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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

In the embodiment shown in FIG. 11, the leading cutting element 116a includes a cutting tip 120a that is oriented at a greater elevation (relative to a base of the pad conditioner, which would be positioned above the cutting elements shown FIG. 16) than does the cutting tip 120b of immediately adjacent cutting element 116b. The embodiment of FIG. 16 also includes a pair of secondary trailing cutting elements 116c, 116d having cutting tips that are aligned at about the same elevation as cutting tip 120b. In this embodiment, the cutting tips 120a and 120b perform the work of removing thin layers of the pad material, while the secondary trailing cutting elements (116c, 116d) can perform very fine smoothing of any bumps or ridges remaining after the pass of cutting tips 120a and 120b.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

base. Thus, in one aspect of the invention, if a pad dresser has a diameter of about 100 mm, and the combined contact areas of the cutting element will be about 10% of that total, then the total contact area of all cutting elements can be about 7850 mm^2. An edge-to-area ratio of each cutting element can be about 4/mm, resulting in a total edge length being about 31400 mm.

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

In this typical application, a slurry can be applied that can aid in planing the workpiece surface. The slurry can be either a water slurry or a chemical slurry. In the case where a chemical slurry is used, the chemical can be selected to provide cooling or to react with the surface of the workpiece to soften the workpiece to provide a more efficient cutting process. It has been found that the wear rate of a silicon wafer can be dramatically increased by softening its surface. For example, a chemical slurry that contains an oxidizing agent (e.g. H_2O_2) may be used to form a relatively highly viscous oxide that will tend to "cling" on the wafer surface. In this case, the PCD cutting devices of the present invention need not necessarily cut the wafer, but rather can scrape the oxide off the surface of the wafer. Consequently, the sharpness of the cutting edge becomes less critical. In addition, the service life of the cutting device can be greatly extended by utilizing a slurry. For example, a PCD scraper used with a slurry may last 1000 times longer than a PCD cutter.

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

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

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

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

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

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

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

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

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

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

CLAIMS

What is claimed is:

1. An abrasive tool, comprising:

an assembly of tool precursors including at least one elongated substrate having a continuous cutting element of polycrystalline diamond, polycrystalline cubic boron nitride, or ceramic formed into a blade shape on a surface thereof; and

a setting material configured to attach the tool precursors into a single mass that forms a predetermined cutting configuration.

2. The abrasive tool of claim 1, comprising a plurality tool precursors having elongated substrates having a continuous cutting element formed into a blade shape on a surface thereof.

3. The abrasive tool of claim 2, wherein the blade shaped tool precursors are arranged in a pattern, wherein the surfaces having the cutting element are oriented into substantially a single plane.

4. The abrasive tool of claim 3, wherein the pattern is an alternating pattern with at least one blank elongated substrates or elongated substrates having a continuous cutting element formed into a non-blade shape on a surface thereof.

5. The abrasive tool of claim 1, further comprising at least one elongated substrate having a continuous cutting element formed into a plurality of asperities.

6. The abrasive tool of claim 5, wherein the plurality of asperities include pyramidal shapes.

7. The abrasive tool of claim 5, wherein the abrasive tool includes at two abrasive precursors having elongated substrates that, when placed together, form asperities having substantially pyramidal shapes.

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

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

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

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

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

13. An abrasive tool, comprising:

an assembly of tool precursors, including an elongated substrate having a continuous cutting element of polycrystalline diamond polycrystalline cubic boron nitride, or a ceramic material on a surface thereof, said precursor assembly providing a tool having a working surface with a predetermined cutting configuration; and

a setting material configured to attach the tool precursors into a single mass that forms the predetermined cutting configuration.

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

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

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

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

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

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

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

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

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

vertically arranging the plurality of tool precursors;

masking a portion of cutting element with a masking material;

setting the tool precursors together using a resinous setting material; and

removing the masking material to reveal a tool having a predetermined working surface.

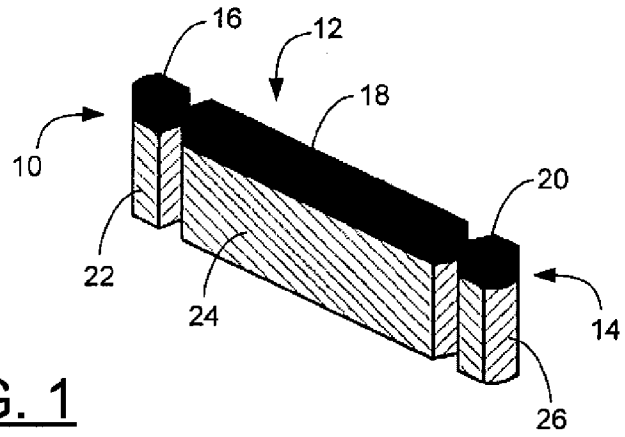


FIG. 1

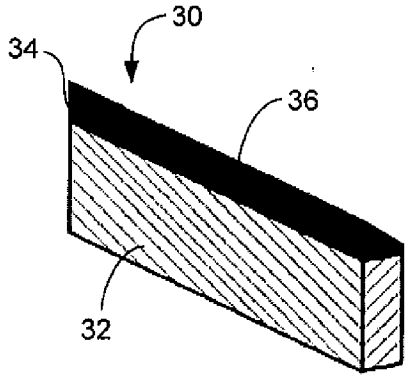


FIG. 2

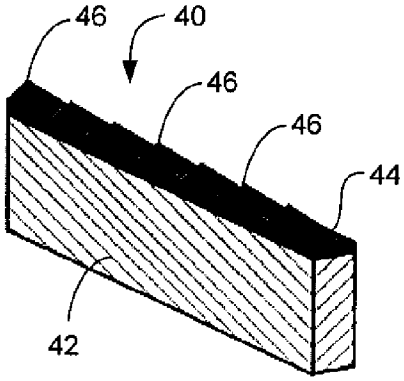


FIG. 3

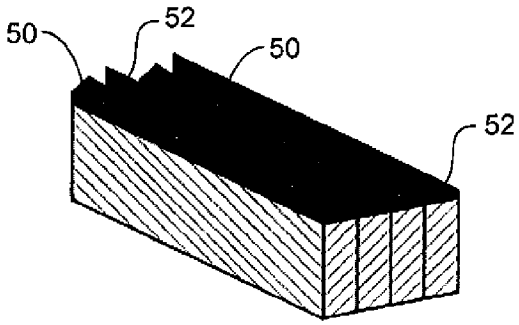


FIG. 4

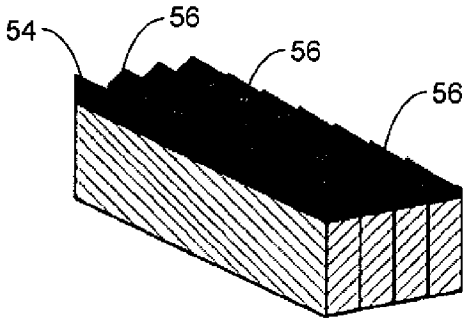


FIG. 5

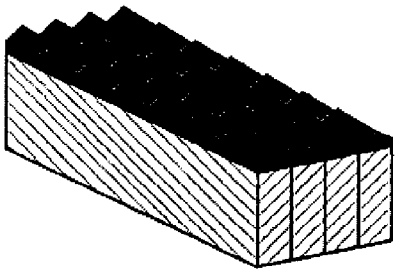


FIG. 6

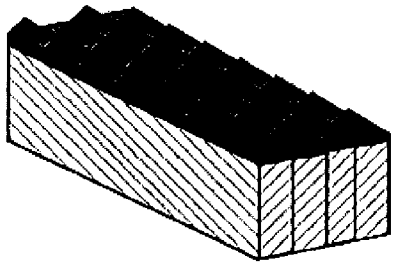


FIG. 7

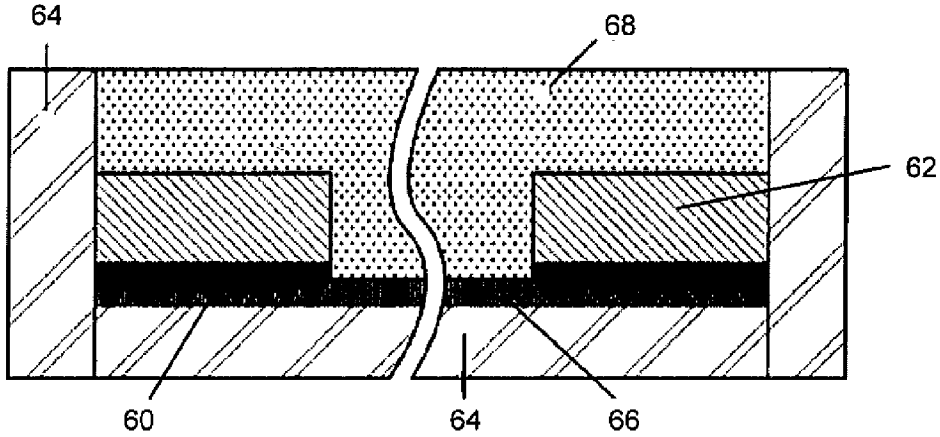


FIG. 8

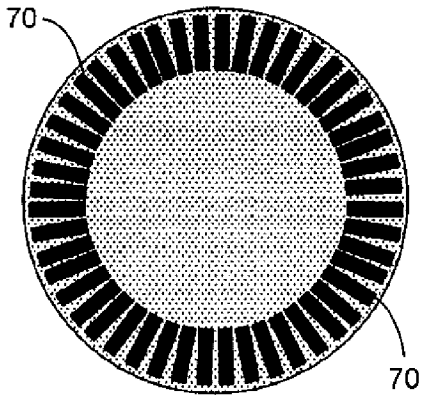


FIG. 9

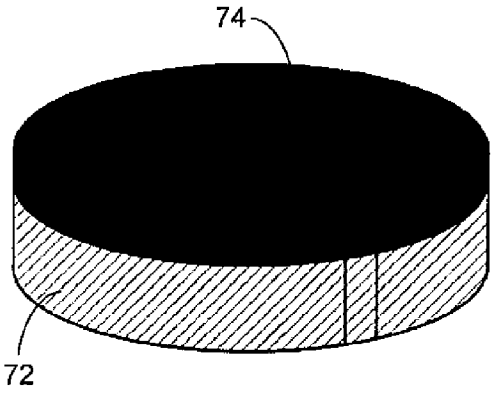


FIG. 10

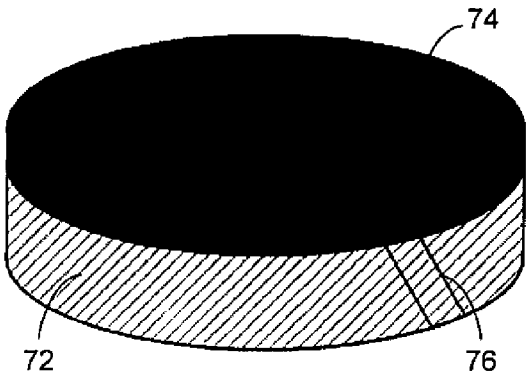


FIG. 11

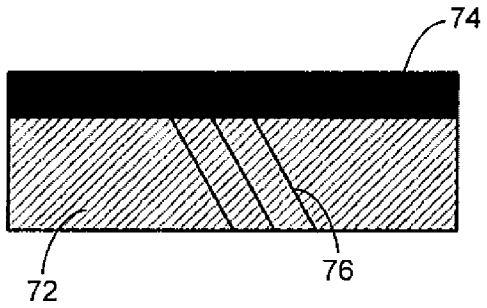


FIG. 12

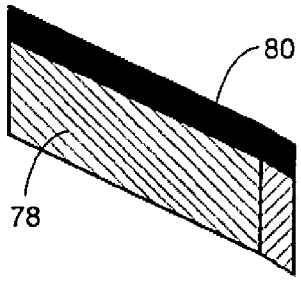


FIG. 13

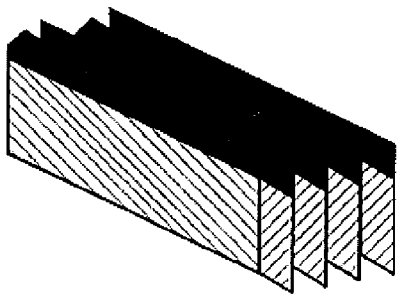


FIG. 14

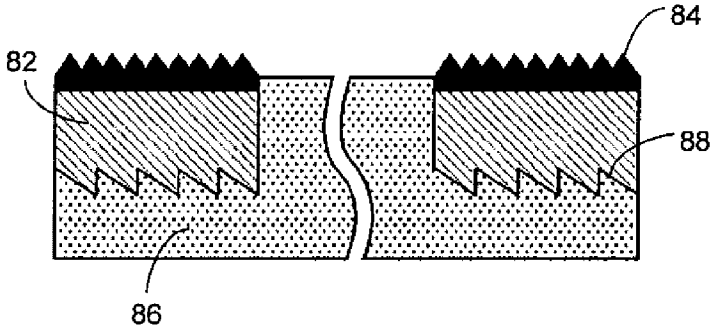


FIG. 15

FIG. 16

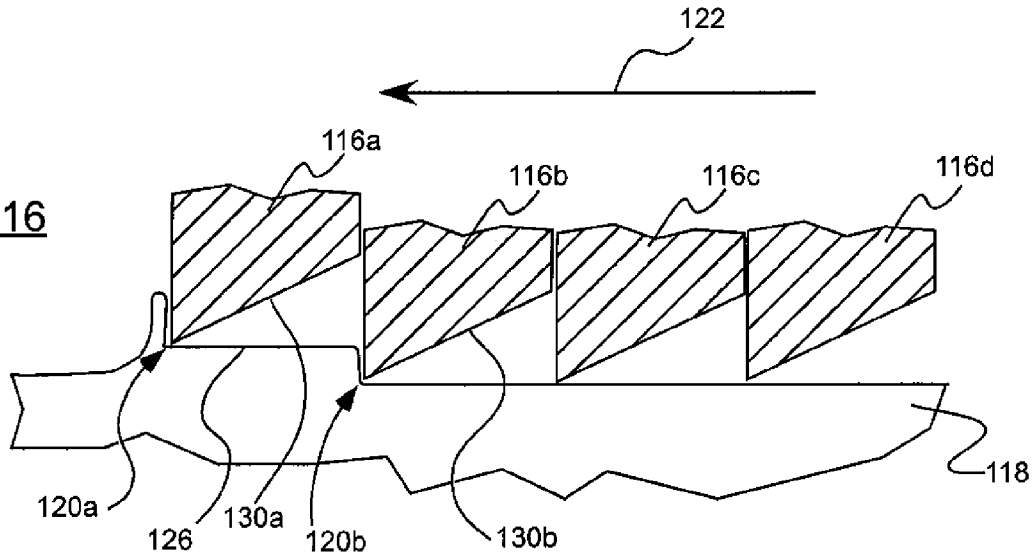


FIG. 17

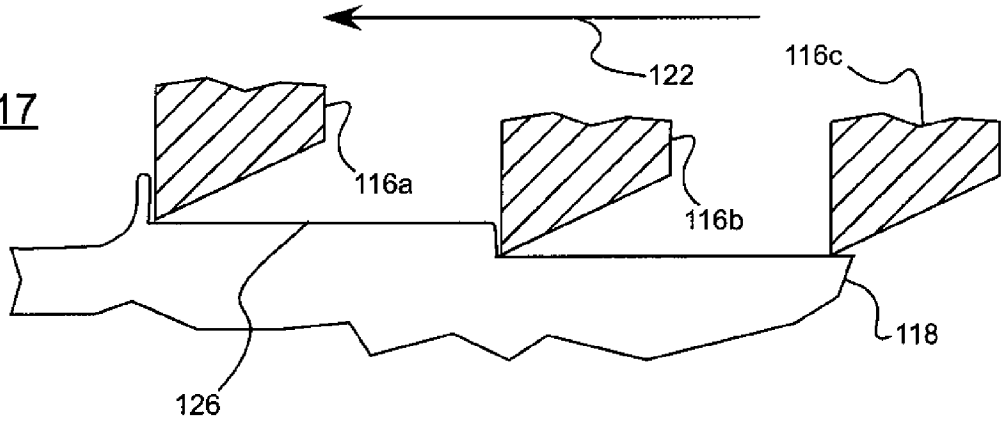
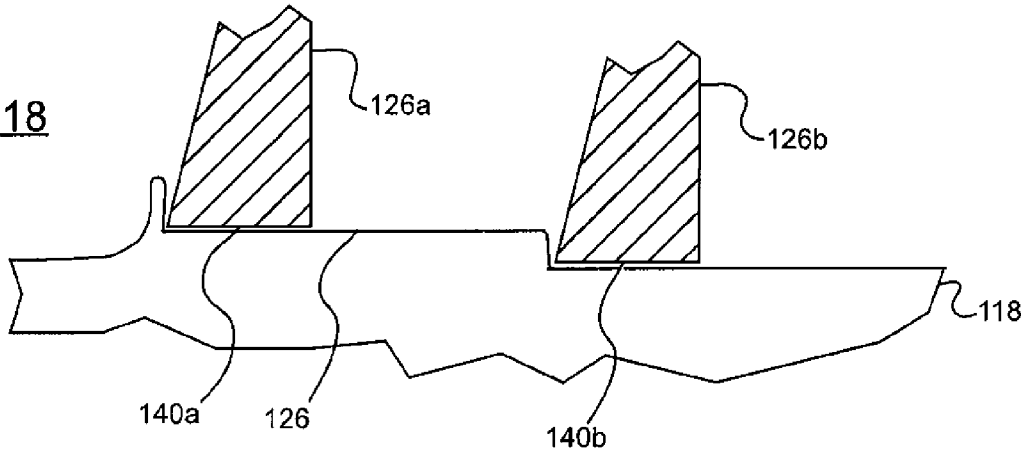


FIG. 18



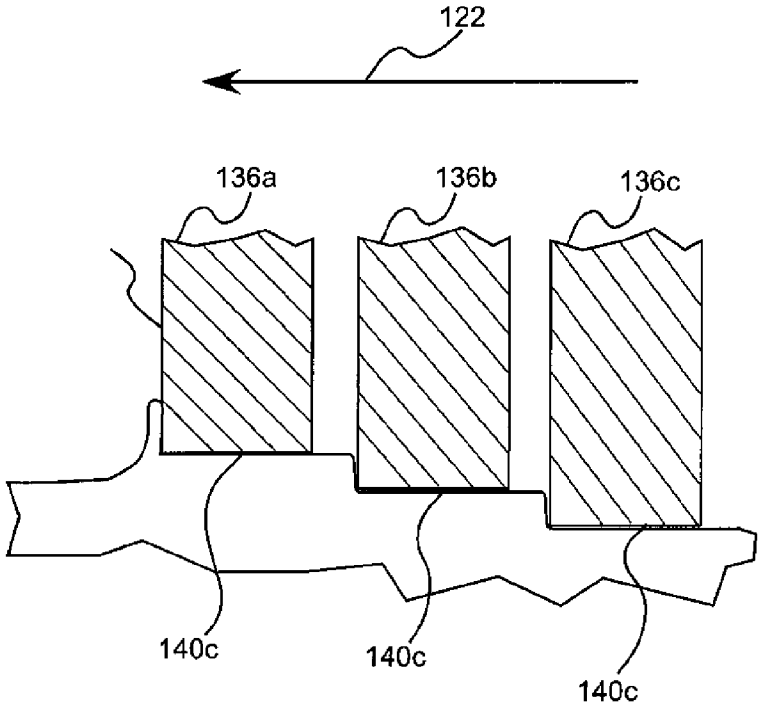


FIG. 19

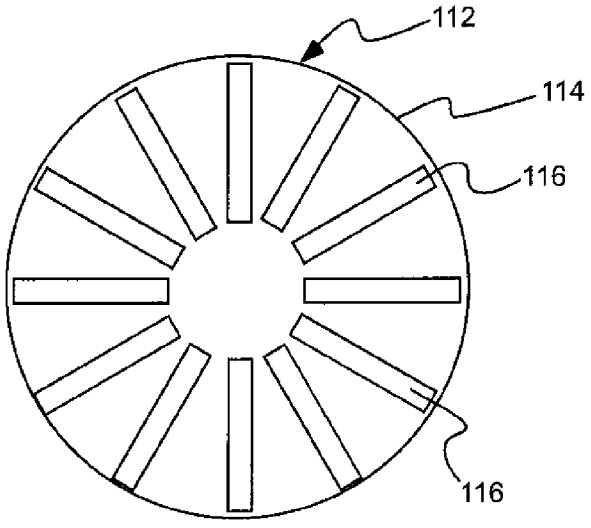


FIG. 20

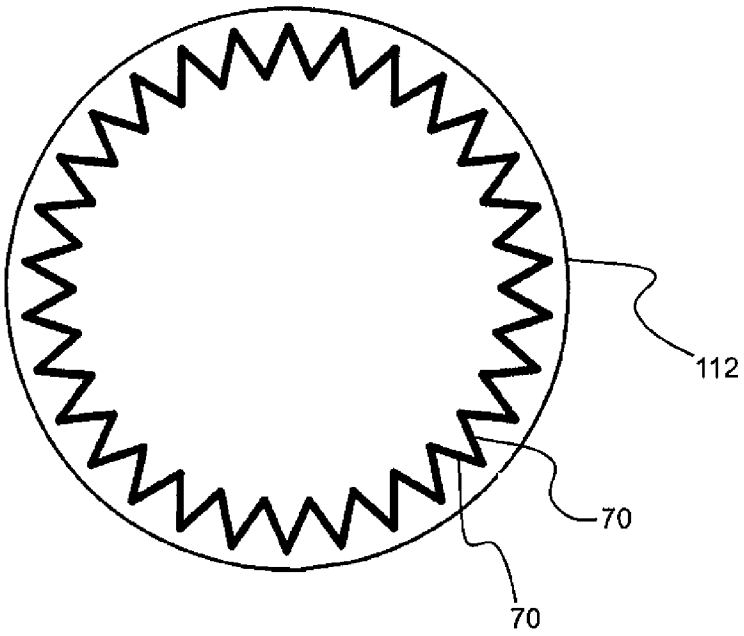


FIG. 21

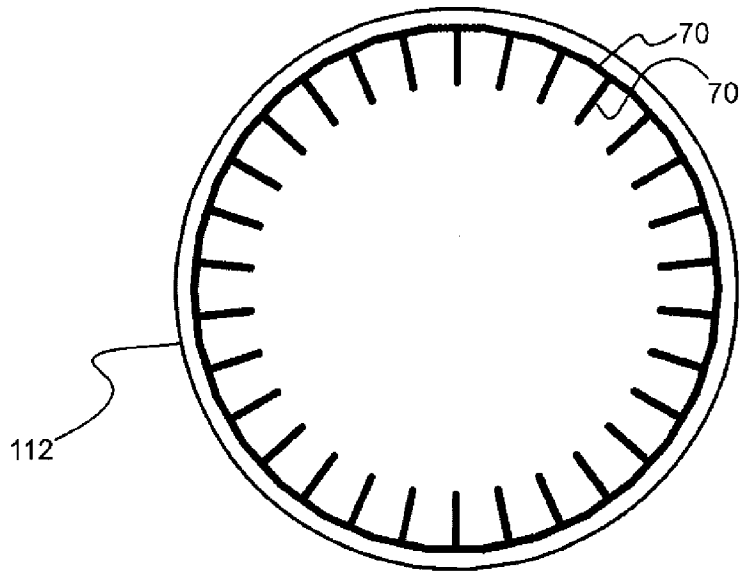


FIG. 22

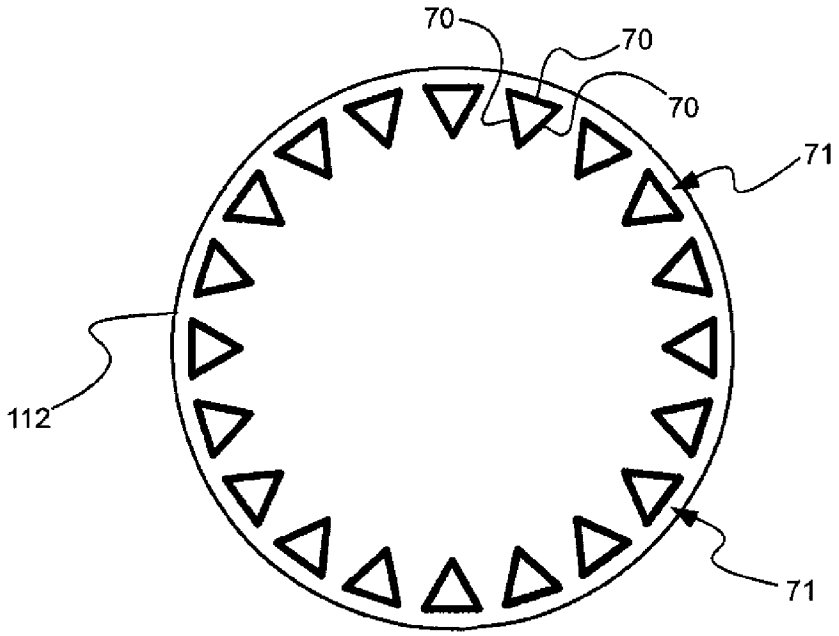


FIG. 23

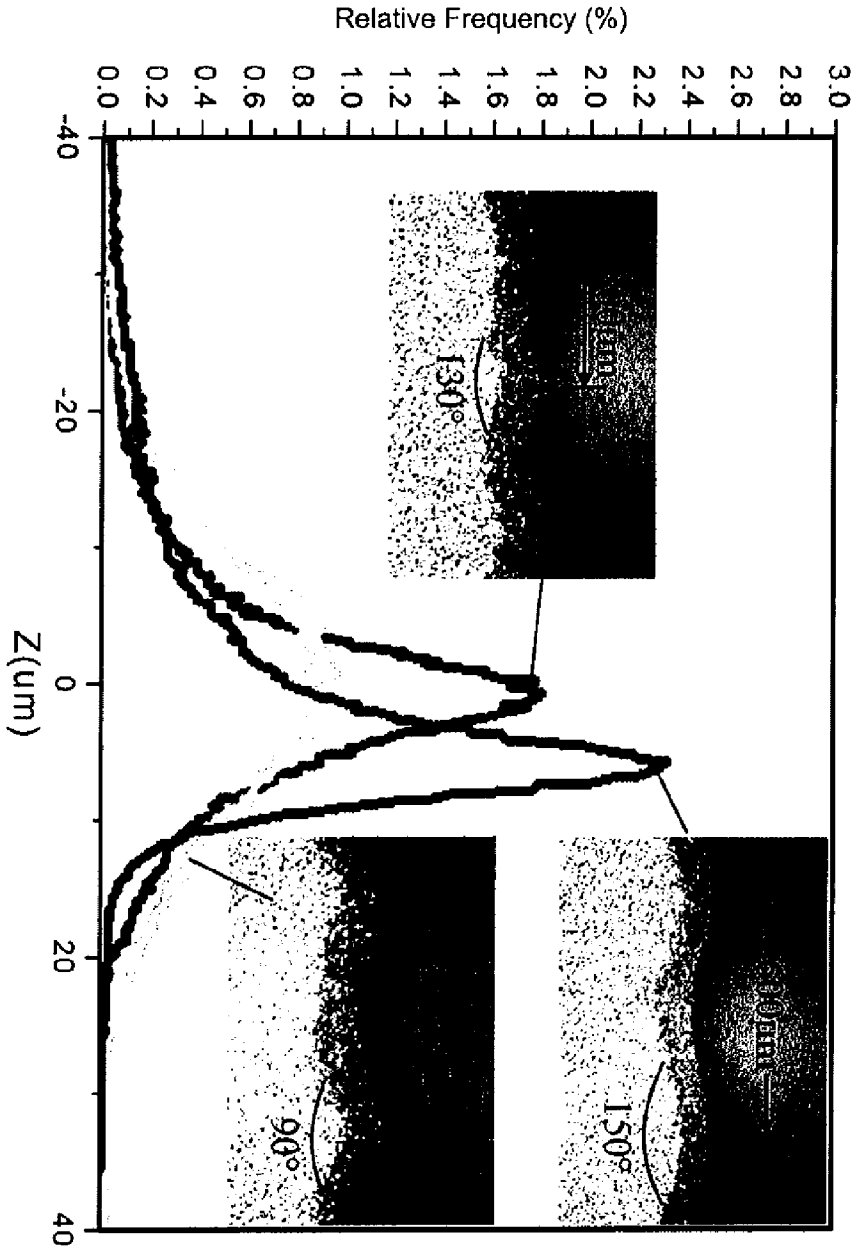

Relative Frequency (%)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
-40
-20
0
20
40
Z(um)
130°
90°
150°

FIG. 24

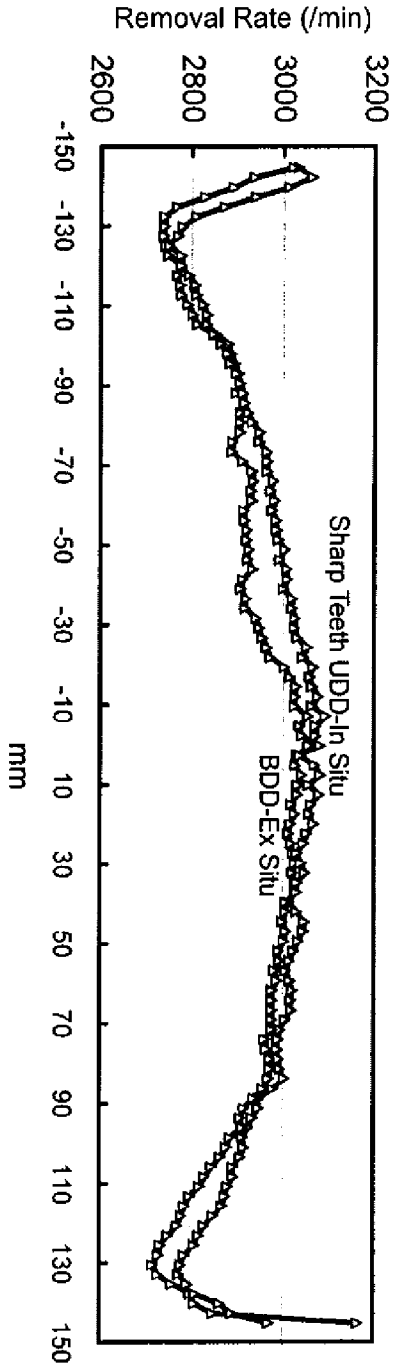

Removal Rate (/min)
2600
2800
3000
3200
-150
-130
-110
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
mm
Sharp Teeth UDD-In Situ
BDD-Ex Situ

FIG. 25

(19)대한민국특허청(KR)
(12) 등록실용신안공보(Y1)

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B24B 37/00

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기초적요건 심사관 : 김상해

기술평가청구 : 없음

(54)화학적-기계적-연마 패드용 다이아몬드 전착 컨디셔너

요약

본 고안은 화학적-기계적-연마(CMP)용 폴리싱 패드의 평탄화를 향상시킴과 동시에, 이 패드의 컨디셔닝을 효과적으로 행하는 기능을 가지고, 더구나 컨디셔닝 성능이 우수하고, 수명이 길며, 컨디셔너의 제조가 용이하여 제조시의 불량률을 현저히 감소시킬 수 있는 CMP 장치용 컨디셔너를 제공함에 그 목적이 있다.

이러한 목적을 달성하기 위한 본 고안은, 샹크(3)의 표면에 구멍 형상의 비마스킹부(1)를 가지는 마스킹 시트(2)를 점착하고, 하나의 비마스킹부(1)에 하나의 다이아몬드 입자(4) 만을 예비 고정한 후에 마스킹 시트(2)를 박리시키고, 이어서 도금액 안에 넣어서 다이아몬드 입자 직경의 40~60% 정도의 두께를 가지도록 Ni 도금층(6)을 석출시키며, 더욱이 1개 구멍 형상의 비마스킹부(1)의 면적이 다이아몬드 입자(4)의 투영 면적의 110~160%배로 하고, 상기한 마스킹 시트(2)의 비마스킹부(1)의 전면적이 마스킹 시트(2)의 전면적의 0.04~0.2배의 범위로 하는 것이 특징으로 된 화학적-기계적-연마 패드용 다이아몬드 전착 컨디셔너를 제공한다.

본 고안에 의해 치수 정밀도가 엄격한 패턴 형상을 재현성 높게 용이하게 형성시킬 수 있고, 마스킹 시트(2)의 샹크(3)에 대한 밀착력이 높으며, 또한 샹크(3)에 전착되는 80~120메쉬의 다이아몬드 입자(4)가, 구멍형의 비마스킹부(1)에 한 개씩 분산된다. 따라서 CMP용 폴리싱 패드의 평탄화를 향상시킴과 동시에, 이 패드의 컨디셔닝을 효과적으로 행하는 기능을 가지고, 더구나 컨디셔닝 성능이 우수하고, 수명이 길며, 컨디셔너의 제조가 용이하기 때문에 제조시의 불량률을 현저히 감소시킬 수 있다.

대표도

도 1

색인어

화학적-기계적-연마, 패드, 컨디셔너, 폴리싱, 다이아몬드

명세서

도면의 간단한 설명

도 1은 마스킹 시트를 점착한 샹크의 부분 평면도

도 2는 다이아몬드 입자가 예비 고정된 샹크의 부분 평면도

도 3은 본 고안 컨디셔너의 연삭면의 부분 단면도

도 4는 본 고안에 의한 일실시예인 컨디셔너의 작용면의 평면도

도 5는 본 고안에 의한 다른 실시예인 컨디셔너의 작용면의 평면도

〈도면의 주요부분에 대한 부호의 설명〉

1 : 구멍형상의 비마스킹부 2 : 마스킹 시트

3 : 샹크 4 : 다이아몬드 입자

5 : 예비 도금층 6 : Ni 도금층

7 : 컨디셔너 8 : 비전착 영역

고안의 상세한 설명

고안의 목적

고안이 속하는 기술 및 그 분야의 종래기술

본 고안은 반도체의 웨이퍼 가공에 사용되는 CMP(Chemical mechanical planarization) 장치의 패드 컨디셔너에 관한 것이다. 보다 상세하게는, 본 고안은 CMP용 폴리싱 패드의 평탄화를 향상시킴과 동시에, 이 패드의 컨디셔닝을 효과적으로 행하는 기능을 가지고, 더구나 컨디셔닝 성능이 우수하고, 수명이 긴 CMP 장치용 컨디셔너에 관한 것이다.

반도체 웨이퍼의 연마를 반복하기 위하여, 연마 입자나 연마칩 등이 폴리싱 패드의 미세한 구멍에 들어가서 눈메움이 일어난다든지, 연마 입자와 웨이퍼와의 화학 반응열에 의해 폴리싱 패드의 표면이 경면화하여 연마 속도를 저하시키게 된다. 이 때문에 폴리싱 패드의 표면을 재생시켜 연마 속도를 회복시키는 컨디셔너라고 불리는 공구가 사용된다. 다이아몬드 입자는 우수한 컨디셔닝 재료이며, 다이아몬드 입자를 이용한 컨디셔닝이 실용화되어 있다. 이와 같은 CMP용 폴리싱 패드의 컨디셔너에 대해서는, 폴리싱 패드의 마멸을 가급적 억제할 수 있으며, 더욱이 패드의 표면 상태를 항상 소정의 연마속도가 얻어지도록 일정하게 유지되는 것과, 다이아몬드 입자의 탈락이 없고, 패드면에 눈메움을 일으키지 않는 것이 요구된다.

다이아몬드 입자를 컨디셔너 본체의 작용면에 금속 결합제를 사용하여 고착하는 방법에는 여러 가지가 있으나, 전착법은 비교적 용이하고 더욱이 다이아몬드 입자를 컨디셔너 본체의 작용면에 확실하게 고착시킬 수 있으므로 많이 사용되고 있다. 전착법에 의해 다이아몬드 입자를 고착하는 경우는, 컨디셔너 본체의 작용면에 다이아몬드 입자의 고정면을 남겨 두고서, 절연성의 마스킹 재료로 피복한다. 컨디셔너의 본체를 도금액에 담그고 입자 고정면에 입자를 놓고서 컨디셔너의 본체에 음극을 접속하고, 도금액에 양극을 접속하여 전기 도금을 행하여 다이아몬드 입자를 예비 고정한다. 다이아몬드 입자를 예비 고정한 후에 대부분의 입자는 그 일 부가 본체의 입자 고정면에 접한 상태에서 예비 고정되지만, 본체의 입자 고정면에 접하지 않은 상태에 부착하여, 부유하는 입자가 존재하는 경우도 있다. 컨디셔너의 본체를 다시 도금액에 넣어서, 본체에 음극을 접속하고 도금액에 양극을 접속하여 다이아몬드 입자 고정면의 도금을 행한다.

그러나 종래의 전착 숫돌의 제조에 있어서, 컨디셔너 본체의 작용면에 다이아몬드 입자의 고정면을 남겨 두고서, 절연성의 마스킹 재료로 피복하는 경우에 미세한 크기의 적절한 치수 정밀도로 피복하는 것이 곤란하여 마스킹 되어 있지 않은 곳에 두 개 이상의 다이아몬드 입자가 동시에 들어가는 문제가 발생하였고, 마스킹 위치가 어긋나서 동일한 형상으로 재현하는 것이 곤란하였고, 피복층이 평활하게 되지않고 요철(凹凸)이 심하였으며, 피복층의 밀착력이 약하여 이후에 공정에서 벗겨지는 경우가 있었기 때문에, CMP 패드를 컨디셔닝 하는데 있어서 불량률이 매우 높았다. 또한 종래의 컨디셔너는, 패드의 표면 상태를 항상 소정의 연마속도가 얻어지도록 일정하게 유지시키는 것이 곤란하였으며, 다이아몬드 입자의 탈락이 많고, 패드면에 눈메움을 일으키는 경우가 많았으며, 종래의 컨디셔너를 사용하여 패드를 컨디셔닝하면, 웨이퍼의 표면거칠기 값 및 스크래치 개수가 높은 것이 큰 문제로 되어왔다.

고안이 이루고자 하는 기술적 과제

본 고안은 CMP용 폴리싱 패드의 평탄화를 향상시킴과 동시에, 이 패드의 컨디셔닝을 효과적으로 행하는 기능을 가지고, 더구나 컨디셔닝 성능이 우수하고, 수명이 길며, 컨디셔너의 제조가 용이하여 제조시의 불량률을 현저히 감소시킬 수 있 는 CMP 장치용 컨디셔너를 제공함에 그 목적이 있다.

고안의 구성 및 작용

본 고안자들은, 상기의 과제를 해결하기 위하여 실험적인 연구를 거듭한 결과, 전착 컨디셔너의 연삭면에 있어서, 하나의 비마스킹부에 한 개씩의 다이아몬드 입자를 분산시키는 것에 의해, 연삭 저항을 감소시키고 컨디셔너의 수명이 증가되며, 연마속도비와 컨디셔닝 속도가 높아지며, 웨이퍼의 표면거칠기 값이 낮아지며, 웨이퍼의 스크래치 개수가 감소됨을 확인하였다. 즉, 본 고안은, 샹크(3)의 표면에 구멍 형상의 비마스킹부(1)를 가지는 마스킹 시트(2)를 점착하고, 하나의 비마스킹부(1)에 하나의 다이아몬드 입자(4) 만을 예비 고정한 후에 마스킹 시트(2)를 박리시키고, 이어서 도금액 안에 넣어서 다이아몬드 입자 직경의 40~60% 정도의 두께를 가지도록 Ni 도금층을 석출시키며, 더욱이 1개의 구멍 형상의 비마스킹부(1)의 면적이 다이아몬드 입자(4)의 투영 면적의 110~160%배로 하고, 상기한 마스킹 시트(2)의 비마스킹부(1)의 전면적이 마스킹 시트(2)의 전면적의 0.04~0.2배의 범위로 하는 것이 특징으로 된 화학적-기계적-연마 패드 컨디셔너를 제공하는 것이다.

아래에, 도면을 참고하여 본 고안을 상세히 설명한다. 그림 1은 마스킹 시트(2)를 점착한 샹크의 부분 평면도이다. 그림 1에서 원으로 표시되는 부분이 비마스킹부(1)로서, 한 개의 비마스킹부(1)에 1개의 다이아몬드 입자(4)가 고착된다. 1개의 비마스킹부(1)에 고착되는 다이아몬드 입자(4)가 2개를 넘으면, 패드에 의한 연마에서 웨이퍼의 표면거칠기 값이 낮아지며, 웨이퍼의 스크래치 개수가 감소되기 쉽다. 그림 1에서 비마스킹부(1)의 전면적이 다이아몬드 입자(4)를 고착한 연삭면 적의 0.04~0.2배이다. 비마스킹부(1)의 전면적이 다이아몬드 입자(4)를 고착한 연삭면의 전면적의 0.04배 미만이면, 컨디셔너(7)로서의 연삭력이 부족한 문제가 있으며, 컨디셔너(7)의 수명이 짧아지게 된다. 또한 비마스킹부(1)의 전면적이 다이아몬드 입자(4)를 고착한 연삭면의 전면적의 0.3배 이상이면 패드에 의한 연마에서 웨이퍼의 표면거칠기 값이 낮아지며, 웨이퍼의 스크래치 개수가 감소되기 쉽다. 본 고안의 컨디셔너의 샹크(3) 재료로는, 스테인레스 강재인 STS 304를 사용하는 것이 바람직하나, 경우에 따라서는 예를 들면 알루미늄 합금 등이 사용될 수 있다.

본 고안의 컨디셔너를 제조하기 위해서는, 우선 샹크(3)의 탈지를 행하는 것이 바람직하다. 탈지를 종료한 샹크면에, 구멍 형상의 비마스킹부(1)를 가지는 마스킹 시트(2)를 점착한다. 그림 1에서, 원형의 구멍 형상의 비마스킹부(1)를 가지는 마스킹 시트(2)가 샹크(3)에 점착되고, 샹크(3)의 일부가 비마스킹부(1)의 형상으로 노출되어 있다. 본 고안에서는, 마스킹 시트(2)를 점착한 상태에서, 컨디셔너의 연삭면으로 되는 샹크면에 예비 도금층(5)을 형성시키는 것이 바람직하다. 예비 도금을 실시하는 것에 의해, 다이아몬드 입자(4)와 샹크(3)가 직접 접촉하는 것이 아니고, 다이아몬드 입자(4)의 샹크(3)에 대한 고착성이 개량된다. 예비 도금하는 금속으로는 니켈 및 니켈 합금을 사용할 수가 있다. 본 고안에서는, 예비 도금을 실시한 샹크를, 마스킹 시트(2)를 점착한 상태에서 도금 용기에 넣고, 도금 용기 중에서 샹크의 마스킹 시트(2)를 점착한 면의 부분에 다이아몬드 입자(4)를 충진한다. 이어서, 샹크에 음극을 접속하고, 도금액에 양극을 접속하여, 예비 도금층(5)의 형성을 위한 전기 도금을 실시한다. 예비 도금을 위한 금속은 다이아몬드 입자(4)를 샹크(3)에 예비 고정할 수 있는 것이라면 제한이 없으나, 니켈 및 니켈 합금을 사용할 수가 있다. 각 다이아몬드 입자(4)의 일부분이 비마스킹부(1)에서 예비 도금층(5)을 사이에 두고 예비고정되며, 샹크 표면에서 탈락하지 않는 상태로 되면, 예비 고정을 위한 도금을 종료하고, 샹크를 도금 용기로부터 꺼낸다. 그림 2는, 다이아몬드 입자가 예비 고정된 샹크의 부분 단면도이다. 본 그림에서, 샹크(3)에 마스킹 시트(2)가 점착되고, 마스킹 시트의 구멍 형상의 비마스킹부(1)에 나이아몬드 입자(4)가 예비 도금층(5)에 의해 예비 고정되어 있다.

이어서 샹크(3)의 표면으로부터 마스킹 시트(2)를 박리시키고, 더욱이 마스킹부의 탈지와 활성화 처리를 행한 후에, 다시 샹크(3)를 도금 용기에 담그서 음극을 접속하고, 도금액에 양극을 접속하여 도금을 계속하며, 다이아몬드 입자(4)를 샹크(3)에 전착하여 연삭면을 형성하고, 컨디셔너를 완성하게 된다. 도금에 사용하는 금속은, 예비 고정의 경우

와 마찬가지로 다이아몬드 입자(4)를 샹크(3)에 고착할 수 있는 것이면 제한이 없고, 예를 들면 니켈 및 니켈 합금을 사용할 수 있다. 그림 3은 본 고안의 컨디셔너의 연삭면의 부분 단면도이다. 본 그림에서 다이아몬드 입자(2)는 샹크(3)에 예비 도금층(5)에 의해 예비 고정되며, 더욱이 도금에 의해 형성된 Ni 도금층(6)에 의해 완전히 고착되어 있다. 본 고안에서 이용하는 마스킹 시트(2)는, 도금 조건에 견딜 수 있는 것이면 제한은 없으며, 예를 들면 폴리 염화비닐 등의 수지 시트의 일면에 아크릴계 또는 비닐 에테르계 등의 점착제를 도포한 뒤에 박리시트를 적층시키고, 또한 구멍 형상의 비마스킹부(1)의 가공을 실시한 것을 용이하게 사용할 수가 있다. 마스킹 시트(2)의 두께란, 수지 시트 및 점착 제 층의 두께의 합이 되며 이러한 마스킹 시트의 두께는 다이아몬드 입자 직경의 60%~140%의 범위로 하는 것이 바람직하다. 또한 더욱이 1개의 구멍 형상의 비마스킹부(1)의 면적이 다이아몬드 입자의 투영 면적의 110~160%배의 범위로 되어야 한다. 마스킹 시트의 두께를 다이아몬드 입자 직경의 60% 미만으로 한다든지, 또는 한 개의 비마스킹부의 면적이 다이아몬드 입자의 투영 면적의 160%를 초과하면, 한 개의 비마스킹부에 2개 이상의 다이아몬드 입자가 고착되어서 균등한 분산이 이루어지지 않는다. 또한 비마스킹부의 면적이 다이아몬드 입자의 투영 면적의 110% 미만에서는, 다이아몬드 입자의 샹크에 대한 부착이 곤란하게 된다. 따라서 마스킹의 두께를 전착할 다이아몬드 입자경의 60~140%의 범위로 하고, 마스킹하지 않는 구멍의 직경을 전착할 입자경의 110~160%의 범위로 하는 것에 의해, 컨디셔너 금속에 전착되는 다이아몬드 입자(4)가, 비마스킹부(1)에 한 개씩 분산되도록 된다. 다이아몬드 입자의 평균 투영 면적은, 다이아몬드 입자가 분산된 상태에서 확대 사진을 촬영하는 것에 의해 구할 수 있다. 본 고안에서는, 상기한 마스킹 시트의 비마스킹부의 전면적이 마스킹 시트의 전면적의 0.04~0.2배의 범위이다. 마스킹 시트의 비마스킹부의 전면적은, 본 고안의 컨디셔너의 연삭면에서 다이아몬드 입자가 고착된 부분의 전면적에 대응한다. 마스킹 시트의 비마스킹부의 전면적이 마스킹 시트의 전면적의 0.04배 미만이면, 구멍 형상의 비마스킹부의 전면적이 다이아몬드 입자를 고착한 연삭면의 전면적의 0.04배 미만으로 되어, 컨디셔너로서의 연삭력이 부족할 염려가 있다. 마스킹 시트의 비마스킹부의 전면적이 마스킹 시트의 전면적의 0.2배를 초과하면, 구멍 형상의 비마스킹부의 전면적이 다이아몬드 입자를 고착 한 연삭면의 전면적의 0.2배를 초과하여, 연삭시에 눈메움이 발생할 염려가 있다.

