro Entity Status (see form PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
❑ Applicant asserting small entity status. See 37 CFR 1.27	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.
❑ Applicant changing to regular undiscounted fee 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: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature /David W. Osborne/ Date December 4, 2013

Typed or printed name David W. Osborne Registration No. 44989

This collection of information 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.

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Electronic Patent Application Fee Transmittal

Application Number:	12726786
Filing Date:	18-Mar-2010
Title of Invention:	CMP PAD DRESSERS WITH HYBRIDIZED ABRASIVE SURFACE AND RELATED METHODS
First Named Inventor/Applicant Name:	Chien-Min Sung
Filer:	David William Osborne/Nicole Solomon
Attorney Docket Number:	02074-32779.NP.CIP2

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

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	1501	1	1780	1780
Publ. Fee- Early, Voluntary, or Normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**2080**

Electronic Acknowledgement Receipt

EFS ID:	17567607
Application Number:	12726786
International Application Number:	
Confirmation Number:	1959
Title of Invention:	CMP PAD DRESSERS WITH HYBRIDIZED ABRASIVE SURFACE AND RELATED 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:	02074-32779.NP.CIP2
Receipt Date:	04-DEC-2013
Filing Date:	18-MAR-2010
Time Stamp:	16:46:24
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$2080
RAM confirmation Number	4070
Deposit Account	
Authorized User	

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)	32779NPCIP2issuefee.pdf	96469 72d07b99fb73689d6b9bf35b1fb2ce2b30443766	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	32249 9bf09ef4b9e5e352072f4091f36b6f5f184c275a	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	128718		

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.

PTO/SB/08A (08-03)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet | | of | 4

Complete if Known	
Application Number	12/726,786
Filing Date	3/18/2010
First Named Inventor	Chien-Min Sung
Art Unit	
Examiner Name	
Attorney Docket Number	00802-32779.NP.CIP2

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	47	US	2033991	03/17/1936	Melton	
	48	US	2035521	03/31/1936	Benner	
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	94	US	5851138	12/1998	Hempel Jr.	

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Sheet | | of |

Complete if Known	
Application Number	12/726,786
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First Named Inventor	Chien-Min Sung
Art Unit	
Examiner Name	
Attorney Docket Number	00802-32779.NP.CIP2

Change(s) applied to document, /C.S./ 10/22/2013

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		8104464	01/2012	Sung	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]- Number[4] – Kind Code[5] (if known)	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]
		CN1351922	06/05/2002	China Emerg Wheel Entpr. Co. Ltd.		
		CN1494984	05/12/2004	Read Co. Ltd.		
		EP 0238434	03/1987	United Technologies Corp.		
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		EP0712941	05/22/1966	Agency of Industrial Sci.		
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		WO02/31078	04/2002	Fries		
		WO94/27883	12/08/1994	Ultimate Abrasive		

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.R./

PTO/SB/08A (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet | | of |

Complete if Known	
Application Number	12/726,786
Filing Date	3/18/2010
First Named Inventor	Chien-Min Sung
Art Unit	
Examiner Name	
Attorney Docket Number	00802-32779.NP.CIP2

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		5919084	07/1999	Powell et al.	
		5961373	10/1999	Lai	
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Change(s) applied to document, /C.S./ 10/22/2013		5980982	11/1999	Degawa et al.	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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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 741 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;

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