〈실시예〉

컨디셔너 샹크(3)의 연삭면으로 되는 작용면을 탈지하고, 마스킹 시트를 점착한 후에, 니켈에 의한 예비 도금층(5)을 형성하였다. 마스킹 시트(2)의 두께를 전착할 #120 메쉬 다이아몬드 입자경의 80%로 하였으며, 더욱이 다이아몬드 입자(4)를 전착시키기 위해 비마스킹부(1)의 직경을 전착할 다이아몬드 입자경의 140%로 하였다. 구멍 형상의 비마스킹부(1)의 전면적을 마스킹 시트(2)의 전면적의 0.1배가 되도록 하였다. 그 후에 컨디셔너의 본체를 도금액에 담그고 입자 고정면에 다이아몬드 입자(4)를 놓고서 컨디셔너의 본체에 음극을 접속하고, 도금액에 양극을 접속하여 전기 도금을 행하여 다이아몬드 입자(4)를 예비 고정하였다. 샹크를 도금액으로부터 빼내고, 마스킹 시트(2)를 박리시키며, 탈지를 행한 후에 컨디셔너의 본체를 다시 도금액에 담그며, 본체에 음극을 접속하고 도금액에 양극을 접속하여 다이아몬드 입자 고정면의 최종 Ni 도금을 행함에 의해 다이아몬드 입자(4)를 샹크의 연삭면에 고착하였다.

컨디셔너의 형상은 실시예 1에서는 도 4와 같은 다이아몬드 입자의 분포를 가지도록 하였으며, 실시예 2에서는 도 5와 같이 전착부가 스파이럴 형상이 되도록 하였고, 실시예 2에는 미전착 영역(8)이 형성되도록 하였다. 실시예 1 및 실시예 2는 컨디셔너의 형상을 제외하고는 다른 모든 제조 조건은 동일하였다. 비교예는 실시예 1 및 실시예 2의 컨디셔너의 성능과 비교를 행하기 위하여 당사에서 종래의 제조방법으로 제조되어 시중에서 판매되는 것으로, 비교예 1은 실시예 1과 동일 형 상이며, 비교예 2는 실시예 2와 동일 형상의 컨디셔너를 사용하였다. 실시예 1, 실시예 2, 비교예 1 및 비교예 2의 컨디셔너를 사용하여, 반도체의 웨이퍼 가공에 사용되는 화학-기계-연마 장치의 패드 컨디셔닝을 행한 결과를 표 1에 나타낸다.

[표 1]

	실시예 1	실시예 2	비교예 1	비교예 2
연마속도비	1.38	1.35	1	0.9
컨디셔닝속도(㎛/h)	35	34	12	11
컨디셔너수명(hr)	600	590	160	155
웨이퍼표면거칠기(nm)	0.33	0.34	0.43	0.44
웨이퍼의 스크래치 개수	1	1	7	8
패드의 표면상태	연삭흔 거의 없음	연삭흔 거의 없음	연삭흔 많음	연삭흔 많음

실시예 1 및 실시예 2의 패드 연마속도비, 컨디셔닝 속도 및 컨디셔너 수명이 비교예에 비해 현저히 높으며, 웨이퍼의 표면거칠기 및 스크래치 개수의 경우에서도 실시예 1과 실시예 2가 비교예에 비해 현저히 낮은 값을 보이며, 실시예 1 및 실시예 2의 컨디셔너를 사용한 경우 패드의 연삭흔이 거의 나타나지 않았으나, 비교예의 컨디셔너를 사용한 경

우는 패드의 표면에 연삭흔이 많이 나타났다.

고안의 효과

이상에서 서술한 바와 같이 본 고안은, 마스킹 시트(2)의 점착에 의해 마스킹을 행하므로 치수 정밀도가 엄격한 패턴 형상을 재현성 높게 용이하게 형성시킬 수 있으며, 마스킹 시트(2)의 컨디셔너 금속에 대한 밀착력이 높으며, 또한 컨디셔너 금속에 전착되는 80~120메쉬의 다이아몬드 입자(4)가, 비마스킹부(1)에 한 개 씩 분산된다. 따라서 CMP용 폴리싱 패드의 평탄화를 향상시킴과 동시에, 이 패드의 컨디셔닝을 효과적으로 행하는 기능을 가지고, 더구나 컨디셔닝 성능이 우수하고, 수명이 길며, 컨디셔너의 제조가 용이하기 때문에 제조시의 불량률을 현저히 감소시킬 수 있다.

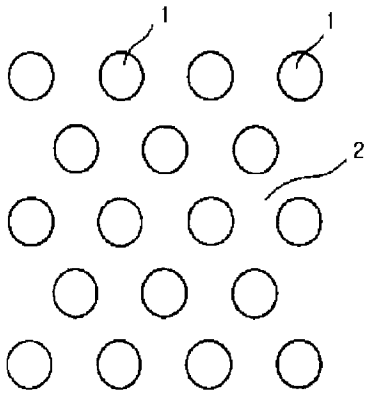
(57) 청구의 범위

청구항 1.

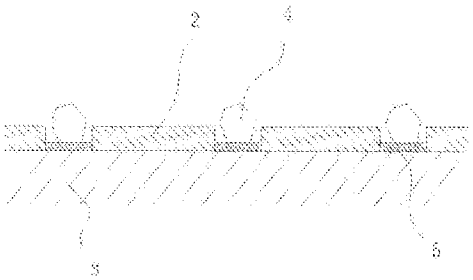
Ni 도금층이 다이아몬드 입자 직경의 40~60% 정도의 두께를 가지며, 샹크의 표면에 있어서, 1개의 구멍 형상의 비마스킹부의 면적이 다이아몬드 입자의 투영 면적의 110~160%배로 하고, 마스킹 시트의 비마스킹부의 전면적이 마스킹 시트의 전면적의 0.04~0.2배의 범위로 하는 것이 특징으로 된 화학적-기계적-연마 패드 컨디셔너.

도면

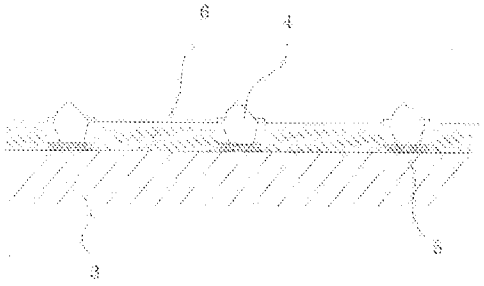
도면1



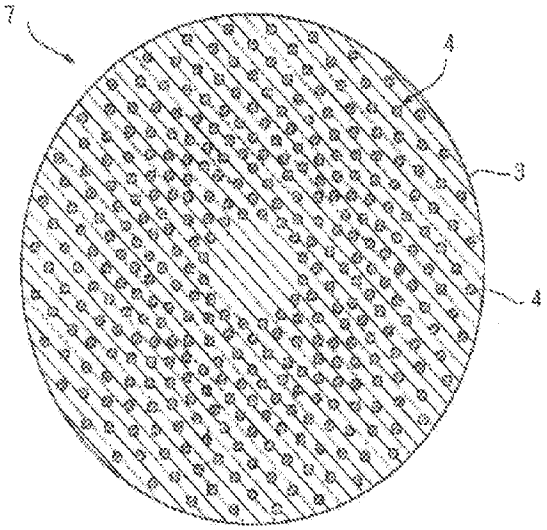
도면2



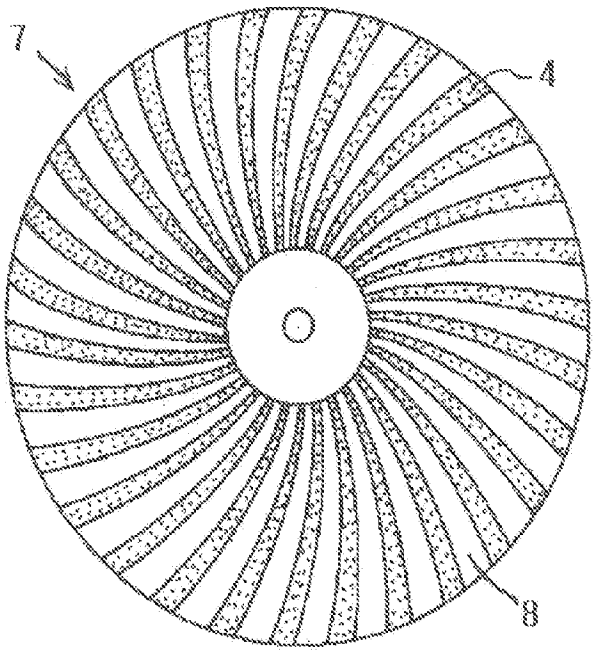
도면3



도면4



도면6



Korean to English translation

Abstract KR 20-0339181

Abstract The present invention Chemical - Mechanical - Polishing (CMP) polishing pad for planarization while improving, the conditioning of the pad has the ability to effectively do more, excellent conditioning performance and long life, easy to manufacture in Conditioner When the manufacturer can significantly reduce the failure rate for devices in the CMP has its purpose in providing conditioners.

This is designed to achieve these goals, the shank (3) the shape of the holes on the surface of bimaseukingbu (1) with masking sheet (2) adhesion, and one bimaseukingbu (1) of a diamond particles (4) only after pre-fixed masking sheet (2) and the detachment, followed by diamond plating, put in 40-60% of particle diameter to have the thickness of Ni plating (6) deposition sikimyeo, moreover, a hole the shape of the non- maseukingbu (1) the area of diamond particles (4), 110-160% of the projected doubling of the area and above-masking sheet (2) of the bimaseukingbu (1) of the full two baseuking sheet (2) of the full in the range from 0.04 to 0.2 times as frequently as the chemical - mechanical - polishing pad diamond deposition provides conditioners.

We have devised a strict dimensional precision by highly reproducible pattern shape can be easily formed, and masking sheets (2) of the shank (3) for the high adhesion, the shank (3) is deposited on the diamond of 80-120 mesh particles (4), hole type bimaseukingbu (1) to be distributed one by one. Therefore, the polishing pads for CMP planarization while improving, the conditioning of the pad has the ability to effectively do more, and superior conditioning performance, long life, easy to manufacture because of conditioner manufacturing significantly reduce the failure rate can.

Chemical - Mechanical - polishing pads, conditioners, polishing, diamond

Espacenet

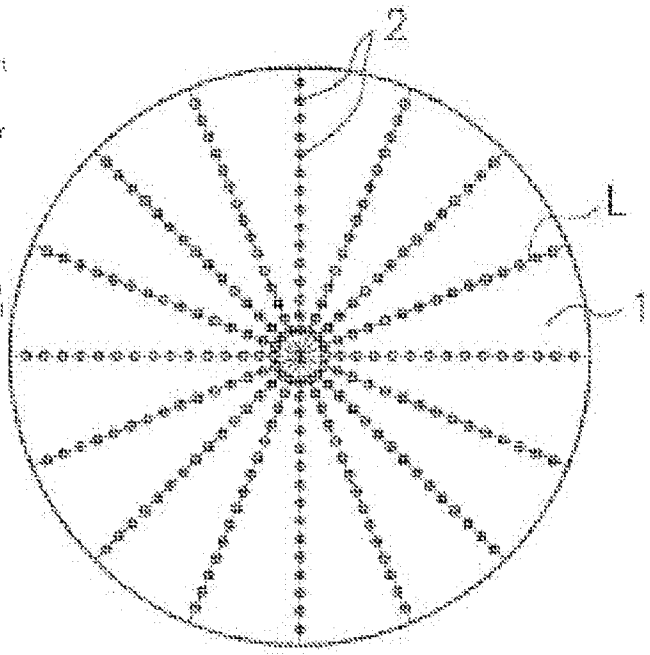
Bibliographic data: JP 2003071718 (A)

CMP CONDITIONER, METHOD FOR ARRANGING HARD ABRASIVE GRAIN USED IN CMP CONDITIONER AND METHOD FOR MANUFACTURING CMP CONDITIONER

Publication date:	2003-03-12	
Inventor(s):	HASHINO HIDEJI; KINOSHITA TOSHIYA; SATO SETSUO; ARAKI RYUICHI ±	
Applicant(s):	NIPPON STEEL CORP ±	
Classification:	**- international:**	***B24B37/00; B24B53/12; B24D3/00; B24D7/18; H01L21/304;*** (IPC1-7): B24B37/00; B24B53/12; B24D3/00; B24D7/18; H01L21/304
	- European:	
Application number:	JP20010262167 20010830	
Priority number (s):	JP20010262167 20010830	

Abstract of JP 2003071718 (A)

PROBLEM TO BE SOLVED: To provide stable CMP conditioner characteristics and to relieve slurry or the like in polishing without forming relief groove or the like on a support member. SOLUTION: This CMP conditioner of polishing cloth for a semiconductor substrate is composed of the support member 1 and plural diamond grains 2 brazed on a surface of the supporting member 1. Plural straight lines or curved lines radially extending from a center of the support member 1 are laid out on the surface of the disk-shaped support member 1 and the diamond grains 2 are arranged on the straight lines or the curved lines. The diamond grains 2 are arranged in such a manner that density of the diamond grains 2 at edge parts is smaller than that at a center par of the support member 1. Since area where no diamond grain 2 exists is secured in radial shape on the surface of the support member 1, slurry can be relieved outward from the support member 1 in polishing.



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Ｂ２４Ｄ	3/00	３１０	Ｂ２４Ｄ 3/00	３１０Ｄ	３Ｃ０６３
	7/18		7/18	Ｚ	
Ｈ０１Ｌ	21/304	６２２	Ｈ０１Ｌ 21/304	６２２Ｍ	

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(21)出願番号　特願2001－262167(P2001－262167)

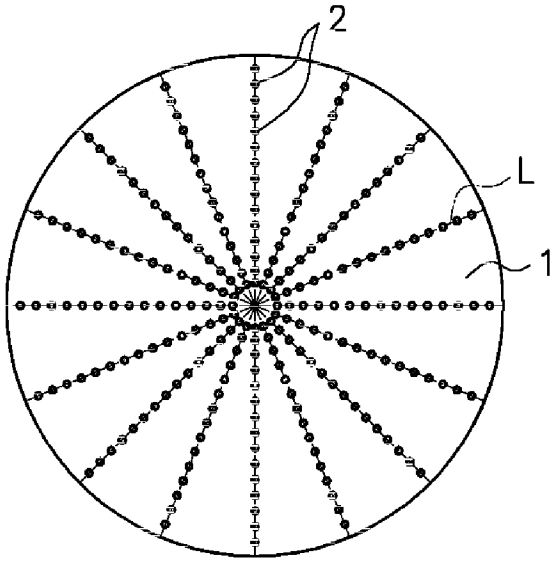
(22)出願日　平成13年８月30日(2001.8.30)

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最終頁に続く

(54)【発明の名称】　ＣＭＰコンディショナー、ＣＭＰコンディショナーに使用する硬質砥粒の配列方法、及びＣＭＰコンディショナー製造方法

(57)【要約】
【課題】　安定したＣＭＰコンディショナー特性が得られるとともに、支持部材に逃し溝等を形成しなくとも研磨時にスラリー等を逃すことができるようにする。
【解決手段】　半導体基盤用研磨布のＣＭＰコンディショナーは、支持部材１と、支持部材１の面上にろう付けされた複数のダイヤモンド粒２とからなり、円板状の支持部材１の表面において、支持部材１の中心から放射状に伸びる複数の直線或いは曲線を考え、それら直線或いは曲線上にダイヤモンド粒２を配置するようにしている。このようにしたＣＭＰコンディショナーでは、ダイヤモンド粒２が支持部材１の中央部分に比べて縁部分における密度が小さくなるよう配列されており、支持部材１の表面上には、ダイヤモンド粒２が存在しない領域が放射状に確保されることになるので、研磨時にスラリーを支持部材１の外側に向けて逃すことができる。



【特許請求の範囲】
【請求項１】　支持部材と、前記支持部材の面上に設けられた複数の硬質砥粒とを備えたＣＭＰコンディショナーであって、
前記支持部材の面上に、前記複数の硬質砥粒を規則的に、かつ、前記支持部材の内側から外側にかけて密度が減少するように配列させたことを特徴とするＣＭＰコンディショナー。
【請求項２】　前記硬質砥粒を、前記支持部材の中心から略放射状に配列させていることを特徴とする請求項１に記載のＣＭＰコンディショナー。
【請求項３】　支持部材と、前記支持部材の面上に設けられた複数の硬質砥粒とを備えたＣＭＰコンディショナーであって、
前記支持部材の面上に、前記複数の硬質砥粒が存在しない領域を略放射状に確保していることを特徴とするＣＭＰコンディショナー。
【請求項４】　前記硬質砥粒はダイヤモンド粒であることを特徴とする請求項１～３のいずれか１項に記載のＣＭＰコンディショナー。
【請求項５】　チタン、クロム、又はジルコニウムより選ばれた１種以上を０．５～２０ｗｔ％含む融点６５０℃～１２００℃の合金を用いて、前記ダイヤモンド粒を金属及び／又は合金からなる前記支持部材に、単層、ろう付けし、前記ダイヤモンド粒と前記合金との界面にチタン、クロム、又はジルコニウムより選ばれた金属の炭化物層が形成されていることを特徴とする請求項４に記載のＣＭＰコンディショナー。
【請求項６】　前記融点６５０℃～１２００℃の合金がニッケル基合金であることを特徴とする請求項５に記載のＣＭＰコンディショナー。
【請求項７】　規則的に、かつ、内側から外側にかけて密度が減少するように配列させた複数の貫通穴が形成された薄板状の配列部材を被配列面上に位置させる手順と、
前記配列部材の各貫通穴に硬質砥粒を入れ込む手順とを有することを特徴とするＣＭＰコンディショナーに使用する硬質砥粒の配列方法。
【請求項８】　複数の貫通穴の存在しない領域が略放射状に確保された薄板状の配列部材を被配列面上に位置させる手順と、
前記配列部材の各貫通穴に硬質砥粒を入れ込む手順とを有することを特徴とするＣＭＰコンディショナーに使用する硬質砥粒の配列方法。
【請求項９】　前記被配列面は、ＣＭＰコンディショナーを構成する支持部材の表面であることを特徴とする請求項７又は８に記載のＣＭＰコンディショナーに使用する硬質砥粒の配列方法。
【請求項１０】　複数の硬質砥粒を規則的に、かつ、内側から外側にかけて密度が減少するように配列させた状態で保持部材に保持する手順と、
前記保持部材により保持された硬質砥粒を、ＣＭＰコンディショナーを構成する支持部材の表面に転写する手順とを有することを特徴とするＣＭＰコンディショナーに使用する硬質砥粒の配列方法。
【請求項１１】　複数の硬質砥粒の存在しない領域が略放射状に確保された状態で前記複数の硬質砥粒を保持部材に保持する手順と、
前記保持部材により保持された硬質砥粒を、ＣＭＰコンディショナーを構成する支持部材の表面に転写する手順とを有することを特徴とするＣＭＰコンディショナーに使用する硬質砥粒の配列方法。
【請求項１２】　前記保持部材には前記硬質砥粒を保持するための第１の接着手段を設け、前記支持部材の表面には第２の接着手段を設け、これら第１、２の接着手段の性質に差を持たせたことを特徴とする請求項１０又は１１に記載のＣＭＰコンディショナーに使用する硬質砥粒の配列方法。
【請求項１３】　請求項７～１２のいずれか１項に記載のＣＭＰコンディショナーに使用する硬質砥粒の配列方法を利用して前記硬質砥粒を前記支持部材の表面上に配列させた後、前記硬質砥粒を前記支持部材の表面に固着することを特徴とするＣＭＰコンディショナー製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、半導体基板用の研磨布の目詰まりを解消し、異物を除去するのに使用されるＣＭＰコンディショナー、ＣＭＰコンディショナーに使用する硬質砥粒の配列方法、及びＣＭＰコンディショナー製造方法に関する。
【０００２】
【従来の技術】ウェハのポリッシングにおいては、ＣＭＰ(Chemical Mechanical Polishing)と呼ばれる研磨方法が提案されている。ＣＭＰは、機械的研磨作用に化学的研磨作用を重畳して働かせることにより、研磨速度の確保と被研磨材が無欠陥であることの両立を可能としたものであり、シリコンウェハの仕上げポリッシング工程で広く使用されている。
【０００３】また、近年ではデバイスの高集積化に伴い、集積回路を製造する所定の段階で、ウェハ表面やウェハ表面に導電体・誘電体層が形成された半導体基板表面を研磨することが必要になってきた。半導体基板は、研磨されて、高い隆起、引っかき傷、粗さ等の表面欠陥が除去される。通常、この工程は、ウェハ上に種々の素子及び集積回路を形成する間に行われる。この研磨工程では、シリコンウェハの仕上げポリッシング工程と同様に、研磨速度と無欠陥であることの両立が必要である。化学スラリーを導入することにより、半導体表面により大きな研磨除去速度及び無欠陥性が与えられる化学的か

つ機械的平坦化が行われる。

【０００４】ＣＭＰ工程の一例としては、図８に示すように、例えば５～３００ｎｍ程度の粒径を有するシリカ粒子を苛性ソーダ、アンモニア及びアミン等のアルカリ溶液に懸濁させてＰＨ９～１２程度に化学スラリー１０１と、ポリウレタン樹脂等からなる研磨布１０２とが用いられる。研磨時には、化学スラリー１０１を流布しながら、半導体基板１０３を研磨布１０２に適当な圧力で当接させ、同図の矢印に示すように相対回転させることにより研磨が行われる。

【０００５】そして、前記研磨布１０２のコンディショニング法としては、研磨布１０２に水又は化学スラリー１０１を流しながら、ＣＭＰコンディショナーを用いたコンディショニングを行って、研磨布１０２の目詰まりを解消し、異物を除去していた。ＣＭＰコンディショナーを用いたコンディショニングは、半導体基板１０３の研磨が終わった後に、ＣＭＰコンディショナーを研磨布１０２に当接させるか、或いは、半導体基板１０３の研磨と同時に、半導体基板１０３が当接する位置とは別の位置でＣＭＰコンディショナーを研磨布１０２に当接させるかして行われる。

【０００６】

【発明が解決しようとする課題】従来の研磨布のコンディショニングに用いられるＣＭＰコンディショナーでは、図９に示すように、円板状の支持部材２０１の表面に、硬質砥粒としてダイヤモンド粒２０２を人手で撒く等して適当に均一に分布させた後、これらダイヤモンド粒２０２を固着させていた。しかし、この場合、いかに丁寧にダイヤモンド粒２０２を散布したとしても、ダイヤモンド粒２０２は不均一に分布し、ＣＭＰコンディショナー固体間での相違の原因となり、安定したＣＭＰコンディショナー特性の発現が妨げられていた。

【０００７】また、従来のＣＭＰコンディショナーでは、スラルーの逃げが悪いため、マイクロスクラッチが多くなった。また、スラリーの逃げを改良するためには、図１０に示すように、支持部材２０１に化学スラリー１０１を逃すための逃し溝２０３等を形成しておき、研磨時に、この逃し溝２０３を介して化学スラリー１０１を逃すことがなされていた。しかし、支持部材２０１に逃し溝２０３を形成するのでは、ＣＭＰコンディショナー特性に悪影響を与えるおそれがあり、また、その逃し溝の加工に手間がかかり、コストアップの要因となってしまう。

【０００８】本発明は前記のような点に鑑みてなされたものであり、安定したＣＭＰコンディショナー特性が得られるとともに、逃し溝等を形成しなくとも研磨時にスラリー等を逃すことができ、マイクロスクラッチを減らすようにすることを目的とする。

【０００９】

【課題を解決するための手段】本発明のＣＭＰコンディショナーは、支持部材と、前記支持部材の面上に設けられた複数の硬質砥粒とを備えたＣＭＰコンディショナーであって、前記支持部材の面上に、前記複数の硬質砥粒を規則的に、かつ、前記支持部材の内側から外側にかけて密度が減少するように配列させた点に特徴を有する。

【００１０】本発明の他のＣＭＰコンディショナーは、支持部材と、前記支持部材の面上に設けられた複数の硬質砥粒とを備えたＣＭＰコンディショナーであって、前記支持部材の面上に、前記複数の硬質砥粒が存在しない領域を略放射状に確保している点に特徴を有する。

【００１１】本発明のＣＭＰコンディショナーに使用する硬質砥粒の配列方法は、規則的に、かつ、内側から外側にかけて密度が減少するように配列させた複数の貫通穴が形成された薄板状の配列部材を被配列面上に位置させる手順と、前記配列部材の各貫通穴に硬質砥粒を入れ込む手順とを有する点に特徴を有する。

【００１２】本発明の他のＣＭＰコンディショナーに使用する硬質砥粒の配列方法は、複数の貫通穴の存在しない領域が略放射状に確保された薄板状の配列部材を被配列面上に位置させる手順と、前記配列部材の各貫通穴に硬質砥粒を入れ込む手順とを有する点に特徴を有する。

【００１３】本発明の他のＣＭＰコンディショナーに使用する硬質砥粒の配列方法は、複数の硬質砥粒を規則的に、かつ、内側から外側にかけて密度が減少するように配列させた状態で保持部材に保持する手順と、前記保持部材により保持された硬質砥粒を、ＣＭＰコンディショナーを構成する支持部材の表面に転写する手順とを有する点に特徴を有する。

【００１４】本発明の他のＣＭＰコンディショナーに使用する硬質砥粒の配列方法は、複数の硬質砥粒の存在しない領域が略放射状に確保された状態で前記複数の硬質砥粒を保持部材に保持する手順と、前記保持部材により保持された硬質砥粒を、ＣＭＰコンディショナーを構成する支持部材の表面に転写する手順とを有する点に特徴を有する。

【００１５】本発明のＣＭＰコンディショナー製造方法は、前記ＣＭＰコンディショナーに使用する硬質砥粒の配列方法を利用して前記硬質砥粒を前記支持部材の表面上に配列させた後、前記硬質砥粒を前記支持部材の表面に固着する点に特徴を有する。

【００１６】

【発明の実施の形態】以下、図面を参照して、本発明の半導体基板用研磨布のＣＭＰコンディショナー、半導体基板用研磨布のＣＭＰコンディショナーに使用する硬質砥粒の配列方法、及びＣＭＰコンディショナー製造方法の実施の形態について説明する。

【００１７】図１を用いて、ＣＭＰコンディショナーについて説明する。同図に示すように、ステンレス鋼等からなる円板状の支持部材１の表面には、硬質砥粒としてダイヤモンド粒２が固着されている。

【００１８】図２、３には、支持部材１の表面におけるダイヤモンド粒２の配列の概要を示す。図２に示す例は、円板状の支持部材１の中心から放射状に伸びる複数の直線（一点鎖線Ｌ）を考え、それら直線上にダイヤモンド粒２を配置したものである。このようにしたＣＭＰコンディショナーでは、ダイヤモンド粒２が支持部材１の内側から外側にかけて密度が小さくなるように配列されており、支持部材１の表面上には、ダイヤモンド粒２の存在しない領域が放射状に確保されることになる。

【００１９】また、図３に示す例は、円板状の支持部材１の中心から放射状に伸びる複数の曲線（一点鎖線Ｌ）を考え、それら曲線上にダイヤモンド粒２を配置したものである。このようにしたＣＭＰコンディショナーでは、ダイヤモンド粒２が支持部材１の内側から外側にかけて密度が小さくなるように配列されており、支持部材１の表面上には、ダイヤモンド粒２が存在しない領域が放射状に確保されることになる。本発明でいう略放射状とは、図２に示すように直線的に放射する場合だけでなく、図３に示すように曲線的に放射する場合も含むものとする。

【００２０】なお、実際のダイヤモンド粒２は、支持部材１に比べて非常に小さなものであるが、図１や後述する図２、３では、説明を簡単にするためダイヤモンド粒２を大きく図示する。また、直線や曲線の数についても、より密な状態で放射させるようにするが、図２、３では簡単に図示する。

【００２１】以下、図４～７を参照して、ダイヤモンド粒２の配列方法について説明する。本実施の形態では、次の２通りの方法により、ダイヤモンド粒２を配列させている。

【００２２】第１の方法では、図４に示すように、ろう材３が設けられた支持部材１の表面に、接着剤４を塗布しておく。そして、接着剤４を塗布した支持部材１の表面上に配列板５を載置して、マスキングする。

【００２３】図５に示すように、配列板５には、ダイヤモンド粒２を配列させるための貫通穴６が形成されている。すなわち、配列板５には、図２や図３に示す配列と同様に貫通穴６を配列させている。貫通穴６の口径Ｘは、ダイヤモンド粒２のサイズＤに対して、１．０Ｄ＜Ｘ＜２．０Ｄとなっており、１つの貫通穴６に１個以上のダイヤモンド粒２が同時に入り込まないようにしている。なお、配列板５の周囲には、飛散防止用壁５ａが設けられている。

【００２４】図４に示すように、前記配列板５を支持部材１の表面に載置した状態で、配列板５上にダイヤモンド粒２を散布する。このとき、配列板５に適当な振動を加える等して、ダイヤモンド粒２が全ての貫通穴６に入り込むようにする。全ての貫通穴６にダイヤモンド粒２が入り込んだならば、配列板５上の余分なダイヤモンド粒２をはけ等を用いて取り除く。その後、配列板５を支持部材１の表面から取り外せば、ダイヤモンド粒２は、図２や図３に示すように配列された状態で支持部材１の表面上に残ることになる。

【００２５】以上述べたようにして支持部材１の表面にダイヤモンド粒２を配列させたならば、単層、ろう付けを行い、ダイヤモンド粒２を固定する。このろう付けの際に、支持部材１の表面に塗布された接着剤４はろう材３への加熱によって昇華し、支持部材１の表面上に残留しない。

【００２６】なお、第１の方法において、配列板５の代わりに、ワイヤで編まれたメッシュを用いてもよい。すなわち、メッシュの各開口部分を配列板５でいう貫通穴６として使用し、該開口部分にダイヤモンド粒２を入れ込んで、支持部材１の表面に配列させる。

【００２７】第２の方法では、前記第１の方法のようにダイヤモンド粒２を支持部材１の表面に直接的に配列するのではなく、粘着シート等の保持部材にいったん配列させてから、支持部材１の表面に転写するようにしている。

【００２８】図６（ａ）に示すように、配列板７には、ダイヤモンド粒２を配列させるための凹部８が形成されている。すなわち、配列板７には、図２や図３に示す配列と同様に凹部８を配列させている。なお、凹部８の口径Ｘを、ダイヤモンド粒サイズＤに対して、１．０Ｄ＜Ｘ＜２．０Ｄとすることは、前記第１の方法で述べた貫通穴６と同じである。

【００２９】前記配列板７上にダイヤモンド粒２を散布する。このときも、前記第１の方法で説明したように、配列板７に適当な振動を加える等して、ダイヤモンド粒２が全ての凹部８に入り込むようにする。全ての凹部８にダイヤモンド粒２が入り込んだならば、配列板７上の余分なダイヤモンド粒２をはけ９等を用いて取り除く。

【００３０】次に、配列板７の凹部８が開口する面に粘着シート１０を貼り付ける。そして、図６（ｂ）に示すように、配列板７の上下を逆にする等して、粘着シート１０を剥がすと、粘着シート１０にダイヤモンド粒２が配列された状態で保持されることになる。

【００３１】前記粘着シート１０のダイヤモンド粒２を保持する粘着面を、接着剤４が塗布された支持部材１の表面に貼り合わせるようにする。したがって、図７に示すように、ダイヤモンド粒２は、一端が粘着シート１０側で、他端が支持部材１の表面側で支持された状態となる。その後、支持部材１の表面側にダイヤモンド粒２を残し、粘着シート１０だけを取り除けば、ダイヤモンド粒２を支持部材１の表面上に配列させることができる。

【００３２】粘着シート１０だけを取り除く手法としては、例えば、粘着シート１０の接着材の溶解性と、支持部材１側の接着剤４の溶解性とに差を持たせておけばよい。この場合、図７に示す状態で粘着シート１０の接着剤が溶けるような環境にすれば、支持部材１側の接着剤

４は保持力を維持したまま、粘着シート１０の接着材だけを溶かし、粘着シート１０だけを取り除くことができる。

【００３３】以上述べたようにして支持部材１の表面にダイヤモンド粒２を配列させたならば、単層、ろう付けを行い、ダイヤモンド粒２を固定する。このろう付けの際に、支持部材１の表面に塗布された接着剤４はろう材３への加熱によって昇華し、支持部材１の表面上に残留しない。

【００３４】なお、第２の方法では、配列板７に凹部８を形成するようにしたが、貫通穴としてよい。この場合、図４に示す支持部材１を粘着シート１０に変更すれば、粘着シート１０にダイヤモンド粒を配列させることができるので、それを支持部材１の表面に転写すればよい。

【００３５】以上述べたように本実施の形態によれば、ダイヤモンド粒２を規則的に配列させているので、ＣＭＰコンディショナー間での固体差がなくなり、安定したＣＭＰコンディショナー特性を得ることができる。また、ダイヤモンド粒２を、支持部材１の中心から略放射状に配列させることにより、支持部材１の内側から外側にかけて密度が小さくなるよう配列するようにし、また、ダイヤモンド粒２が存在しない領域を放射状に確保するようにしたので、研磨時にスラリーを支持部材１の外側に向けて逃すことができ、マイクロスクラッチが減少する。そして、スラリーを逃すための特別な加工を支持部材１に施す必要がなくなるので、加工の手間やコストを軽減させることができる。

【００３６】なお、本実施の形態では、本発明でいう硬質砥粒としてダイヤモンド粒２を用いたが、その他の材質、例えば立方晶窒化ホウ素、炭化ホウ素、炭化珪素又は酸化アルミニウム等からなるものであってもよい。

【００３７】また、ダイヤモンド粒２の支持部材１への固着方法としては、ろう付け以外の方法、例えばニッケル電着等により固着させてもよい。

【００３８】ここで、好適な一例として、ダイヤモンド粒をろう付けにより固着する方法について説明すると、ろう材として、チタン、クロム、又はジルコニウムより選ばれた１種以上を０．５～２０ｗｔ％含む融点６５０℃～１２００℃の合金を用いることにより、ダイヤモンド粒とろう付け合金との界面に当該金属の炭化物層が形成される。ろう材に含まれるチタン、クロム、又はジルコニウムより選ばれた１種以上を０．５～２０ｗｔ％とするのは、０．５ｗｔ％より少ない含有量ではダイヤモンド－ろう付け合金の界面に当該金属の炭化物層が形成されないためであり、２０ｗｔ％添加すれば十分な接合強度を示す炭化物層が形成されるためである。

【００３９】ろう付け合金を融点６５０℃～１２００℃の合金とするのは、６５０℃未満のろう付け温度では、接合強度が得られず、１２００℃超のろう付け温度では、ダイヤモンドの劣化が起こるので好ましくないからである。ろう付け合金としては、例えば、上記成分を含有するニッケル（Ｎｉ）基合金等が好適に用いることができる。

【００４０】ろう付け合金の厚さは、ダイヤモンド粒の０．２～１．５倍の厚さが適当である。薄すぎると、ダイヤモンドとろう付け合金との接合強度が低くなり、厚すぎると、ろう材と支持部材との剥離が起こりやすくなるためである。

【００４１】ダイヤモンド粒の径は、５０μｍ～３００μｍとすることが好ましい。５０μｍ未満の微粒ダイヤモンド粒では、十分な研磨速度が得られず、また、凝集しやすい傾向があり、脱落しやすくなるためである。また、３００μｍ超の粗粒のダイヤモンド粒では、研磨時の応力集中が大きくなり、脱落しやすくなるためである。

【００４２】

【発明の効果】以上述べたように本発明によれば、ＣＭＰコンディショナー間での固体差がなくなり、安定したＣＭＰコンディショナー特性を得ることができるので、安定した量産ＣＭＰプロセスを実現することが可能となる。また、研磨時にスラリーを逃すことができ、マイクロスクラッチを減らすことができ、しかも、そのための特別な加工を支持部材に施す必要がなくなるので、加工の手間やコストを軽減させることができる。

【図面の簡単な説明】

【図１】ＣＭＰコンディショナーについて説明するため図である。

【図２】ダイヤモンド粒２の配列の一例を示す図である。

【図３】ダイヤモンド粒２の配列の一例を示す図である。

【図４】第１の方法によるダイヤモンド粒２の配列方法を説明するための図である。

【図５】配列板５を説明するための図である。

【図６】第２の方法によるダイヤモンド粒２の配列方法を説明するための図である。

【図７】第２の方法によるダイヤモンド粒２の配列方法を説明するための図である。

【図８】ＣＭＰ工程を説明するための図である。

【図９】従来のＣＭＰコンディショナーについて説明するための図である。

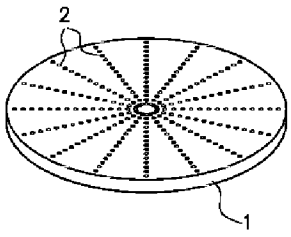
【図１０】逃し溝２０３を形成したＣＭＰコンディショナーを示す模式図である。

【符号の説明】

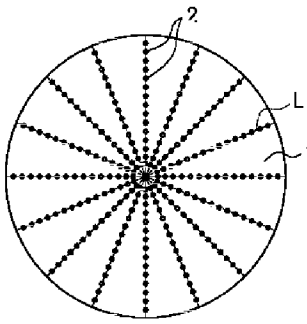
１　支持部材
２　ダイヤモンド粒
３　ろう材
４　接着剤
５　配列板

5a　飛散防止用壁
6　貫通穴
7　配列板
8　凹部
9　はけ
10　粘着シート
101　化学スラリー
102　研磨布
103　半導体基板

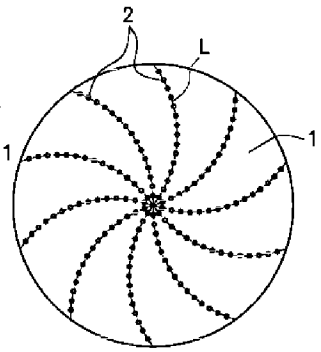
【図1】



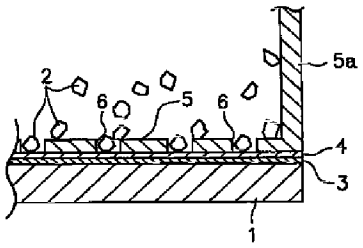
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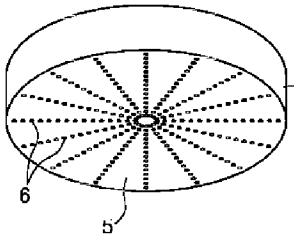
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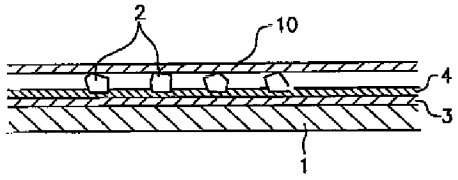
【図4】



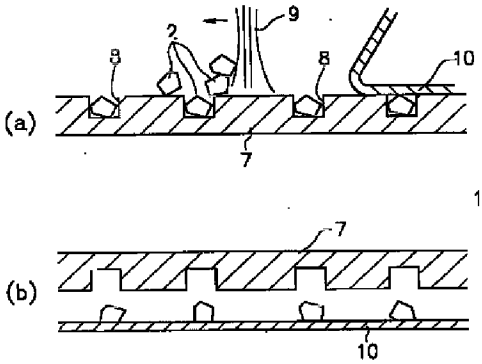
【図5】



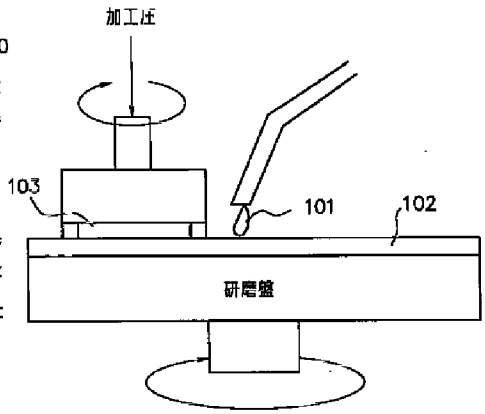
【図7】



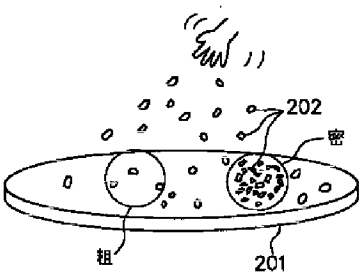
【図6】



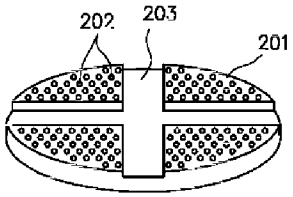
【図8】



【図９】



【図１０】



フロントページの続き

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SURFACE MOUNT AND FLIP CHIP TECHNOLOGY

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Abstract of WO9531006

An integrated circuit chip has full trench dielectric isolation of each portion of the chip. A heat sink cap (100) is attached to a diamond passivation layer (96) on the substrate front side surface. The passivation layer is a CVD diamond film which provides both electrical insulation and thermal conductivity. In a flip chip version, frontside electrical contacts (174a, 174b) extend through the frontside passivation layer to the heat sink cap. In a surface mount version, vias are etched through the substrate, with surface mount posts (90a, 90g) formed on the vias, to contact the frontside electrical contacts and provide all electrical contacts on the substrate backside surface. The wafer is then scribed into die in both versions without need for further packaging.

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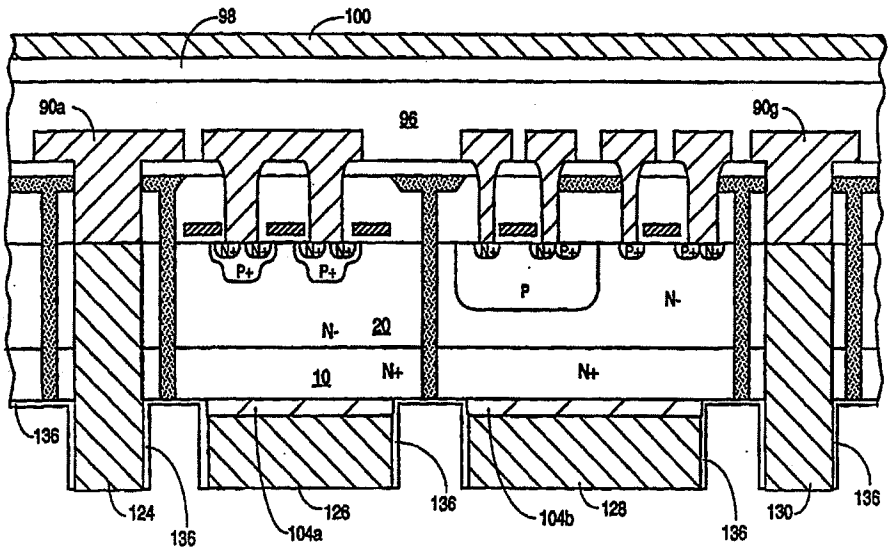
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(57) Abstract

An integrated circuit chip has full trench dielectric isolation of each portion of the chip. A heat sink cap (100) is attached to a diamond passivation layer (96) on the substrate front side surface. The passivation layer is a CVD diamond film which provides both electrical insulation and thermal conductivity. In a flip chip version, frontside electrical contacts (174a, 174b) extend through the frontside passivation layer to the heat sink cap. In a surface mount version, vias are etched through the substrate, with surface mount posts (90a, 90g) formed on the vias, to contact the frontside electrical contacts and provide all electrical contacts on the substrate backside surface. The wafer is then scribed into die in both versions without need for further packaging.

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SURFACE MOUNT AND FLIP CHIP TECHNOLOGY

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to integrated circuit electrical isolation, and more specifically to integrated circuit total isolation using both surface mount and flip chip fabrication technologies with a diamond film passivation layer.

Description of the Prior Art

Dielectric isolation for integrated circuits is well known. A trench or groove is formed in the semiconductor chip substrate and is lined or filled with an insulative material, to electrically isolate various portions of the chip. For instance, a particular portion of the chip such as power (high voltage) transistors is surrounded by an insulated trench, thereby electrically isolating the power transistors from logic type (low voltage) transistors.

This prior art trench isolation has the significant disadvantage that the bottom of each trench is an area of substantial mechanical stress in the silicon substrate, thereby being detrimental to chip functionality. Such trenches thus reduce yield (increase cost). This deficiency is sometimes overcome by using "round hole" techniques to form the bottom of

each trench (providing a U-shaped rather than a rectangular cross-section) which however, also tends to increase cost.

Another method for achieving isolation uses two wafers, with an oxide layer formed on a surface of one wafer which is then bonded to the second wafer; the oxide layer provides the isolation. After bonding the two wafers, the backside of one of the wafers is polished away down to the oxide layer to isolate a portion of the remaining substrate. However, this is very expensive because there can be no defects in the bond between the two wafers. Defects are often induced by particles in the bond between the two wafers, causing low production yield and hence high cost. Also, oxidation induced stacking faults (OISF) due to processing temperature cycles are undesirably more pronounced in such a bond than in bulk silicon.

Therefore, the prior art is deficient in not providing practical and inexpensive dielectric isolation, especially for use with power transistors but also for other types of integrated circuits.

SUMMARY OF THE INVENTION

An integrated circuit structure and a fabrication method use trench dielectric isolation. This trench dielectric isolation is part of a chip fabrication process which allows the packaging for each chip to be formed on the wafer, thereby eliminating the prior art separate step of packaging a semiconductor die after the wafer is scribed into multiple die. Therefore the disclosed process is the equivalent of assembly or packaging the integrated circuit die at "waferscale", since each die is already packaged before the wafer is scribed.

In accordance with the invention, transistors (or other semiconductor devices) are conventionally

fabricated on a semiconductor substrate. Some of these devices may be power transistors (operating at high voltage) and others may be lower voltage logic-type transistors formed in another portion of the substrate. In one embodiment, the devices are field effect transistors having gate electrodes formed in an insulated layer overlying the principal surface of the semiconductor substrate. Alternatively, the transistors are IGBT's (insulated gate bipolar transistors), or bipolar transistors, or other semiconductor devices. The fabrication process technology may be a CMOS, NMOS, PMOS, DMOS, BiCMOS, or bipolar technology, for example. Then an interconnect pattern is conventionally formed overlying and interconnecting the gate electrodes (or other transistor elements), and for contacting the semiconductor regions (e.g. source and drain) formed in the substrate.

A plurality of insulated trenches are then formed penetrating the principal surface of the substrate into the depth thereof, and surrounding (in a top view) various portions of the substrate. The trenches are conventionally insulated by filling or lining them with an insulative material followed by a planarization. This step may be prior to metallization. Then a portion of the backside of the substrate is removed by conventional machining or chemical processes, exposing the bottom portion of each of the trenches, and thereby achieving full (total) electrical isolation of the various substrate portions surrounded by each trench.

Prior to the step of removing the backside portion of the substrate, the frontside surface is bonded to a heat sink cap or plate (made for instance of silicon) using epoxy or similar bonding materials. This heat sink cap also provides the needed mechanical support for the substrate, which is otherwise quite thin

following the substrate removal step.

Electrical contact is achieved in two different embodiments. In a surface mount embodiment, vias penetrate from the backside surface of the substrate to its principal (frontside) surface, allowing electrically conductive material formed in the vias to contact an interconnect structure already formed on the substrate frontside surface. Extensions of the vias on the substrate backside define posts for surface mount electrical contacts. Other similar posts formed on the backside surface of the substrate make contact to the bulk substrate. The heat sink cap attached to the frontside substrate surface has a mechanical and heat dissipation function, with no electrical connections provided thereby.

In a flip chip type embodiment, the heat sink cap also carries on it an electrical interconnect, making electrical contact to the conventional interconnect on the substrate frontside surface. This heat sink cap may be attached to a conventional flip chip backplate. In this embodiment the electrical contacts formed on the substrate backside surface are the conventional drain or collector contacts for e.g. power integrated circuits.

In both embodiments, the individual integrated circuits are packaged while still being part of a single wafer, by the application of the heat sink cap which is attached (by epoxy or other adhesive) to the wafer frontside surface. This cap replaces the conventional plastic or ceramic packaging which in the prior art is applied only after the wafer is scribed into individual die. In the present case the full trench isolation between the die allows the die to be scribed adjacent to the isolation trenches, together with attached front end mechanical support plate (cap), so no further packaging is needed.

Typically, the thickness of the substrate after the substrate removal step is less than about 50 micrometers. This very thin substrate is free of heat induced mechanical stresses, due to its mechanical flexibility. Advantageously, integrated circuit chips in accordance with the invention are inexpensively fabricated using essentially conventional steps which provide a high yield, thus reducing cost.

The dielectric isolation trenches may conventionally be lined, for instance with silicon dioxide (formed from the silicon trench walls), or may be completely filled with silicon dioxide, or may be lined with silicon dioxide and then filled with another material such as CVD (chemical vapor deposition) nitride, polysilicon or oxide. In another embodiment, the trenches are filled with conventional spun on glass. Other insulating materials may be used for the trench dielectric.

The heat sink cap (plate) is typically silicon, silicon carbide, silicon nitride, aluminum nitride, molybdenum, or other material which provides sufficient heat transfer and is conveniently fabricated. The removal of the backside of the substrate advantageously eliminates mechanical stresses normally present at the bottom of a trench formed in silicon. Thus the principal problem with prior art trench isolation is overcome, resulting in a thin, flexible substrate.

Also, the prior art requirement for a semiconductor buried layer in the substrate is eliminated, due to the very thin substrate and formation of a layer of conductive material on selective areas of the substrate backside surface. Thus the processing problems associated in the prior art with establishing an effective buried layer are avoided, and the parasitic bipolar transistor effects typically present in prior art integrated circuits

(especially for power integrated circuits) are eliminated by a backside contact which is a metal plate or metallization layer rather than a buried semiconductor layer.

The metallized drain (or collector) contact on the backside surface, which is in relatively close proximity to the active transistors (due to the thinness of the substrate), increases current carrying capability over that of the prior art chips which require either the buried layer or current being transmitted through the relatively thick bulk of the semiconductor substrate. Thus advantageously the actual thickness of the final substrate itself is the minimum necessary to support (mechanically and electrically) the active transistor regions. This thickness may be as little as 10 microns, in contrast to prior art integrated circuits typically having a 400 micron die thickness needed for mechanical support for the integrated circuit.

Additionally, the step of removing the backside portion of the substrate after trench formation means that the initial trench depth need not be precisely determined. In the prior art, formation of trenches of precise depth is a significant processing limitation. In the present case, since the bottom portion of each trench is removed, exact trench depth is not critical.

Also, the fabrication process in accordance with the invention advantageously allows for an isolated backside contact structure which is not a single contact but a plurality of individual backside contacts, each contact associated with a particular portion of the die. This allows for instance a first backside contact to a power transistor portion of the integrated circuit, and a second backside contact associated with a low voltage transistor portion of the integrated circuit. Thus the backside contacts are

selectable for a particular portion of the integrated circuit, and various portions of the chip need not share a common collector or common drain.

In another embodiment, the passivation layer which serves as an isolation layer and an attachment layer to bond the IC wafer (substrate) to the heat sink cap or plate is a CVD (Chemical Vapor Deposition) diamond film. Such material advantageously has high thermal conductivity and high electric resistivity. The diamond film is deposited on top of the substrate after the final front side surface metal patterning. A thermally conductive adhesive (such as silver epoxy) is applied to the exposed surface of the deposited diamond film to attach the substrate to the plate. This use of diamond film is compatible both with the surface mount and flip chip embodiments described above. In accordance with the invention the diamond layer may be patterned so that particular portions of the metal contact or bonding pads are connected to and through the support plate to external leads from the front side of the wafer, in the flip chip embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 to 12 illustrate exemplary fabrication steps of the surface mount embodiment of the invention.

Figs. 13 to 17 illustrate exemplary fabrication steps of the flip chip type embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Surface Mount Embodiment

Figs. 1 to 12 illustrate steps to fabricate a surface mount integrated circuit chip in accordance with the invention. It is understood that these are conventionally drawn cross sections of an integrated

circuit showing only a small portion of the circuit, i.e. a small portion of a wafer. No topside views are provided, since the top side geometry of the integrated circuit is conventional, as will be understood by one of ordinary skill in the art from the following description. Also, this is only an illustration of the surface mount approach, which is not limited to semiconductor devices of the type shown.

Fig. 1 shows initial steps in fabrication of this embodiment. Fig. 1 is conventional both in structure and fabrication as typically used for integrated circuits which include both power transistors and low voltage transistors on one chip. See U.S. Patent Application No. 07/948,276, filed 9/21/92, Hamza Yilmaz et al., entitled "BiCDMOS Process Technology and Structure", incorporated by reference, for an example of such a fabrication process. Shown in Fig. 1 is silicon (or other material) substrate 10 which is conventionally N+ doped, having formed on an upper portion thereof in one embodiment an epitaxial (silicon) layer 20 which is conventionally N- doped. The epitaxial layer is an option but is not a necessary part of the invention; the active portions of the transistors may be formed in the substrate. (It is to be understood that materials, dimensions, transistor structure, conductivity types, and other elements disclosed herein are illustrative only and not limiting.)

Substrate 10 is approximately 500 micrometers thick, and silicon layer 20 is 1 to 50 micrometers thick. Conventionally formed (in this illustrative embodiment) in silicon layer 20 are two "deep body" conventionally doped P+ regions 22 and 24. Formed respectively in body regions 22 and 24 are N+ source regions 26, 28, 30 and 32 each of which is conventionally doped. It is to be appreciated that in

this embodiment P+ body regions 22 and 24 and the associated other doped regions are a part of a power portion of the integrated circuit, i.e. power transistors.

Formed adjacent to regions 22 and 24 is P tub 38 which is conventionally doped. Formed in P tub 38 are N+ doped regions 40 and 42. Also formed in silicon layer 20 are P+ regions 46 and 48 which are similar in their doping level and structure to region 44, and N+ region 50 which is similar to regions 40 and 42. Formed immediately overlying the upper surface of silicon layer 20 is a conventional gate oxide layer 60 of e.g. silicon dioxide.

Formed conventionally overlying oxide gate layer 60 is a doped polysilicon gate electrode layer 54 including (as a result of a masking step) portions 54a, 54b, 54c and 54d and 54e which in this embodiment form the gate electrodes of various transistors.

Overlying gate electrode layer 54 is a second overlying (upper) insulative layer 62 formed of silicon dioxide and also covering the respective side edges of the gate electrodes 54a, ..., 54e.

Overlying upper oxide layer 62 is a BPSG layer 64 (borophosphorsilicate glass) formed to a thickness of 0.5 to 1.5 micrometers and then conventionally reflowed to completely cover gate electrodes 54a, ..., 54e.

Fig. 2 shows subsequent processing with a conventional masking layer 70 formed overlying BPSG layer 64. Masking layer 70 is conventionally patterned and the underlying structure etched, with the etchant penetrating through silicon layer 20 and into substrate 10 to define trenches 72a, 72b, 72c, 72d, and 72e. These trenches are 0.5 to 5 micrometers in width and 5 to 50 micrometers in depth. (The depth is relatively arbitrary for reasons discussed later and the width dimension is also not critical.) The trench etch is a

conventional anisotropic process. It is to be understood that trenches 72a, ..., 72e as shown here in cross-section, would in a topside view interconnect so as to surround various portions of the integrated circuit, i.e. so as to surround the power transistor portion 22, 24 thereby separating this portion from the portion including P tub 38.

Then (not shown) the remaining portions of masking layer 70 are conventionally stripped off.

Next in Fig. 3, a glass layer 76 is formed conventionally such as by being spun on in each of trenches 72a, ..., 72e thereby filling each of these trenches, and also overlying the upper surface of BPSG layer 64, to a thickness of 1 to 2 micrometers. Alternatives to SOG for layer 76 are CVD formed materials or plasma enhanced CVD formed materials. After formation of spun on glass layer 76, this material is cured. Spun on glass 76 here is the trench dielectric insulating material. In other embodiments, the trenches e.g. are lined with a layer of grown silicon dioxide and then filled with another material such as CVD oxide, or nitride, or polysilicon. (These are conventional processes for forming dielectric layers.)

Next in Fig. 4, first an etch back (planarization) step using for instance CMP of the spun on glass layer 76 effectively removes those parts of layer 76 overlying the gate electrodes 54a, ..., 54e. An alternative to CMP is to apply a layer of photoresist then etch back using a dry etch.

Following the etch back step, an LTO (low temperature oxide) layer 80 is deposited over the upper surface of the structure to a thickness of 0.5 to 2.0 micrometers. Following the LTO layer 80 deposition, an electrical contact mask layer (not shown) is applied overlying LTO layer 80. The contact mask layer is then

conventionally patterned and the underlying layers etched, with the etch extending through LTO layer 80, through the remaining portions of spun on glass layer 76, and down to the principal surface of the silicon layer 20, thus exposing portions of the principal surface of the silicon layer 20 and defining contact openings 84a, ..., 84g.

Next in Fig. 5, a layer of conductive material 90 (such as aluminum) is conventionally deposited over the surface of the substrate, filling the various contact openings 84a, ..., 84g and making contact with the underlying semiconductor regions formed in silicon layer 20. Then conductive layer 90 is conventionally masked, the masking layer is patterned, and layer 90 is etched to define electrical contacts 90a, ..., 90g.

Then in Fig. 6 a conventional passivation layer of e.g. plasma nitride material is formed overlying electrical contacts 90a, ..., 90g. Passivation layer 96 is 0.5 to 2.5 micrometers thick.

Overlying passivation layer 96, an epoxy material layer 98 is conventionally deposited 25 to 250 micrometers thick. This epoxy material 98 is e.g. a high performance epoxy resin composition that is thermally conductive (such as silver epoxy).

Next a "cap" (plate) 100 is affixed to epoxy layer 98 which is then cured, bonding cap 100 to passivation layer 96. Cap 100 is about 500 micrometers thick and is e.g. undoped silicon. A single cap 100 covers the entire wafer which includes substrate 10 and silicon layer 20. Other bonding materials and processes other than epoxy may be used to affix cap 100. Cap 100 achieves thermal conductivity through epoxy layer 98 and also provides sufficient mechanical support for the substrate 10, silicon layer 20, and the active transistor regions and interconnect formed thereon.

Next in Fig. 7, the backside surface of substrate

10 is partially removed by grinding, etching, or CMP (chemical-mechanical polishing) so that the total thickness of substrate 10 and/or silicon layer 20 is in the range of 5 to 100 microns. This is in contrast to the original total thickness of structures 10 and 20 of about 500 microns. (Again, these dimensions are illustrative and not limiting.) The goal is to reduce the thickness of substrate 10 and silicon layer 20 to a minimum necessary for electrical functioning of the transistors formed therein. The removing step reduces the thickness of substrate 10 so that the bottom portion of each of trenches 72a, ..., 72e is exposed, and thereby the insulative material formed in each of these trenches is exposed at the backside surface of substrate 10. This achieves full electrical isolation of each portion of substrate 10. It is to be understood that in this case the attachment of heat sink cap 100 is done prior to the removing step to ensure that the substrate, after the removing step, remains in one integrated piece. Conventional masking, implantation, and annealing steps may be added to this process, as desired to form N+ or P+ contacts on the backside surface of substrate 10 for subsequent metal layer 104.

Next in Fig. 8, the backside surface of substrate 10 is metallized by a conventional sputtering or evaporative process to form a metal layer 104 (aluminum) thereon having a thickness of e.g. 0.15 to 1.5 micrometers. Then metal layer 104 is conventionally covered with a mask layer, the mask layer is patterned, and metal layer 104 then etched to define backside contact pads 104a, 104b on the backside surface of substrate 10. Each of contact pads 104a, 104b is associated with a selected portion of the integrated circuit die as defined by the trenches 72a, ..., 72e. Of course each portion of the die need not

have a contact pad; contact pads 104a, 104b are only provided to those portions of the die which require same. (It is to be understood that conventionally some types of transistors do not require backside contacts.)

Next in Fig. 9, a protective/passivation layer 110 is deposited on the backside surface of substrate 10 overlying contact pads 104a and 104b. Then layer 110 is conventionally patterned to define openings 112a and 112b. Each opening 112a and 112b is associated with a particular electrical contact 90a, 90g on the upper side surface of silicon layer 20, as shown.

Next in Fig. 10, a deep silicon etch is undertaken through openings 112a and 112b to define vias 116a, 116b extending through substrate 10 and/or silicon layer 20 to expose the underside portions of electrical contacts 90a, 90g. This deep silicon etching step uses a wet or wet/dry or dry etching technique.

Vias 116a, 116b need only be wide enough to establish good electrical paths to contacts 90a, 90g and otherwise their dimensions in terms of width are not critical; neither is their cross-sectional shape critical. Then as shown in Fig. 10 the remaining portions of layer 110 may be conventionally stripped off or kept as a passivation layer.

Next in Fig. 11 by a plating step (electrodeposition), vias 116a and 116b are filled with a solderable metal (e.g. nickel, gold, copper) to define posts 124, 130 extending therefrom. In the same electrodeposition step, metal posts 126, 128 are deposited on metal contacts 104a, 104b.

Alternatively, posts 126, 128 are formed by screen printing the desired type of metal on respectively the backside 104, 104b interconnection leads to establish the desired thickness for the surface mount posts. The diameter of the surface mount posts may vary, depending on the particular application.

Next in Fig. 12, an (optional) passivation layer 136 is deposited over all exposed surfaces of the surface mount posts 124, 126, 128 and 130 to a thickness of 0.8 to 1.2 micrometers. Passivation layer 136 is e.g. polyamide or low temperature oxide.

Then portions of passivation layer 136 are removed (by masking and etching or other means, for instance CMP) from the bottom surfaces of each surface mount post 124, 126, 128, 130, so as to leave the post bottom surfaces exposed for soldering, such as to a printed circuit board. The height of the surface mount posts extending from the lower backside surface of substrate 10 is conventionally 10 to 300 micrometers, or any other height as needed depending on the mounting application.

In Fig. 12 all of the electrical interconnections to outside of the chip are provided on the backside surface of substrate 10 by the surface mount posts 124, 126, 128 and 130.

Subsequently (not shown) the wafer is scribed into individual integrated circuit die along predescribed scribe lines which are for instance adjacent to dielectrically filled trenches. Thus as a result of the scribing step, the various integrated circuit die are already packaged by the top side cap 100 and the bottom side passivation layer 136; hence no further packaging is needed.

Flip Chip Embodiment

In the flip chip embodiment, the initial processing steps are identical to those shown in Figs. 1 to 5 for the surface mount embodiment, resulting in the structure of Fig. 13. Again, the flip chip embodiment is not limited to semiconductor devices of the type shown. The structure of Fig. 13 is identical to that of Fig. 5, except that in Fig. 13 the next step is that passivation layer 160 (which is similar in

material and thickness to passivation layer 96 in Fig. 6) is masked using a mask layer (not shown) which is patterned, with subsequent etching to define contact openings 164a, 164b, therethrough. Contact openings 164a, 164b, expose a portion of the underlying electrical contacts 90a, 90g. The goal in this embodiment is to define both substrate frontside and backside electrical contacts; openings 164a, 164b define the frontside contact openings.

Next in Fig. 14, silicon (or other suitable material) heat sink cap 172 is provided, having formed thereon (prior to assembly to the substrate 10) metal (aluminum or a solderable material) interconnect structures 176a, 176b. Interconnect structures 176a, 176b include interconnect lines on the surface of cap 172 which faces contacts 90a, 90b; these interconnect lines have a thickness of e.g. 10 to 50 micrometers. Cap 172 is electrically insulated on all surfaces by e.g. oxide dielectric layer 175. Interconnect structures 176a, 176b are then conventionally soldered or sintered to underlying contacts 90a, 90g. This electrical contact can be provided by any other conventional method.

Cap 172 is attached to the underlying structure by a high performance thermally conductive (and electrically insulative) epoxy resin layer 168 (or other high performance adhesive) formed on passivation layer 160 to a thickness of 25 to 250 micrometers. Adhesive layer 168 is prevented from fouling the electrical interconnections (between elements 176a, 176b and 90a, 90b) by masking and etching the adhesive layer 168 or by polishing it away from the interconnections. For instance, adhesive layer 168 is initially formed in a thick layer covering structures 176a, 176b, then etched back to expose the ends of structures 176a, 176b using a wet or dry etch.

It is to be understood that cap 172 serves as a heat sink and supports contact structures 176a, 176b which connect through vias extending through cap 172 to form interconnect contacts 174a, 174b on the opposite surface of cap 172. These interconnect contacts 174a, 174b are suitable for attachment to an underlying supporting conventional flip chip-type back plate (not shown) providing mechanical support and electrical bonds thereto.

Next in Fig. 15, (similar to Fig. 7) the backside surface of substrate 10 is polished or etched away to expose the lower portions of dielectrically insulated trenches 72a, ..., 72e. Again, the total thickness of substrate 10 and silicon layer 20 is minimized by this removing step to that needed for proper electrical functioning. Next in Fig. 16, backside contacts 178a, 178b are formed, similar to contacts 104a, 104b in Fig. 8. Next in Fig. 17, backside passivation layer 186 is deposited to a thickness of e.g. 0.5 to 2.5 micrometers using oxide or nitride or an oxide-nitride "sandwich" material over the backside surface of substrate 10 and initially over contact areas 178a and 178b, but is then removed from the exposed surfaces by use of a mask which is then patterned, and etching away of the unneeded portions of passivation layer 186. This exposes the bonding area of the power device drain contact 178a and a collector type drain contact 178b if desired. (Again the use of the backside contact depends on the nature of the associated semiconductor devices). Thus the flip chip configuration of Fig. 17 provides both frontside substrate electrical contacts 174a, 174b through cap 172 and also backside contacts 178a, 178b. The frontside leads are beam or tunnel lead structures or types to the transistors.

Again, after the steps of Fig. 17, the entire wafer is conventionally scribed along predetermined

scribe lines (not shown); thus as a result of scribing the chip is complete (packaged), advantageously without any need for further packaging steps.

Diamond Film Passivation Layer Embodiment

The above-described flip chip type and surface mount embodiments use conventional silicon dioxide or nitride as the dielectric insulation and passivation layer between the semiconductor wafer itself and the heat sink plate. These materials are known to provide relatively poor heat conduction, due to for instance the very low thermal conductivity of silicon dioxide of approximately 2 W/mK. In contrast, diamond film (which is also a good dielectric insulating material) provides thermal conductivities of about 2,000 W/mK. Also diamond is well known to be chemically inert, and due to its having the densest crystal lattice of any known material, the diffusion of other elements into diamond is very low. Thus diamond is not only a good dielectric insulator with excellent thermal conductivity but it is also a material which serves effectively as a passivation layer, providing good corrosion protection.

It has been determined in accordance with invention that diamond film has the best combination of thermal conductivity and electrical resistivity of available materials. Other materials such as aluminum nitride, aluminum oxide, or silicon carbide also provide high dielectric insulation but much less thermal conductivity than diamond. The only materials providing thermal conductivity similar to that of diamond film are electrically conductive metals such as copper and silver, which are not useful for passivation.

It is well known to provide chemical vapor deposition (CVD) of diamond film deposited at

temperatures of 600° to 950°C and at sub-atmospheric pressures. Typically methane or acetylene is used as the carbon source with significant partial pressure of atomic hydrogen. Excitation sources used include microwave and radio frequency plasmas, hot filament and thermal plasmas and combustion flames.

It has also been known to achieve a diamond deposition at temperatures below 600°C, for instance by using other process gas mixtures such as adding rare gases to the commonly utilized mixtures of carbon containing gases and hydrogen, mixtures of alcohols and water, halogenated gases and other gaseous combination. Typically growth rates of about 0.2 micrometers per hour have been achieved at deposition temperatures of about 400°C.

Methods for depositing diamond film in accordance with the present invention include low temperature microwave plasma assisted CVD. An alternative is an arc jet CVD process. It is known to pattern diamond films using conventional oxygen-based RIE (reactive ion etching) processes, as are well known in semi-conductor fabrication.

Thus in accordance with the invention for the above-described surface mount embodiment, a diamond film formed by one of the above described processes (or any other process) is substituted for passivation layer 96. The diamond film is formed to be a layer e.g. approximately 0.5 to 10 micrometers thick (but this is not limiting). Then the next substitution is, instead of using an ordinary epoxy material layer 98, a thermally conductive adhesive such as commercially available silver epoxy is used to bond the plate 100 to the diamond film. All other processing steps are as described above for this embodiment.

Similarly, for the above-described flip chip type embodiment, passivation layer 160 is a CVD (or other

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

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

We Claim:

1. An integrated circuit comprising:

A semiconductor substrate having a principal surface;

a plurality of semiconductor devices formed in the substrate;

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

a diamond film at least partially overlying the pattern of conductive lines;

a thermally conductive plate bonded to the diamond film and overlying the pattern of conductive lines; and

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

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

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

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

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

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

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

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

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

providing a semiconductor substrate having a principal surface;

forming a plurality of semiconductor devices in the substrate;

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

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

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

forming a diamond film layer overlying the substrate;

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

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

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

forming a conductive layer on the backside surface; and

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

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

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

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

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

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

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

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

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

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

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

AMENDED CLAIMS

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

1. An integrated circuit comprising:

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

a plurality of semiconductor devices formed in the substrate;

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

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

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

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

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

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

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

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

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

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

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

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

providing a semiconductor substrate having a principal surface;

forming a plurality of semiconductor devices in the substrate;

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

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

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

forming an electrically insulating film layer overlying the substrate;

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

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

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

forming a conductive layer on the backside surface; and

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

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

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

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

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

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

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

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

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

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

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

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

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

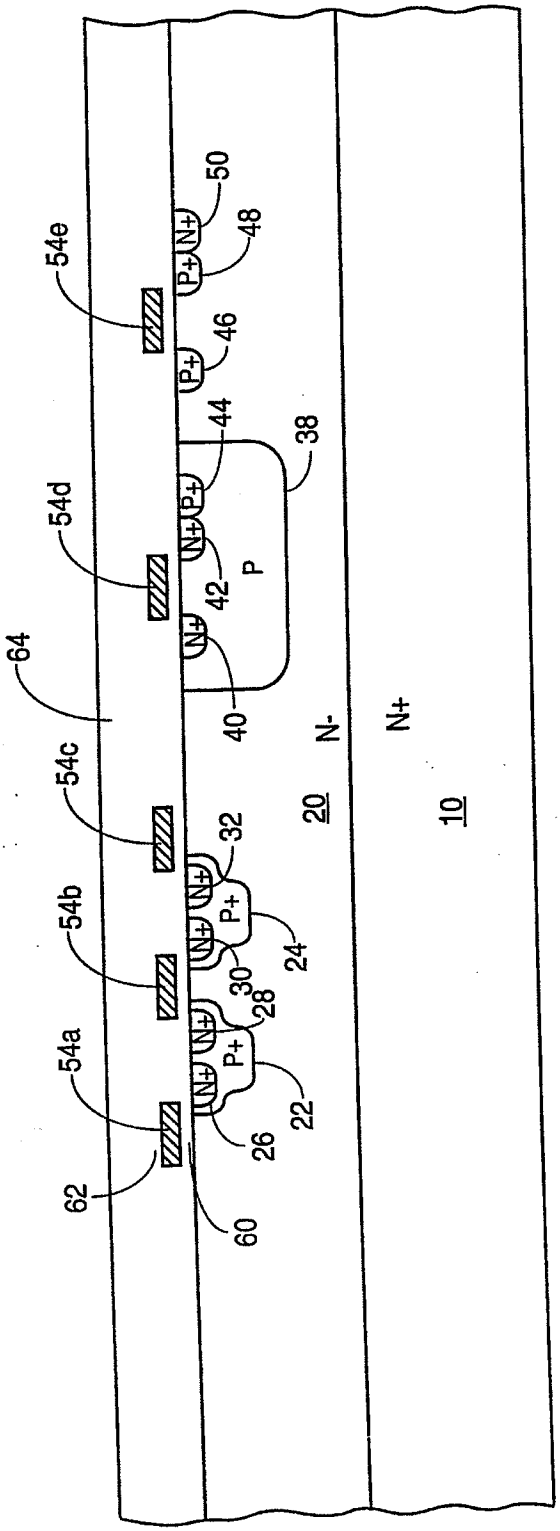

54e
54d
54c
54b
54a
62
64
60
50
48
46
44
38
42
40
32
30
28
26
24
22
P+
N+
P
N-
20
10

Fig. 1

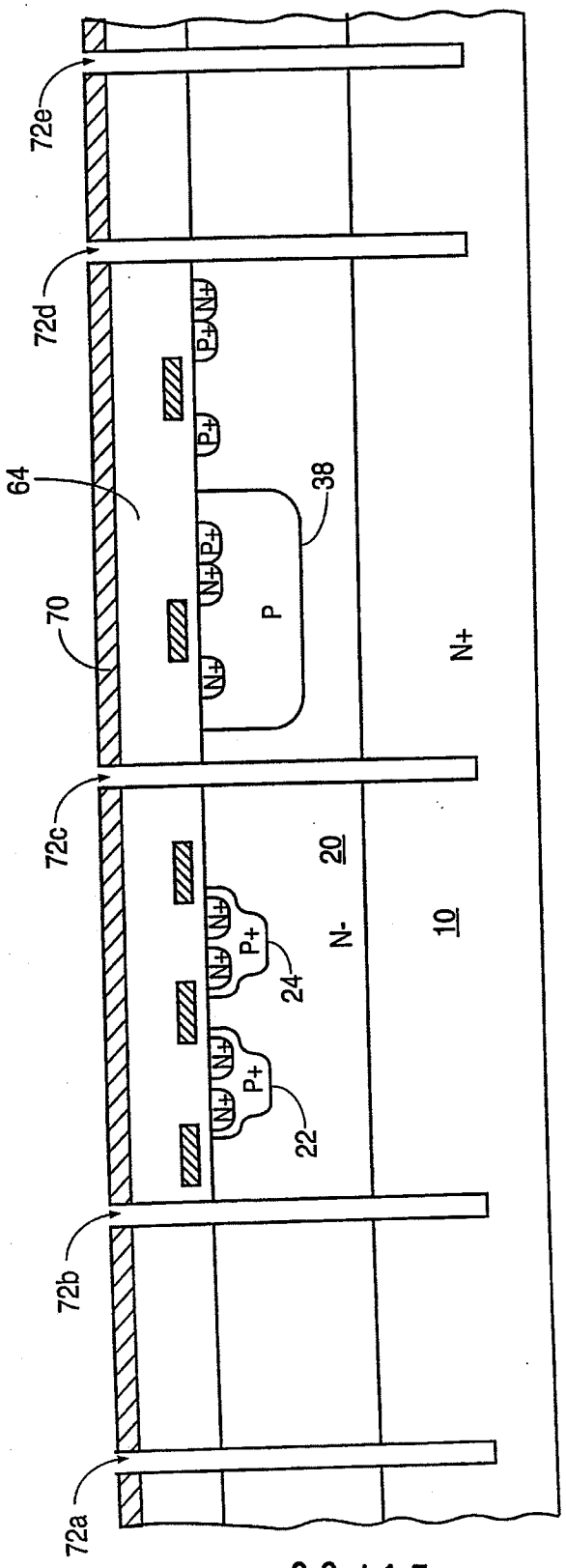


Fig. 2

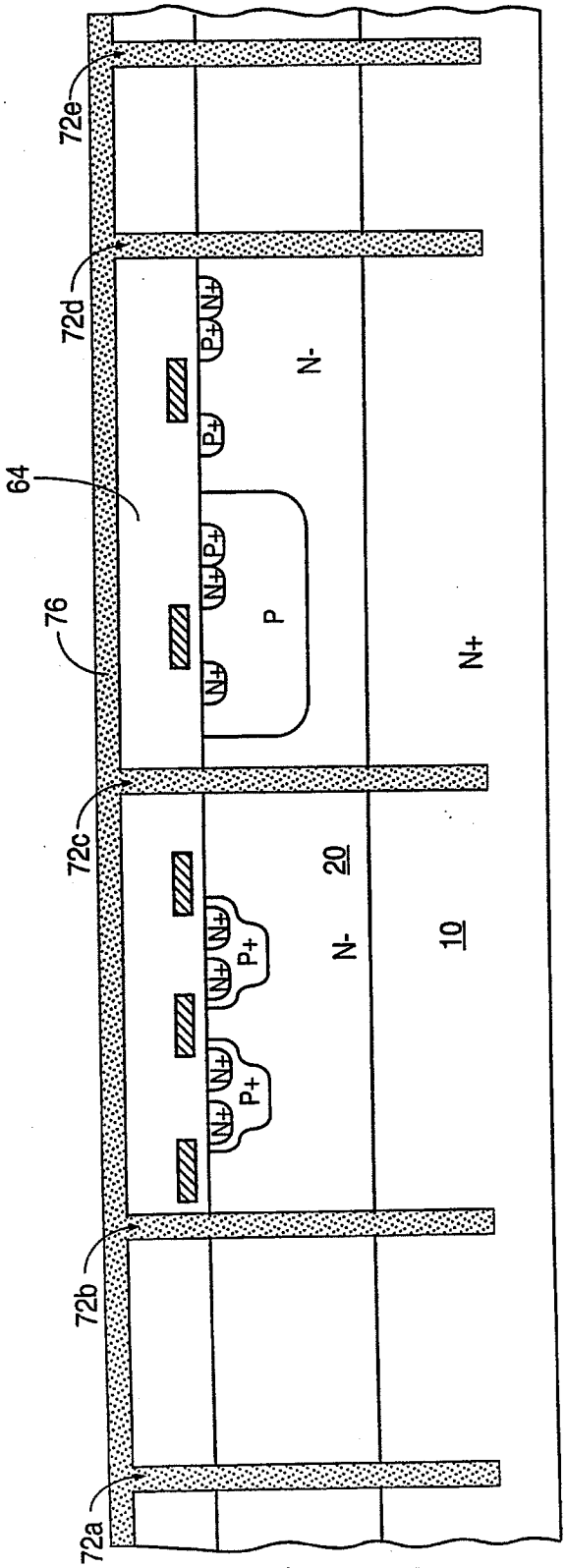


Fig. 3

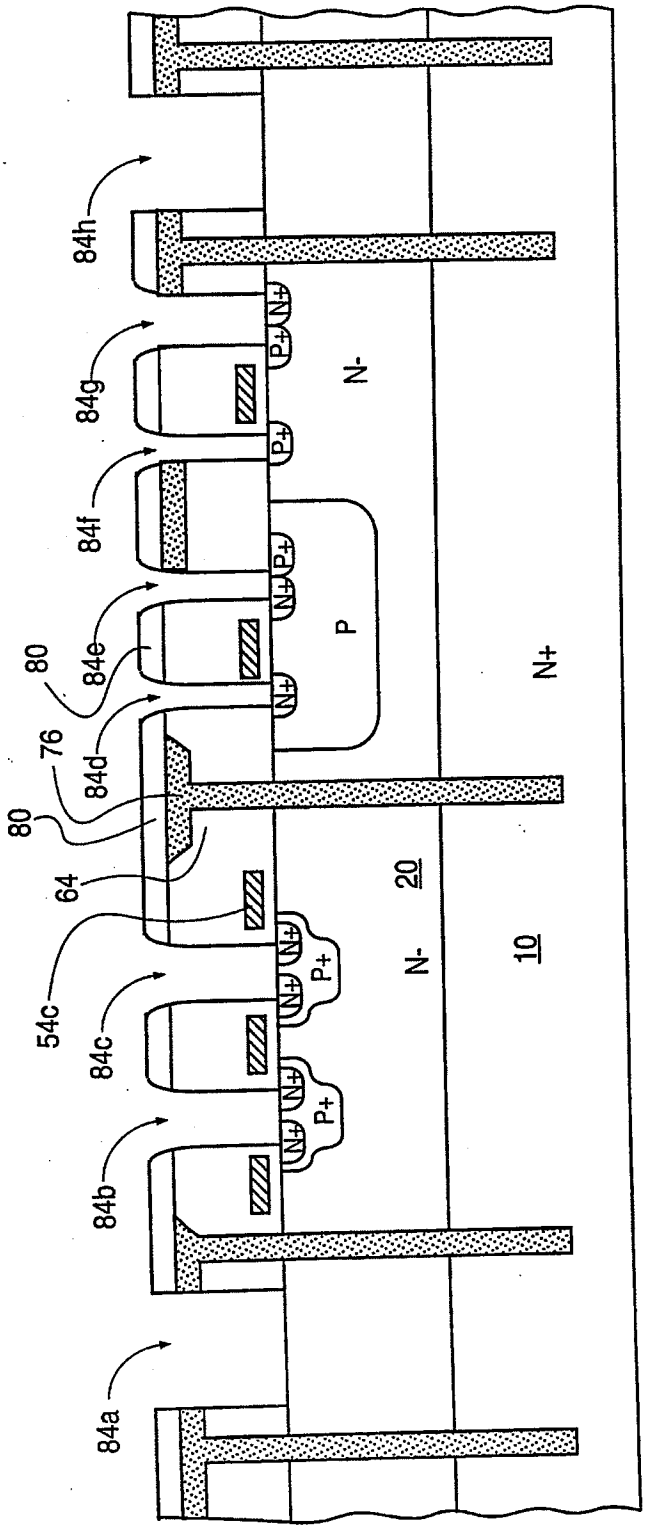


Fig. 4

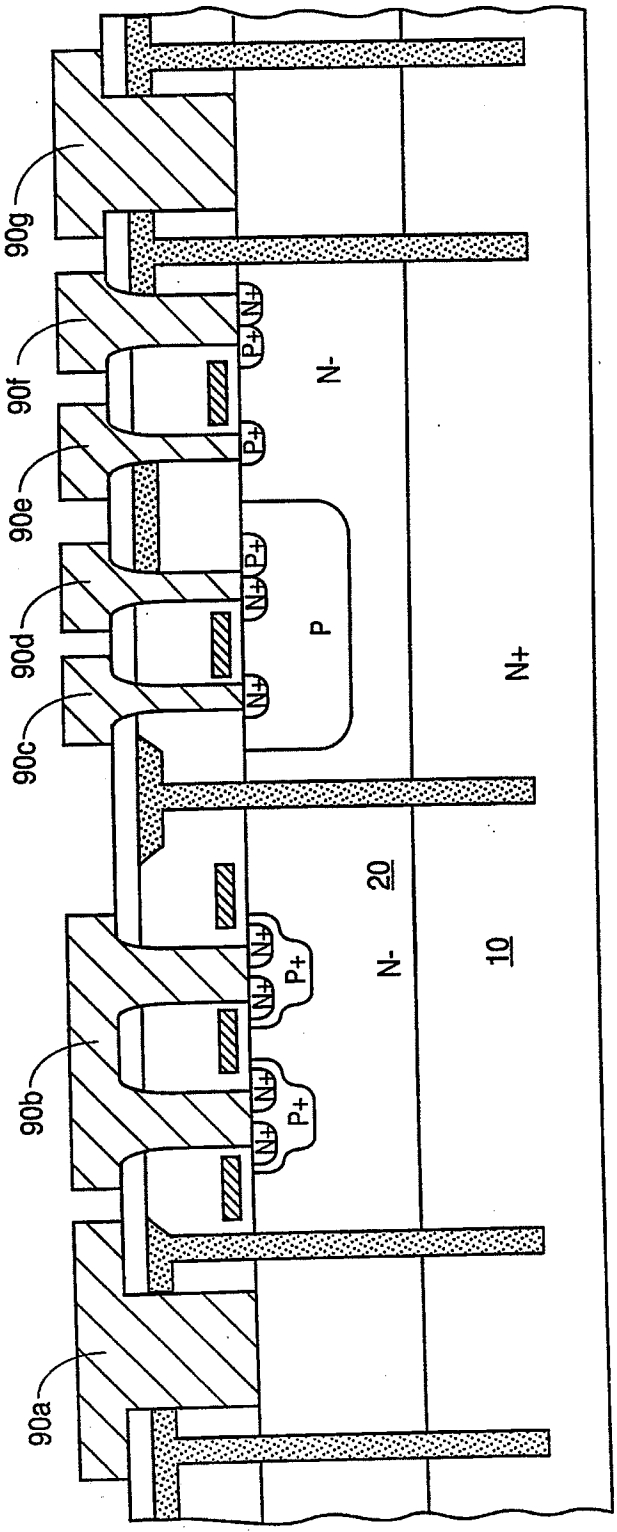


Fig. 5

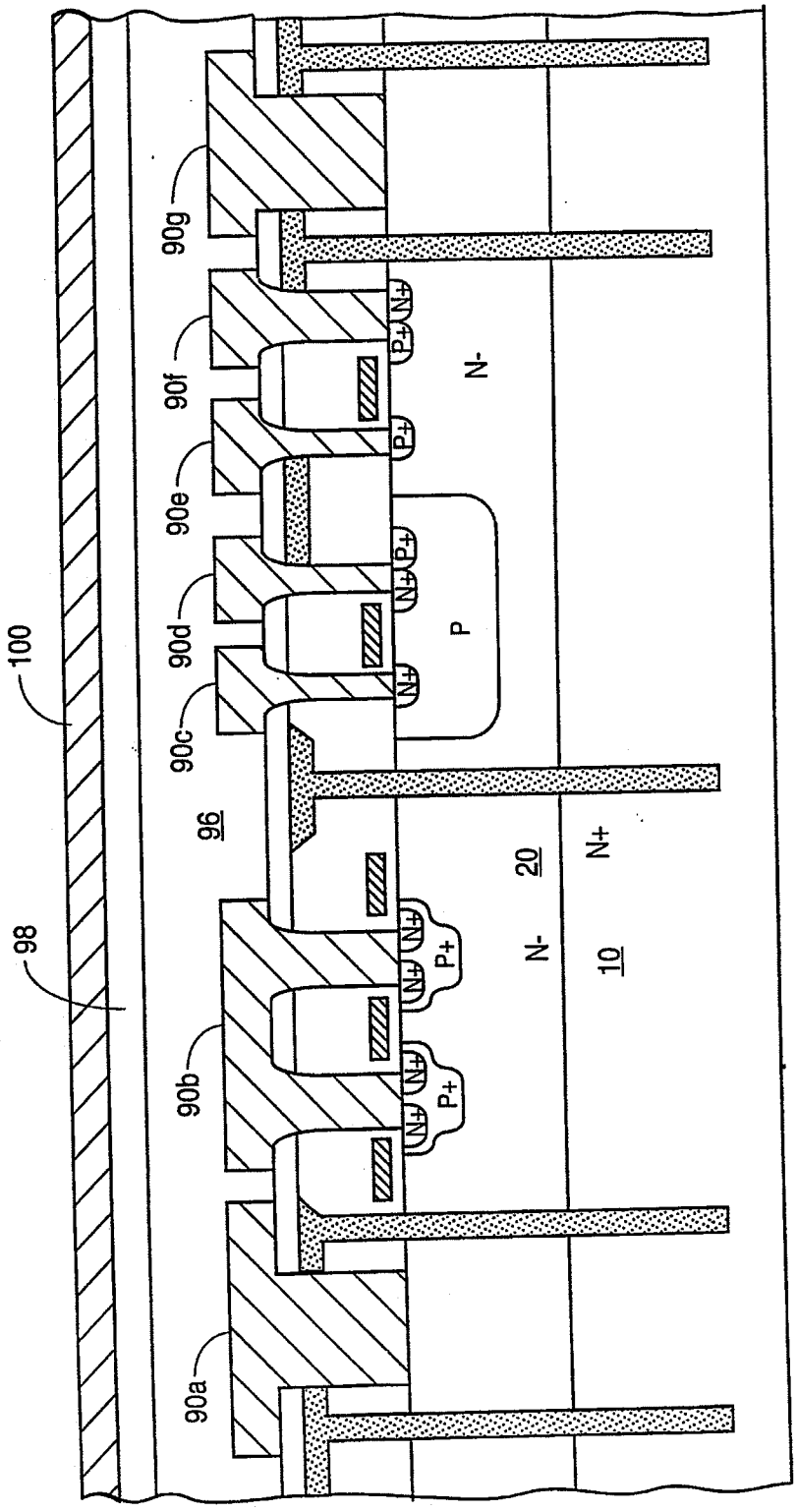


Fig. 6

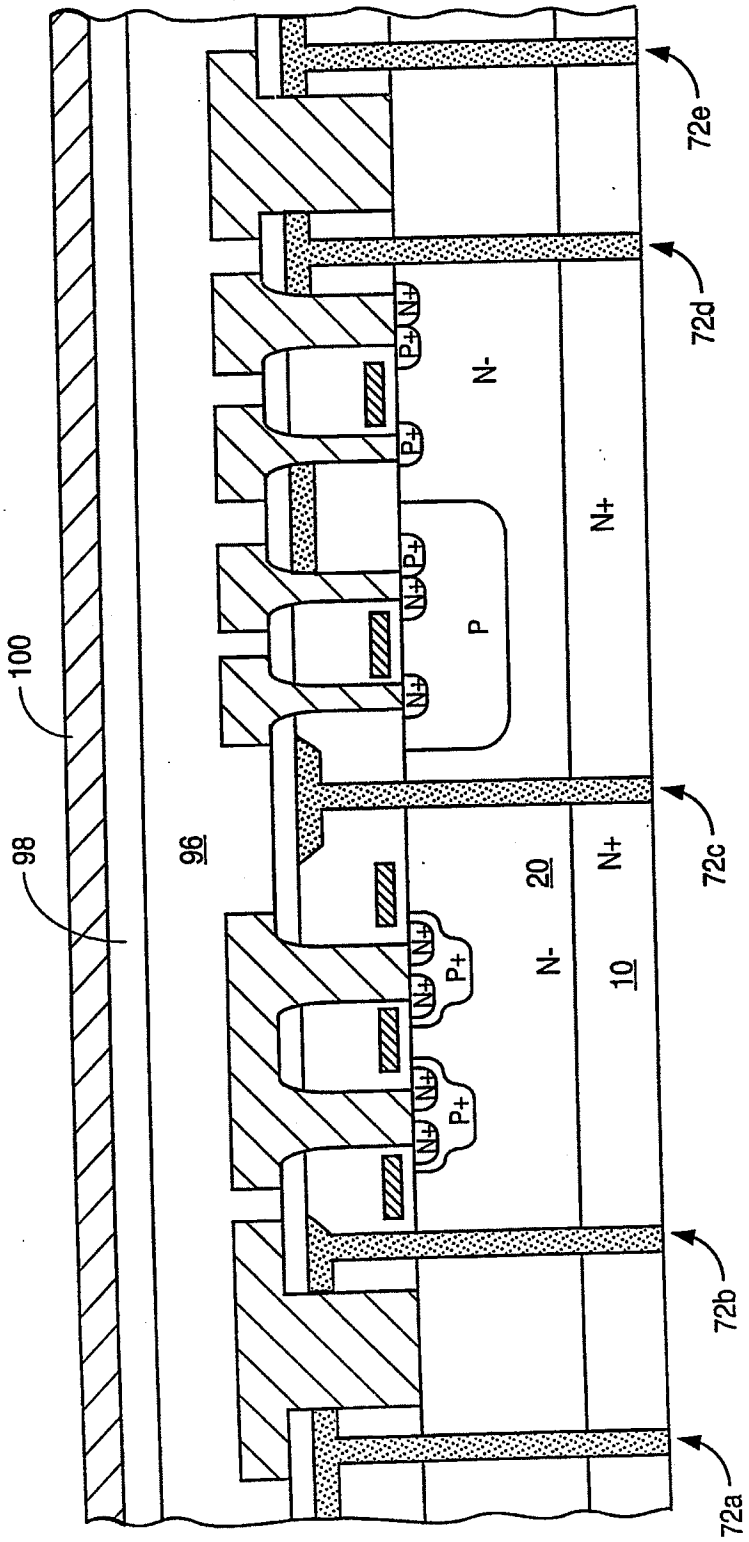


Fig. 7

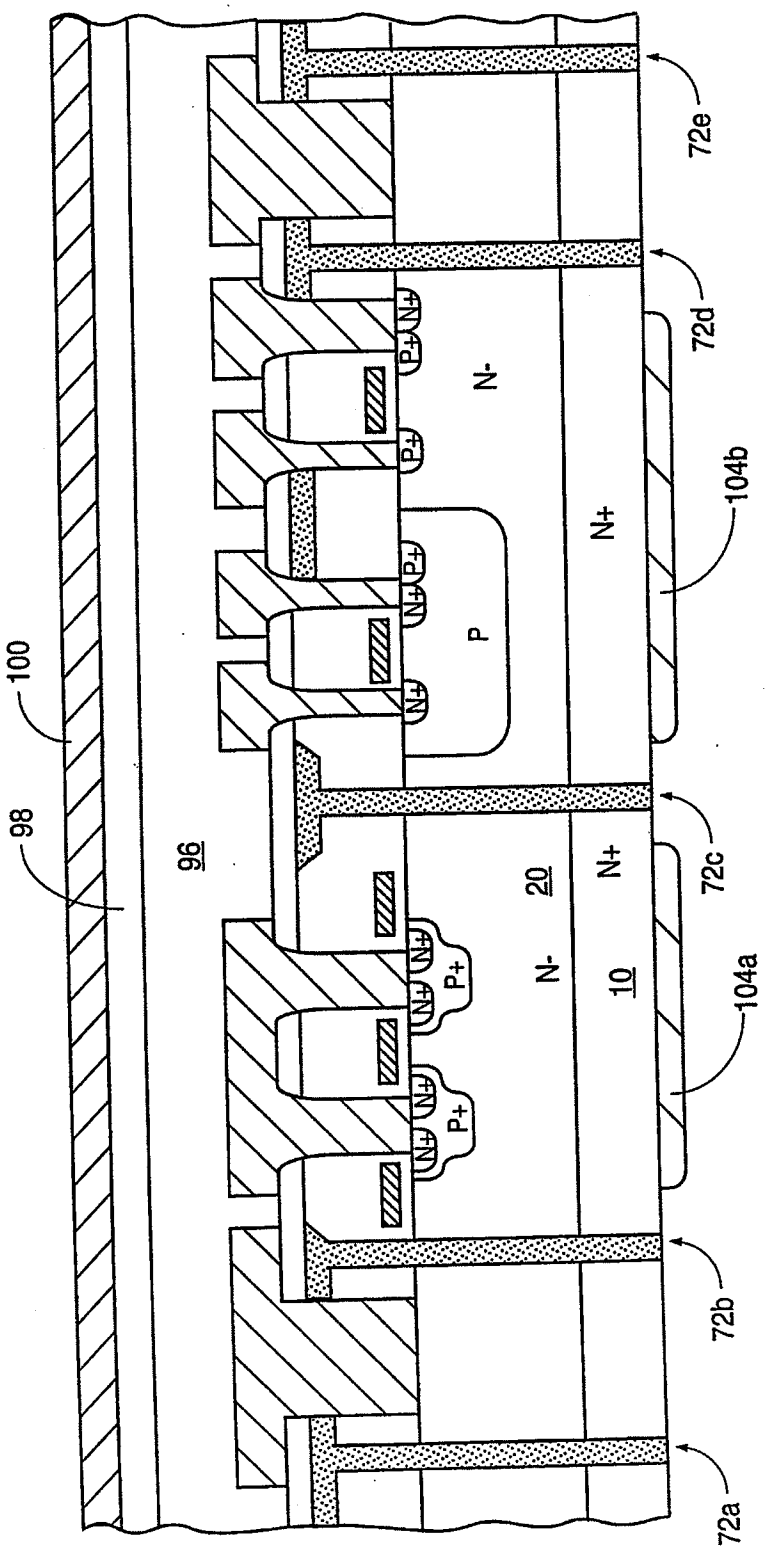


Fig. 8

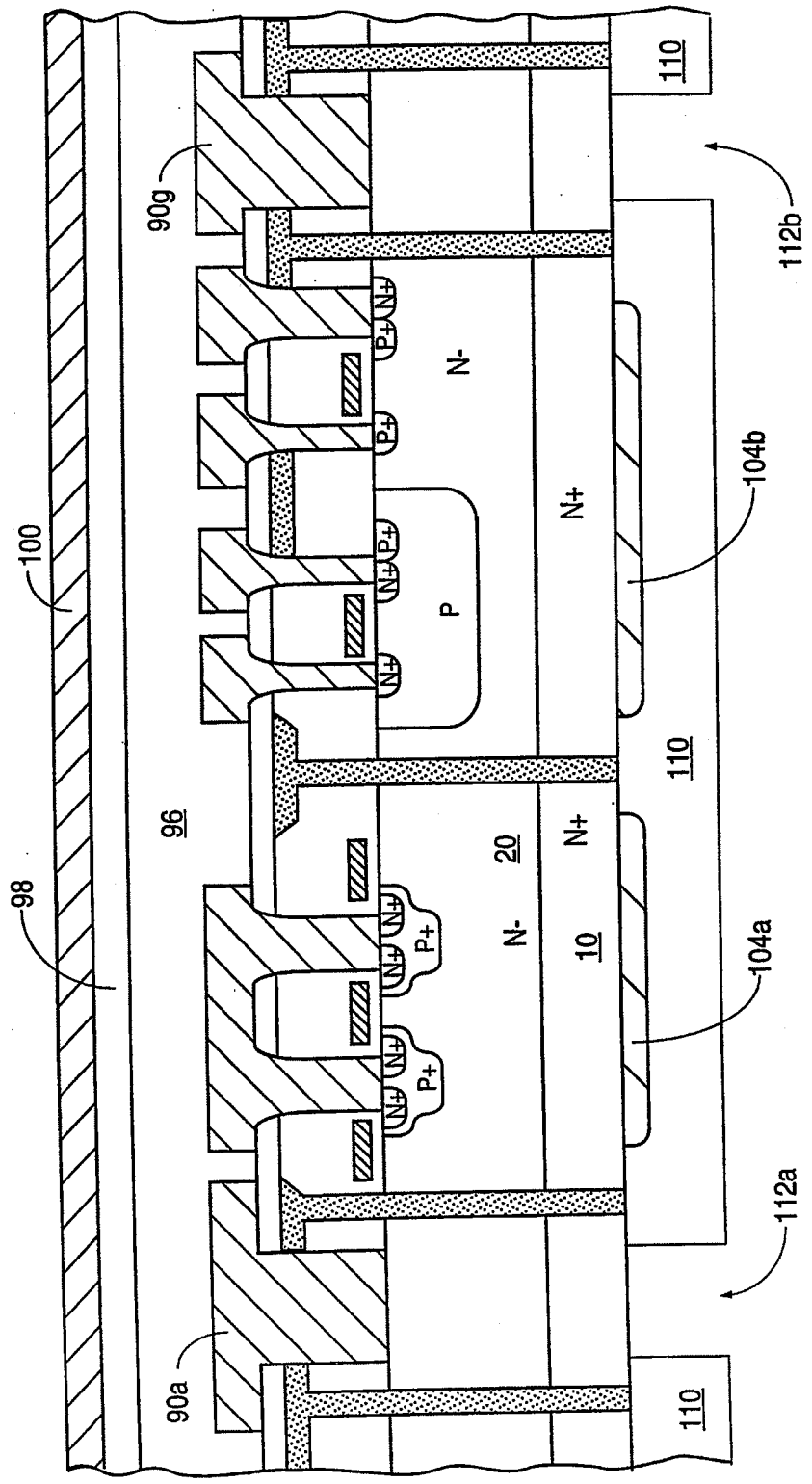

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P+
N+
P+
104b
100
P
N+
N+
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104a
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P+
N+
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90a
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Fig. 9

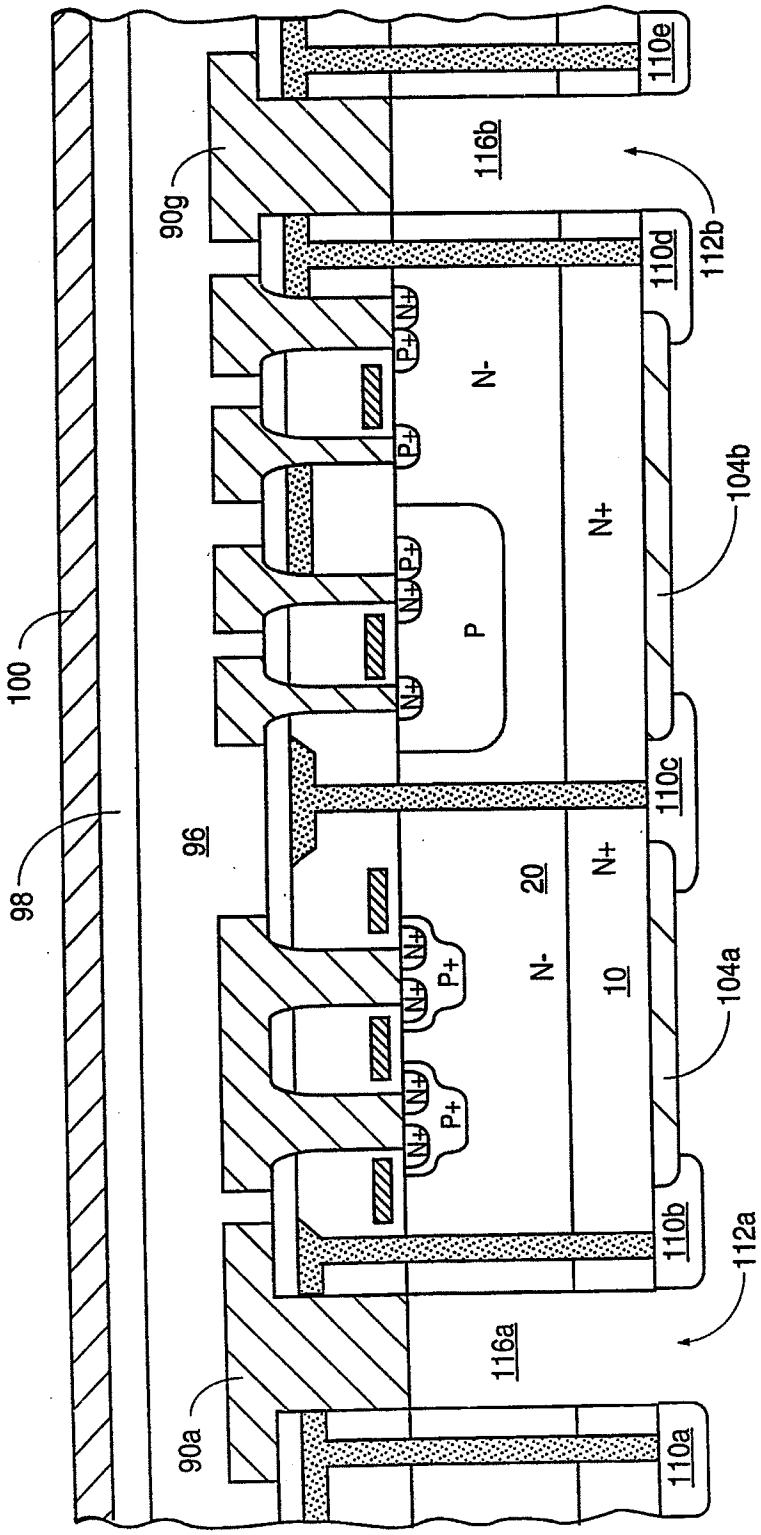

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104a
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110b
112a
116a
90a
110a

Fig. 10

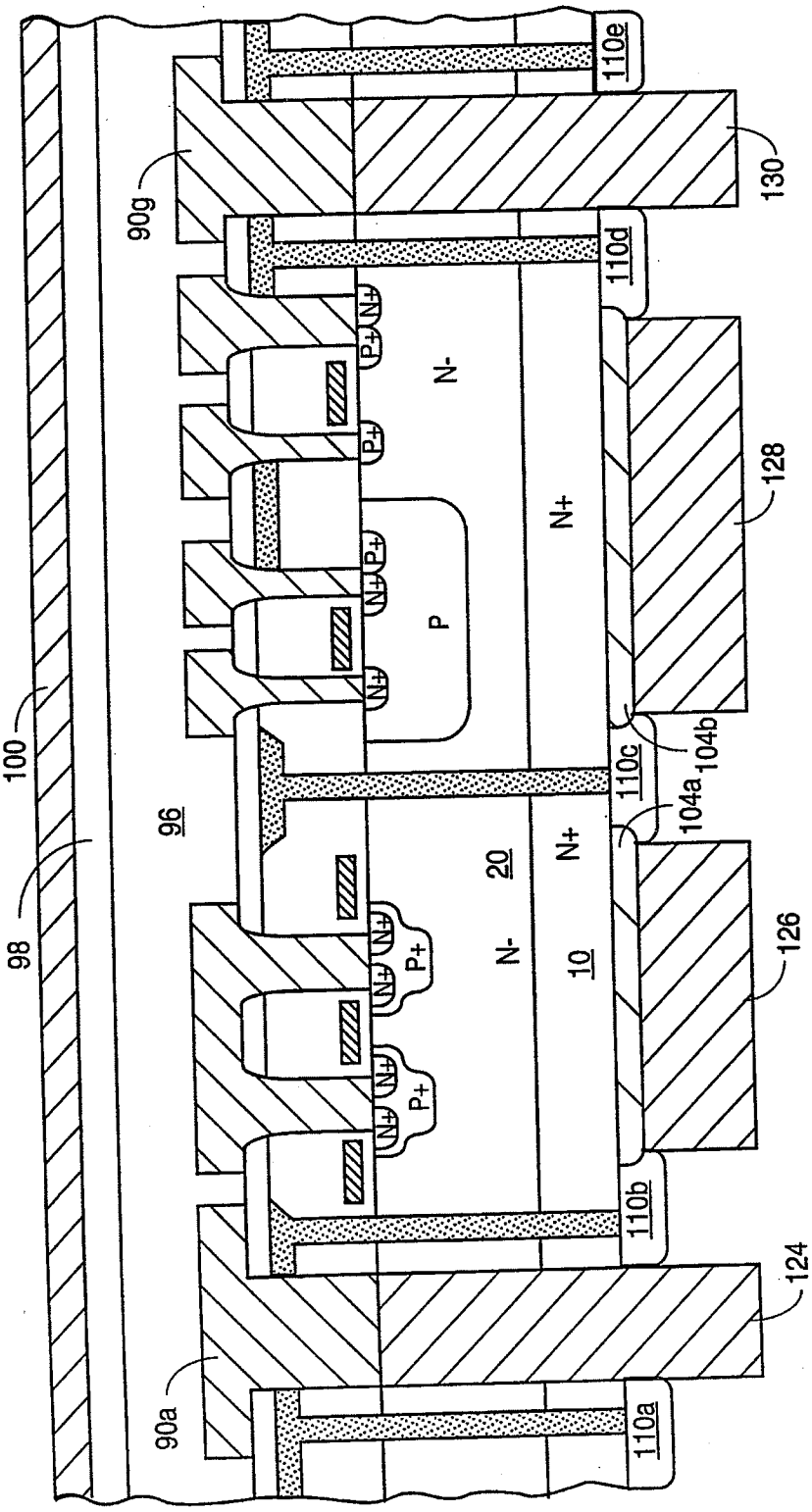

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P+
N+
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P
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90a
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Fig. 11

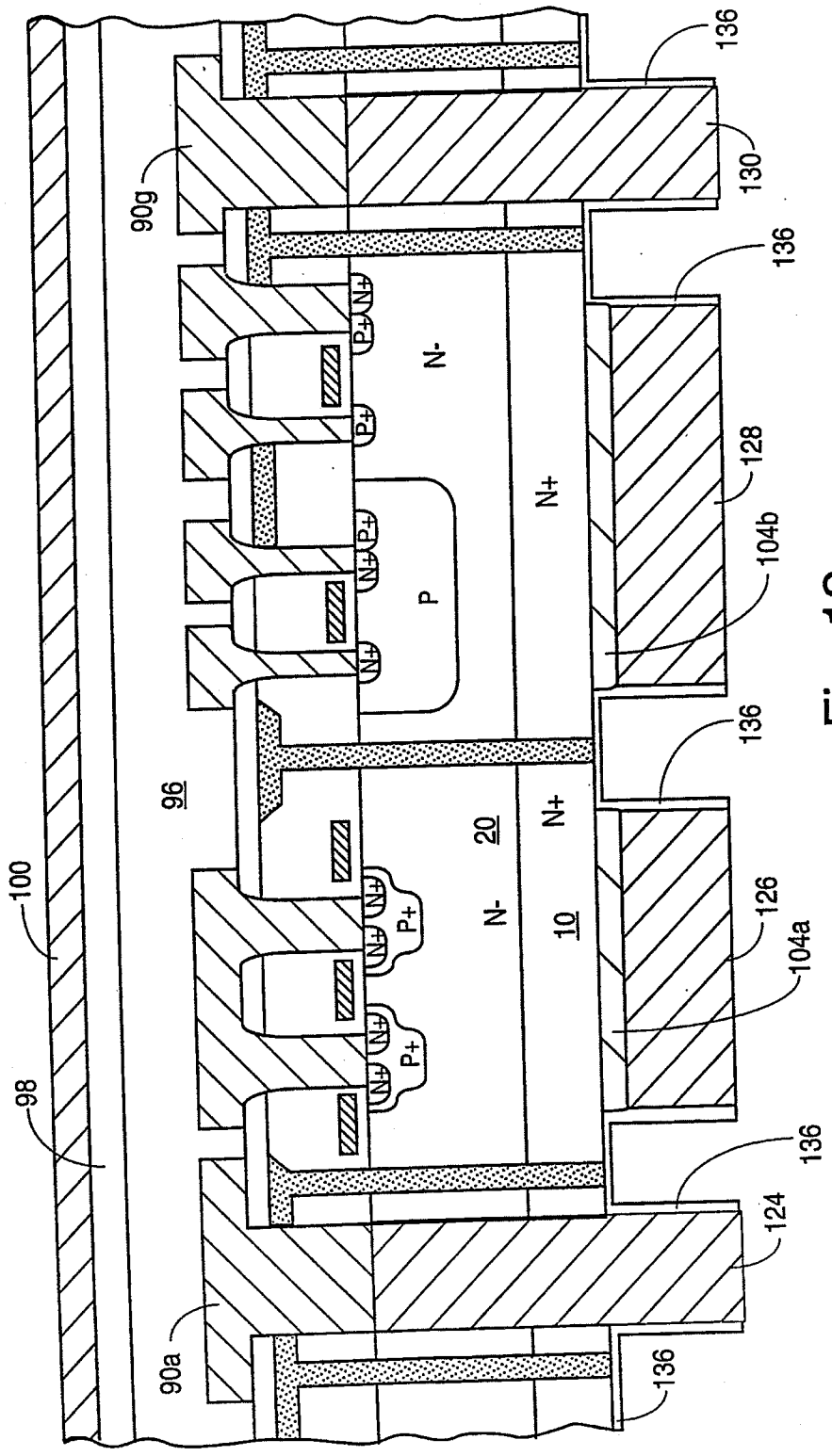

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Fig. 12

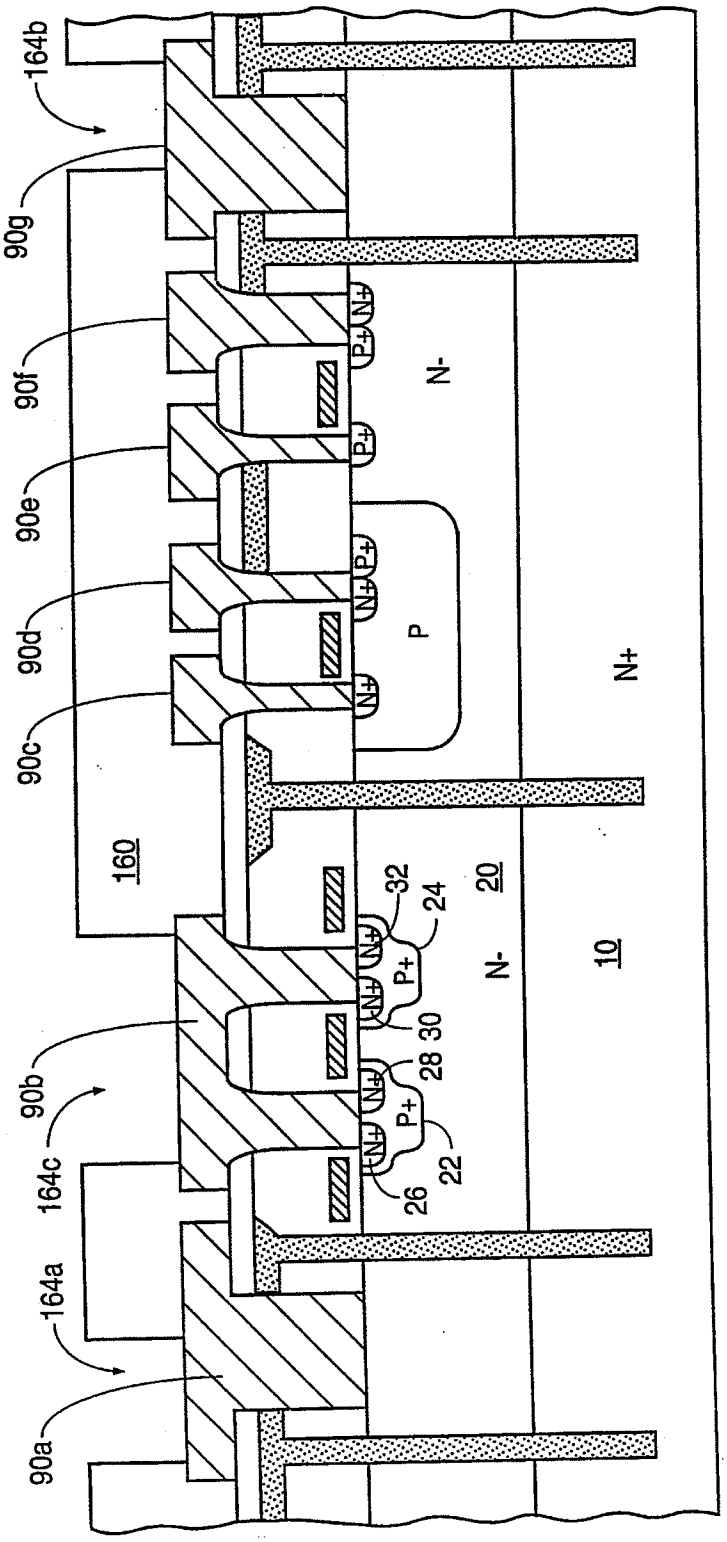

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Fig. 13

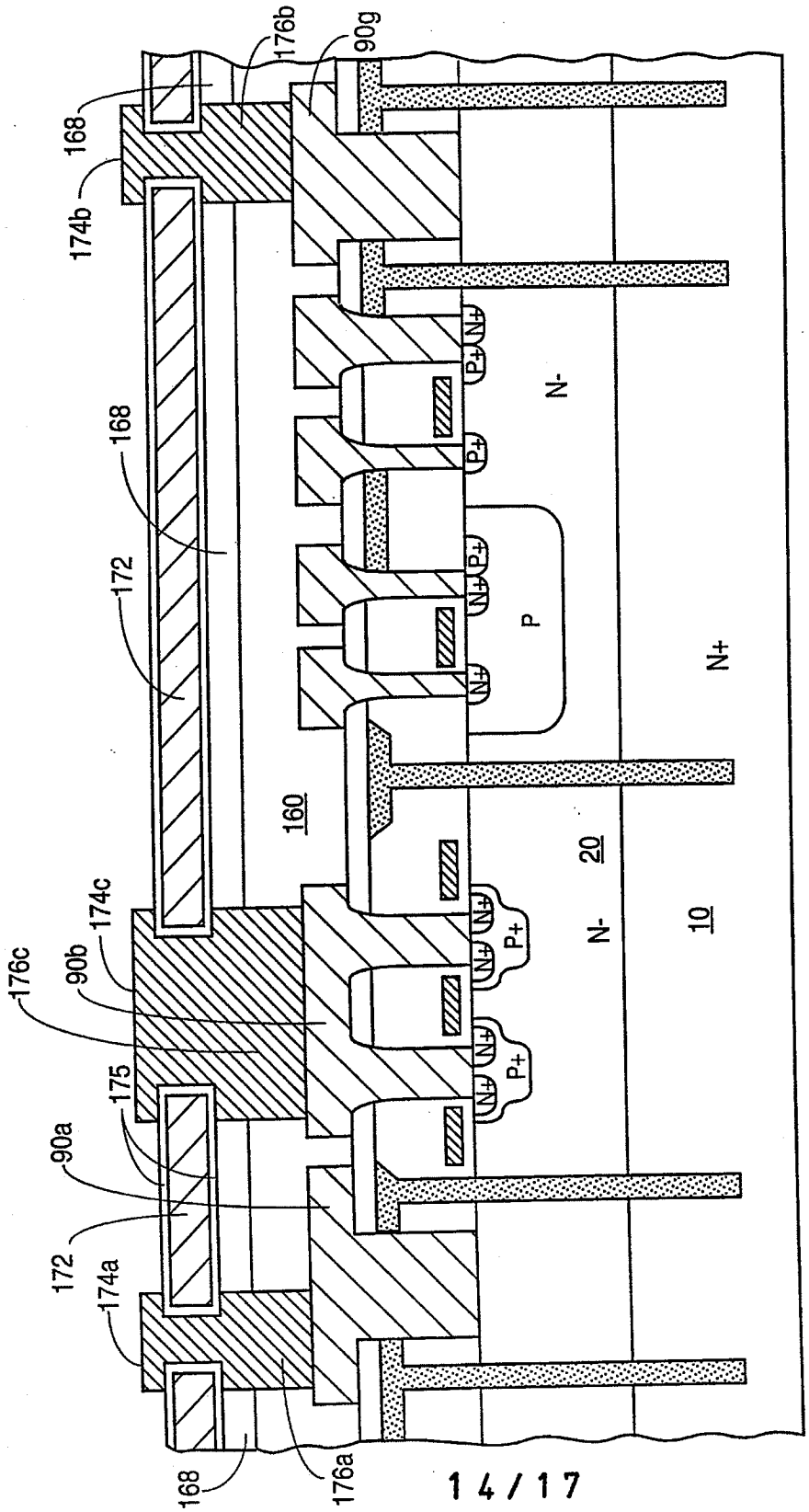

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174c
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Fig. 14

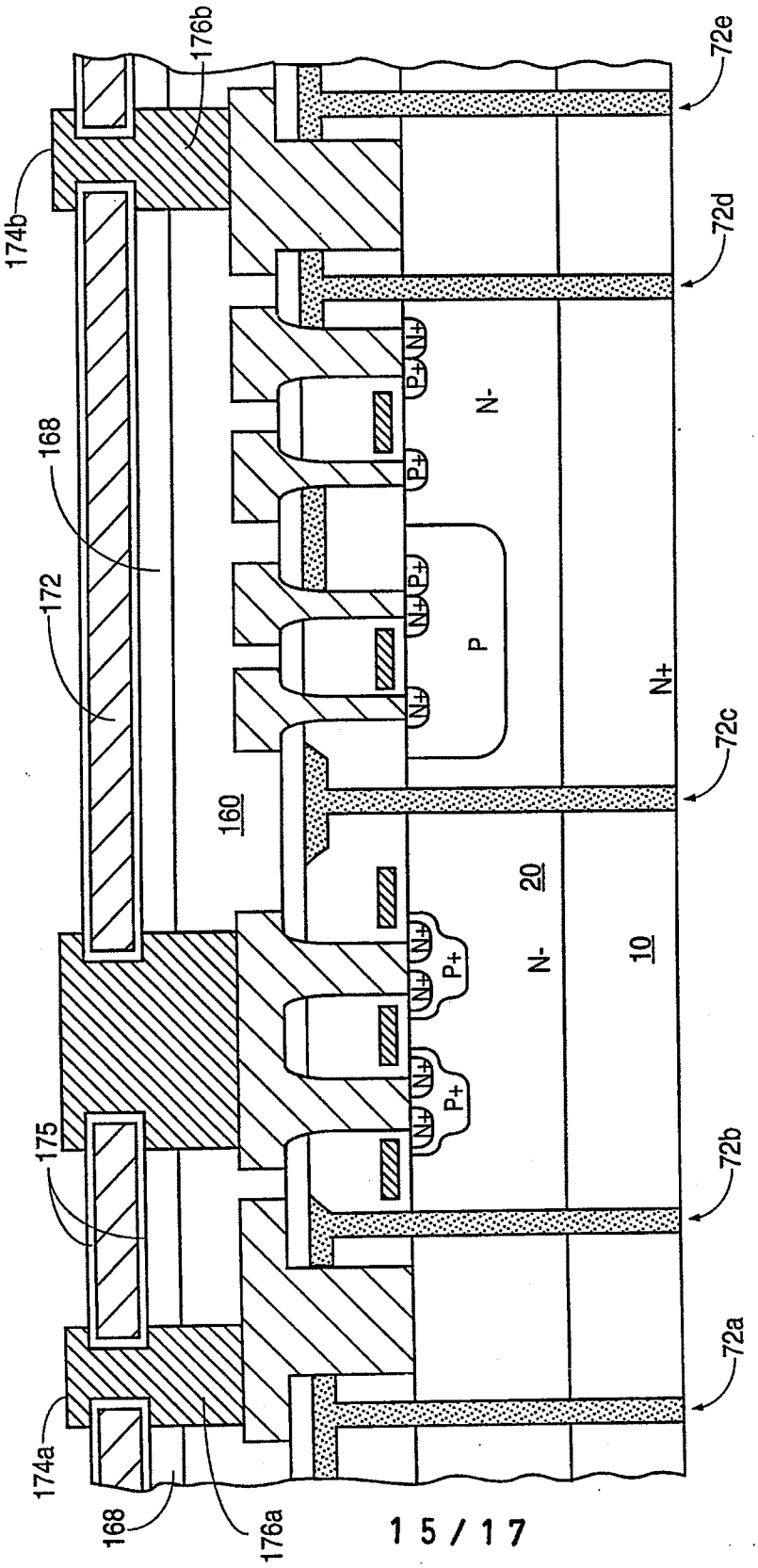

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72d
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172
P+
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Fig. 15

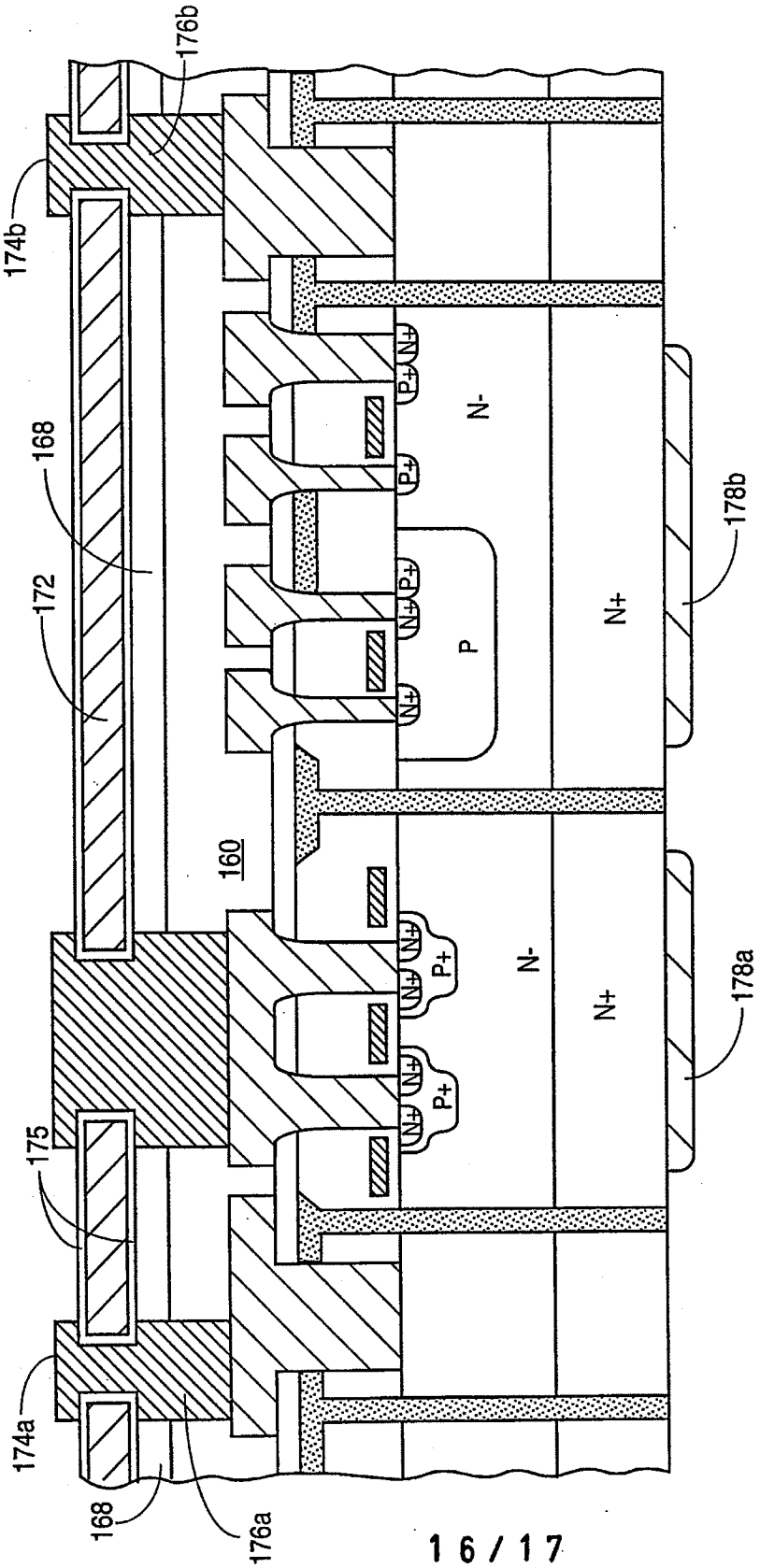


Fig. 16

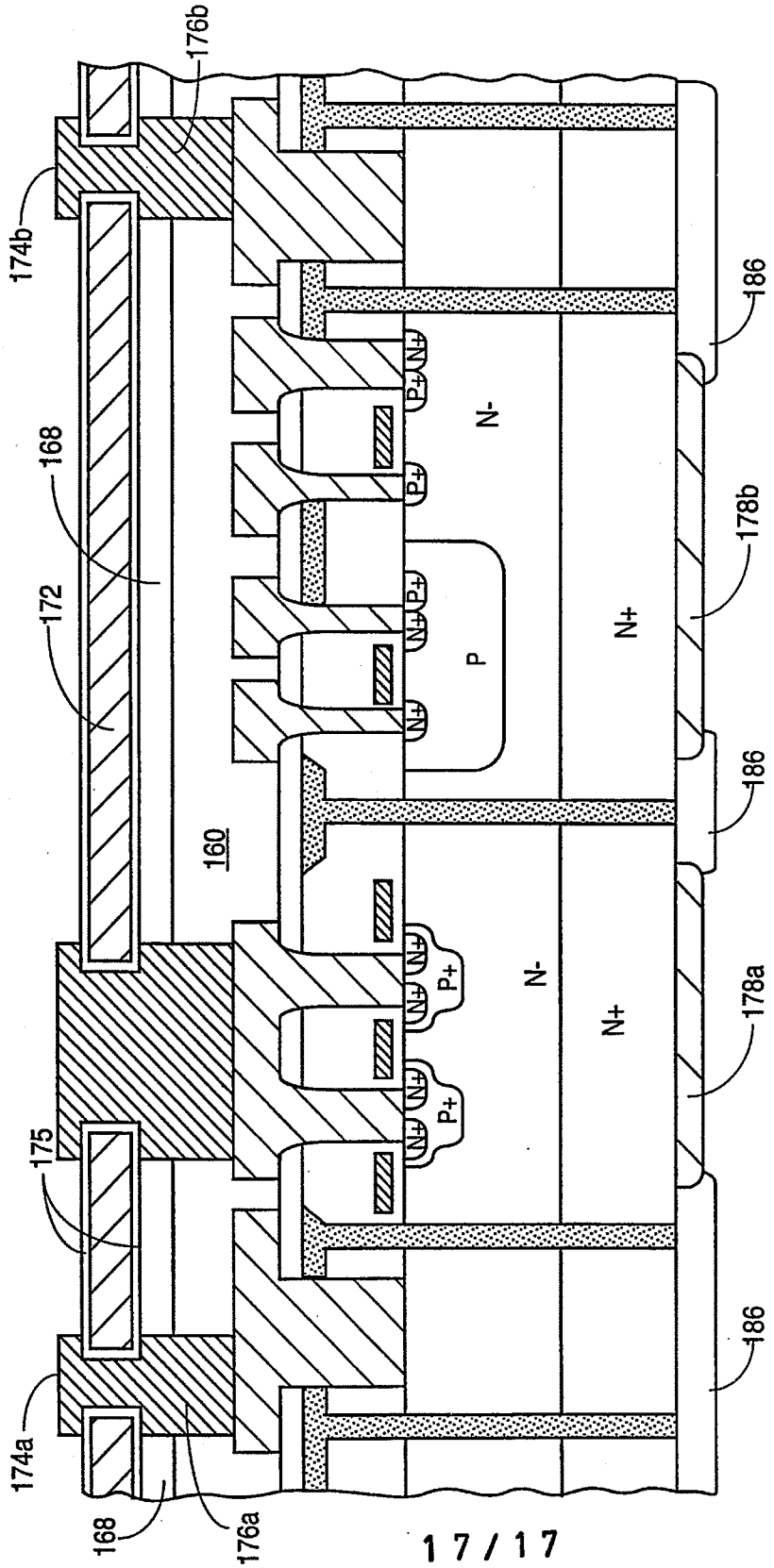


Fig. 17

SUBSTITUTE SHEET (RULE 26)

INTERNATIONAL SEARCH REPORT

Int. ..national application No.
PCT/US95/05217

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H01L 23/48, 21/76
US CL :257/631,686,706,724; 437/62,63

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

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

NONE

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

USAPS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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

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

*	Special categories of cited documents:	"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
"A"	document defining the general state of the art which is not considered to be of particular relevance	"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
"E"	earlier document published on or after the international filing date	"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
"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)	"&"	document member of the same patent family
"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		

Date of the actual completion of the international search	Date of mailing of the international search report
07 JULY 1995	19 JUL 1995
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer J. CARROLL Telephone No. (703) 308-4926

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

Electronic Acknowledgement Receipt

EFS ID:	9819870
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/kelley warner
Filer Authorized By:	David William Osborne
Attorney Docket Number:	00802-32779.NP.CIP2
Receipt Date:	06-APR-2011
Filing Date:	18-MAR-2010
Time Stamp:	12:34:56
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	79606 21f2dc33963872b218d8cfbfc6dabf7d3b02f107	no	4

Warnings:	
Information:	

2	Information Disclosure Statement (IDS) Filed (SB/08)	a.PDF	241652 14c335981d00a33a8bb2ce39c6bcb9f2845be99b	no	4
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Information Disclosure Statement (IDS) Filed (SB/08)	b.PDF	75991 4c0fde289c73236d03f72dcf2833a34a4ac74b72	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
4	Foreign Reference	EP1075898.pdf	1317596 c817cd2845ce39f72120dc54d52e024599643c5b	no	29
Warnings:					
Information:					
5	Foreign Reference	GB2239011.pdf	652440 04e862aa3230112009b502bf1962a4915952547d	no	18
Warnings:					
Information:					
6	Foreign Reference	GB2366804.pdf	807025 9ac4679ad48226748f7274c15cdfdfa0ce1c126f	no	28
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7	Foreign Reference	WO0231078.pdf	524338 904b230265795258cbb7e4c3ee439a616ed2bfb3	no	16
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8	Foreign Reference	WO2004094106.pdf	609892 f87979625963ecfdd43606f9958142959659ef6b	no	17
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9	Foreign Reference	WO2006124792.pdf	1894611 7ab8b7d622c300a196a00f859c84d1dd8dd04c06	no	32
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10	Foreign Reference	WO2007032946.pdf	2149000 360f47d617ac91da4d074bed113eead18a96aea0	no	41
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11	Foreign Reference	WO2008063599.pdf	1808304 917f424a2b90ebc59bffec2ee3517330098d8d46	no	39
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12	Foreign Reference	WO2009043058.pdf	1578557 228184b3c9ac22f3c414567107d85cead0b485ce	no	39
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13	Foreign Reference	WO2009064677.pdf	1718526 294d2f50b3e01da8eab1ac0933a5b53560389931	no	44
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14	NPL Documents	syndite.pdf	719737 1ea07e1a5e1c3a8f6275db5e67c75941705a2189	no	2
Warnings:					
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15	Foreign Reference	ke200307178222.pdf	383608 7865815bf76edea2c15b617fdc492bfa16be9a6b	no	8
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16	Foreign Reference	jp2003071718eng222.pdf	420648 c70413556f7b8926acee98f807b93d17de404d88	no	8
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Information:					
			Total Files Size (in bytes):	16936241	

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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: 04/06/2011 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

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 168 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 06 day of April, 2011.

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

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
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	
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
		2006/0135050	06/22/2006	Petersen et al.	
		5011513	04/1991	Zador et al.	
		6258138	07/2001	DeVoe et al.	

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 2004/025401	01/29/2004	Airtec Japan: KK et al.		

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.

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
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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	
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]
		PCT Application PCT/US2007/024165; filed 11/16/2007; Chien-Min Sung; International Search Report mailed 05/23/2011	
		US Application 12/328,338; filed 12/04/2008; Chien-Min Sung; Office Action issued 05/10/2011	

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.**

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

PATENT COOPERATION TREATY

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JUN - 1 2011
THORPE NORTH & WESTERN

From the INTERNATIONAL SEARCHING AUTHORITY

To:

OSBORNE DAVID W.

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

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 00802-24462.NP.CIP. PCT	Date of mailing *(day/month/year)* 23 MAY 2011 (23.05.2011) **FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. **PCT/US2007/024165**	International filing date *(day/month/year)* **16 NOVEMBER 2007 (16.11.2007)**
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 Government Complex-Daejeon, 189 Cheongsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer COMMISSIONER Telephone No. 82-42-481-8755

Form PCT/ISA/220 (July 2010)

* 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 : **2DWQD2EV**

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.
00802-24462.NP.CIP.		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2007/024165	**16 NOVEMBER 2007 (16.11.2007)**	16 NOVEMBER 2006 (16.11.2006)
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/US2007/024165

A. CLASSIFICATION OF SUBJECT MATTER

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

B24D 7/06; B24D 3/00; B24D 11/00; B24D 15/00

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:cutting, device, polycrystalline, tip

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2004-025401 A (AIRTEC JAPAN:KK et al.) 29 January 2004	1-8,11,13,15-22
	see paragraph 11 - paragraph 18; claim 2 and figure 1.	,25-30,41,42
Y		12
A		9,10,14,23,24
		,31-40,43-45
Y	US 6319108 B1 (ADEFRIS; NEGUS B. et al.) 20 November 2001	12
A	see column 3, line 47 - column 11, line 3 and figure 3.	1-11,13-45
A	US 2006-0135050 A1 (JOHN PETERSEN et al.) 22 June 2006	1-45
	see paragraph 22 - paragraph 80 and figure 1.	

☐ 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
23 MAY 2011 (23.05.2011)	**23 MAY 2011 (23.05.2011)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 189 Cheongsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea	KIM, DONG JIN
Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-5415

Form PCT/ISA/210 (second sheet) (July 2008)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2007/024165

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2004-025401 A	29.01.2004	None	
US 6319108 B1	20.11.2001	AU 2000-59174 A1	30.01.2001
		CN 1359322 A0	17.07.2002
		EP 1198529 A2	24.04.2002
		JP 04-582980 B2	10.09.2010
		JP 2003-504218 A	04.02.2003
		JP 2003-504218 T	04.02.2003
		JP 4582980 B2	17.11.2010
		KR 10-2002-0029075 A	17.04.2002
		TW 533229 A	21.05.2003
		TW 533229 B	21.05.2003
		WO 01-04227 A2	18.01.2001
		WO 01-04227 A3	18.01.2001
		WO 01-04227A2	18.01.2001
		WO 01-04227A3	07.09.2001
US 2006-0135050 A1	22.06.2006	CN 101080305 A0	28.11.2007
		EP 1827763 A1	05.09.2007
		JP 2008-524000 A	10.07.2008
		JP 2008-524000 T	10.07.2008
		KR 10-2007-0086274 A	27.08.2007
		KR20070086274A	27.08.2007
		KR20070086274A	27.08.2007
		US 7169029 B2	30.01.2007
		WO 2006-065411 A1	22.06.2006
		WO 2006-065411 A1	22.06.2006

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
OSBORNE DAVID W.

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

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)*	**23 MAY 2011 (23.05.2011)**
Applicant's or agent's file reference 00802-24462.NP.CIP.	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2007/024165	**16 NOVEMBER 2007 (16.11.2007)**	16 NOVEMBER 2006 (16.11.2006)

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

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

Applicant

SUNG CHIEN-MIN

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

- [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
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

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

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

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

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 189 Cheongsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	23 MAY 2011 (23.05.2011)	KIM, DONG JIN Telephone No.82-42-481-5415

Form PCT/ISA/237 (cover sheet) (April 2007)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2007/024165

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

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

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

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. type of material
   - ☐ a sequence listing
   - ☐ table(s) related to the sequence listing

   b. format of material
   - ☐ on paper
   - ☐ in electronic form

   c. time of filing/furnishing
   - ☐ contained in the international application as filed.
   - ☐ filed together with the international application in electronic form.
   - ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or 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/US2007/024165

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

1. Statement

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

2. Citations and explanations :

Reference is made to the following documents:

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

1. Novelty and Inventive Step

1.1 Claims 1-10

1.1.1 Claim 1

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

1.1.2 Claim 2

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

1.1.3 Claims 3-8

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

1.1.4 Claims 9 and 10

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

1.2 Claims 11-24

1.2.1 Claim 11

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

1.2.2 Claim 12

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

Continued on Supplemental Box

Supplemental Box

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

Box V

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

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

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

1.2.6 Claims 16-20
The additional feature of claims 16-21 is already disclosed in document D1(see figure 1). Therefore, claims 16-21 lack novelty under PCT Article 33(2).

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

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

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

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

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

Espacenet

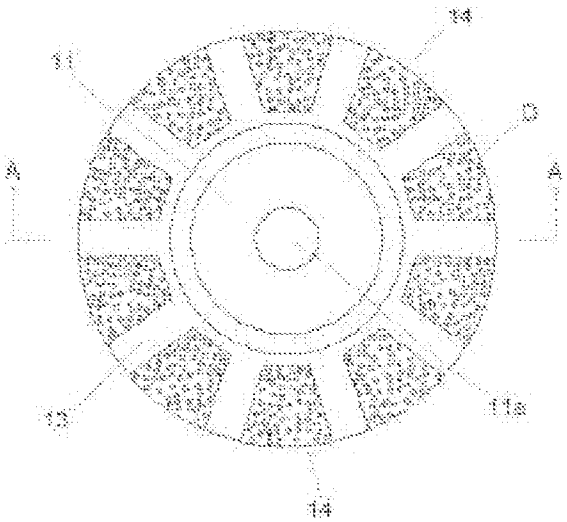
Bibliographic data: JP 2004025401 (A)

DISC-SHAPED DIAMOND GRINDING WHEEL

Publication date:	2004-01-29
Inventor(s):	NAGAYA AKIHIKO; KOTANI NORIOMI +
Applicant(s):	AIRTEC JAPAN KK; GOEI SEISAKUSHO KK +
Classification:	**- international:** ***B24D3/00; B24D3/06; B24D7/06;*** (IPC1-7): B24D3/00; B24D3/06; B24D7/06 **- European:**
Application number:	JP20020188194 20020627
Priority number(s):	JP20020188194 20020627

Abstract of JP 2004025401 (A)

PROBLEM TO BE SOLVED: To provide a disc-shaped diamond grinding wheel hardly causing loading and having flexibility. ; SOLUTION: A base plate 11 of the disc diamond grinding wheel is made into a cup form of 10 cm in diameter having flexibility, and a jig mounting hole 11a to mount the base plate 11 on a grinder, etc. is provided on a central part of the base plate 11. Additionally, a rubber sheet 13 is adhered on a do-nut shaped part on a flat surface of a peripheral part of the base plate 11 , and a plurality of polishing chips 14 are adhered along a circumference under a deposition method coating diamond abrasive grains D on its upper layer. As they are supported by the base plate 11 excellent in flexibility, strength, etc. and the rubber sheet 13 transmits its elasticity to the polishing chips 14, the polishing chips 14 respectively and independently polish a polishing article along its surface and also polish the small area part and the curved surface. ; COPYRIGHT: (C)2004,JPO



Last updated:
26.04.2011 Worldwide
Database 5.7.23; 92p

(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2004-25401
(P2004-25401A)
(43)公開日　平成16年1月29日(2004.1.29)

(51)Int.Cl.[7]	F I		テーマコード（参考）
B24D 7/06	B24D 7/06		3C063
B24D 3/00	B24D 3/00	310F	
B24D 3/06	B24D 3/00	320B	
	B24D 3/06	A	

審査請求 有　請求項の数 4　OL　（全 5 頁）

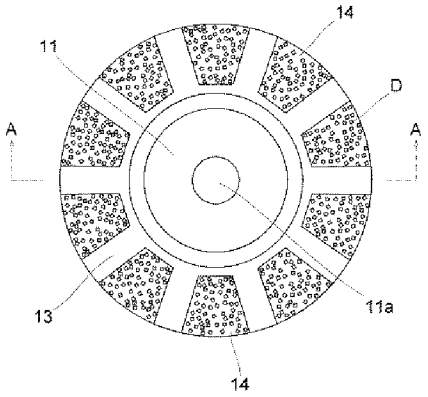
(21)出願番号　特願2002-188194(P2002-188194)
(22)出願日　平成14年6月27日(2002.6.27)

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広島県豊田郡安芸津町大字小松原字新開５７６

Fターム(参考)　3C063 AA02 AB05 BA03 BB02 BC02 BF02 BG07 BH07 CC02 EE28

(54)【発明の名称】ディスク状ダイヤモンド砥石

(57)【要約】
【課題】目詰まりの起こし難く、可撓性を有するディスク状ダイヤモンド砥石を得る。
【解決手段】ディスク状ダイヤモンド砥石の基板１１は可撓性を有する直径１０ｃｍのカップ状とされ、基板１１の中心部には基板１１をグラインダ等に取り付けるための治具取付孔１１ａが設けられている。また、基板１１の周辺部の平面上のドーナツ状部分にはゴムシート１３が接着され、更にその上層にダイヤモンド砥粒Ｄを塗布した溶着法による複数個の研磨チップ１４が円周に沿って接着されている。可撓性、強度等に優れた基板１１に支持され、ゴムシート１３がその弾力性を研磨チップ１４に伝えるため、研磨チップ１４はそれぞれ独立に被研磨物の面に沿って研磨でき、小面積部や曲面も研磨することができる。
【選択図】　図１



【特許請求の範囲】
【請求項1】
ダイヤモンド砥粒を塗布した複数個の金属片から成る研磨チップを可撓性材料から成るディスク状基板上の外周平坦部表面に配列したことを特徴とするディスク状ダイヤモンド砥石。
【請求項2】
前記研磨チップは前記ディスク状基板の円周に沿って等間隔に配列したことを特徴とするディスク状ダイヤモンド砥石。
【請求項3】
前記研磨チップは前記ディスク状基板上に積層したゴム層上に接着した請求項１に記載のディスク状ダイヤモンド砥石。
【請求項4】
前記ダイヤモンド砥粒は溶着法により前記研磨チップに塗布した請求項１に記載のディスク状ダイヤモンド砥石。

【発明の詳細な説明】
【０００１】
【発明の属する技術分野】
本発明は、グラインダ等の回転工具に取り付け、硬質材料表面に塗装された表面塗膜を剥離したり、金属表面の錆を除去したり、或いは研磨をするディスク状ダイヤモンド砥石に関するものである。
【０００２】
【従来の技術】
例えば、既設の橋梁や工場の煙突、タンク等の保守に際して、表面塗膜の補修をする場合において、それらの表面に塗装されている重防食系塗料の剥離はなかなか困難であり、二度、三度の手間を要する難作業である。
【０００３】
通常では、グラインダ等の電動工具の回転により金属片を表面塗膜に打ち付けることにより面を荒らし、その後にディスク状サンドペーパによって塗膜を剥離する。
【０００４】
【発明が解決しようとする課題】
しかしながら上述の従来例においては、金属片を打ち付ける際に、その母材の鉄やコンクリートの打撃音や振動が激しく、母材を痛めることもある。また、ディスク状サンドペーパも重防食塗料により短時間で目詰まりを起こしてしまい、交換頻度も多く、作業効率も極めて悪い。
【０００５】
通常の建物の外壁塗膜の剥離においても、塗料の違いこそあれ、目詰まりによる交換損失を生ずる。目詰まりさえしなければ摩耗し難い砥粒が好適であることは明白であるが、実際には砥粒は摩耗しておらず研磨性能は十分あっても、目詰まりで砥石が使用できなくなるという問題がある。
【０００６】
現在、ダイヤモンド砥石を使用した研磨材としては、図４に模式的に示すような金属粉末を用いてダイヤモンド砥粒を混入して固めたメタルボンドと称される研磨剤１と、図５に示すように表面にメッキによる電着法により製造された研磨剤２が知られている。
【０００７】
しかしながら、前述のメタルボンド製の研磨剤１は、ダイヤモンド砥粒Ｄの突き出しが少なく、目詰まりするため砥膜剥離には不適である。後者の電着製の研磨剤２は砥粒の突き出しは多いが、ダイヤモンド砥粒Ｄとメッキの間に隙間Ｓが発生してメッキが剥離し易く、ダイヤモンド砥粒Ｄの脱落が多く目詰まりを生じ易い。
【０００８】
また、現状のディスク状ダイヤモンド砥石としては、カップ型のものが多く用いられてい

るが、金属製の椀形基板の平坦部にメタルボンド製ダイヤモンドを下駄歯状のブロックにして取り付けたものが多く、騒音、振動共に非常に激しい。

【０００９】

本発明の目的は、上述の問題点を解消し、金属片を打ち付ける作業を不要とし、目詰まりが少なく長時間の作業に耐え、作業音や振動が静かな可撓性を有し、小面積部や曲面をも研磨することのできるディスク状ダイヤモンド砥石を提供することにある。

【００１０】

【課題を解決するための手段】

上記目的を達成するための本発明に係るディスク状ダイヤモンド砥石は、ダイヤモンド砥粒を塗布した複数個の金属片から成る研磨チップを可撓性材料から成るディスク状基板上の外周平坦部表面に配列したことを特徴とする。

【００１１】

【発明の実施の形態】

本発明を図１～図３に図示の実施の形態に基づいて詳細に説明する。

図１は本実施の形態におけるディスク状ダイヤモンド砥石の平面図、図２は図１におけるＡ－Ａ線に沿った断面図を示している。基板１１は例えばエポキシ樹脂材に繊維質材としてガラスファイバ材料を混合し、例えば直径１０ｃｍの可撓性を有するカップ状とされ、基板１１の中心部には基板１１をグラインダ等に取り付けるための治具取付孔１１ａが設けられている。また、基板１１の周辺部の平面状のドーナツ状部分１２にはゴムシート１３が接着され、更にその上層にダイヤモンド砥粒Ｄを塗布した例えば１０個の研磨チップ１４が接着されている。

【００１２】

研磨チップ１４としては、特に溶着方法を用いてダイヤモンド砥粒Ｄを塗布したたものが好適である。溶着方法は自溶性合金タイプとブロンズタイプの２種があり、自溶性合金タイプはＮｉ－Ｃｒ系合金粉末、ブロンズタイプはブロンズ系粉末及びＴｉ等の活性金属粉末を、市販の真空用バインダと混合することにより、先ずペーストを作製する。続いて、所定の形状、例えば本実施の形態では、周辺の基板１１と同曲率にして扇状に打ち抜いた金属片上に、厚みが一定になるようにすり切り治具を使用して上述のペーストを塗布する。

【００１３】

ペーストを塗布すり切りした後に、塗布したペースト上に振動機等を用い、ダイヤモンド砥粒を散布する。なお、自溶性合金タイプの場合には市販の真空用バインダを金属片上に均一に塗布し、ダイヤモンド砥粒Ｄを散布した後に、Ｎｉ－Ｃｒ系合金粉末を振りかける方法でも同様なものが作製できる。

【００１４】

次に、ダイヤモンド砥粒Ｄを散布した金属片を乾燥機に入れ、２４時間程乾燥することにより、バインダに含まれている油脂成分を十分に除去する。続いて、この乾燥処理を行った金属片を真空炉にセットし、真空度が10^{-2}以上の高真空とした後に、自溶性合金タイプは１０００～１１００℃、ブロンズタイプは８００～９５０℃の温度で焼成を行う。これらの温度で焼成を行うことによりダイヤモンド砥粒ＤをＮｉ－Ｃｒ系金属、活性金属含有ブロンズ系金属でそれぞれ良好に溶着することができる。

【００１５】

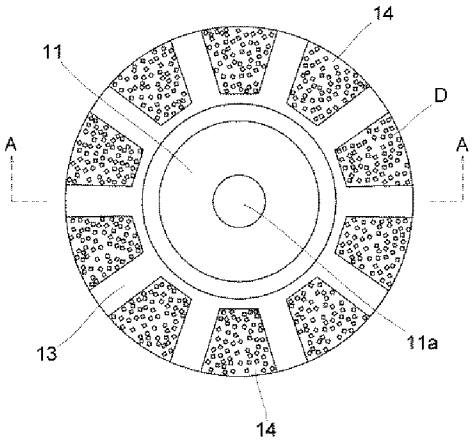
溶着されたダイヤモンド砥粒Ｄは、図３の模式図に示すように活性金属と反応層Ｒを形成し強固な金属結合することにより、研磨チップ１４上からのダイヤモンド砥粒Ｄの突き出しが大きい。そして、研磨チップ１４は真空炉内の温度が室温に下った後に取り出す。

【００１６】

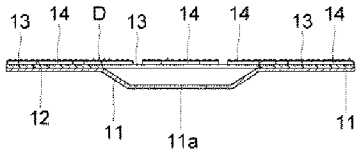
なお、研磨チップ１４のダイヤモンド砥粒Ｄの溶着や電着等の塗布方式では、被研磨物によって耐久性上問題があることもあり、基板１１にダイヤモンド砥粒Ｄを混入したメタルボンド製のブロックを、円形や扇状等に成形し貼り付けたものでも、振動や騒音を格段に解消することができる。

【００１７】
ディスク状ダイヤモンド砥石を被研磨物の研磨に用いる際には、基板１１をグラインダ等の回転工具に取り付けて回転させ、被研磨物に研磨チップ１４を押し当てる。この際に、基板１１は柔軟性、屈曲性、強度等に優れた基板１１に支持されつつ、ゴムシート１３がその弾力性を研磨チップ１４に伝えるため、研磨チップ１４はそれぞれ独立に被研磨物の面に沿って研磨できるため、小面積部や曲面においても、優れた研磨を行うことができる。
【００１８】
なお、本実施の形態においては研磨チップ１４はゴム層１３を介して取り付けたが、ゴム層１３を省略して基板１１に直接取り付けてもよい。また、研磨チップ１４は扇状の金属片上にダイヤモンドを散布したが、研磨チップ１４の形状は扇状に限らず、円形やその他の形状でも支障はない。
【００１９】
【発明の効果】
以上説明したように本発明に係るディスク状ダイヤモンド砥石は、特に、金属の錆取りや硬質樹脂類、塗料等の研磨・剥離に好適であり、均一な広い面或いは狭い面をも容易に得ることができると共に、打撃音や振動を押さえ、作業者の労務上も、周囲への騒音問題についても、問題が発生することは少ない。
【００２０】
また、可撓性を有するため研磨チップが被研磨面に良く密着し、効率良く剥離作業をうことができる。更に、ダイヤモンド砥粒を溶着法により塗布すれば、電着法のように切れ味があり、メタルボンド法に近い耐久性のあるものとなる。
【図面の簡単な説明】
【図１】ディスク状ダイヤモンド砥石の平面図である。
【図２】図１のＡ－Ａ線に沿った断面図である。
【図３】溶着による研磨チップの模式的断面図である。
【図４】メタルボンドによる研磨チップの模式的断面図である。
【図５】電着法による研磨チップの模式的断面図である。
【符号の説明】
１１　基板
１２　ドーナツ状部分
１３　ゴムシート
１４　研磨チップ
Ｄ　ダイヤモンド砥粒
Ｒ　反応層

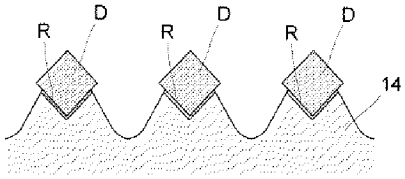
【図1】


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11a
14

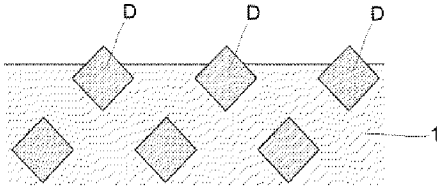
【図2】


13
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11a
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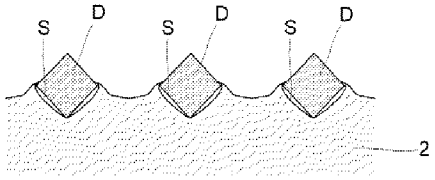
【図3】


R
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【図4】


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【図5】


S
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S
D
S
D
2

Electronic Acknowledgement Receipt

EFS ID:	10798300
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/kelley warner
Filer Authorized By:	David William Osborne
Attorney Docket Number:	00802-32779.NP.CIP2
Receipt Date:	23-AUG-2011
Filing Date:	18-MAR-2010
Time Stamp:	18:47:11
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	79481 4979ddcf00b3ea6ef3f497486fdf43cddf20f5b9	no	4

Warnings:	
Information:	

2	Information Disclosure Statement (IDS) Form (SB08)	a.PDF	97117 7e305362ae00617e239a41a683429e07c5e1d240	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
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4	Non Patent Literature	search.pdf	480065 6de36a0ca07b47799cc467501d1c777a21a2e042	no	9
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Warnings:					
Information:					
6	Non Patent Literature	JP2004025401.pdf	243145 6188691fd34f0021329c8f9e080a02543a2d712f	no	7
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Information:					
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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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

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

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

ART UNIT: 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: 08/23/2011 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 23rd day of August, 2011.

Respectfully submitted,

/David W. Osborne/

David W. Osborne
Attorney for Applicant
Registration No. 44989

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

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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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

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
		2004/0107648	06/2004	Sung	
		2010/0139174	06/2010	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]

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**.

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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

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
		US Application 13/021,350; filing date 02/04/2011; Chien-Min Sung; office action issued 08/31/2011	

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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Electronic Acknowledgement Receipt

EFS ID:	11218553
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/kelley warner
Filer Authorized By:	David William Osborne
Attorney Docket Number:	00802-32779.NP.CIP2
Receipt Date:	19-OCT-2011
Filing Date:	18-MAR-2010
Time Stamp:	14:04:43
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	79373 0d84f42e70a2ef1da990b5bb6453076d55985812	no	4

Warnings:	
Information:	

2	Information Disclosure Statement (IDS) Form (SB08)	a.PDF	103758 74a453078cf76fbc906b985e9238290b25048a6a	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Information Disclosure Statement (IDS) Form (SB08)	b.PDF	76603 8afa0ae6122e1b6497b11c9462861010304 16aa8	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
4	Non Patent Literature	oa.pdf	676545 8b9d0fc271b95cc60d0581a546cf1d0444070026	no	13
Warnings:					
Information:					
		Total Files Size (in bytes):	936279		

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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: 10/19/2011 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 19th day of October, 2011.

Respectfully submitted,

/David W. Osborne/

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PTO/SB/08A (08-03)
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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	
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
		5243790	09/14/1993	Gange	

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]
		CN 1494984	05/12/2004	Read Co. Ltd.		

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**.

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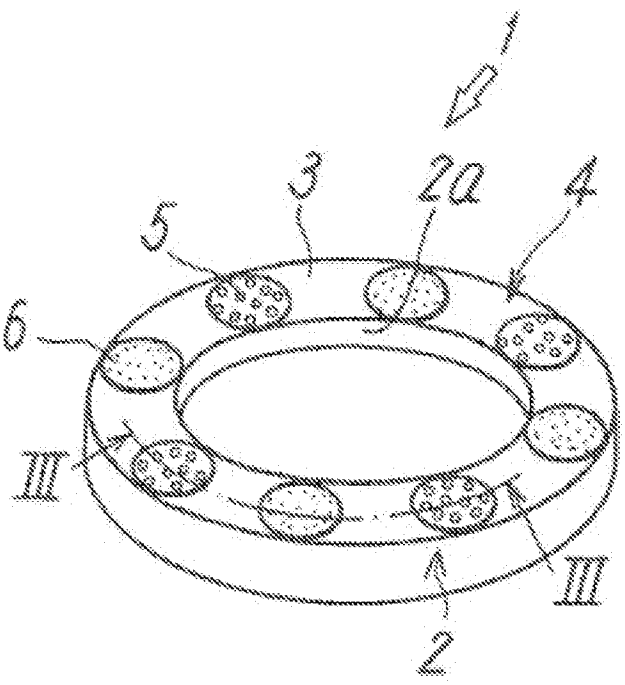
Bibliographic data: CN 1494984 (A)

Sander for polishing cloth and polishing cloth sanding method using said sander

Publication date:	2004-05-12	
Inventor(s):	TADAKATSU NABETANI [JP] +	
Applicant(s):	READ CO LTD [JP] +	
Classification:	**- international:**	***B24B37/00; B24B37/04; B24B53/02; B24B53/12; B24D13/14; B24D3/10; B24D7/06; H01L21/304;*** (IPC1-7): B24B53/00; B24B53/12
	- European:	B24B53/017; B24D7/06
Application number:	CN20031056576 20030909	
Priority number (s):	JP20020263215 20020909	
Also published as:	• CN 1274465 (C) • US 2004048557 (A1) • TW I228066 (B) • KR 20040023556 (A) • JP 2004098214 (A)	

Abstract not available for CN 1494984 (A)
Abstract of corresponding document: US 2004048557 (A1)

An abrasive cloth dresser is provided which is capable of adjusting the state of its dressing face so as to give an abrasive cloth a uniform polishing surface, and capable of giving the surfaces of an abrasive cloth a suitable polishing capability according to polishing objects, even if the dressing face state exhibits individual differences in, for example, the end shapes of abrasive grains. The abrasive cloth dresser 1 includes a base metal 2 having a ring-shaped dressing face 4 in the outer region of the base metal 2. First abrasive grain units 5 and second abrasive grain units 6 formed of abrasive grains with different grain sizes from each other are alternately arranged on the dressing face 4. The base metal 2 includes adjusters 7 for arbitrarily adjusting the height difference delta between reference planes S1 and S2 of the respective abrasive grain units 5 and 6. The reference planes S1 and S2 each include the ends of the abrasive grains with the largest grain size.



Last updated: 12.10.2011 Worldwide Database 5.7.23.1; 92p

[19] 中华人民共和国国家知识产权局

[51] Int. Cl[7]
B24B 53/12
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[12] 发明专利申请公开说明书

[21] 申请号 03156576.X

[43] 公开日 2004 年 5 月 12 日

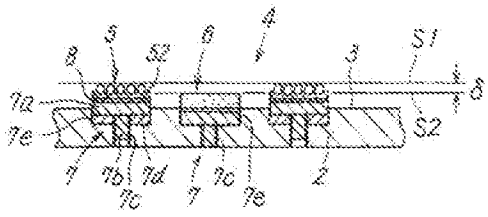
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[74] 专利代理机构 北京市金杜律师事务所
代理人 韩登营
权利要求书 2 页 说明书 12 页 附图 4 页

[54] 发明名称 抛光布用打磨器和使用该打磨器的抛光布的打磨方法

[57] 摘要

本发明提供一种抛光布用打磨器和使用该打磨器的抛光布的打磨方法，使可调整抛光布用打磨器中的打磨面的状态，即使在磨粒的前端形状等打磨面的状态中产生个体差异，也可以造成均一的抛光布表面，而且能够对抛光布表面赋予适应被加工物的适当的抛光性能，上述打磨器构成为，在金属基体(2)的周缘部上备有打磨面(4)的抛光布用打磨器(1)中，在该打磨面(4)上分别交互地并列设置由彼此不同的粒度的磨粒组成的第1、第2磨粒群(5)、(6)，在上述金属基体(2)上，设置能够任意调节这些各磨粒群(5、6)中包含的粒度最大的磨粒的前端的基准面(S1)、(S2)间的高低差(δ)的调节机构(7)。



ISSN 1008-4274

1. 一种抛光布用打磨器，是在能够旋转的金属基体的表面上形成打磨面而成的抛光布用打磨器，其特征在于，

在上述打磨面上，在其圆周方向上并列设置多个磨粒群，

在上述金属基体上，对全部或一部分磨粒群，设置能够调节由多个磨粒的前端分别形成的基准面的上述打磨面上的高低差的调节机构。

2. 如权利要求 1 中所述的抛光布用打磨器，其特征在于，有上述调节机构的磨粒群，分别固定于构成与上述金属基体分开形成的上述调节机构的基台上，沿着上述打磨面中的金属基体的周缘部各磨粒群环状地并列设置。

3. 如权利要求 1 中所述的抛光布用打磨器，其特征在于，上述磨粒群分别形成为从与上述打磨面的周缘平行的环形片形状、与上述打磨面的周缘成一定的角度的螺旋片形状、小圆形状之中选择的一种或两种的平面形状。

4. 如权利要求 3 中所述的抛光布用打磨器，其特征在于，上述磨粒群分别形成为从上述平面形状之中选择的两种平面形状，

这些平面形状不同的两种磨粒群在打磨面的圆周方向上交互地并列设置。

5. 如权利要求 1 或 2 中所述的抛光布用打磨器，其特征在于，并列设置在打磨面上的各磨粒群是由彼此同一粒度的磨粒所形成的磨粒群，或者，由不同的粒度的磨粒所形成的两种磨粒群来构成。

6. 如权利要求 5 中所述的抛光布用打磨器，其特征在于，并列设置在打磨面上的磨粒群，由彼此不同的粒度的磨粒所形成的第 1 磨粒群和第 2 磨粒群来构成，

这些第 1 磨粒群和第 2 磨粒群在打磨面的圆周方向上交互地并列设置。

7. 如权利要求 6 中所述的抛光布用打磨器，其特征在于，上述

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第 1 磨粒群由同一粒度的磨粒或者两种粒度的磨粒来形成。

8. 如权利要求 1 或 2 中所述的抛光布用打磨器，其特征在于，在各磨粒群中，各磨粒颗粒在前述打磨面上二维地具有规律性地排列，相互邻接的磨粒颗粒形成的最小格子为正三角形或者平行四边形地排列。

9. 一种抛光布的打磨方法，是用权利要求 1～8 中所述的任何一项抛光布用打磨器打磨抛光布的方法，其特征在于，

借助上述调节机构，在相互邻接的磨粒群的上述基准面间设置一定的高低差，打磨上述抛光布。

10. 一种抛光布的打磨方法，是用权利要求 6～8 中所述的任何一项抛光布用打磨器打磨抛光布的方法，其特征在于，

借助上述调节机构，上述打磨面中的第 1 磨粒群的基准面的高度调节成比第 2 磨粒群的基准面的高度高出一定量，打磨上述抛光布。

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抛光布用打磨器和使用该打磨器的抛光布的打磨方法

技术领域

本发明涉及在机械的化学抛光（Chemical Mechanical Polishing；以下简称CMP）中在进行抛光布的布网孔堵塞或异物去除之际使用的抛光布用打磨器和用它的抛光布的打磨方法。

背景技术

一般来说在硅晶片基板上制造半导体硅晶片基板或集成电路等微细电子电路的过程中，出于去除存在于基板表面上的凹凸或结晶缺陷的目的用CMP加工。在此一CMP加工中，一边以规定的载荷把晶片基板压住粘贴于抛光装置的固定盘的由泡沫聚氨酯构成的抛光布上，一边供给称为浆液的抛光液，使晶片与抛光布两方旋转而进行抛光。

作为上述CMP加工中的浆液，用使氧化铁、碳酸钡、氧化铈、氧化铝、胶态二氧化硅等的抛光颗粒悬浮于氢氧化钾、稀盐酸、稀硝酸、过氧化氢水溶液、硝酸铁等抛光液中的浆液，这些是根据抛光速度和晶片或晶片基板上的前述被加工物的种类适当选择。

此一CMP加工，为了用同一抛光布多张或者多次重复地抛光晶片，随着CMP加工的次数的增大，所去除的被加工物的碎屑或凝集的抛光颗粒进入抛光布的微细的孔而引起堵塞，晶片的抛光速度降低。因此有必要经常或者定期地进行去除布网孔堵塞后的抛光布的表层、再生抛光布表面的面粗糙性而恢复抛光速度的被称为打磨的作业，在此一作业中使用被称为抛光布用打磨器的工具。

因为金刚石磨粒在抛光布的打磨中是优良的材料，故研究了利用金刚石磨粒的抛光布用打磨器，通过镀镍在不锈钢上电沉积金刚石磨粒的方法一般被实用化了。除此以外提出了借助金属纤料把金刚

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石磨粒钎焊于不锈钢上的方法（例如，参照特开平 10－012579 号公报），通过烧结使金刚石磨粒与保持料反应烧结而固定的方法（例如，参照特开 2001－179638 号公报）。此外出于得到稳定的抛光布的表层去除能力的目的，还提出了均等间隔地排列磨粒的 CMP 抛光布打磨器(例如,参照特开 2000－141204 号公报、特开 2002－127017 号公报）。

可是，在上述这种现有技术中的抛光布用打磨器中，因为在其结构上，无法避免因磨粒的前端形状等在打磨面的方式上产生个体差异，故即使使用同一抛光布用打磨器也难以造成均一的抛光布表面，此外，抛光布的表面状态有必要根据被加工物进行调整，例如，对在硅晶片表面形成层间氧化膜的晶片，通过抛光布的表面状态成为粗糙状态，抛光布引起的机械去除加工的因素增强而抛光速度提高，此外，对于 Cu 配线，出于使存在于抛光布表面的抛光液（浆液）的化学反应引起的因素比抛光布引起的机械去除加工的因素更强的目的，有必要维持某种程度的一定的抛光布的表面粗糙度，因此，关于打磨该抛光布的表面的抛光布用打磨器也是，有必要准备需要数量的、打磨面的状态适应上述被加工物的，存在着成本提高这样的问题。

发明内容

本发明将要解决的技术课题，在于提供一种通过能够调整抛光布用打磨器中的打磨面的状态，即使在磨粒的前端形状等打磨面的状态中产生个体差异，也可以通过该打磨面的调整造成均一的抛光布表面，或者，能够对抛光布表面赋予适应被加工物的适当的抛光性能的抛光布用打磨器和用它的抛光布的打磨方法。

为了解决上述课题，本发明的抛光布用打磨器是在能够旋转的金属基体的表面上形成打磨面而成的抛光布用打磨器，其特征在于，在上述打磨面上，在其圆周方向上并列设置多个磨粒群，在上述金属基体上设有对全部或一部分磨粒群、能够调节由多个磨粒的前端

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分别形成的基准面的上述打磨面中的高低差的调节机构。

如果用上述抛光布用打磨器，则由于借助上述调节机构可以任意调节多个磨粒群中的上述各基准面的高低差，所以即使在磨粒的前端形状等打磨面的状态中产生个体差异也可以通过调节上述多个磨粒群中的基准面的高低差，调整打磨面的状态，造成均一的抛光布表面，或者，可以对抛光布表面即抛光布的抛光面，赋予适应被加工物的适当的抛光性能。在此一场合，基准面高的磨粒群主要用于抛光布表面的磨耗，基准面低的磨粒群主要用于抛光布的表面粗糙度的调整。

在上述抛光布用打磨器中，也可以取为有上述调节机构的磨粒群，分别固定于与上述金属基体分开形成的构成上述调节机构的基台上，沿着上述打磨面中的金属基体的周缘部各磨粒群环状地并列设置。

如果上述磨粒群分别以从与上述打磨面的周缘平行的环状片形状，与上述打磨面的周缘成一定的角度的螺旋片形状、小圆形状之中选择的一种或两种的平面形状形成，则最好由打磨所去除的抛光布的切削屑或凝集的浆液容易向外部排出。

在上述磨粒群分别形成为从上述平面形状之中选择的两种平面形状的场合，这些平面形状不同的两种磨粒群在打磨面的圆周方向上交互地并列设置是适当的。

此外，并列设置在打磨面上的各磨粒群也可以由彼此同一粒度的磨粒所形成的同一的磨粒群，或者，由不同的粒度的磨粒所形成的两种磨粒群来构成。

而且，在并列设置在上述打磨面上的磨粒群，由彼此不同的粒度的磨粒所形成的第 1 磨粒群和第 2 磨粒群来构成的场合，把这些第 1 磨粒群和第 2 磨粒群在打磨面的圆周方向上交互地并列设置是适当的。在此一场合，可以由同一粒度的磨粒或者不同的两种粒度的磨粒来形成上述第 1 磨粒群。

这里，虽然在上述各磨粒群中，磨粒颗粒在前述打磨面上二维地

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具有规律性地排列，相互邻接的磨粒颗粒造成的最小格子如果成为正三角形或者平行四边形地排列，则可以进一步提高打磨的稳定性和均匀性。

进而，上述课题可以通过靠上述调节机构，在相互邻接的磨粒群的上述基准面间设置一定的高低差，打磨上述抛光布的抛光布的打磨方法来解决。

在上述抛光布的打磨方法中，在多个磨粒群由上述第 1 磨粒群和第 2 磨粒群来构成的场合，借助上述调节机构，上述打磨面中的第 1 磨粒群的基准面的高度调节成比第 2 磨粒群的基准面的高度高出一定量，打磨上述抛光布是合适的。

如果用这种本发明的抛光布用打磨器和用它的抛光布的打磨方法，则由于可以借助调节机构任意调节在各磨粒群中由磨粒的前端分别形成的磨粒基准面的上述打磨面上的高低差，所以即使磨粒的前端形状等打磨面的状态中产生个体差异，也可以造成均一的抛光布表面，而且，对抛光布表面也可以赋予适应被加工物的适当的抛光性能。

附图说明

图 1A～图 1D 是表示使本发明的抛光布用打磨器的磨粒群的配置形状不同的第 1 实施方式的立体图。

图 2A～图 2D 是表示使本发明的抛光布用打磨器的磨粒群的配置形状不同的第 2 实施方式的立体图。

图 3 是图 1A 中的 III－III 剖视图。

图 4 是图 2A 中的 IV－IV 剖视图。

图 5 是表示第 1 磨粒群 5 中的磨粒的排列状态的示意图。

图 6 是图 3 中的局部放大图。

具体实施方式

图 1A～图 1D 示出本发明的抛光布用打磨器的磨粒群的配置形状

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不同的第 1 实施方式。抛光布用打磨器 1 由在其表侧的中心有圆形的凹部 2a，和在其周围的金属基体表面 3 上形成环状的打磨面 4 而成的圆盘状的金属基体 2 来构成，在上述打磨面 4 上，分别环状地并列设置多个沿着其圆周方向独立的第 1 和第 2 磨粒群 5、6。换句话说，沿着金属基体表面 3 即上述金属基体 2 的周缘部环状地并列设置多个磨粒群 5、6 形成上述打磨面 4。

而且，如图 3 中所示，在上述金属基体 1 上设有调节机构 7，以便在各磨粒群 5、6 中以包含粒度最大的磨粒的前端的平面为基准面 S1、S2 时，可以任意调节在打磨面 4 上，上述多个磨粒群 5、6 中的各基准面 S1、S2 间相互的高低差 δ。

这里，没有必要一定在上述金属基体 2 上设置上述凹部 2a。

具体地说，上述调节机构 7 由基台 7a、调节用螺栓 7b 和垫片 7d 构成，其中，基台 7a 的表面上固定磨粒群 5 或 6，上下滑动自如地嵌入开口于上述金属基体 2 的表面 3 的凹部 7e；调节用螺栓 7b 设在该基台 7a 的背面，螺纹配合于从上述金属基体 2 的凹部 7e 的底面向该金属基体 2 的背面侧贯通的螺纹孔 7c；当调节固定于上述基台 7a 的磨粒群 5、6 处的基准面的高度位置时，垫片 7d 夹在上述基台 7a 的背面与上述凹部 7b 的底面之间。而且，分别固定于上述调节机构 7 的基台 7a 的表面上的多个磨粒群 5、6 沿着上述金属基体 2 的周缘部环状地并列设置，形成上述打磨面 4。

因而，为要调节上述磨粒群 5，6 的基准面 S1、S2 的高度位置把具有所需厚度的垫片 7d 放入上述金属基体 2 的凹部 7e 内，通过借助上述调节用螺栓 7b 夹持于该凹部 7e 的底面与上述基台 7a 的背面之间，可以调节上述各磨粒群 5、6 处的基准面 S1、S2 对金属基体表面 3 的高度位置，即多个磨粒群 5，6 处的各基准面 S1、S2 间相互的高低差 δ，可以调整打磨面 4 的状态。再者，在本实施方式中，借助调节机构 7，上述基准面 S1、S2 对金属基体表面 3 的高度可以在 0～300 μm 的范围内调节。

上述磨粒群当中，基准面高的磨粒群主要用于抛光布的磨耗，基

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准面低的磨粒群主要用于抛光布的表面粗糙度的调整。即，因为通过加在打磨器总体上的载荷集中地作用于基准面高的磨粒群，每单位面积的负载载荷增大，故它们主要用于抛光布的磨耗，另一方面，基准面低的磨粒群负担载荷到某种程度，使上述基准面高的磨粒群引起的抛光布的磨耗速度降低。再者，在基准面间相互的高低差δ变得极大的场合，因为成为基准面低的磨粒群完全不负担载荷，故成为它们不发挥使抛光布的磨耗速度降低的效果。此一基准面低的磨粒群还在抛光布的切削屑的排出中有效地起作用。

此外，在抛光布用打磨器1中，上述多个磨粒群5、6由彼此粒度不同的磨粒所形成的第1磨粒群5与第2磨粒群6来构成，这两种磨粒群5、6沿着上述金属基体2的周缘部在其圆周方向上交互地并列设置形成打磨面4。

具体地说，上述第1磨粒群5，如图5、图6中所示，由大小两种粒度的磨粒50、51来形成，这些磨粒50、51，如图5中所示，在基台7a的表面上即前述打磨面4上二维地有规则性地均等地排列，相互邻接的磨粒颗粒彼此连成的最小格子成为正三角形或者平行四边形地排列着。再者大的磨粒颗粒50彼此的间隔比小的磨粒颗粒51彼此的间隔要宽。

通过像这样把大小两种粒度的磨粒有规则性地均等地排列，可以进一步提高打磨的稳定性和均匀性。

另一方面，在上述第2磨粒群6中，虽然也可以以粒度与上述第1磨粒群5的磨粒不同的同一粒度的磨粒或者多种粒度的磨粒这两种形式中的任何一种来形成，但是最好是与上述第1磨粒群5同样，磨粒二维地有规则性地均等地排列。

这里，作为形成上述磨粒群5、6的磨粒，可以用例如金刚石磨粒，该磨粒的粒度，一般来说，最好是JIS B 4130中规定的#325／#400～#60／#80的范围。

此外，形成上述第1磨粒群5的磨粒，没有必要一定如上所述是大小两种粒度的磨粒50、51，也可以是同一粒度的磨粒（参照图2A～

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图 2D 的实施方式）。此外，上述调节机构 7 没有必要一定在第 1 磨粒群 5 和第 2 磨粒群 6 的两方中设置，也可以仅在磨粒群的一部分，即第 1 磨粒群 5 或第 2 磨粒群 6 的一方中设置。在此一场合，未设置调节机构 7 的磨粒群，基台 7a 直接固定于金属基体 2 的周缘部。

这样一来，如果每个磨粒群用不同粒度的磨粒，或者在各磨粒群中使不同粒度的磨粒混合，大粒度的磨粒主要用于抛光布的磨耗，小粒度的磨粒主要用于抛光布的表面粗糙度的调整，通过它们的粒度的调整，可以把抛光布的表面粗糙度弄成适合特定对象物的 CMP 加工的状态。

进而，如图 1A～图 1D 中所示，在抛光布用打磨器 1 中，上述第 1 磨粒群 5 和第 2 磨粒群 6 的平面形状可以从小圆形状、成为与上述金属基体 2 的周缘即打磨面 4 的周缘平行的环形片形状、与上述金属基体 2 的周缘即打磨面 4 的周缘成一定角度的螺旋片形状之中选择一种或两种。图 1A 示出两个磨粒群 5、6 都是小圆形状的场合，图 1B 示出第 1 磨粒群 5 是小圆形状而第 2 磨粒群 6 是螺旋片形状的场合，图 1C 示出两个磨粒群 5、6 都是环形片形状的场合，图 1D 示出两个磨粒群 5、6 都是螺旋片形状的场合。通过把形成为这种平面形状的磨粒群 5、6 沿着金属基体表面 3 即金属基体 2 的周缘部排列成环状，形成打磨面 4，因打磨而去除的抛光布的切削屑或凝集的浆液容易向打磨器外部排出，此外可以调整其排出性能。

再者，上述磨粒群 5、6，如图 3、图 6 中所示，磨粒靠保持料 52 保持而形成，通过借助粘接剂 8 等把保持该磨粒的保持料 52 固定于上述调节机构 7 中的基台 7a 的表面，该磨粒群 5、6 固定于上述基台 7a。

此外，作为上述保持料 52，虽然在磨粒为金刚石的场合，可以利用和金刚石磨粒反应烧结的硅和／或硅合金，但是只要是适合于磨粒的保持的保持料没有特别限制，靠一般的电镀镍或借助钎料的接合来保持也是可能的。

接下来就对由上述抛光布用打磨器 1 进行的抛光布的打磨方法进行说明，借助上述调节机构 7，在交互邻接的第 1 磨粒群 5 和第 2

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磨粒群 6 的各基准面 S1、S2 间，设定对金属基体表面 3 的一定的高低差 δ，打磨上述抛光布。换句话说，借助上述调节机构 7，调节成上述第 1 磨粒群 5 的基准面 S1 一方比上述第 2 磨粒群 6 的基准面 S2 上述金属基体表面 3 的垂直方向的高度高出一定量 δ，通过适当调整上述打磨面 4 的状态，可以把上述抛光布表面打磨成适应被加工物的想要的状态。

像这样如果用上述抛光布用打磨器 1，则因为通过调节基准面 S1、S2 的高低差 δ，可以把打磨面 4 的状态调节成可以发挥想要的抛光性能，故不仅即使在打磨面 4 的状态中产生个体差异，也可以造成均一的抛光布表面，而且可对抛光布表面赋予适应被加工物的适当的抛光性能。

图 2A～图 2D 示出本发明的抛光布用打磨器的磨粒群的配置形状不同的第 2 实施方式。在本实施方式的抛光布用打磨器 10 中，多个磨粒群仅由上述第 1 磨粒群 5 组成，通过把这些同一的磨粒群 5 沿着金属基体 2 的周缘部并列设置成环状而形成打磨面 4。

此外，该磨粒群 5 的平面形状，与上述第 1 实施方式的场合同样，可以从小圆形状、成为与上述打磨面 4 的周缘平行的环形片形状、与上述打磨面 4 的周缘成一定角度的螺旋片形状之中选择。图 2A 示出磨粒群 5 全都是小圆形状的场合，图 2B 示出磨粒群 5 为小圆形状和螺旋片形状、具有这两种不同的平面形状的磨粒群 5 在打磨面 4 的圆周方向上交互地并列设置的场合，图 2C 示出磨粒群 5 全都是环形片形状的场合，图 2D 示出磨粒群 5 全都是螺旋片形状的场合。

关于包含调节机构 7 的其他构成，因为与上述第 1 实施方式共同，所以为了避免重复这里省略说明。

而且、在用上述抛光布用打磨器 10 打磨抛光布时，如图 4 中所示，借助调节机构 7 在相互邻接的上述磨粒群 5 的基准面 S1 间设定对金属基体表面 3 的一定的高低差 δ 并进行打磨。

像这样如果用上述抛光布用打磨器 10，则与上述抛光布用打磨器 1 同样，因为可以适当调节上述邻接的磨粒群 5 的基准面 S1 间的

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高低差 δ 而把打磨面 4 的状态调整成想要的状态，故不仅即使在打磨面 4 的状态中产生个体差异，也可以造成均一的抛光布表面，而且可对抛光布表面赋予适应被加工物的适当的抛光性能。

再者，上述调节机构 7 本身的构成，不限于参照图说明的上述构成，可以采用在微细的范围内可以上下调整磨粒群的基准面的各种机构。

以下与比较例一起具体地示出本发明的抛光布用打磨器和使用该打磨器的抛光布的打磨方法的实施例。但是，本发明不受这些实施例的任何限定。

〔第 1 实施例〕

作为第 1 磨粒群 5 的磨粒，分别用相当于粒度#120／#140 的处于 150～170 μm 的范围的金刚石磨粒 50，与相当于粒度#325／#400 的处于 55～65 μm 的范围的金刚石磨粒 51，通过把这些磨粒 50、51 与保持料 52 反应烧结，得到磨粒 50、51 被保持于保持料 52 的烧结体。

此时，把上述两种磨粒 50、51 在磨粒排列面上排列成，包含粒度#120／#140 的磨粒 50 的前端的平面，与包含粒度#325／#400 的磨粒 51 的前端的平面的级差为 40～60 μm、并且邻接的磨粒 50、51 彼此造成的最小格子为正三角形，粒度#120／#140 的磨粒 50 的间隔为 2.0 mm 的等间隔，粒度#325／#400 的磨粒 51 的间隔为 0.4 mm 的等间隔。

另一方面，作为第 2 磨粒群 6 的磨粒，用相当于粒度#60／#80 的处于 250～320 μm 范围的金刚石磨粒，把这些排列成 0.8 mm 的等间隔。

而且，在把这样做所得到的烧结体通过机械加工，加工成规定的尺寸·形状，形成第 1 磨粒群 5 和第 2 磨粒群 6 后，把这些磨粒群 5、6 分别用环氧树脂粘接于调节机构 7 中的 SUS316L 不锈钢制的直径 φ100 mm 的基台 7a 上。再者，在本实施例中，把上述第 1 磨粒群 5 和第 2 磨粒群 6 的平面形状取为图 1D 中所示的与打磨面 4 的周缘成

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一定角度的螺旋片形状。

把这样做成的抛光布用打磨器以 19.6kPa 的压力压在以 100 rpm 旋转的泡沫聚氨酯制抛光布上，与该抛光布同一方向以 80 rpm 旋转，同时一边供给每分 25 ml 包含湿二氧化硅的抛光浆液（キャボット制 SS－25）一边进行抛光布的研磨。

此时，借助上述调节机构 7 把前述打磨面 4 上的前述第 1 磨粒群 5 的磨粒前端基准面 S1 与前述第 2 磨粒群 6 的磨粒前端基准面 S2 对金属基体表面 3 的高低差 δ 调节成 15、30、60μm 三个水准，测定打磨速度（抛光布的磨耗速度）与抛光布的表面状态（抛光布的表面粗糙度）后，测定用该抛光布的晶片的抛光速度，这些测定结果示于表 1。

再者，在本实施例中，n 数即取样数取为 20，算出在各试样中所测定的上述各测定值的平均值（Ave）示于表 1。而且表 1 中 σ_{n-1} 表示各测定结果的标准偏差。此外，在晶片的抛光速度的测定中用 ADE 公司制的晶片平坦度测定器（ultragage 9800），根据抛光前后的测定结果算出平均抛光速度。

表 1

			实施例		
磨粒间隔	第 1 磨粒群	#120／#140	2.0 mm		
		#320／#400	0.4 mm		
	第 2 磨粒群	#60／#80	0.8 mm		
磨粒基准面的高低差 δ（μm）			15	30	60
抛光布的磨耗速度（μm／Hour）		Ave.	69.2	108	122
		σn－1	1.33	1.25	1.78
抛光布的表面粗糙度 Ra（μm）		Ave.	4.12	4.05	4.19
		σn－1	0.12	0.15	0.14
晶片抛光速度（nm／min）		Ave.	126	129	121
		σn－1	6.7	7.2	5.6
划痕发生率（%）			0.00	0.00	0.00

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如此一表 1 中所示，如果用本发明的抛光布用打磨器，则可以调节多个磨粒群中的磨粒的粒度或各磨粒群基准面间的高低差 δ，把打磨面调整成想要的状态，特别是，弄清了通过上述磨粒群的基准面的高低差 δ 磨耗速度有很大差别。因此，借助一个抛光布用打磨器可以在种种条件下进行稳定的抛光布的打磨。

此外，如果用上述实施例的测定值，则与以下说明的比较例的测定值相比总体上性能提高，而且因为各种测定值的标准偏差非常小，所以所得到的抛光布中离散极小，可以给抛光布用打磨器赋予稳定的抛光性能。

〔第 1 比较例〕

用把粒度相当于#80／#100 的处于 210～250 μm 的范围的金刚石磨粒以磨粒间隔 0.25 mm 的等间隔地排列的状态，使用由电镀镍固定而成的现有技术中的 CMP 抛光布打磨器，在与第 1 实施例同一条件下研磨泡沫聚氨酯制抛光布。其研磨结果示于表 2。

〔第 2 比较例〕

用把粒度相当于#120／#140 的处于 150～170μm 的范围的金刚石磨粒，在烧结体的磨粒排列面上，排列成邻接的第 1 磨粒彼此造成的最小格子为正三角形，其一边的磨粒间隔成为 2.1 mm 的等间隔，使用由该磨粒组成的磨粒群的平面形状为，如图 2C 中所示的，与打磨面的周缘平行的环形片形状的抛光布用打磨器，在与第 1 实施例同一条件下研磨泡沫聚氨酯制抛光布。其研磨结果与第 1 比较例一起示于表 2。

〔第 3 比较例〕

与第 1 实施例的第 1 磨粒群同样，分别用粒度相当于#120／#140 的处于 150～170 μm 的范围的金刚石磨粒、和粒度相当于#325／#400 的处于 55～65 μm 的范围的金刚石磨粒。而且，把这些磨粒，在烧结体的磨粒排列面上排列成包含粒度#120／#140 的磨粒的前端的平面，与包含粒度#325／#400 的磨粒的前端的平面的级差成为

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40～60 μm，并且邻接的磨粒彼此造成的最小格子为正三角形，粒度#120／#140 的磨粒的间隔为 2.0 mm 的等间隔，粒度#325／#400 的磨粒的间隔为 0.4 mm 的等间隔。而且，用具有这种磨粒排列的磨粒群，形成为图 2C 中所示的成为与打磨面的周缘平行的环形片形状，在打磨面中沿着金属基体的周缘部环状地排列而成的抛光布用打磨器，在与第 1 实施例同一条件下研磨泡沫聚氨酯制抛光布。其研磨结果与第 1、2 比较例一起示于表 2。

表 2

		第 1 比较例	第 2 比较例	第 3 比较例
金刚石粒度		#80／#100	#120／#140	①#120／#140 ②#325／#400
磨粒间隔		0.25 mm	2.1 mm	①2.1 mm ②0.4 mm
磨粒保持方法		电镀	烧结	
抛光布的磨耗速度	Ave.	61.6	189	138
（μm／Hour）	σn－1	7.84	14.6	2.43
抛光布的表面粗糙度	Ave.	3.01	3.32	3.45
Ra（μm）	σn－1	0.36	0.36	0.13
晶片抛光速度	Ave.	105	98.3	120
（nm／min）	σn－1	35.2	25.3	9.6
划痕发生率（%）		0.52	0.00	0.00

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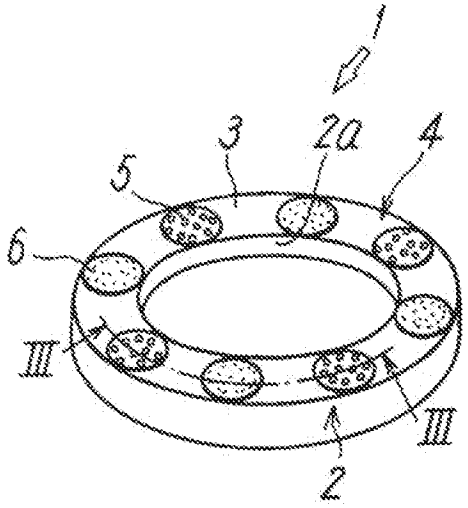


图 1A

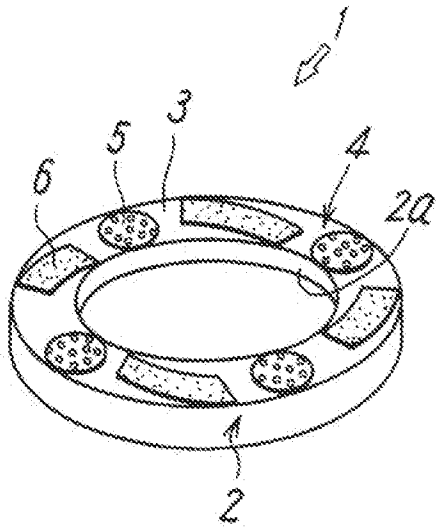


图 1B

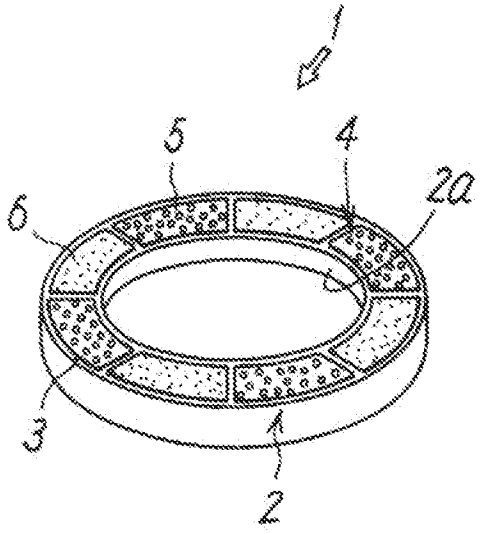


图 1C

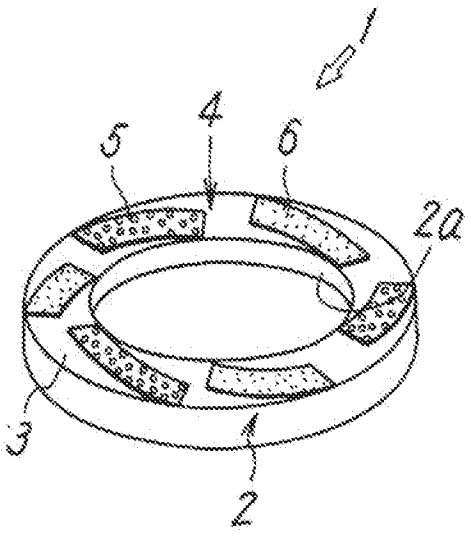


图 1D

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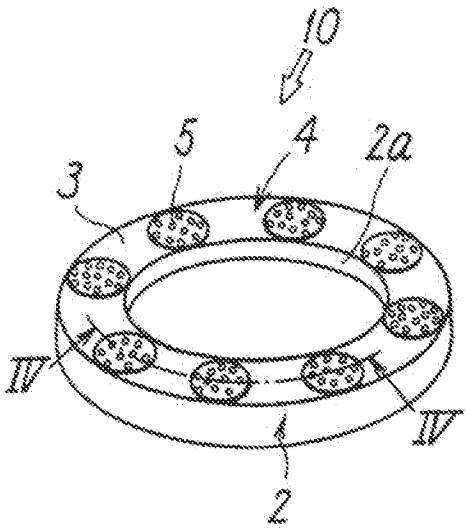


图 2A

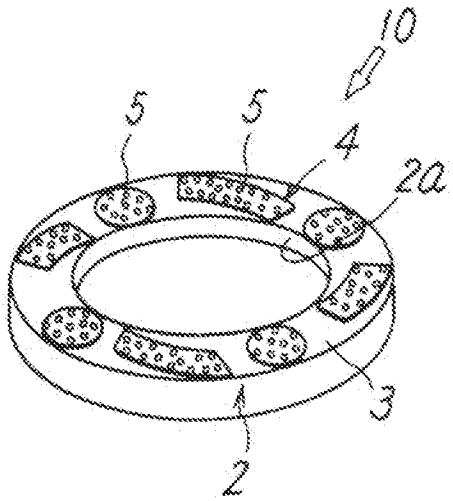


图 2B

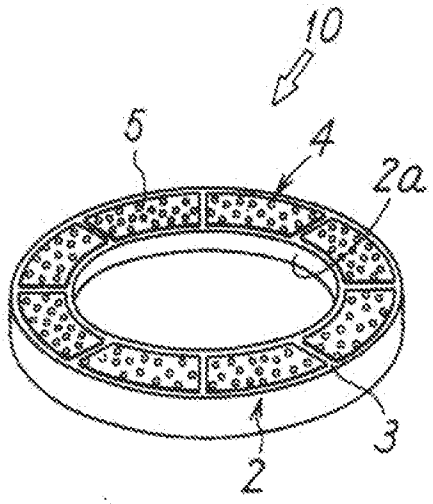


图 2C

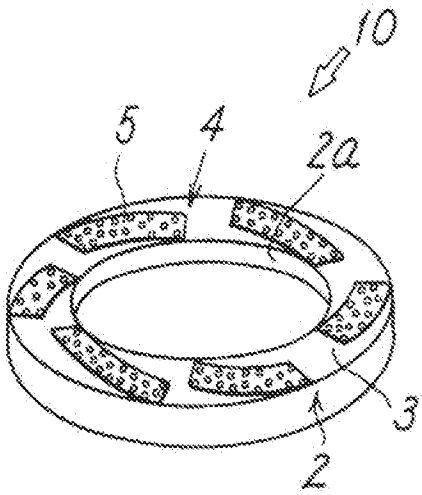


图 2D

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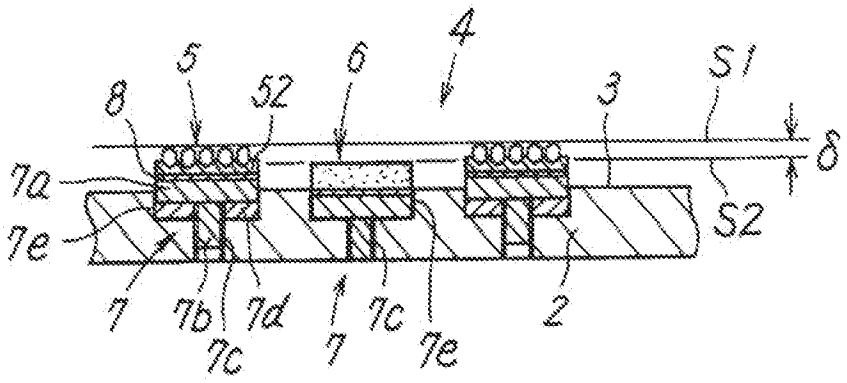


图 3

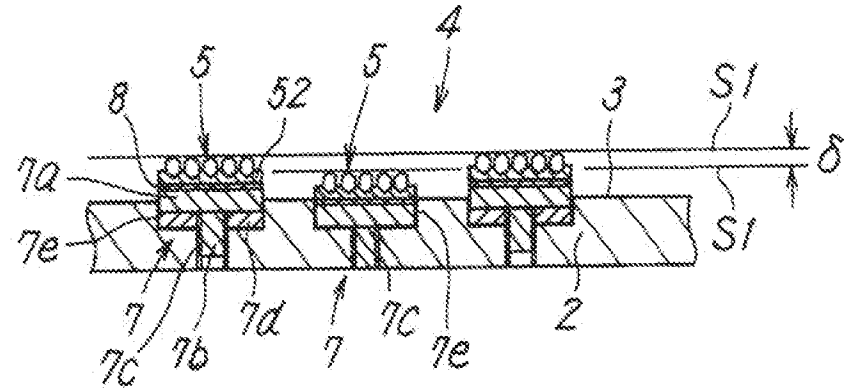


图 4

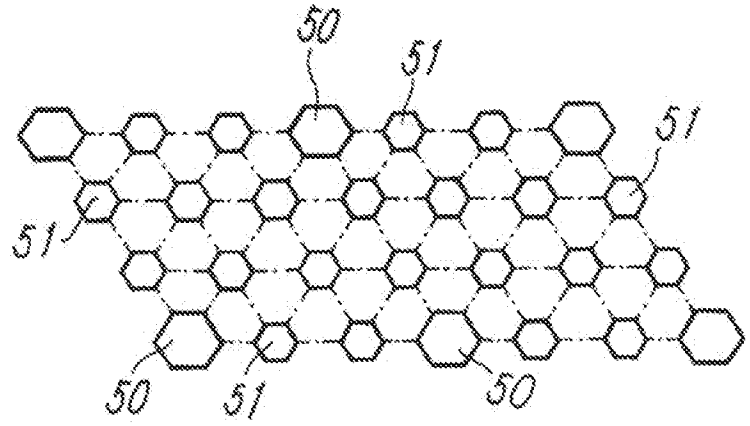


图 5

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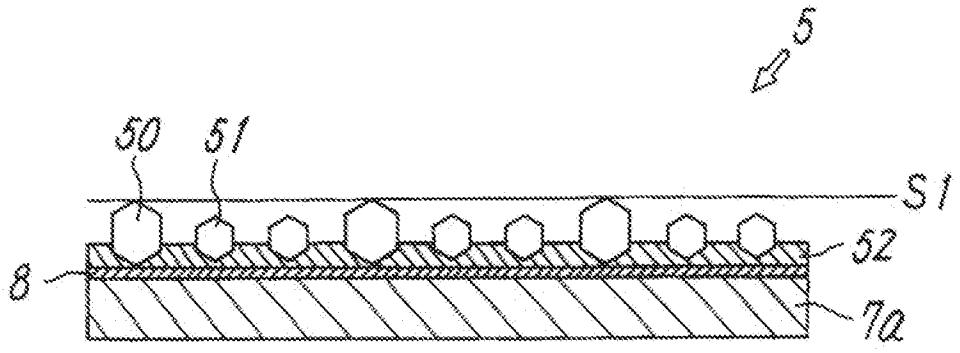


图 6

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Electronic Acknowledgement Receipt

EFS ID:	11253122
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/kelley warner
Filer Authorized By:	David William Osborne
Attorney Docket Number:	00802-32779.NP.CIP2
Receipt Date:	24-OCT-2011
Filing Date:	18-MAR-2010
Time Stamp:	17:14:12
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	79461 6763e00d16ea0aa971080fcb74d256b9bf050be3	no	4
Warnings:					
Information:					

2	Information Disclosure Statement (IDS) Form (SB08)	a.PDF	104029 111ef3b63306d9e00f8c4addcc6b12d5971ed149	no	1
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Information:					
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3	Foreign Reference	CN1494984A.pdf	3303468 aca859c9dbc95f1ff39f8b2faebc5d4781bc328a	no	20
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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.

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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: 10/24/2011 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 24th day of October, 2011.

Respectfully submitted,

/David W. Osborne/

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PTO/SB/08B (08-03)
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(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]
		US Application 12/715,583; filing date 03/02/2010; Chien-Min Sung; office action issued 10/25/2011	

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.**

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

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EFS ID:	12156478
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/kelley warner
Filer Authorized By:	David William Osborne
Attorney Docket Number:	00802-32779.NP.CIP2
Receipt Date:	24-FEB-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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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: 02/24/2012 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

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☐ 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

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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.

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☐ 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.

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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 24th day of February, 2012.

Respectfully submitted,

/David W. Osborne/

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Application Number	«Patent Patent Application Number»
Filing Date	«Patent Patent Filing Date»
First Named Inventor	«Patent First Named Inventor»
Art Unit	«Examiner and Art Unit Art Unit: (Once)»
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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
		2002/0164928	11/2002	Tolles	
		2008/0153398	06/2008	Sung	
		7658666	02/2010	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]
		EP1075898	02/2001	Tanaka et al.		

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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

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

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EP1075898A2

Publication Title:

Dresser and dressing apparatus

Abstract:

Abstract of EP 1075898

(A2) Translate this text A dresser (21) for dressing a polishing pad used for polishing a material to be polished is disclosed, the dresser (21) comprising: a dresser principal (22) and a dressing-working part (23) which is provided as a body other than the dresser principal (22); and a holding means for holding the dressing-working part (23) in such a manner that the dressing-working part (23) can be attached to and detached from the dresser principal (22).

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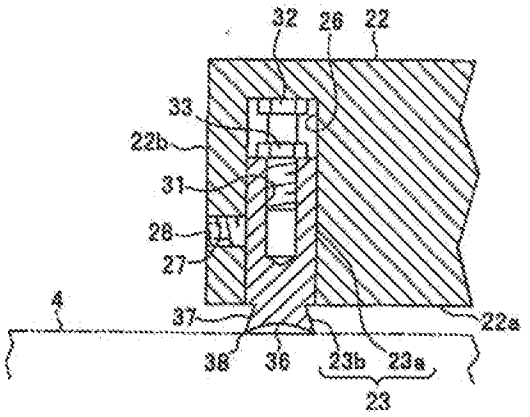
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(54) Dresser and dressing apparatus

(57) A dresser for dressing a polishing pad used for polishing a material to be polished is disclosed, the dresser comprising: a dresser principal and a dressing-working part which is provided as a body other than the dresser principal; and a holding means for holding the dressing-working part in such a manner that the dressing-working part can be attached to and detached from the dresser principal.

FIG. 2



EP 1 075 898 A2

Description

BACKGROUND OF THE INVENTION

Field of the Invention:

[0001] The present invention relates to a dresser and a dressing apparatus for dressing the surface of a polishing pad which is used for polishing materials to be polished, for example, semiconductor wafer or the like.

[0002] The present specification is based on Japanese patent applications (NO. HEI 11-229495, NO. HEI 11-271178, NO. 2000-131784 and NO. 2000-131785) and the contents of these applications are incorporated herein as a part of the present specification.

Description of the Related Art:

[0003] A chemical and mechanical polishing method (CMP method) which provides a high flatness is used for polishing the surface of materials to be polished for which excellent polishing accuracy is required, for example, for polishing semiconductor wafers or the like.

[0004] The CMP method is a method where the surface of wafer is polished chemically and mechanically to obtain a flatness of the surface, using an alkali slurry containing SiO_2, a neutral slurry containing CeO_2, an acid slurry containing Al_2O_3 or a slurry containing abrasive grains. For example, the following polishing apparatus is known as an apparatus for polishing the surfaces of wafers.

[0005] As schematically shown in Fig 17 of an enlarged perspective view of an important part, a polishing pad 4 comprising, for example, hard urethane, is provided on a disc-shaped platen 3 attached to a center shaft 2 in a polishing apparatus 1 and a wafer-polishing head 5 which holds a wafer 6 is disposed facing the polishing pad 4 and in a position eccentric from the center shaft 2 of the platen 3 to the polishing pad such that the head can be rotated on its own axis.

[0006] In the polishing apparatus 1, the polishing pad 4 and the wafer 6 are moved relatively each other while the wafer 6 is held in the state of being pressed against the polishing pad 4 by the wafer-polishing head 5 and the above-mentioned slurry S is interposed between the wafer 6 and the polishing pad 4, thereby to polish one surface of the wafer 6.

[0007] A lot of fine pores, channels or the like are provided on the polishing pad 4 for holding the slurry S, whereby the wafer 6 is polished by the slurry S held on the polishing pad 4.

[0008] However, repeating the polishing causes the decrease of the surface flatness of the polishing pad 4 and causes clogging and dulling thereof with the result of bringing about a problem to decrease the polishing accuracy and efficiency of the wafer 6.

[0009] Accordingly, a dressing apparatus 7 has conventionally been arranged in a CPM apparatus as shown in Fig 17, thereby to dress the surface of the polishing pad 4.

[0010] In the above-mentioned dressing apparatus, a dresser 11 is, through an arm 9, attached to a rotary shaft 8 which is disposed outside a platen 3, while the dresser 11 is moved to perform a reciprocating and oscillatory motion on the rotating polishing pad 4 by rotating the arm 9 with the rotary shaft 8 to shave a slight amount of the surface of the polishing pad 4, whereby the surface flatness and the like of the polishing pad are recovered and maintained, and the clogging, dulling and the like are dissolved. The surface of the polishing pad is shaved off little by little in such a manner that while pressed against the surface of the polishing pad 4, the dresser 11 is rotated by a friction force between the dresser and the polishing pad or is rotated by being driven by a drive unit which is not shown in the drawing.

[0011] The conventional dresser 11 has a nearly circular shape having an opening in the center, for example, as shown in Fig.18 (a) of a side cross-sectional view and Fig.19 of a plane view and is provided with a dresser principal 11a wherein a projection 11b is formed in the outer peripheral portion of one end face. As shown in Fig.18 (b) of a partially enlarged side sectional view, the conventional dresser having a dressing-working part is used which comprises a diamond electrodeposited part 11d formed by electrodepositing on the projection 11b abrasive grains 11c (super abrasive grain) such as diamond or cBN. The dressing-working part shaves little by little the polishing pad 4 (such a dresser is called electrodeposited grindstone). Fig.19 is a plane view illustrating the under surface of the dresser 11. A dressing apparatus using this type of dresser is disclosed in, for example, JP-A 9-168961.

[0012] In the conventional dresser 11, there has been encountered the dropping off of the abrasive grains 11 such as diamond grain during dressing. In this case, a trouble is brought about due to scratching the surface of the wafer 6, when the wafer is polished while the dropped grains are filled up in the surface of the polishing pad.

[0013] In order to dissolve the above-mentioned problem, there was a proposal in JP-A 10-217103 as in Fig.20. A dresser 12 shown in Fig.20 has the following construction as a dressing-working part: a lot of projections 13 having a shape of pyramid are formed in the surface of a metal base 12a by machining and a surface 13a of the metal base 12a having the formed projections 13 was coated by a hard film. Dressing is carried out by pressing the projections 13 against a polishing cloth (polishing pad). There is no fear in the dressing apparatus having the dresser 12 for dropping of abrasive grains such as diamond grain with the result that there is little anxiety for suffering from a damage in the surface of materials to be polished.

[0014] However, in the dressers 11 and 12 as men-

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tioned above, a cutting quality degreases due to reasons such as wear of the dressing-working part in proportion to repeated dressings. In this case, changing a dresser unit is required, which takes a high cost.

[0015] In addition, as shown in Fig.19, the dressing of the polishing pad 4 is carried out by the whole surface of the dressing-working part which is projected in a shape of ring in the under surface of the outer peripheral portion of a dresser principal 11a. Chatter is apt to be caused due to a force acting all over the whole surface of the dressing-working part. Further, if once the chatter is caused, the vibration of the dressing 11 continues due to reasons such as the resonance of the vibration, which causes cases leading to a failure to polish uniformly the surface of the polishing pad.

[0016] Further, chips generate from the polishing pad 4 shaved little by little during dressing with dresser 12. In the above-mentioned construction having a lot of projections 13, the chips clog the spaces between each projection, thereby to bring about a problem of degreasing the dressing performance.

[0017] Furthermore, it is difficult to maintain always a stable dressing performance, as it is difficult to estimate how much the wear of the hard film 14 proceeds with the passage of time and a criterion for use becomes unclear.

[0018] The Constitution of the dresser 11 is shown in a side sectional view illustrated in Fig.21 (a schematically illustrated view). A dresser 11 is attached to an arm 9 by the aid of a setting shaft 10 and on a dresser principal 11a connected to the setting shaft 10, there is formed a diamond-electrodepositing part 11d (an abrasive grain layer) including abrasive grains 11c, thereby to form a dressing-working face 15. The diamond-electro-depositing part 11d has the following construction: electroplating is carried out on a ground face positioned on the dresser principal 11a, whereby the abrasive grains 11c such as diamond, cBN or the like are fastened dispersedly on the ground face.

[0019] In the dresser 11, the dressing-working face 15 comprises the under surface of the diamond-electro-depositing part 11d (an abrasive grain layer). In Fig.21, the thickness of the diamond-electro-depositing part 11d and the size of abrasive grains are illustrated larger than actual ones so as to understand easily the shape of the dressing-working face 15.

[0020] If the dresser 11 contacts partially the polishing pad 4 during dressing the pad 4 with the dresser 11, the contact area of the dressing-working face 15 to the polishing pad 4 becomes small with the result that the dressing efficiency becomes lower and it takes a longer time to dress the pad than in unpartial contact cases, though the pad 4 can be dressed at any rate. Every time after polishing a wafer 6 has finished, the polishing pad 4 is dressed and it is carried out at every two and half to three minutes. Therefore, the working efficiency of polishing the wafer 6 becomes low when it takes a long time to dress the polishing pad 4.

[0021] Still further, when the dressing condition is unstable as mentioned above, the surface condition of the polishing pad varies widely and the polishing condition of the wafer 6 with the polishing pad 4 scatters. As the result, it becomes difficult to keep the rate of operation of CMP apparatus and the flatness of the wafer 6.

[0022] Because of the above-mentioned reasons, in order to stabilize the dressing condition, an arrangement is carried out such that the dressing-working face 15 is flat and the dressing-working face cross orthogonally the rotary axis of the dresser 11.

[0023] In a dresser having a prescribed shape formed by fixing abrasive grains by a binder, the above-mentioned arrangement is available by shaving the dressing-working face in the state that the dresser is attached to the setting shaft of a dressing apparatus 7 (this treatment is called "tooling"). However, the tooling can not be carried out in the case of an electrodeposited grindstone due to its own property.

[0024] Accordingly, in the case of using an electrodeposited grindstone for the dresser 11, it is necessary to increase the shape accuracy of the dresser principal 11a where the abrasive grain layer is formed and to increase the accuracy of attaching the dresser principal 11a to the setting shaft.

[0025] However, there are cases in the electrodeposited grindstone that the shape of the dresser principal 11a changes during the process of making thereof and the flatness of the dressing-working face 15 becomes inferior. The flatness of the dresser 11 is measured while contacing directly a dial gauge to the dressing-working face 15, and in the case of the electrodeposited grindstone, as the surface roughness of the dresser-working face is coarse which is a degree of #100, the measurement error is large and it is difficult to measure the flatness thereof accurately.

[0026] Further, there are cases during attaching the dresser 11 to the setting shaft that the dressing-working face 15 of the dresser 11 inclines against the rotary axis due to troubles such as an attaching error caused by a worker, dust interposed between the dresser 11 and the setting shaft, and so on. In order to detect the inclination, there is no way except measuring the deviation of the dressing-working face 15 while contacting directly the dial gauge to the dressing-working face, which has a problem in having a large measurement error. Therefore, it is difficult to obtain the attaching accuracy within a prescribed criterion.

[0027] In addition, as the polishing pad has a softness, it is difficult to detect the partial contact of the dresser 11 to the polishing pad 4 by observing the dressed state of the polishing pad 4, which is different from polishing materials having rigidity such as metal.

[0028] As mentioned above, it has been difficult to stabilize the dressing condition of the polishing pad 4 with the dresser 11.

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SUMMARY OF THE INVENTION

[0029] An object of the present invention is to provide a dresser which can be used economically and a dressing apparatus having the same.

[0030] In order to attain the above-mentioned object, the dresser of the present invention is one used for dressing a polishing pad for polishing materials to be polished and comprises a dresser principal, a dressing-working part which is provided as a body other than the dresser principal and a holding means for holding the dressing-working part in such a manner that the dressing-working part can be attached to and detached from the dresser principal.

[0031] According to the dresser of the present invention, the dressing-working part can be attached and detached, and when a dressing performance thereof degreases due to reasons such as the wear of the dressing-working part, the dressing-working part is exchanged for a new one to recover the dressing performance. In this way, the dressing performance can be recovered only by exchanging a dressing-working part, thereby to degrease a cost for a dresser.

[0032] Another object of the present invention is to provide a dresser which enables a vibration hardly to take place, and which enables to suppress the vibration within a short time if the vibration takes place, and is to provide a dressing apparatus having the same.

[0033] In order to attain the above-mentioned object, the dresser of the present invention is one used for dressing a polishing pad for polishing materials to be polished and comprises a plurality of dressing-working parts which are disposed at unequal spaces in the circular direction of a dresser principal.

[0034] According to the dresser of the present invention, the dressing-working parts are disposed at unequal spaces in the circular direction of the dresser principal, whereby forces which cause the vibration of the dresser are not brought about periodically and are brought about aperiodically to suppress the resonance of the dresser.

[0035] As the result, a vibration hardly takes place and the vibration can be suppressed within a short time if the vibration takes place.

[0036] The interval between each dressing-working part can be decided by any way and for example, can be decided by using random numbers.

[0037] As another way, the interval can be unequal by arranging positions in such a manner that positions are designated as a standard position in the case of disposing dressing-working parts at an equal space each other, and each position is deviated from each standard position to the circular direction. In this case, the deviation of each dressing-working part from the corresponding standard position can be decided by using the random numbers or, for example, can be decided by designating as a starting point any position among each standard position, designating as θ an angle between the starting point and each standard position when looked from the center of axis, and specifying $x=\sin\theta$ as the deviation x of each dressing-working part from each standard position (or $x=\cos\theta$).

[0038] In the above-mentioned ways, when the deviation is too large, dressing-working parts having the too large deviation have a life shorter than the other dressing-working parts as a result of dressing more amount of a polishing pad. In contrast, when the deviation is too small, an effect on suppressing a resonance is lowered. Therefore, the deviation value is preferably by the absolute value within 10 to 30% of an interval between the corresponding standard positions.

[0039] The dresser is rotated in a position having an eccentric relation with the polishing pad, and the speed of the dresser relative to the polishing pad is lower in half a range of the circular direction (an inward peripheral side or an outward peripheral side of the polishing pad when looked from the center of axis of the dresser) than in the other half range and a load imposed on the dressing-working part is small. Therefore, it is estimated that the vibration of the dresser is hardly caused by a force imposed on a side which has a lower speed relative to the polishing pad. That is, dressing-working parts can be provided which are disposed in a same pattern every half a round.

[0040] A further object of the present invention is to provide a dresser which enables to always maintain an excellent dressing performance and can be used economically.

[0041] In order to attain the above-mentioned object, the dresser of the present invention is applied to an equipment which is used for polishing materials to be polished having a flat surface such as semiconductor wafer with a dressing pad, and is a dresser used for dressing the surface of the polishing pad, and is characterized by the following construction: the cutters are arranged in such a manner that the cutters are projected from the under surface of a dresser principal; the polishing pad surface is shaved by moving the edge of cutter which is a movement relative to and parallel to the polishing pad surface while the edge of the cutter is pressed against the polishing pad surface.

[0042] As the dressing pad is shaved with a cutter in the dresser of the present invention, the dresser is protected from the lowering of the dressing performance which is caused by clogging of the polishing pad with the shaved chips of the dressing pad in between abrasive grains, as compared with the conventional one, whereby a stable dressing performance is available. In addition, as an amount of wear can be decided from the flank of the cutter, a criterion for use is clear as compared with the conventional one, thereby to enable to maintain easily the dressing performance. Further, as a cutter is used, reusing the cutter is possible, which is different from the conventional one, with result of providing excellence in a cost for the dresser.

[0043] Still further object of the present invention is

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to provide a dresser wherein the polishing condition of the polishing pad can be stabilized.

[0044] In order to attain the above-mentioned object, the dresser of the present invention comprises: a dressing-working face formed by providing an abrasive grain layer including abrasive grains on the surface of a dresser principal, wherein the dresser principal comprises a ground face on which the abrasive grain layer is provided and a basic face which is disposed in a portion of the dresser principal more inward than the ground face and is formed in parallel to the ground face.

[0045] In the dresser of the present invention, as the basic face of the dresser principal is a plane parallel to the ground face, it is possible to predict the flatness of the ground face having the abrasive-grain layer formed thereon, that is, the flatness of the dressing-working face, by measuring the flatness of the basic face, whereby dressers can be selected which have a good flatness with regard to a dressing-working face.

[0046] In addition, when the dresser is attached to the dressing apparatus, the attaching situation can be confirmed according to the basic face as a basis, as the basic face is a plane parallel to the ground face.

BRIEF DESCRIPTION OF THE DRAWINGS

[0047]

Fig.1 is a plan view illustrating the under surface of the dresser of Example 1 of the present invention.

Fig.2 is a sectional view looking in the direction of the arrows A-A in the Fig.1.

Fig.3 (a) is a side sectional view showing another embodiment of the dresser-working part used in the dresser of Example 1.

Fig.3 (b) is an end surface view showing another embodiment of the dresser-working part used in the dresser of Example 1.

Fig.4 (a) is a side sectional view showing a further embodiment of the dresser-working part used in the dresser of Example 1.

Fig.4 (b) is a side sectional view showing still another embodiment of the dresser-working part used in the dresser of Example 1.

Fig.5 is a side sectional view illustrating another construction of the dresser in Example 1 of the present invention.

Fig.6 is an under surface view illustrating the shape of the dresser in Example 2 of the present invention.

Fig.7 (a) is a side sectional view illustrating the shape of the dresser in Example 2 of the present invention.

Fig.7 (b) is a side sectional view illustrating another shape of the dresser in Example 2 of the present invention.

Fig.8 is an under surface view illustrating the shape of the dresser in Example 3 of the present invention.

Fig.9 is a schematic view illustrating the dresser of Example 4 of the present invention, which is an enlarged side view of the important part of the dresser principal.

Fig.10 is a schematic view illustrating the dresser of Example 4 of the present invention, which is an under surface view of the dresser principal.

Fig.11 is a schematic view illustrating the dresser of Example 4 of the present invention, which is a side sectional view of the dresser principal.

Fig. 12 is an enlarged side view of a cutter used in the dresser shown in Figs.9 to 11.

Fig.13 is an enlarged under surface view of the cutter used in the dresser shown in Figs.9 to 11.

Fig.14 is a plan view showing a positional relationship between the dresser principal shown in Fig.9 to 13 and a platen to which a polishing pad is attached, when dressing is carried out.

Fig.15 is an enlarged side sectional view showing another embodiment of the cutter used in the dresser of Example 4.

Fig. 16 is a side sectional view illustrating the constitution and construction of the dresser in Example 5 of the present invention.

Fig.17 is an enlarged perspective view of the important part of the conventional polishing equipment and dressing apparatus, which is illustrating the schematic constitutions thereof.

Fig.18 (a) is a side sectional view illustrating the shape of the conventional dresser.

Fig. 18 (b) is a partially enlarged side sectional view of Fig. 18 (a).

Fig.19 is a plan view showing the under surface of the conventional dresser.

Fig.20 is an enlarged side sectional view of an important part illustrating the shape of the conventional dresser.

Fig.21 is a side sectional view illustrating the constitution and construction of the conventional dresser.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0048] The dresser of the present invention and the dressing apparatus having the same are described in detail hereunder.

[0049] Fig.1 is a plan view illustrating the under surface of the dresser of Example 1 of the present invention. Fig.2 is a sectional view looking in the direction of the arrows A-A in the Fig.1.

[0050] The dressing apparatus of the present invention comprises a constitution almost similar to that of, for example, a dressing apparatus 7 shown Fig.17, and a dresser 21 of the present invention is used as a dresser in place of a dresser 11.

[0051] The dresser 21 of the present invention comprises a dresser principal 22 having an approximately circular shape and a plurality of dressing-working parts

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23 disposed in the circular direction in the under surface of the outer peripheral portion of the dresser principal 22. The dresser-working parts 23 which are provided as bodies other than the dresser principal 22 are arranged and are held to the dresser 22 by a means mentioned after in such a manner that the dresser-working parts 23 can be attached to and detached from the dresser principal 22. The number and disposition of the dressing-working parts 23 shown in Fig.1 is only an example. The dressing-working parts 23 can be disposed at equal spaces in the circular direction of the dresser principal or at irregular spaces in the circular direction. The dressing-working parts 23 can be arranged in a plurality of lines in the circular direction of the dresser principal 22, which is similar to that of the conventional dresser.

[0052] In the present example, the dresser principal 22 is composed of an approximately circular shape having an opening in the center thereof.

[0053] As shown in Fig.2, the dressing-working part 23 is composed of a member having an approximately pin-like shape. A receiving hole 26 for receiving a part of the dressing-working part 23 is formed from the under surface 22a to a predetermined depth in the dresser principal 22. In the dresser principal 22, a tapped hole 27 is formed which leads to the intermediate position of the receiving hole 26 from the outer periphery 22b thereof. In the tapped hole 27, a clamp screw 28 is screwed such that the end of the clamp screw can be advanced and retreated in the receiving hole 26.

[0054] The dressing-working part 23 is fixed in the receiving hole 26 by pressing the side of dressing-working part 23 received in the receiving hole 26 to the inner wall of the receiving hole with the end of the clamp screw 28 and is released from being fixed by releasing the pressing of dressing-working part 23 with the end of the clamp screw.

[0055] The present example comprises a holding means which hold dressing-working part 23 to the dresser principal 22 in such a manner that the dressing-working part 23 can be attached to and detached from the dresser principal 22 by the receiving hole 26, the tapped hole 27 and the clamp screw 28.

[0056] Here, in the present example, the receiving hole 26 is approximately parallel to the axis of the dresser principal 22 and the bottom surface thereof is a plane which approximately crosses orthogonally the axis of the dresser principal 22.

[0057] As shown in Fig.2, the dressing-working part 23 is a cutter having approximately a pin-like shape, and comprises a base 23a having an approximately columnar shape and a cutting edge 23b formed in the end of the base 23a.

[0058] The base 23a is received in the receiving hole 26 of the dresser 22 and the side of the base is subjected to the pressure given by the clamp screw 28. A position-adjusting screw hole 31 is formed in the base 23a, which has a prescribed depth along the axis from the end face of the base.

[0059] A position-adjusting screw 32 is screw-clamped to the position-adjusting screw hole 31 and an amount of projection of the position-adjusting screw 32 from the base 23a can be adjusted by controlling a screwed length to the position-adjusting screw hole 31.

[0060] The upper surface of the head of the position-adjusting screw 32 is pressed against the bottom surface of the receiving hole 26 when the dressing-working part 23 is received in the receiving hole 26. An amount of projection of the dressing-working part 23 from the receiving hole 26, that is, an amount of projection of the dressing-working part 23 from the dresser principal 22 can be adjusted by controlling an amount of projection of the position-adjusting screw 32 from the base 23a. In the present example, the upper surface of the head of the position-adjusting screw 32 is a plane crossing approximately orthogonally to the axis thereof.

[0061] Further, a fixing nut 33 is screw-clamped to the position-adjusting screw 32 which is positioned on the position-adjusting screw hole 31. The position-adjusting screw 32 is fixed in a state projected at any distance from the base 23a by screwing the fixing nut toward the edge of the position-adjusting screw 32 while pressed against the base 23a.

[0062] The present example comprises a projection adjusting means having the position-adjusting screw hole 31, the position-adjusting screw 32 and the fixing nut 33 for controlling an amount of projection of the dresser-working part 23 from the dresser principal 22.

[0063] The cutting edge portion 23b of the dressing-working part 23 comprises: a flank 36 which is formed by concaving one end face of the cutter toward the base end of the cutter; a rake face 37 comprising a circumferential surface in the end portion of the cutter; and a cutting edge 38 which is a ridgeline formed by crossing of the end face and the circumferential surface in the end portion of the cutter. Namely, the cutting edge portion 23b has a nearly Japanese soup cup-like shape.

[0064] Here, ceramics, diamond, cBN and the like can be used for the cutting edge 38, and the surface of the cutting edge portion 23b can be covered by a hard film comprising hard materials such as diamond or the like.

[0065] Almost in the same manner as in the dressing apparatus shown in Fig. 17, the surface of a polishing pad 4 is dressed by the dressing apparatus of the present invention, which comprises the steps of: oscillating a dresser 21 while the dresser 21 is pressed against the surface of the polishing pad 4; rotating of the dresser owing to a friction force caused by friction with the polishing pad 4 or rotating the dresser by driving by a drive unit which is not shown in Figs while the dresser 21 is pressed against the surface of the polishing pad.

[0066] In the dresser 21, the surface of the polishing pad 4 is shaved little by little by the dresser 21 by providing to the dresser a relative movement to a direction parallel to the polishing pad 4, while the cutting edge 38 of the dressing-working part 23 is pressed

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against the surface of the polishing pad 4.

[0067] As an amount of projection of the dressing-working part 23 from the dresser principal 22 can be adjusted, the dressing performance of the dresser 21 is controlled by adjusting the depth of cut of the dressing-working part 23 into the dressing pad 4 according to the material and hardness of the dressing pad.

[0068] The dressing apparatus of the present invention can be composed of a constitution other than the above-mentioned one, in which the dresser 21 is connected to an arm 9 through a ball bearing, and the dresser can freely be inclined according to the surface of the polishing pad 4. In this case, in the dressing apparatus, the dresser is pressed against the dressing pad 4 by the dead weight thereof or by a force obtained by pressing the arm 9, and a depth of cut of the dressing-working part 23 into the polishing pad 4 is adjusted by controlling an amount of force of the pressing.

[0069] Adjusting an amount of projection of the dressing-working part 23 is carried out as follows: first, an amount of the position-adjusting screw 32 from the base 23a is adjusted by turning round the position-adjusting screw 32 which is screw-clamped to the base 23a to any of two directions in the state of detaching the dressing-working part 23 from the dresser principal 22 and the position-adjusting screw 32 is fixed to the base 23a by the fixing nut 33; then, the dressing-working part 23 is inserted into the receiving hole 26 of the dresser principal 22 and the clamp screw 28 is driven and tightened which is screw-clamped to the tapped hole 27, whereby the dressing-working part 23 is fixed in such a state that the cutting edge 38 of the dressing-working part 23 is projected from the under surface 22a of the dresser principal 22 by a prescribed amount.

[0070] In addition, as the dressing-working part 23 has the cutting edge 38 in the whole round thereof, the shaving of the polishing pad 4 can be carried out for any direction thereto, thereby to enable to increase a dressing performance.

[0071] And, as the dressing-working part 23 is a cutter, the dressing performance can be recovered by repolishing the cutter edge 38 when the dressing performance degreases, thereby to enable to lower a cost for the dresser.

[0072] Furthermore, though shaved chips generate due to shaving a little the polishing pad 4, the polishing pad 4 is hardly clogged with the shaved chips, which is different from a dresser having a dressing-working part comprising an abrasive grain layer and projections, thereby to obtain a stable dressing performance.

[0073] Still further, as the dressing performance can be judged from an amount of wear of the cutting edge 38 to clear a criterion for use, the stable dressing performance can always be obtained.

[0074] Yet further, there is no fear to scratch the surfaces of materials to be polished due the dropping of abrasive grains, as the abrasive grains are not used in the dressing-working part 23.

[0075] Still furthermore, if a dressing performance lowers due to reasons such as the wear of the dressing-working part 23, the dressing performance can be recovered by exchanging only the dressing-working part 23, thereby to enable to decrease a cost for a dresser.

[0076] The example is exemplified by a case wherein the dressing-working part 23 is used which comprises a cutting edge portion 23b having a Japanese soup cup-like shape and the example is not limited to the case. For another example, a dressing-working part 39 can be used which has a plurality of projections in the end thereof as shown in Fig.3 (a) of a side sectional view and Fig.3 (b) of an end surface view. The projection 40 of a dressing-working part 39 has a cross section approximately equal to an end face 40a from one end of the projection to near another end of the projection from which the projection is started and a cutting edge 40b is provided by a ridgeline formed by crossing of the end face 40a and the side surface of the projection. The projections are disposed in any way, regularly or irregularly. In addition, any shape can be provided to the end face 40a of the projection 40, for examples, the end face 40a can be nearly circular (the projection 40 is approximately columnar) or can be a polygon (the projection 40 is a square pillar having a polygonal section).

[0077] Further, ceramics, diamond, cBN and the like can be used for the cutting edge 40b, and the surface of the cutting edge 40b can be covered by a hard film comprising hard materials such as diamond.

[0078] In the dressing-working part 39 formed as mentioned above, the surface of the polishing pad 4 is dressed by the cutting edge 40b of each projection 40. Here, as the cutting edge 40b is formed in the wholly around of each projection 40, the polishing pad 4 can be dressed from any direction. The projection 40 has a cross section approximately equal to an end face 40a from one end of the projection to near another end of the projection from which the projection is started and the change of shape and area of the end face 40a is small when the projection 40 wears with the result that the dressing performance hardly changes and the stable dressing performance can be obtained.

[0079] Further, for example, as shown in Fig.4 (a) of a side sectional view, a dressing-working part 41 can be used which has a cutting edge 42 having a cutting edge portion 41b directed to one direction of the circular direction of dressing-working part. Here, ceramics, diamond, cBN and the like can be used for the cutting edge 42 and the surface of the cutting edge portion 41b can be covered by a hard film comprising hard materials such as diamond.

[0080] In addition, the polishing pad can be shaved from any direction, as a whole dresser, by providing to the dressing-working part 41 the cutting edges 42 which are directed in various directions each other.

[0081] Further, a dressing-working part 43 can be used as a dressing-working part, which comprises a grindstone 44 in the end of the base 43a which is

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approximately columnar as shown in Fig.4 (b). In this case, the grindstone 44 can be a grindstone which is conventionally used for dressing the polishing pad 4, for examples, can be a grindstone formed by an abrasive grain layer prepared by electrodepositing abrasive grains such as diamond or can be a metal bonded grindstone.

[0082] Further, a means for controlling an amount of projection can be composed of a constitution other than the above-mentioned one, in which a bolt inserting hole 29 leading to the upper surface of the dresser principal 22 is formed in the bottom face of a receiving hole 26 as shown in Fig.5 of a side sectional view and a position-adjusting screw 32 is inserted into the bolt inserting hole 29 from the upper surface of the dresser principal 22 and screw-clamped to a position-adjusting screw hole 31 (a fixing nut becomes unnecessary). Here, the position adjusting screw 32 is attached to the dresser principal 22 in such a manner that the screw is possible to turn around an axis while the head of the screw is received in the bolt inserting hole 29. When a means for controlling an amount of projection is provided as mentioned above, as the dressing-working part 23 can be moved along the position adjusting screw 32 by handling the position adjusting screw 32 in the state of attaching the dresser-working part 23 to the dresser principal 22, an amount of projection of the dressing-working part 23 can be controlled without detaching the dressing-working part 23 from the dresser principal 22.

Example 2:

[0083] The dresser of Example 2 of the present invention and the dressing apparatus having the same are described in detail hereunder, referring to Figs.

[0084] Fig.6 is an under surface view illustrating the shape of the dresser of Example 2. Fig.7 is a side sectional view illustrating the dresser.

[0085] The dressing apparatus of the present invention comprises a constitution almost similar to that of a dressing apparatus 7 shown Fig. 17, and the dresser 51 of the present invention is used as a dresser in place of a dresser 11.

[0086] A dresser 51 of the present invention comprises a dresser principal 52 having an approximately circular shape and a plurality of dressing-working parts B disposed in the circular direction in the under surface of the outer peripheral portion of the dresser principal 52. The dresser principal 22 of the present invention is composed of a shape having an opening in the center thereof in the same manner as in the conventional dresser. The dresser-working parts B are provided as bodies other than the dresser principal 52 and are fixed to the dresser principal 52 by, for examples, brazing, a clamp method, a blade method and so on.

[0087] In the present example, the dressing-working parts are members having a approximately pin-like shape.

[0088] The dressing-working parts B are disposed at unequal spaces in the circular direction of the dresser principal 52. A space between each dressing-working part B is decided by any way. In the present example, the positions in the case of disposing dressing-working parts B at equal spaces are designated as a standard position P and any one among the standard positions is designated as a starting point P_0 and an angle between each standard position P and the starting point P_0 when looked from the center of axis O of the dresser 52 is designated as θ, and $x=\sin\theta$ is specified as a deviation x of each dressing-working part B from each standard position P. Here, in Fig.6, accompanied characters are provided to standard positions P (and a dressing-working part B, angle θ and an amount of deviation x corresponding to each standard position P), in a counterclockwise order starting from the starting point P_0.

[0089] In the above-mentioned way, when the deviation x of a dressing-working part B from the corresponding standard position P is too large, a distance becomes large which is between one dressing-working part B and another dressing-working part B next to the former dressing-working part. In this case, the life of the dressing-working parts B become shorter as an amount of dressing of the polishing pad 4 carried out by the dressing-parts B becomes always too much as compared with the other dressing-working parts B. In contrast, when the deviation is too small, an effect on suppressing a resonance is lowered. Therefore, a deviation value of each dressing working part B from the corresponding standard position P is preferable by the absolute value within 10 to 30% of a space H between standard positions P.

[0090] The dressing-working part is approximately pin-like and can comprise any construction such as a dressing-working part having a diamond-electro-deposited part formed by electrodepositing abrasive grains such as diamond in the end which is directed to the under surface side of the dresser principal 52 or a dressing-working part having a cutter having a cutting edge formed in the end which is directed to the under surface side of the dresser principal 52 if dressing the polishing pad 4 is possible.

[0091] In the present example, as shown in Fig.7 (a), there is provided to the dresser principal 52 a receiving hole 56 having a prescribed depth from an under surface 52a and there is provided thereto a tapped hole 57 which leads to the intermediate position of the receiving hole 56 from the outer periphery 52b of the dresser principal 52 and to which a clamp screw 58 is clamped. The dressing-working part B is fixed to the receiving hole 56 by the following mechanism: the side thereof is pressed by the clamp screw 58 which is screw-clamped to the tapped hole 57, whereby the dressing-working part B is fixed to the receiving hole 56. And, as shown in Fig.7 (a), in the dressing-working part B, a position-adjusting screw hole 59 having a prescribed depth is formed along an axis from the end face

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of the base end thereof and a position-adjusting screw 60 is screw-clamped to the position-adjusting screw hole 59. An amount of projection of the dressing-working part B from the base end can be controlled by controlling a screw-clamping length of the position-adjusting screw 60 to the position-adjusting screw hole 59, and the upper face of head of the position adjusting screw 60 can be contacted to the bottom face of the receiving hole 56 when the dressing-working B is received in the receiving hole 56. Here, an amount of projection of the dressing-working part B from the receiving hole 56, that is, an amount of projection of the dressing working part B from the under surface 52a of the dresser principal 52a can be controlled by adjusting an amount of projection of the position-adjusting screw 60 from of the base end of the dressing-working part B.

[0092] In the present example, the dressing-working part B is a cutter having approximately a pin-like shape. A cutting edge portion 54 formed in one end of the cutter comprises: a flank 54a which is formed by concaving the end face of the cutting edge portion toward the base end of the cutter; a rake face 54b comprising a circumferential surface in the end portion of the cutting edge portion; and a cutting edge 54c which is a ridgeline formed by crossing of the end face and the circumferential surface in the end portion. Namely, the cutting edge 54 has a nearly Japanese soup cup-like shape and whole the round of the edge makes it possible to shave the polishing pad 4.

[0093] For example, as shown in Fig.7 (b) of a side sectional view, the dresser 51 can be composed of a constitution other than the above-mentioned one, in which a bolt inserting hole 53 is formed in the dresser principal 52 from the bottom face of a receiving hole 56 to the upper surface of the dresser principal 52 and a position-adjusting screw 60 is inserted into the bolt inserting hole 53 from the upper side of the dresser principal 52, thereby to screw-clamped the screw to a position adjusting screw hole 59. In this case, the position-adjusting screw 60 is attached to the dresser principal 52 in such a manner that the screw is possible to turn around an axis while the head of the screw is received in the bolt inserting hole 53. When the dresser 51 is constituted as mentioned above, as the dressing-working part B can be moved along the position adjusting screw 60 by handling the position-adjusting screw 60 in the state of attaching the dresser-working part B to the dresser principal 52, an amount of projection of the dressing-working part B can be controlled without detaching the dressing-working part B from the dresser principal 52.

[0094] Dressing the polishing pad 4 by using a dressing apparatus having the dresser 51 constructed as mentioned above is carried out in the same manner as in the conventional dressing apparatus.

[0095] In the present example, as the dressing-working parts B are disposed at unequal spaces in the circular direction of the dresser principal 52, forces which cause the vibration of the dresser 51 are not brought about periodically and are brought about aperiodically to suppress the resonance of the dresser 51.

[0096] Thus, according to the dresser 51 of the present invention and the dressing apparatus having the same, the vibration of the dresser 51 hardly takes place and the vibration can be suppressed within a short time if the vibration takes place.

[0097] The number and disposition of arranged dressing-parts B are not limited to the example shown in Fig.6 and any embodiment is available as long as the dressing-working parts B are disposed at unequal spaces in the circular direction of a dresser principal 52.

Example 3:

[0098] The dresser of Example 3 of the present invention and the dressing apparatus having the same are described in detail hereunder, referring to Fig.8 showing an under surface view.

[0099] A dresser 61 of the present example comprises a dresser principal 62 having an approximately circular shape and a dressing-working part C comprising a grindstone disposed along the circular direction in the under surface of the outer peripheral portion of the dresser principal 62.

[0100] Nicks N are provided to the dressing-working part C by forming a plurality of notches at unequal spaces in the circular direction of the dresser principal 62.

[0101] The arrangement of the nicks N can be decided in the same manner as in the dressing-working parts of Example 2. In the present example, the positions in the case of disposing dressing-working parts C at equal spaces are designated as a standard position P_i and any one among the standard positions P is designated as a starting point P_0, and an angle between each standard position and the starting point when looked from the center of axis of the dresser principal 62 is designated as θ, and $x=\sin\theta$ is specified as a deviation x of each dressing-working part C from each standard position P. Here, in Fig.8, accompanied characters are provided to standard positions P (and a dressing-working part C, nick N, angle θ and an amount of deviation x corresponding to each standard position P), in a counterclockwise order starting from the starting point P_0.

[0102] Dressing a polishing pad 4 is carried out in the thus-constituted dresser 61 and a dressing apparatus having the same, in the same manner as in the dresser 51 of Example 2 and the dressing apparatus having the same.

[0103] In this example, as the nicks N are disposed at unequal spaces in the circular direction of the dresser principal 62, forces which cause the vibration of the dresser 61 are not brought about periodically and are brought about aperiodically to suppress the resonance of the dresser 61.

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[0104] Thus, according to the dresser 61 of the present invention and the dressing apparatus having the same, the vibration of the dresser 61 hardly takes place and the vibration can be suppressed within a short time if the vibration takes place.

[0105] The number and disposition of arranged nicks N are not limited to the example shown in Fig.8 and any embodiment is available as long as the nicks are disposed at unequal spaces in the circular direction of a dresser principal 62.

Example 4:

[0106] Example 4 of the present invention is described in detail hereunder, referring to Figs.

[0107] Fig.10 and 11 are schematically illustrating the present example. In the Figs., symbol 71 shows a dresser.

[0108] As shown in the Figs., the dresser 71 comprises a plurality f cutters 75 disposed at a prescribed spaces in the circular direction of a dresser principal 72, in a peripheral edge portion 74 of an under surface 73 of the dresser principal 72 having a circular shape.

[0109] The cutters 75 are arranged in the state that the cutter is projected from the under surface73 of the dresser principal 72 as shown in Fig.9 of an enlarged view (a view illustrating the vicinity of the cutter 75 when looked from a p direction in Fig.11). As further enlarged in Fig.12, the cutter 75 comprises an edge of cutter 76 having a flat surface 77 parallel to a polishing pad surface to be dressed (not show in Figs.). The width of the flat surface (a land width:l) is 0.001 to 0.5mm.

[0110] The rake angle D of the cutter 75 is 10° and the clearance angle E thereof is also 10°. The edge of cutter 76 of the cutter 75 is arranged in such a manner having a -15° of an inclined angle α, wherein, as shown in Fig.13, the inclined angle is defined as an angle of the edge of the cutter 76 inclined from a straight line L1 passing through an edge of end 76a in the edge of cutter 76 at the center side of the dresser principal 72 (not shown in the Fig.) and the center of the dresser principal 72 (not shown in the Fig.), and a movement direction of the cutter 75 relative to the polishing pad, that is, a rotational direction of the dresser principal 72 (mentioned after) is defined as positive (a q direction in Fig.13). In addition, nicks 78 are provide to the edge of cutter 76 of the cutter 75 as shown in Fig.13.

[0111] Hard materials such as diamond having a single crystal, cBN, sintered compact produced under a high pressure such as polycrystalline diamond, and materials coated by hard materials as mentioned above are used for the edge of cutter 76.

[0112] When a polishing pad is dressed by using the dresser 71, the polishing pad is shaved by the cutter 75 by rotating a platen 79 having the polishing pad attached thereto an h direction in the Fig.14 and rotating the dresser principal 72 to an i direction in the Fig.14 while pressing the under surface of the dresser principal 72 in such a manner that the flat surface 77 of the cutter 75 is pressed against the under surface of the dresser principal 72, thereby to dress the upper surface of the polishing pad. Here, the i direction is a movement direction of the cutter 75 mentioned above relative to the polishing pad (a q direction in Fig.13).

[0113] In the above-mentioned dresser 71, as the shaving of the polishing pad surface is carried out by providing to the edge of cutter 76 of the cutter 75 a movement relative to the polishing pad in a direction parallel to the polishing pad surface while the edge of cutter 76 is pressed against the polishing pad surface, the dresser is protected from the lowering of the dressing performance thereof which is caused by clogging of the polishing pad surface with the shaved chips in between abrasive grains, as compared with the conventional one, whereby a stable dressing performance is available. Further, as the polishing pad is shaved by using the cutter 75 as mentioned above, an amount of wear can be decided from the flank of the cutter 75 with result that the criterion for use is clear as compared with the conventional one, thereby to enable always to maintain easily a stable dressing performance. Furthermore, as the cutter 75 is used, reusing a cutter 75 which has worn is possible, which is different from the conventional one, with the result of providing excellence in a cost for the dresser.

[0114] In the dresser 71, as the flat surface 77 is formed in the edge of cutter 76 of the cutter 75, the edge of cutter 76 of the cutter 75 is disposed always at a settled position to the polishing pad without causing the vibration of the edge of cutter 76 of the cutter 75 when the dresser principal 72 is pressed against the polishing pad surface, whereby the flatness of the polishing pad can be obtained and in its turn, the polished performance of materials to polished such as semiconductor wafer can be increased.

[0115] Still further, in the dresser 71, the shaved chips of the polishing pad and the residues of slurries left in the polishing pad which have generated in polishing materials to be polished by methods such as a CMP method can be scooped up by the cutter 75 owing to providing a positive angle to a rake angle D of the cutter 75, whereby the dressing performance can be increased and the polishing pad can be easily cleaned.

[0116] In addition, in the dresser 71, the edge of cutter 76 of the cutter 75 is arranged in such a manner having a negative angle wherein a rotational direction of the dresser principal 72 (a q direction in Fig.13) is defined as positive to a straight line L1 passing through an edge of end 76a at the center side of the dresser principal 72 (not shown in the Fig.) and the center of the dresser principal 72. In such a construction, as a normal line L2 (refer to Fig.13) of the rank face 80 of the cutter 75 (refer to Figs.12 and 13) is always directed to the outward of the dresser principal, the shaved chips of the polishing pad scraped away and the residues left in the polishing pad of slurries which have generated in polish-

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ing materials to be polished by the CMP are scraped out by the edge of cutter 76 from the center side of the dresser 72 to the outward thereof. As mentioned above, as the shaved chips of the polishing pad and the residues of slurries left in the polishing pad which have generated in polishing materials to be polished by the CMP are scraped out to the outside by the cutter 75, the polishing pad can easily be cleaned.

[0117] It is to be understood that, within the spirit of the present invention, designs may be practiced otherwise than as specifically described in the present example.

[0118] For example, the rake angle D can be from -20 to 30°. Specifically, in case where channels having a embossed pattern or a latticed pattern are provide to the polishing pad, the rake angle D is preferably a negative angle such that the side wall of the channel can not be shaved off. In case where the polishing pad is too soft, a negative rake angle is also effective as the rake angle D in order to protect the polishing pad from an excessive shaving.

[0119] Further, in case where the rake angle D is from -5° to -15° , the mechanical strength of the cutter 75 can be ensured and it is useful for cases which require the strength of an edge of cutter.

[0120] Further, a width of land 1 can be within the range of 0.005 to 0.5mm and is preferably from 0.05 to 0.1mm. Further, the clearance angle can be from 3° to 15°. An amount of biting depth of the cutter to the polishing pad can be controlled by adjusting an amount of clearance angle E and a width of flank, as mentioned above. Thereby, an optimum shape can be adopted according to the materials and hardness of the polishing pads. Further, the angle α of inclination of the edge of cutter 76 of the cutter 75 can be within the rage of -10 to -30°. In addition, a construction is possible which has no nick 78.

[0121] Further, the edge of cutter 76 can be selected according to the materials of polishing pads to be dressed and slurry materials used in polishing materials to polished by a CMP method. With regard to a method for attaching the edge of cutter 75, brazing, a clamp method, a blade method and so on can be used.

[0122] Further, the clearance angle of the cutter 75 can comprise two steps as in shown in Fig.15 (for example, α 1=5° , β=15° ,in Fig.15). In this case, an amount of biting depth of the cutter 75 to the polishing pad is controlled by adjusting the clearance angle and the width of the first flank W, thereby to enable to obtain a pertinent dressing rate.

Example 5:

[0123] The dresser 81 of Example 5 of the present invention is described in detail hereunder, referring to Fig.16. The same symbols are provided to the same parts as those of the conventional dresser 11 described in the related art and the description thereon is omitted.

[0124] A dresser 81 is attached to an arm 9 of a dressing apparatus 7 by the aid of a setting shaft 82 in a CPM apparatus 1 shown in Fig.17, in the same manner as in the dresser 11.

[0125] Here, with regard to the setting shaft 82, one end of the setting shaft directed to a rotary shaft is connected to a drive unit (not shown in Figs.) by the aid of the arm and the setting shaft 82 is rotated around the rotary shaft. In the other end thereof, a flange 84 is formed for fixing the dresser 81 (refer to Fig.16 illustrating a side sectional view). In the flange 84, a plurality of bolt inserting holes 86 for bolts 85 for screw-clamping the dresser 81 to the flange 84 are disposed at appropriate spaces in the circular direction thereof (only one portion is illustrated in Fig. 16). Hereunder, in the present specification, the side of the dresser 81 contacting to the setting shaft 82 is defined as the upper side thereof and another side of the dresser 81 where a dressing-working part 15 is formed is defined as the lower side thereof.

[0126] The dresser 81 is an electrodeposited grindstone having a dressing-working face 15 formed by providing an abrasive grain layer 93 including abrasive grains 93 on the surface of a dresser principal 83 having a approximately annular shape, as shown in Fig.16, and the dresser is fixed to the setting shaft 82 while, the center of the dresser is matched with the center of the setting shaft 82.

[0127] The material of the dresser principal 83 comprises aluminum, stainless steel, steel or a combination of aluminum and steel and the section thereof is approximately a rectangle. A convex 87 of the outer peripheral side which is projected at the outer peripheral side of the under surface of the dresser principal 83 toward the lower side is formed all around the periphery, and the under surface of the convex 87 comprises a ground face 88 having an abrasive grain layer 93 formed thereon. The ground face is formed in such a manner that the face thereof is orthogonally crossed to a rotary axis AX of the dresser principal 83. In Fig.16, the thickness of the abrasive grain layer 93 is illustrated larger than the actual one so as to easily understand the shape of the dressing-working face 15.

[0128] A convex 89 of the inward peripheral side having an amount of projection to the lower side smaller than that of the convex 87 of the outer peripheral side is formed in a position closer to the center of rotation than the convex 87 of the outer peripheral side in such a manner that the convex 89 is concentric with the convex 87 and the under surface of the convex 89 comprises a basic face 90 which is parallel to the ground face 88. A recess 92 is formed between the convex 87 and the convex 89 so as to obtain the working accuracy thereof. A plurality of holes for bolt 91 for screw-clamping the bolts 85 are formed at appropriate spaces in the upper face of the dresser principal 83 all around the periphery (only one portion is illustrated in Fig.16).

[0129] Here, the dresser principal 83 is screw-

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clamped to the under surface of the flange 84 of the setting shaft 82 by screw-clamping the bolts 85 to the holes for bolt 91.

[0130] When the dressing of a polishing pad 4 is carried out with the dresser 81 constructed as mentioned above, the following operations are carried out so as to stabilize conditions for dressing the polishing pad 4.

[0131] First, dressers 81 are checked on whether or not a dresser 81 has a flatness of the dressing-working face 15 within a range which is proper to a use for the dressing apparatus 7, and dressers 81 are selected which have the proper flatness.

[0132] The flatness of a dressing-working face 15 can be predicted by inspecting the flatness of the ground face 88 for forming the dressing-working face 15, and the flatness of the ground face 88 can be predicted by inspecting the flatness of the basic face 90 parallel to the ground face 88.

[0133] Namely, if the flatness of a basic face 90 is within the range proper for a use in the dressing apparatus 7, the flatness of the corresponding ground face 88 and dressing-working face 15 can be predicted to be also within the range proper for the use, thereby to select dressers 81 which have the flatness of a basic face which is within the range proper for the use and to use the selected dressers.

[0134] Next, a dresser 81 which has been confirmed to have a flatness within the proper range is attached to the under surface of the flange 84 of the setting shaft 82 by the bolts 85.

[0135] Then, the deflection of the basic face 90 of the dresser 81 is measured with dial gauge, while rotating the setting shaft 82 together with the dresser 81 by a drive unit which is not shown in Figs., and the setting condition of the dresser is adjusted so as to attain a deflection having a proper range.

[0136] When the deflection is not within the proper range, it is considered as a reason that dust is contained in between the setting shaft 82 and the dresser 81, together with another reason due to an error in attaching the setting shaft 82. If the dust problem is considered, the dresser 81 is detached from the setting shaft 82 to confirm whether or not the dust is interposed in between. When the dust is interposed, the dust is removed, followed by attaching again the dresser 81 to the setting shaft 82.

[0137] According to the thus constructed dresser 81, as a ground face 88 having a dressing-working face 15 formed thereon can be predicted whether to be flat or not, dressers having a good flatness of the dressing-working face can be selected and used.

[0138] Further, the condition of attaching a dresser 81 to the setting shaft 82 of the dressing apparatus 7 is confirmed whether to be proper or not, the accuracy of attaching to the dressing apparatus 7 can be increased.

[0139] Thereby, the condition of dressing a polishing pad 4 with the dresser 81 can be stabilized.

[0140] Furthermore, as the basic face 90 is disposed in a position closer to the center of rotation as mentioned above than the ground face 88, that is, at the inward peripheral side of the dresser principal 83, a possibility of damaging the basic face 90 due to hitting the basic face 90 against something is decreased during delivering the dresser 81 or attaching the dresser 81 to the dressing apparatus 7, thereby to ensure an accuracy for predicting the flatness of the dressing-working face 15.

[0141] Still further, as the basic face 90 is disposed in a position close to the center of rotation, the outside diameter of the dresser 81 can be minimized and the dresser 81 can be easily handled.

[0142] In the above-mentioned example, a metal plating layer comprising the abrasive grain layer 93 can be formed by a metal which is not limited to Ni, and other metals can used. A method for forming the metal layer is not limited to electroplating, and the metal layer can be formed on the dresser principal 83 by PVD or CVD.

[0143] The present invention is not limited to the examples as mentioned above and various modified examples are included which contain the combinations of the examples (for examples, a combination of Example 1 and Example 2, and the combinations of any of Examples 1 to 4 and Example 5).

Claims

1. A dresser for dressing a polishing pad used for polishing a material to be polished, the dresser comprising:

   a dresser principal and a dressing-working part which is provided as a body other than the dresser principal; and
   a holding means for holding the dressing-working part in such a manner that the dressing-working part can be attached to and detached from the dresser principal.

2. The dresser as claimed in claim 1, wherein a projection adjusting means is provided for controlling an amount of projection of said dressing-working part from said dresser principal.

3. The dresser as claimed in claim 2, wherein said dressing-working part is a cutter.

4. The dresser as claimed in claim 3, wherein said cutter has an approximately columnar shape and comprises: a flank which is formed by concaving one end face of the cutter toward the base end of the cutter; a rake face comprising a circumferential surface in the end portion of the cutter; and a cutting edge which is a ridgeline formed by crossing of the end face and the circumferential surface in the end

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portion.

5. The dresser as claimed in claim 3, wherein said cutter comprises:

a plurality of projections formed in one end of the cutter;
said projection having a cross section approximately equal to an end face of the projection from one end of the projection to near another end of the projection from which the projection is started; and
a cutting edge which is a ridgeline formed by crossing of the end face of the projection and the side surface of the projection.

6. The dresser as claimed in claim 1, wherein said dressing-working part is a cutter.

7. The dresser as claimed in claim 6, wherein said cutter has an approximately columnar shape and comprises: a flank which is formed by concaving one end face of the cutter toward the base end of the cutter; a rake face comprising a circumferential surface in the end portion of the cutter; and a cutting edge which is a ridgeline formed by crossing of the end face and the circumferential surface in the end portion.

8. The dresser as claimed in claim 6, wherein said cutter comprises:

a plurality of projections formed in one end of the cutter;
said projection having a cross section approximately equal to an end face of the projection from one end of the projection to near another end of the projection from which the projection is started; and
a cutting edge which is a ridgeline formed by crossing of the end face of the projection and the side surface of the projection.

9. A dressing apparatus for dressing with a dresser the surface of a polishing pad used for polishing a material to be polished, said dresser comprising a dresser according to claim 1.

10. A dresser for dressing a polishing pad used for polishing a material to be polished, said dresser comprising a plurality of dressing-working parts for dressing the polishing pad which are disposed at unequal spaces in the circular direction of a dresser principal.

11. A dressing apparatus for dressing with a dresser the surface of a polishing pad used for polishing a material to be polished, said dresser comprising a dresser according to claim 10.

12. A dresser for dressing a polishing pad used for polishing a material to be polished, said dresser comprising: a dressing-working part for dressing the polishing pad along the circular direction of a dresser principal; and a plurality of nicks formed in the dressing-working part at unequal spaces in the circular direction of the dresser principal.

13. A dressing apparatus for dressing with a dresser the surface of a polishing pad used for polishing a material to be polished, said dresser comprising a dresser according to claim 12.

14. A dresser for dressing a polishing pad surface which is used for an apparatus for polishing, with the polishing pad, materials to be polished such as a semiconductor wafer having a flat surface, said dresser comprising at least one cutter projected from the under surface of a dresser principal,
wherein shaving the polishing pad surface is carried out by providing to the edge of cutter of the cutter a movement relative to the polishing pad surface in a direction parallel to the polishing pad surface, while the edge of cutter is pressed against the polishing pad surface.

15. The dresser as claimed in claim 14, wherein said edge of cutter comprises a flat surface which is parallel to the polishing pad surface and is pressed against the polishing pad surface.

16. The dresser as claimed in claim 14, wherein said cutter comprises a positive rake angle.

17. The dresser as claimed in claim 14, wherein said cutter comprises a rake angle having from -5° to -15°.

18. The dresser as claimed in claim 14, wherein said dresser principal has a circular shape and is constructed in such a manner that the dresser principal is rotated around a rotary shaft formed in the center thereof; and the edge of cutter of the cutter is arranged in such a manner that the edge of cutter has a negative angle wherein a rotational direction of the dresser principal is defined as positive to a straight line passing through the edge of end of the edge of cutter at the center side of the dresser principal and the center of the dresser principal.

19. A dresser which comprises a dresser principal and a dresser-working part having an abrasive grains layer including abrasive grains formed on the dresser principal,
wherein the dresser principal comprises a ground face on which the abrasive-grain layer is provided

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and a basic face which is disposed in a portion of the dresser principal more inward than the ground face and is formed in parallel to the ground face.

20. The dresser as claimed in claim 19, wherein said ground face comprises an approximately annular shape having a center which is the same as the center of rotation of said dresser principal; and the basic face is disposed in a position closer to the center of rotation than the ground face and is concentric with the ground face.

FIG. 1

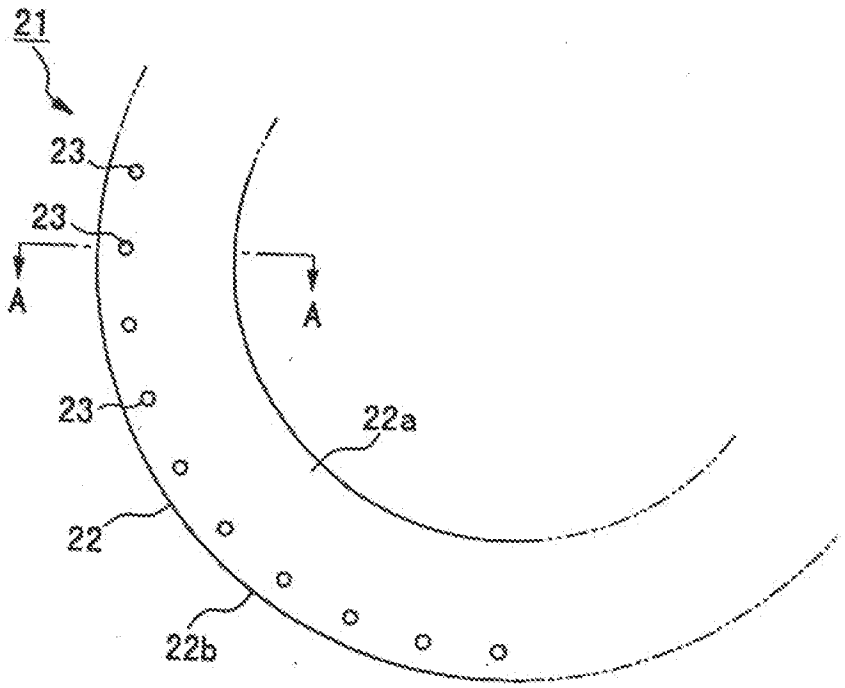


FIG. 2

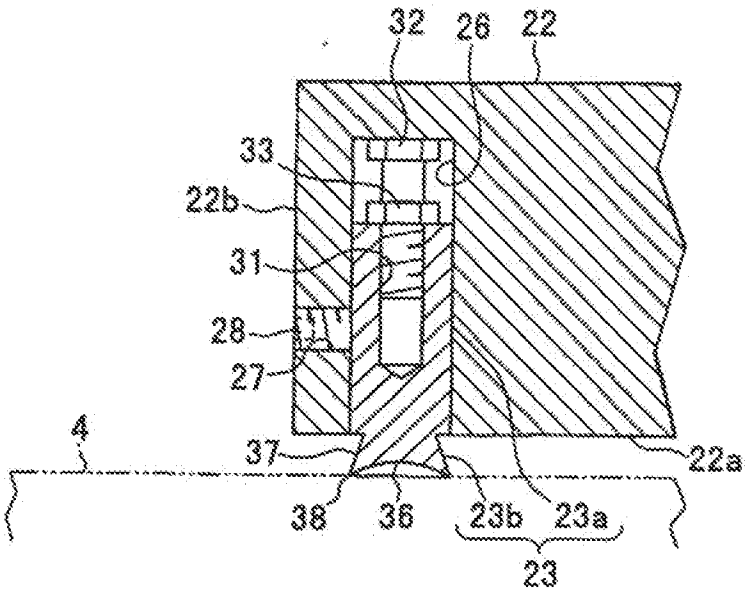

32
26
22
33
22b
31
28
27
4
37
22a
38
36
23b
23a
23

FIG. 3

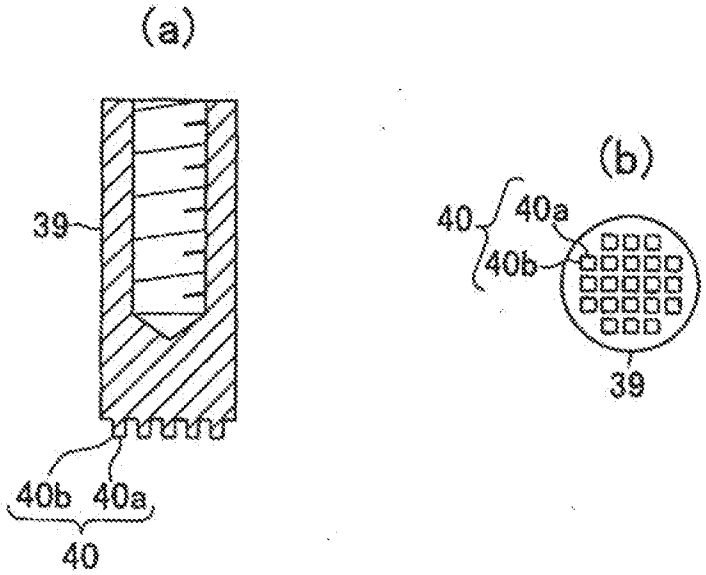

(a)
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40b
40a
40
(b)
40
40a
40b
39

FIG. 4

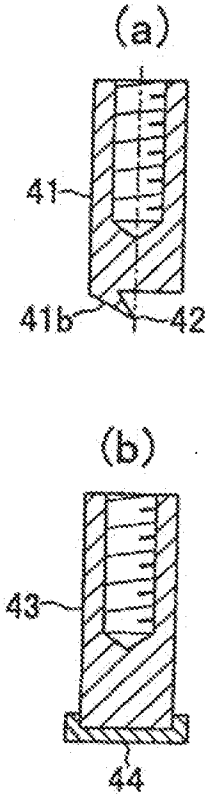


FIG. 5

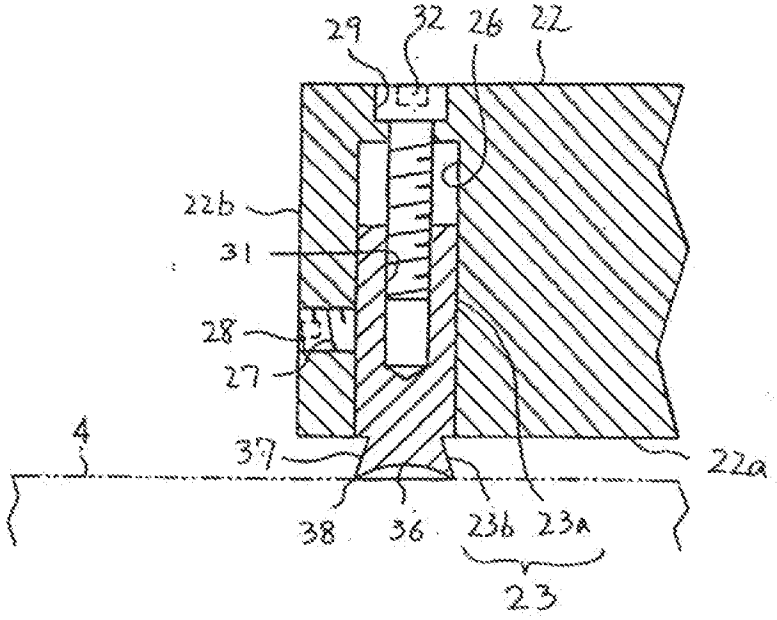


FIG. 6

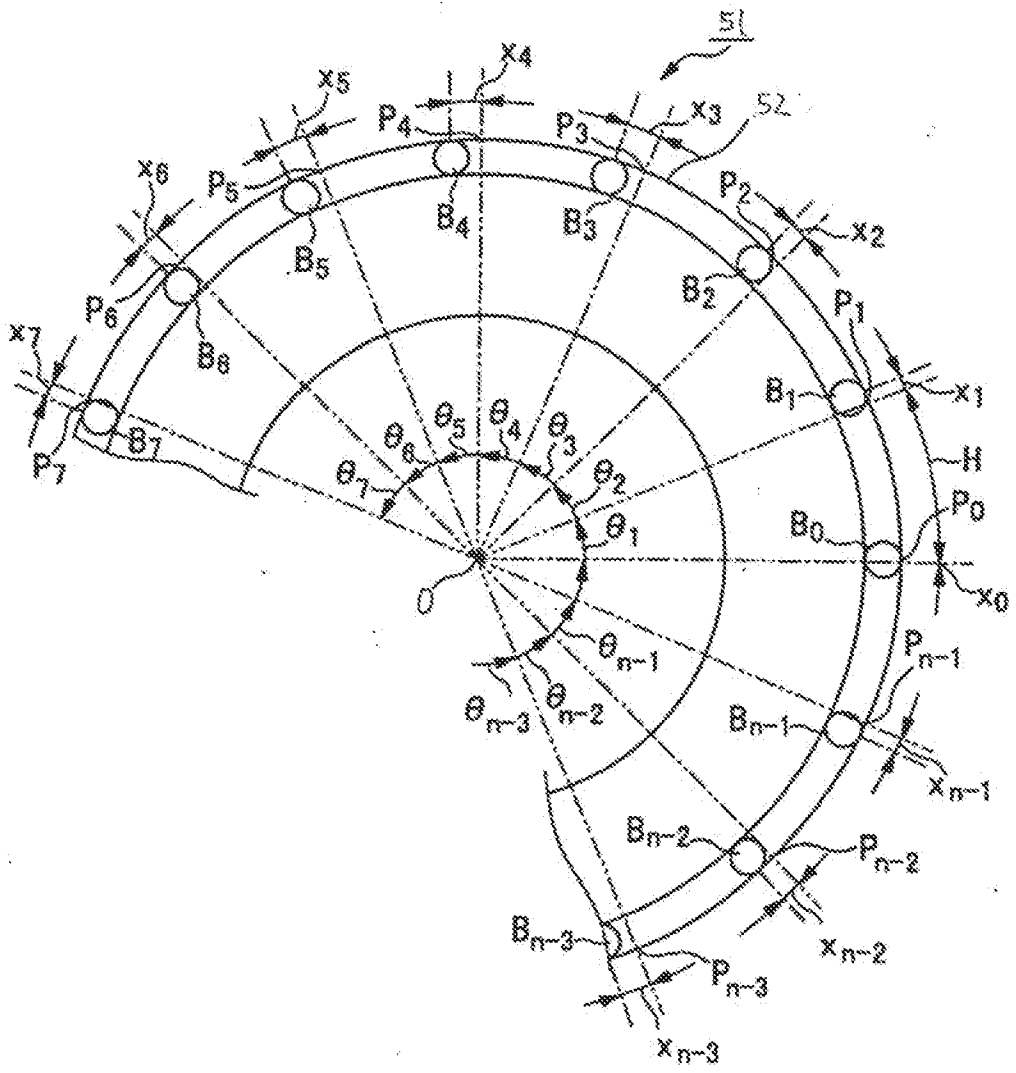

51
52
x_4
x_5
x_3
P_4
P_3
x_6
P_5
P_2
x_2
B_4
B_3
B_5
B_2
P_6
P_1
x_7
B_6
B_1
x_1
B_7
θ_5
θ_4
θ_3
θ_6
H
P_7
θ_7
θ_2
P_0
θ_1
B_0
x_0
O
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θ_{n-3}
θ_{n-2}
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x_{n-2}
P_{n-3}
x_{n-3}

FIG. 7

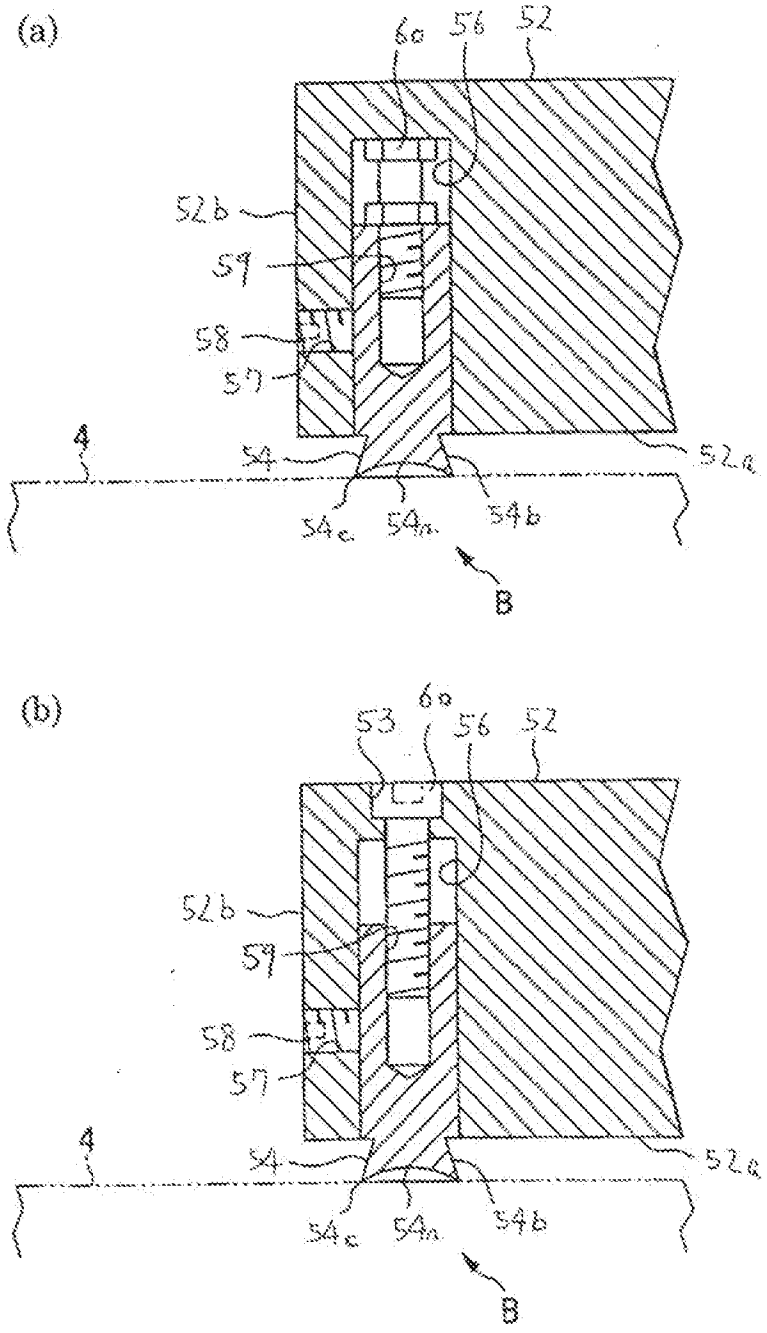

(a)
6a
56
52
52b
59
58
57
4
54
52a
54c
54a
54b
B
(b)
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54a
54b
B

FIG. 8

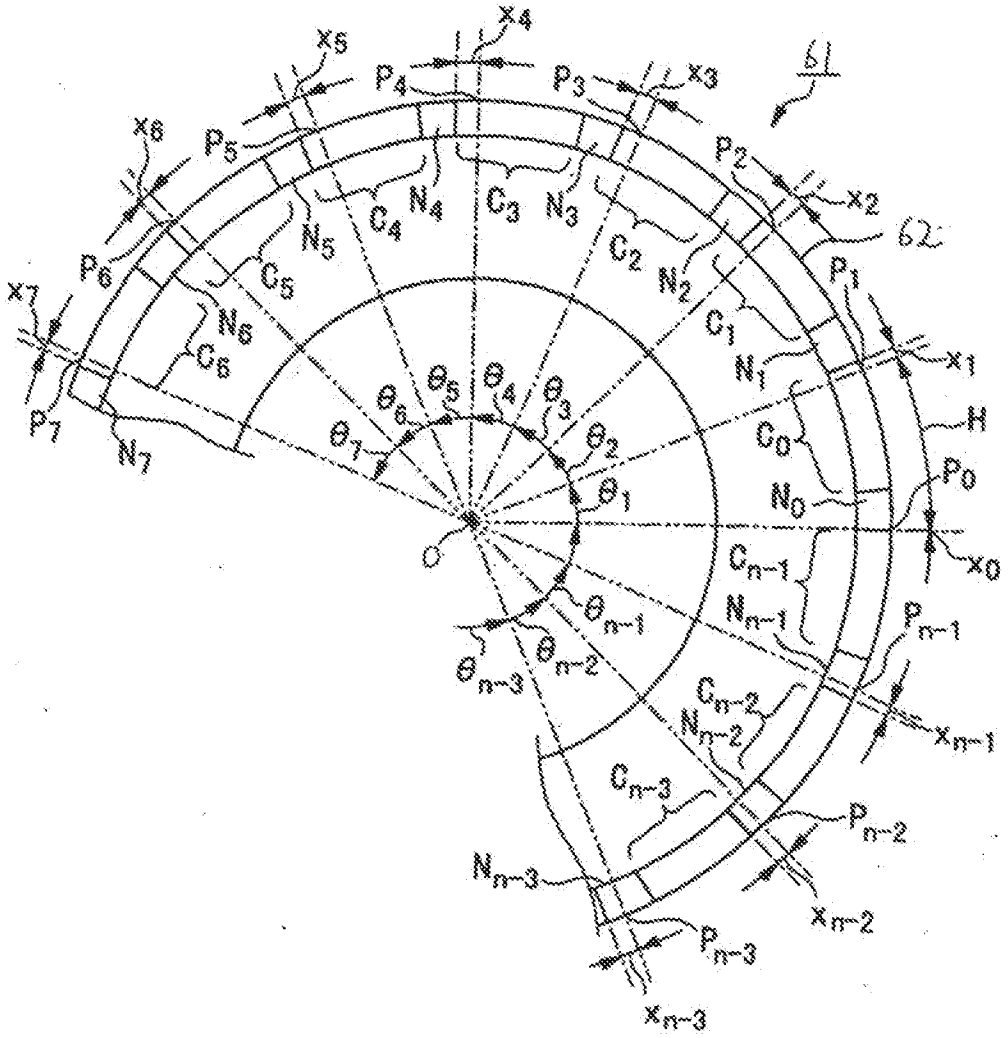

X4
X5
P4
P3
X3
61
X6
P5
P2
X2
62
P6
N4
C3
N3
N5
C4
C2
N2
P1
X7
C5
C1
X1
N6
N1
C6
H
θ5
θ4
θ3
θ6
C0
P7
θ2
P0
θ1
N0
N7
θ7
O
Cn-1
X0
θn-1
Nn-1
Pn-1
θn-3
θn-2
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Pn-3
Xn-3

FIG. 9

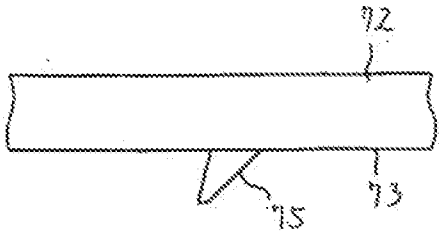


FIG. 10

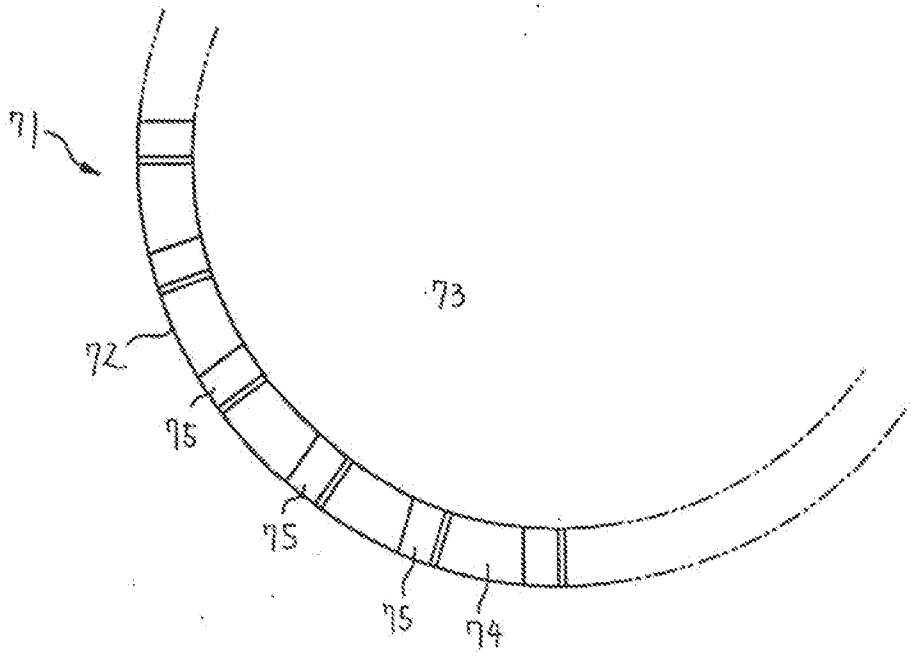


FIG. 11

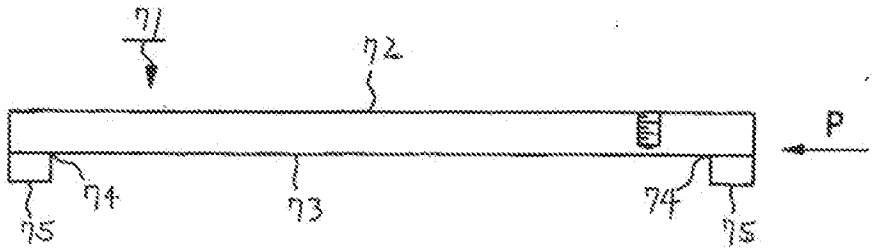


FIG. 12

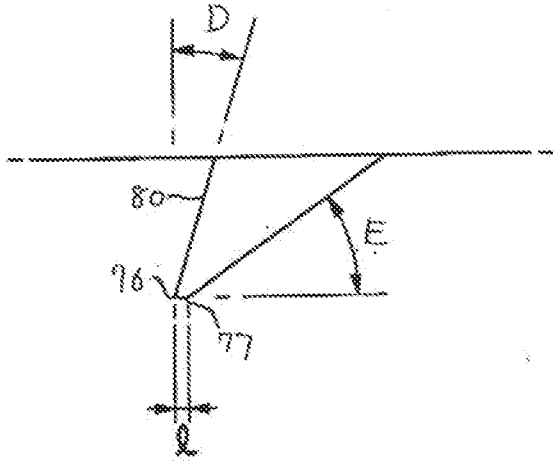


FIG. 13

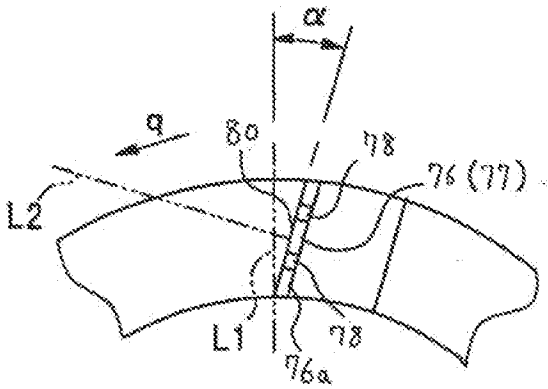


FIG. 14

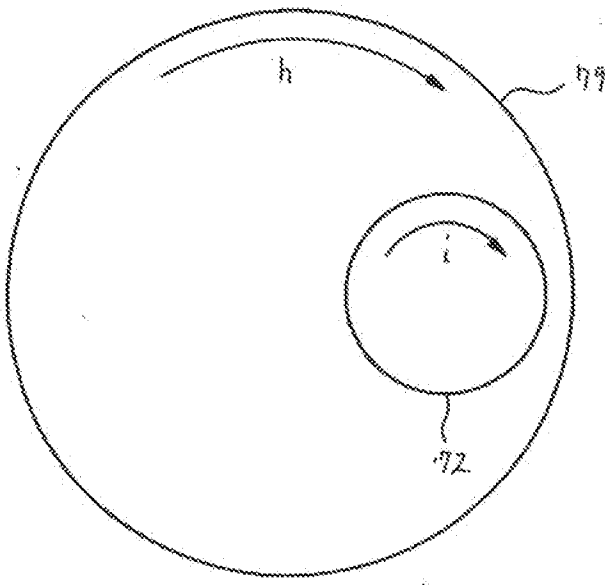


FIG. 15

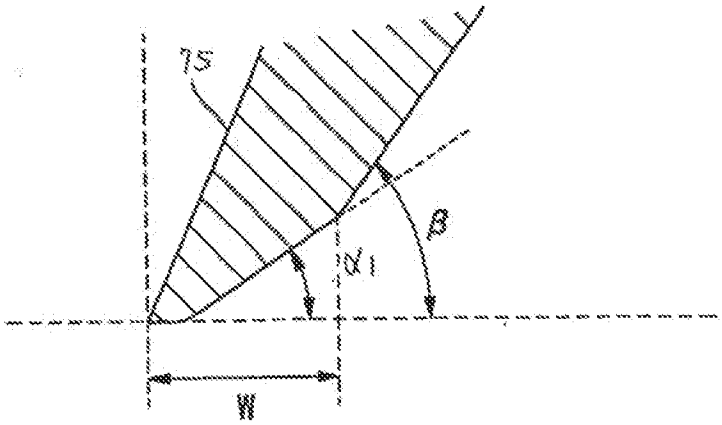


FIG. 16

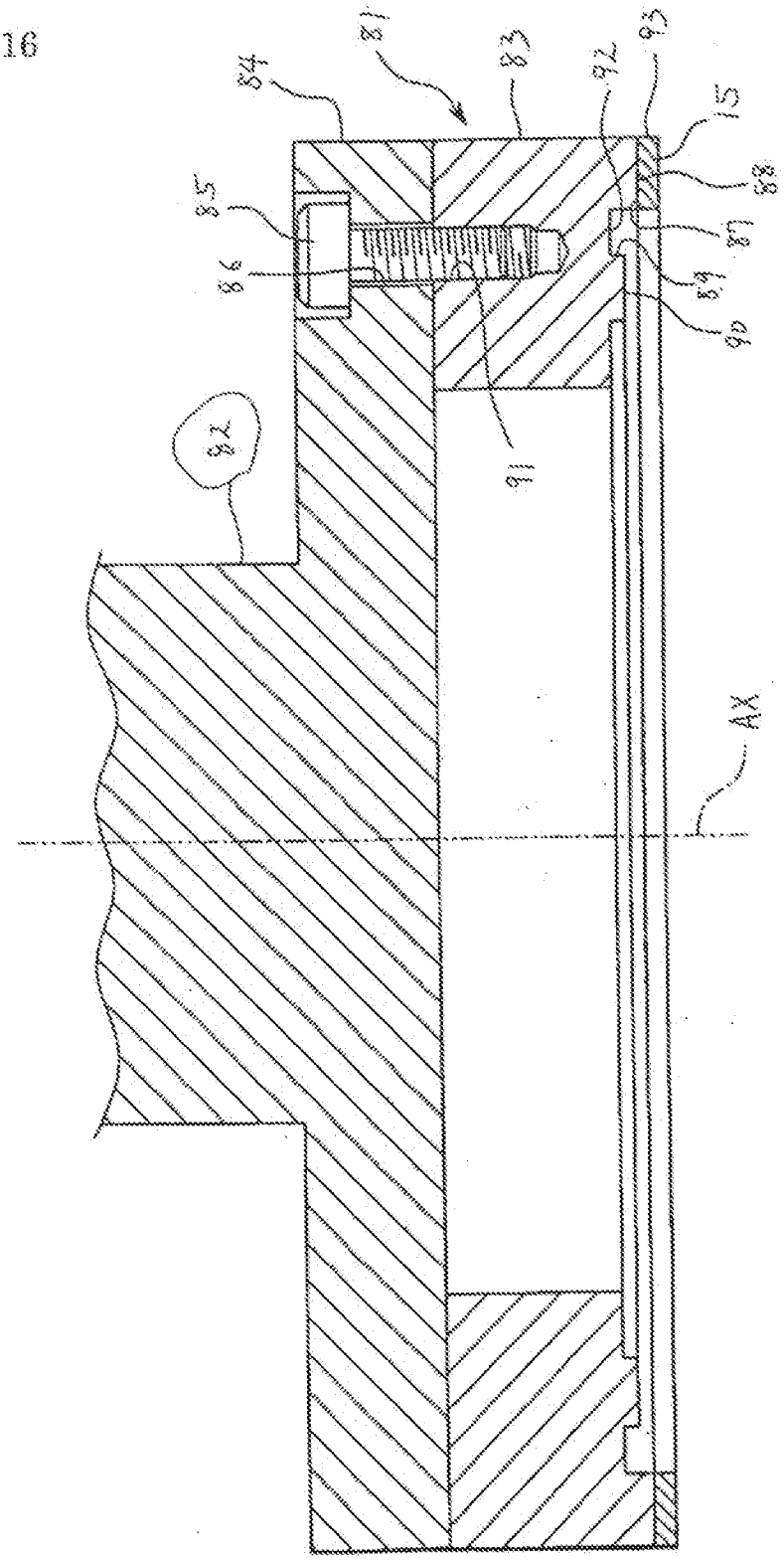


FIG. 17

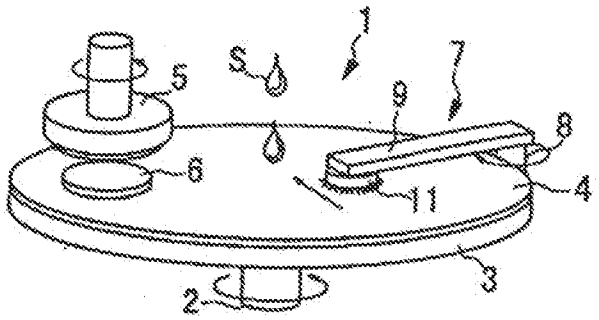


FIG. 18

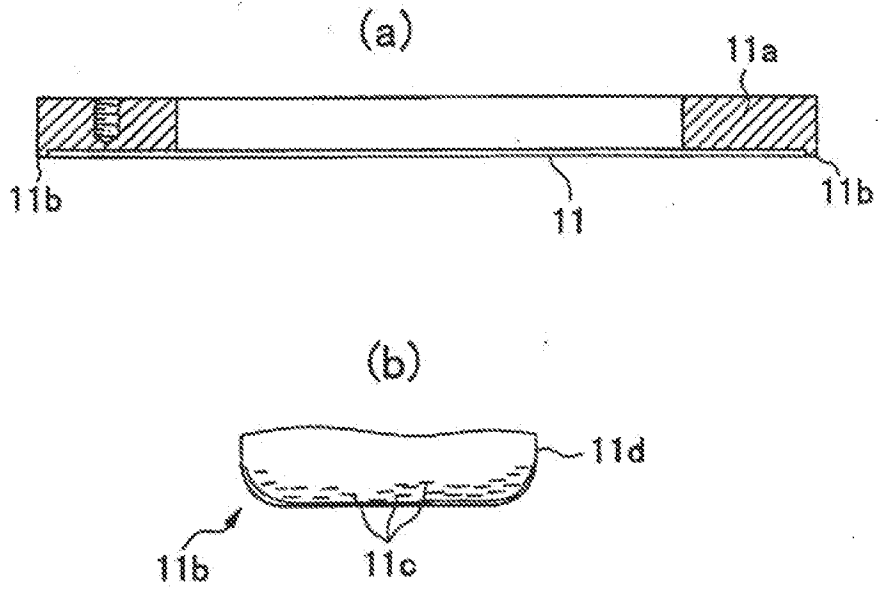


FIG. 19

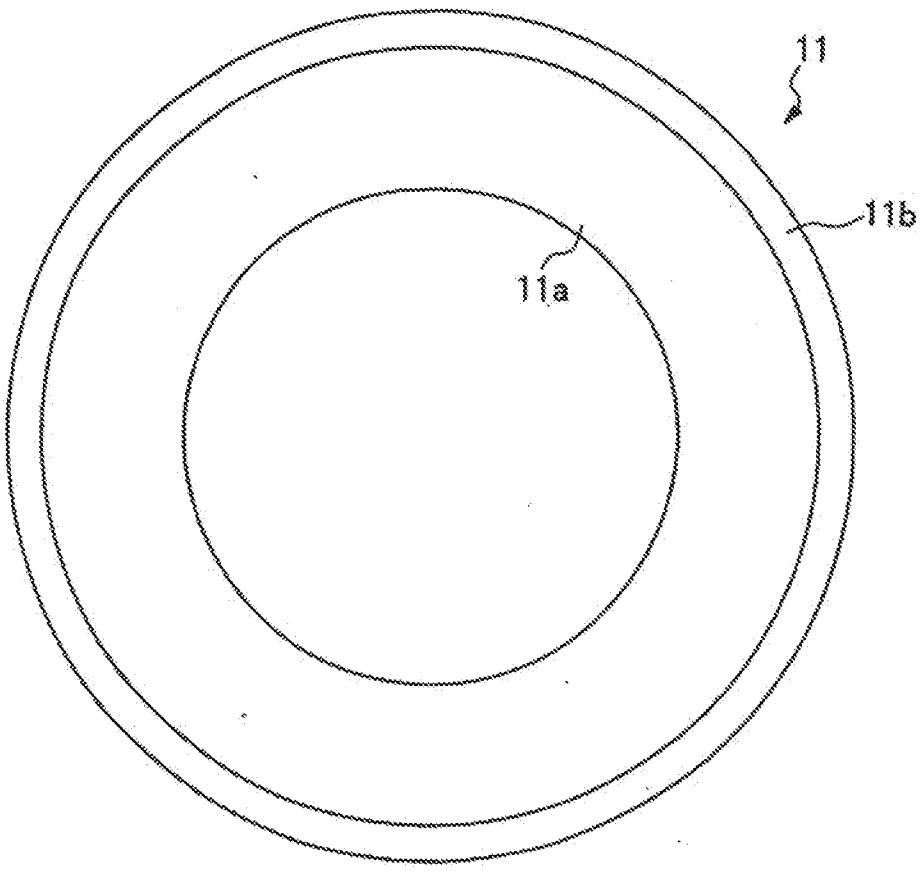


FIG. 20

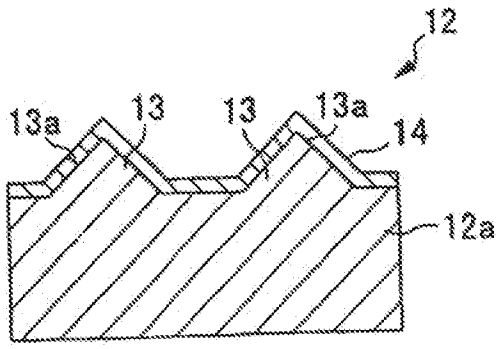
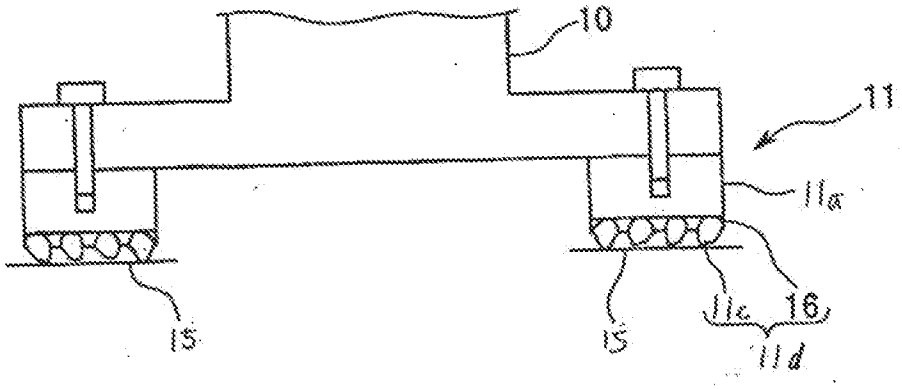


FIG. 21



Electronic Acknowledgement Receipt

EFS ID:	12464646
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/kelley warner
Filer Authorized By:	David William Osborne
Attorney Docket Number:	00802-32779.NP.CIP2
Receipt Date:	04-APR-2012
Filing Date:	18-MAR-2010
Time Stamp:	11:32:58
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	79361 7ccdb3d2dd117f1355c3706d8dfbddb9121684fc	no	4

Warnings:	
Information:	

2	Information Disclosure Statement (IDS) Form (SB08)	a.PDF	105267 1d638a81a8f182839da75c7f269c6a98bc9adaad	no	1
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4	Non Patent Literature	oa.pdf	1652102 0c041392a865f415ad35fff8e67a096c0538bb36	no	31
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5	Foreign Reference	EP1075898.pdf	5012809 4438f6d902080056b0087c054513e271017ff368	no	29
Warnings:					
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			Total Files Size (in bytes):	6926171	

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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.

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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.

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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: 04/04/2012 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.

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☐ 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.

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REMARKS

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

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Dated this 4th day of April, 2012.

Respectfully submitted,

/David W. Osborne/

David W. Osborne
Attorney for Applicant
Registration No. 44,989

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

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	
Examiner Name	
Attorney Docket Number	3356-32779.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]
		US Application 12/267,172; filing date 11/07/2008; Chein-Min Sung; office action issued 01/03/2012	

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.**

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

Electronic Acknowledgement Receipt

EFS ID:	12594065
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/kelley warner
Filer Authorized By:	David William Osborne
Attorney Docket Number:	00802-32779.NP.CIP2
Receipt Date:	20-APR-2012
Filing Date:	18-MAR-2010
Time Stamp:	15:45:23
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	79314 07cdf186a0fa0125920a18e3ddf9477115d788c0	no	4
Warnings:					
Information:					

2	Information Disclosure Statement (IDS) Form (SB08)	b.PDF	75989 dd0cff3327058cc4414c3539759a9ec9ad0c55de	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Non Patent Literature	oa.pdf	342849 2c36b48721dcba1fed167c8df001d08f79cd4545	no	9
Warnings:					
Information:					
			Total Files Size (in bytes):	498152	

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

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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.: 3356-32779.NP.CIP2	**CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8** DATE OF DEPOSIT: 04/20/2012 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:

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☐ 37 C.F.R. § 1.97(c), after a first office action on the merits, but before a Final Office Action or a Notice of Allowance, whichever occurs first, and is accompanied by **EITHER** a statement in accordance with 37 C.F.R. § 1.97(e), **OR** the fee set forth in 37 C.F.R. § 1.17(p); or

☐ 37 C.F.R. § 1.97(d), after a Final Office Action or Notice of Allowance, whichever occurs first, but on or before payment of the issue fee, and is accompanied by **BOTH** a statement in

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

SUBMISSIONS

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☐ 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)

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

REMARKS

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

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Dated this 20th day of April, 2012.

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

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

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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Electronic Acknowledgement Receipt

EFS ID:	12722097
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/kelley warner
Filer Authorized By:	David William Osborne
Attorney Docket Number:	00802-32779.NP.CIP2
Receipt Date:	07-MAY-2012
Filing Date:	18-MAR-2010
Time Stamp:	18:14:47
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	32779NPCIP2-Trans.PDF	79361 59a588acb5a9fc682feb7ce785da7bf2dd7e552c	no	4

Warnings:	
Information:	

2	Information Disclosure Statement (IDS) Form (SB08)	32779NPCIP2-B.PDF	76562 7c21aa772dc9d5b0d5896dc43ae1f7db2d266559	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Non Patent Literature	officeaction.pdf	342849 2c36b48721dcba1fed167c8df001d08f79cd4545	no	9
Warnings:					
Information:					
		Total Files Size (in bytes):	498772		

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IN THE UNITED STATES PATENT & TRADEMARK OFFICE

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

Mail Stop Amendment
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Dated this 7th day of May, 2012.

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

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

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		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.

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	
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]
		US Application 12/255,823; filing date 10/22/2005; Chien-Min Sung; office action issued 03/07/2012	
		US Application 12/168,110; filing date 07/05/2008; Chien-Min Sung; office action issued 05/14/2012	
		US Application 12/715,583; filing date 03/02/2010; Chien-Min Sung; office action issued 03/21/2012	

Examiner Signature		Date Considered	

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[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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Electronic Acknowledgement Receipt

EFS ID:	12958431
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/kelley warner
Filer Authorized By:	David William Osborne
Attorney Docket Number:	00802-32779.NP.CIP2
Receipt Date:	07-JUN-2012
Filing Date:	18-MAR-2010
Time Stamp:	14:09:59
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	79587 f12470843160e3545f2be68b3224b1b316ac0612	no	4

Warnings:	
Information:	

2	Information Disclosure Statement (IDS) Form (SB08)	A.PDF	106427 a9282ed610f2bcf90e02b34c36e5dc7782649cd9	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Information Disclosure Statement (IDS) Form (SB08)	B.PDF	77813 800290e521d3e4c6a0d93dffd63a51e3d333e8e0	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
4	Non Patent Literature	32779OA.pdf	1476592 3e2c0ced3dc992f2353a359e581a33b3e8075e49	no	28
Warnings:					
Information:					
5	Non Patent Literature	32779NPOA.pdf	1549910 1388c7700899be53c5ea824e32426c4fda65ef47	no	30
Warnings:					
Information:					
6	Non Patent Literature	25023DIVCONOA.pdf	250406 fa96fc3ab4692bffb15f871767f5c7d197c79114	no	7
Warnings:					
Information:					
		Total Files Size (in bytes):	3540735		

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

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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

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

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

ART UNIT: 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: 06/07/2012 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 7th day of June, 2012.

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

PTO/SB/08A (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

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
		2008/0271384	11/06/2008	Puthanangady et al.	
		7198553	04/03/2007	Goers	

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		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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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 [ ]

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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]
		PCT Application PCT/US2011/052627; filing date 09/21/2011; Chien-Min Sung; International Search Report mailed 05/11/2012	

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.**

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:

DAVID W. OSBORNE

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

RECEIVED
MAY 18 2012
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)* 11 MAY 2012 (11.05.2012)	
Applicant's or agent's file reference 3356-32820.PCT2	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. **PCT/US2011/052627**	International filing date *(day/month/year)* **21 SEPTEMBER 2011 (21.09.2011)**
Applicant **SUNG CHIEN-MIN et al**	

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 Government Complex-Daejeon, 189 Cheongsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea	Authorized officer COMMISSIONER
Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-8753

Form PCT/ISA/220 (July 2010)

OVER

* 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 : **PJGDHYKN**

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

Notes to Form PCT/ISA/220 (July 2010)

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.
3356-32820.PCT2		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2011/052627	**21 SEPTEMBER 2011 (21.09.2011)**	21 SEPTEMBER 2010 (21.09.2010)

Applicant

SUNG CHIEN-MIN et al

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

This international search report consists of a total of **4** 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. **4**
      ☒ 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/US2011/052627

A. CLASSIFICATION OF SUBJECT MATTER

B24B 53/12(2006.01)i, H01L 21/304(2006.01)i, B24D 18/00(2006.01)i, B24B 37/04(2006.01)i, B24D 7/06(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)

B24B 53/12; C09K 3/14; B24D 3/06; B24B 1/00; B24B 21/18

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, abrasive, particle, layer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2008-0271384 A1 (THOMAS PUTHANANGADY et al.) 06 November 2008 See paragraphs 22-38 and figures 2-6.	1-13,18-23 14-17
Y	US 7198553 B2 (BRIAN D. GOERS) 03 April 2007 See column 3, line 13 - column 4, line 33 and figure 5.	14-17
A	US 7651386 B2 (CHIEN-MIN SUNG) 26 January 2010 See column 14, line 29 - column 18, line 14 and figures 1-6.	1,12,22
A	US 2006-0073774 A1 (CHIEN-MIN SUNG) 06 April 2006 See paragraphs 54-57 and figures 1-4.	1,12,22

☐ 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
10 MAY 2012 (10.05.2012)	**11 MAY 2012 (11.05.2012)**

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
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Facsimile No. 82-42-472-7140

Authorized officer

MYUNG Dae Keun

Telephone No. 82-42-481-8417

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

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2011/052627

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008-0271384 A1	06.11.2008	AT 515372 T	15.07.2011
		CN 101563188 A	21.10.2009
		EP 2083967 A1	05.08.2009
		EP 2083967 B1	06.07.2011
		KR 10-1140243 B1	26.04.2012
		KR 2009-0082360 A	30.07.2009
		TW 200849360 A	16.12.2008
		WO 2008-036892 A1	27.03.2008
US 7198553 B2	03.04.2007	AU 1998-93829 A1	01.11.1999
		CA 2327448 A1	21.10.1999
		EP 1071540 A1	31.01.2001
		EP 1071540 B1	31.03.2004
		EP 1459847 A2	22.09.2004
		EP 1459847 A3	06.10.2004
		JP 2002-511345 A	16.04.2002
		JP 4409766 B2	20.11.2009
		US 2004-0033772 A1	19.02.2004
		US 2004-0180617 A1	16.09.2004
		US 6123612 A	26.09.2000
		US 6629884 B1	07.10.2003
		US 7641538 B2	05.01.2010
		WO 99-52677 A1	21.10.1999
US 7651386 B2	26.01.2010	CN 101001934 A	18.07.2007
		CN 101001934 B	08.12.2010
		CN 101001934 C0	18.07.2007
		CN 101137463 A0	05.03.2008
		CN 101528414 A	09.09.2009
		CN 101722475 A	09.06.2010
		CN 101878094 A	03.11.2010
		CN 101903131 A	01.12.2010
		EP 1879719 A2	23.01.2008
		JP 2008-540154 A	20.11.2008
		KR 10-2008-0007343 A	18.01.2008
		KR 10-2008-0045075 A	22.05.2008
		KR 10-2008-0065612 A	14.07.2008
		KR 10-2010-0087297 A	04.08.2010
		KR 10-2010-0106328 A	01.10.2010
		TW I304761A	01.01.2009
		TW I315691A	11.10.2009
		TW 200911462 A	16.03.2009
		TW 200927382 A	01.07.2009
		US 2006-0042172 A1	02.03.2006
		US 2006-0258276 A1	16.11.2006
		US 2007-0060026 A1	15.03.2007
		US 2007-0155298 A1	05.07.2007
		US 2007-0249270 A1	25.10.2007
		US 2007-0264918 A1	15.11.2007

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2011/052627

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 2008-0028686 A1	07.02.2008
		US 2008-0171503 A1	17.07.2008
		US 2009-0068937 A1	12.03.2009
		US 2009-0093195 A1	09.04.2009
		US 2009-0123705 A1	14.05.2009
		US 2010-0139174 A1	10.06.2010
		US 2010-0221988 A1	02.09.2010
		US 2010-0221990 A1	02.09.2010
		US 2010-0248596 A1	30.09.2010
		US 2011-212670 A1	01.09.2011
		US 7384436 B2	10.06.2008
		US 7658666 B2	09.02.2010
		US 7690971 B2	06.04.2010
		US 7762872 B2	27.07.2010
		US 7901272 B2	08.03.2011
		WO 2006-023845 A1	02.03.2006
		WO 2006-124792 A2	23.11.2006
		WO 2006-124792 A3	23.11.2006
		WO 2007-032946 A2	22.03.2007
		WO 2007-032946 A3	22.03.2007
		WO 2007-032946 A3	16.04.2009
		WO 2008-063599 A2	29.05.2008
		WO 2008-063599 A3	29.05.2008
		WO 2009-043058 A2	02.04.2009
		WO 2009-043058 A3	02.04.2009
		WO 2009-064677 A2	22.05.2009
		WO 2009-064677 A3	22.05.2009
US 2006-0073774 A1	06.04.2006	CN 101039775 A0	19.09.2007
		CN 101039775 B	15.12.2010
		EP 1793965 A2	13.06.2007
		JP 2008-514446 A	08.05.2008
		JP 2008-514446 T	08.05.2008
		KR 10-2007-0063570 A	19.06.2007
		TW I306048A	11.02.2009
		US 2009-0186561 A1	23.07.2009
		US 7491116 B2	17.02.2009
		US 8043145 B2	25.10.2011
		WO 2006-039413 A2	13.04.2006

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
DAVID W. OSBORNE

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

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)* **11 MAY 2012 (11.05.2012)**

Applicant's or agent's file reference
3356-32820.PCT2

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2011/052627	**21 SEPTEMBER 2011 (21.09.2011)**	21 SEPTEMBER 2010 (21.09.2010)

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

B24B 53/12(2006.01)i, H01L 21/304(2006.01)i, B24D 18/00(2006.01)i, B24B 37/04(2006.01)i, B24D 7/06(2006.01)i

Applicant

SUNG CHIEN-MIN et al

DOCKETED

Description	Due Date	Initials
Response	8-11-12	dc

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

- [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
- [ ] Box No. VIII Certain observations on the international application

INITIAL

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 Government Complex-Daejeon, 189 Cheongsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	10 MAY 2012 (10.05.2012)	MYUNG Dae Keun Telephone No.82-42-481-8417

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

DOCKETED MAY 23 2012 TNW

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2011/052627

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/US2011/052627

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	1-23	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-23	NO
Industrial applicability (IA)	Claims	1-23	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following documents:

D1: US 2008-0271384 A1 (THOMAS PUTHANANGADY et al.) 06 November 2008
D2: US 7198553 B2 (BRIAN D. GOERS) 03 April 2007
D3: US 7651386 B2 (CHIEN-MIN SUNG) 26 January 2010
D4: US 2006-0073774 A1 (CHIEN-MIN SUNG) 06 April 2006

1. Novelty and Inventive Step

1.1 Independent Claim 1

D1, which is considered to be the closest prior art to the subject matter of claim 1, discloses a CMP pad dresser comprising a first monolayer of superabrasive particles disposed on and coupled to one side of a substrate, and a second monolayer of superabrasive particles disposed on and coupled to the substrate on an opposite side from the first monolayer. Claim 1 differs from D1 in that a CMP pad dresser of claim 1 comprises superabrasive particles of a first monolayer having substantially the same distribution as superabrasive particles of a second monolayer. However, it would be easily predicted by the feature that the dresser of D1 comprises superabrasive particles equally applicable on both sides of the substrate. Therefore, claim 1 lacks an inventive step under PCT Article 33(3).

1.2 Dependent Claims 2-11

1.2.1 Concerning Claim 2-7

The additional features of claims 2-7 to be related with the material of superabrasive particles would be easily predicted by the feature that the CMP pad dresser of D1 comprises diamond and cubic boron nitride as the material of superabrasive particles. Therefore, claims 2-7 lack an inventive step under PCT Article 33(3).

1.2.2 Concerning Claim 8

The additional feature of claim 8 would be easily predicted by the feature that the CMP pad dresser of D1 comprises a zirconia support coupled to the second monolayer. Therefore, claim 8 lacks an inventive step under PCT Article 33(3).

(Continued on Supplemental Box)

Supplemental Box

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

Box V

1.2.3 Concerning Claim 9 and 10

The additional features of claims 9 and 10 to be related with a braze alloy would be easily predicted by the feature that the CMP pad dresser of D1 comprises brazing alloy to couple the first and second monolayers to the substrate. Therefore, claims 9 and 10 lack an inventive step under PCT Article 33(3).

1.2.4 Concerning Claim 11

The additional feature of claim 11 would be easily predicted by the feature that the dresser of D1 comprises superabrasive particles equally applicable on both sides of the substrate. Therefore, claim 11 lacks an inventive step under PCT Article 33(3).

1.3 Independent Claim 12

D1, which is considered to be the closest prior art to the subject matter of claim 12, discloses a method of making a CMP pad dresser comprising the steps of disposing a first monolayer of superabrasive particles on a substrate; disposing a second monolayer of superabrasive particles on the substrate on a side opposite the first monolayer, wherein the superabrasive particles of the second monolayer are positioned to have substantially the same distribution as the superabrasive particles of the first monolayer; and bonding the first monolayer and the second monolayer to the substrate. Claim 12 differs from D1 in that a method of claim 12 comprises bonding monolayers to a metal suppport layer such that symmetrical forces precludes substantial warping of the metal support layer. However, it would be easily predicted by the feature that the method of D1 comprises superabrasive particles equally applicable on both sides of the substrate. Therefore, claim 12 lacks an inventive step under PCT Article 33(3).

1.4 Dependent Claims 13-21

1.4.1 Concerning Claim 13

The additional feature of claim 13 would be easily predicted by the feature that the method of D1 comprises brazing alloy to couple the first and second monolayers to the substrate. Therefore, claim 13 lacks an inventive step under PCT Article 33(3).

1.4.2 Concerning Claims 14 and 17

The additional features of claims 14 and 17 would be easily predicted by the feature that a method of D2 comprises the step of bonding abrasive particles (6) to a substrate (4) under heat and pressure. Accordingly, claims 14 and 17 would have been obvious over D1 in view of D2. Therefore, claims 14 and 17 lack an inventive step under PCT Article 33(3).

(Continued on Next Page)

Supplemental Box

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

Previous Page

1.4.3 Concerning Claims 15 and 16

The additional features of claims 15 and 16 dependent on claim 14 would be easily predicted by the feature that the method of D1 comprises the steps sintering and brazing during bonding. Therefore, claims 15 and 16 lack an inventive step under PCT Article 33(3).

1.4.4 Concerning Claim 18

The additional feature of claim 18 would be easily predicted by the feature that the method of D1 comprises superabrasive particles equally applicable on both sides of the substrate. Therefore, claim 18 lacks an inventive step under PCT Article 33(3).

1.4.5 Concerning Claims 19 and 21

The additional features of claims 19 and 21 would be easily predicted by the feature that the method of D1 comprises a zirconia support coupled to the second monolayer. Therefore, claims 19 and 21 lack an inventive step under PCT Article 33(3).

1.4.6 Concerning Claim 20

The additional feature of claim 20 would be easily predicted by the feature that the method of D1 comprises the steps sintering and brazing during bonding. Therefore, claim 20 lacks an inventive step under PCT Article 33(3).

1.5 Independent Claim 22

D1, which is considered to be the closest prior art to the subject matter of claim 22, discloses a method of minimizing warpage of a CMP pad dresser comprising bonding a plurality of superabrasive particles to a substrate. Claim 22 differs from D1 in that a method of claim 22 comprises the step of substantially equalizing warping forces on opposing sides of a metal support layer. However, it would be easily predicted by the feature that the method of D1 comprises superabrasive particles equally applicable on both sides of the substrate. Therefore, claim 22 lacks an inventive step under PCT Article 33(3).

1.6 Dependent Claim 23

The additional feature of claim 23 would be easily predicted by the feature that the method of D1 comprises superabrasive particles equally applicable on both sides of the substrate. Therefore, claim 23 lacks an inventive step under PCT Article 33(3).

2. Industrial Applicability

Claims 1-23 are industrially applicable under PCT Article 33(4).

Electronic Acknowledgement Receipt

EFS ID:	13474057
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/kelley wanrer
Filer Authorized By:	David William Osborne
Attorney Docket Number:	00802-32779.NP.CIP2
Receipt Date:	10-AUG-2012
Filing Date:	18-MAR-2010
Time Stamp:	18:24:46
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	79359 6299c1fd86ed00095dfa8227af51ddb0cddfb1cc	no	4

Warnings:	
Information:	

2	Information Disclosure Statement (IDS) Form (SB08)	a.PDF	104045 562ef1afb7f1dd919b7aa0e91278828caeef1ff9	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Information Disclosure Statement (IDS) Form (SB08)	b.PDF	76692 58712c04e19936c9a4baa8e683d26ca43fe7994b	no	1
Warnings:					
Information:					
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4	Non Patent Literature	search.pdf	587766 3080ffcd30cdabcf3ce33a3ee9ffef3a321426ee	no	11
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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

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

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

ART UNIT: 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: 08/10/2012 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 10th day of August, 2012.

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

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
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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]
		US Application 13/021,350; filing date 02/04/2011; Chien-Min Sung; office action issued 08/10/2012	
		US Application 12/715,583; filing date 03/02/2010; Chien-Min Sung; office action issued 08/09/2012	
		US Application 12/267,172; filing date 11/07/2008; Chien-Min Sung; office action issued 07/09/2012	
		US Application 13/362,917; filing date 01/31/2012; Chien-Min Sung; office action issued 06/14/2012	
		US Application 12/168,110; filing date 07/05/2008; Chien-Min Sung; Notice of Allowance issued 09/28/2012	
		US Application 12/255,823; filing date 10/22/2008; Chien-Min Sung; Notice of Allownace issued 09/21/2012	
		Colmonoy Technical Data Sheet; no. DSP-A; 1993	
		Endecott's Specifications; 2004	
		Kennametal Specification for DMHPM002 Hot Press Matrix N-50 12/06/2001	
		Material Safety Data Sheet (MSDS), Wall Colmonoy Corporation; prepared 07/20/1989	
		Material Safety Data Sheet MSDS); Kennametal; issued 06/11/2004	
		SUNG et al.; The Eastern Wind of Diamond Symthesis; New Diamond and Frontier Carpon Technology; 2003; pages 47-61; vol. 13, no. 1	
		SUNG et al; Mechanism of the Solvent-Assisted Graphite to Diamond Transition Under High Pressure:	

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)

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

Sheet | | of |

		Implications for the Selection of Catalysts, High Temperatures-High Pressure; 1995/1996; pages 523-546; vol. 27/28	
		Syndite, CTM302; Announcement, Elementsix Advancing Diamond; 01/14/2003; http://www.e6.com/en/resourches/announcementsheets/CTM302.pdf; as accessed on 12/16/2008	
		Syndite, Elementsix Advancing Diamond; 2 pages	
		US Application 08/832,852; filing date 04/04/1997; Chien-Min Sung	
		US Application 09/447,620; filing date 11/22/1999; Chien-Min Sung	
		YASINAGA et al; Advances in Abrasive Technology, III; Soc. Of Grinding Engineers (SGE) in Japan; 2000	
		US Application 11/512/755; filed 08/29/2006; Chien-Min Sung	

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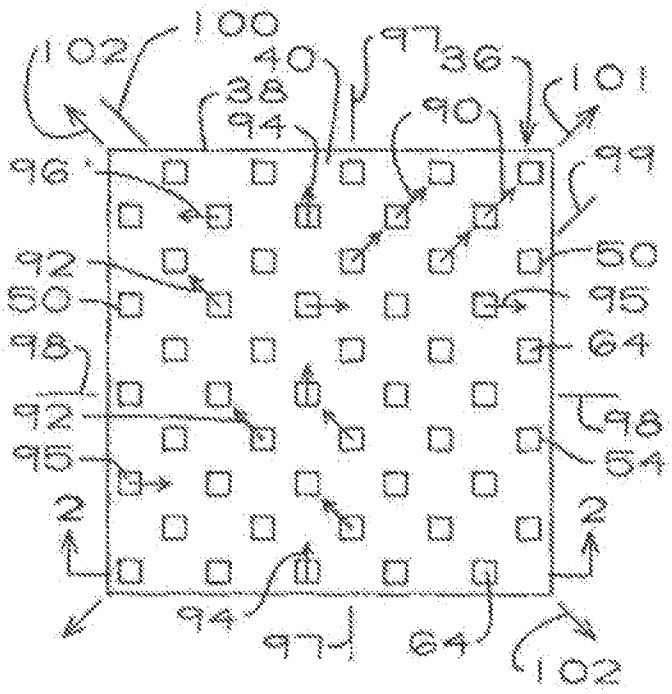
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(54) Title: ORIENTED CRYSTAL ASSEMBLIES

(57) Abstract

An article of manufacture comprising synthetic single crystals (50, 60, 350) of uniform size and shape selected from the group consisting of diamond or cubic boron nitride and held in a formation (figs. 1, 10, 39, 33) with selected crystallographic directions of the crystals oriented in the same direction so that the crystals as a group exhibit a common crystallographic direction (101, 102, 248, 360, 670, 672) which may selectively be the hardest or near-hardest direction, and a method of making such an article. Such orientation takes advantage of the hardness properties of the individual crystals by imparting such properties to the assembly. Various embodiments of the article are thus useful as an abrasive, a bearing, a heat sink or a semiconductor.



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Description

Oriented Crystal Assemblies

Technical Field

This invention relates to oriented crystal assemblies and more particularly to an article of oriented single synthetic crystals and to a method for making such an article.

Diamond has numerous physical properties that are well known and which have great utility for industrial purposes but which in the past have not been fully exploited. These properties include abrasion and wear-resistance, thermal conductivity, electrical insulation, and receptivity to the deposit of a layer of diamonds by chemical vapor deposition.

The very high degree of abrasion resistance exhibited by diamond varies with the crystallographic direction of hardness by a factor of as much as about one hundred times, and this most resistant direction is along the diagonal of a cubic face in the plane of the face. Diamond crystals also have another direction of high hardness along a line tangential to an edge of the crystal; crystals of cubic boron nitride (CBN) have a similar direction of high hardness.

Until the present invention, however, it has not been recognized how to take advantage of such crystallographic directions of hardness of diamond , CBN, and perhaps other materials, when these materials are employed to make an article having wear-resistant or abrasive qualities and other desired characteristics. Thus, the prior art devices have not optimized the hardness characteristics of a hard surface including particles of diamond and CBN.

Background Art

In abrasives, for example, the grits or particles of the prior art have been incorporated in a backing member in either a random manner or an oriented manner. The prior art orientation has been to disperse the grits uniformly (U.S. Patent No. 4,925,457), to arrange planar faces of the grits so they seat flat against a workpiece (U.S. Patent No. 3,230,672), or to orient the grit particles by electrostatic or electromagnetic means (U.S. Patent Nos. 4,240,807 and 5,203,881).

Although these orientations may provide useful abrasive articles, these and like prior art abrasive or wear-resistant articles have failed to take advantage of the maximum hardness available in the abrasive materials used, such as diamond and CBN. The concept of orienting particles in a backing member so as to transfer to the abrasive or wear-resistant surface as a whole the hardness qualities of the individual particles per se has not been recognized. Thus, it has not been known how to control the hardness of the surface either to insure that the resulting surface would have the maximum hardness possible or to provide a predetermined degree of hardness for abrasive or bearing applications.

For semiconductor applications, the Geis et al. PCT application and related article (WO 92/01827 published 6 February 1992, and Geis et al. "Large-Area Mosaic Films Approaching Single-Crystal Quality," *Applied Physical Letters*, Vol. 58, No. 22 (3 June 1991), 2485-2487) recognize that diamond's excellent electrical properties have not been fully utilized. These references teach the placing of synthetic diamond seed crystals of 0.10 mm diameter or less in spaced complementary pits or grooves, and subsequently growing a film about the seeds by chemical vapor deposition. Geis et al. intentionally separate the seed crystals to enable the CVD crystal growth to envelope the seeds. Thus, although Geis et al. state that such placement orients the crystallographic directions, their method creates spaces or gaps between adjacent seed crystals. They state that at the point where adjacent crystals merge, there is the possibility that crystal defects may occur. Moreover, Geis et al. is concerned with electrical applications and thus does not teach how to produce an abrasive or bearing surface having a crystallographic direction of maximum abrasive resistance.

Disclosure of the Invention

The present invention involves an article of manufacture comprising synthetic single crystals of uniform size and shape selected from the group consisting of diamond or cubic boron nitride and held in a formation with selected crystallographic directions of the crystals oriented in the same direction and to a method of making such an article. The article is useful as an abrasive, a bearing, a heat sink or a semiconductor.

It is an object of the present invention to maximize the characteristics of a surface composed of hard materials such as diamond, CBN, and perhaps other materials, to produce an article having various industrial uses, such as abrasives, bearings, heat sinks and semiconductors.

Another object is to provide an article composed of synthetic single crystals of diamond, CBN, and perhaps other materials, having their crystallographic directions oriented in the same direction.

It is a further object of this invention to take advantage of the fact that synthetic single crystals of diamond and CBN have predetermined crystallographic directions lying along lines in contact with certain portions of their crystals, by aligning these directions when the crystals are positioned in a working formation.

It is also an object to take advantage of the fact that diamond and CBN are commercially synthesized in shapes and sizes that permit single crystals of these materials to be oriented with their crystallographic directions aligned.

A further object is to provide an article including a formation of synthetic single crystals for abrading a workpiece which, as contrasted with prior art tools: abrades faster; lasts longer; requires less frequent replacement and adjustment; is less costly to operate; maintains tolerances longer; saves abrasive material; requires less power; and minimizes dulling or flatting of grains.

Another object is to provide a method for making the article of the present invention.

Brief Description Of The Drawings

Fig. 1 is a plan view of one embodiment of an abrasive article made in accordance with the present invention but showing the article on a greatly enlarged scale from actual size.

Fig. 2 is a cross-sectional view taken along line 2-2 of Fig. 1.

Fig. 3 is an isometric view of a single, synthetic, cubic crystal of diamond as used in the article of Fig. 1 but greatly enlarged from Fig. 1.

Fig. 4 is an isometric view of a single, synthetic, predominately cubic crystal of diamond, but with small octahedral facets, as used in the present invention and also greatly enlarged from actual size.

Fig. 5 is an enlarged view of a face of the cubic crystal of Fig. 3 showing directional lines of hardness and the Miller indices of the cube face and hardness directions.

Fig. 6 illustrates a step of the method of the present invention and specifically is an isometric view of a corner of a template containing three cubic crystals oriented by the template into desired positions.

Fig. 7 illustrates a portion of an alternate form of template used in practicing the method referred to in regard to Fig. 6.

Fig. 8 illustrates another step of the method of the present invention and specifically is a cross section of the template and crystals therein, as if taken along line 8-8 of Fig. 6 when the template is full of crystals, and further showing a backing member of epoxy overlaying the crystals and the template.

Fig. 9 is a cross-section taken along the same plane as Fig. 8 but showing the backing member and the crystals, that is the abrasive article, removed from the template.

Fig. 10 is a plan view of another embodiment of an abrasive article made in accordance with the present invention and also shown on a greatly enlarged scale from actual size.

Fig. 11 is a cross-sectional view taken along line 11-11 of Fig. 10.

Fig. 12 is an edge view of the cubic diamond crystal of Fig. 3, although on a reduced scale from Fig. 3, showing its orientation as used in the article of Fig. 10, but enlarged from Fig. 10, and further showing its second hardest directional line of hardness and Miller index.

Fig. 13 is a face view of the diamond crystal of Fig. 12.

Fig. 14 illustrates a step of an embodiment of the present method used to make the article shown in Fig. 10 and specifically is an isometric view of a corner of a template containing two cubic crystals oriented by the template into desired positions which differ from the positions of Fig. 6.

Fig. 15 illustrates a step similar to that illustrated by Fig. 8 but pertains to the method of making the article shown in Fig. 10 and specifically is a cross-section of the template and crystals therein, as if taken along line 15-15 of Fig. 14 when the template is full of crystals, and further showing a backing member of epoxy overlaying the crystals and the template.

Fig. 16 is a cross-section along the same plane as Fig. 15 but showing the article of Fig. 10 removed from the template.

Fig. 17 is a plan view of a portion of a variation of the second embodiment of an abrasive article made in accordance with the present invention.

Fig. 18 is an isometric view of part of a template for use in making the variation shown in Fig. 17.

Fig. 19 is a plan view of a third embodiment of an abrasive article made in accordance with the present invention using tetrahedral cubic boron nitride crystals and also shown on a greatly enlarged scale from actual size.

Figs. 20 and 21 are partial cross-sectional views taken along lines 20-20 and 21-21, respectively, of Fig. 19.

Fig. 22 is a greatly enlarged isometric view of a tetrahedral crystal of cubic boron nitride as used in the article of Fig. 19 but greatly enlarged from Fig. 19 and showing Miller notations for two of the faces of the crystal.

Fig. 23 is a face view of the crystal of Fig. 22 on a reduced scale and also showing a Miller notation.

Fig. 24 is an edge view of the crystal of Fig. 23 but turned ninety degrees therefrom and again showing a Miller notation.

Fig. 25 is a fragmentary isometric view similar to Fig. 18 but showing a template used to make the article of Fig. 19.

Figs. 26 and 27 are cross-sectional views similar to Figs. 15 and 16 but showing steps for making the article of Fig. 19 and taken along the same plane as Fig. 21.

Fig. 28 is an isometric view of a corner of a template used to make a variation, not shown, of the embodiment shown in Fig. 19.

Figs. 29 and 30 are schematic views showing how the articles of the present invention are used in a tool to surface a workpiece along a linear path but specifically showing the article of Fig. 19.

Figs. 31 and 32 are schematic views showing how the articles of the present invention are used in a tool to surface a workpiece along a rotary path but specifically showing articles made in accordance with the embodiment of Fig. 17.

Fig. 33 is a plan view, enlarged approximately two times actual size, of an assembly of synthetic cubic crystals of diamond, or like material, made in accordance with the present invention.

Fig. 34 is an elevation or edge view of the assembly of Fig. 33.

Fig. 35 is an isometric view of formation of synthetic cubic diamond crystals illustrating the aligned crystallographic directions of hardness by directional arrows and Miller indices. Again, the crystals and thus the assembly are enlarged from actual size. It is

also noted that the crystals shown in Fig. 35 are in fact cubic, although they may not appear so because of the rules of isometeric projection.

Fig. 36 is an isometric view of a corner of the assembly of Fig. 33 showing a binder applied to the crystals and showing in dashed lines the edges of crystals under the binder.

Fig. 37 is also an isometric view of the initial steps of assembling cubic diamond crystals into an integrated formation by placing the crystals in side-by-side contact on the bottom flat surface and in the corner of a tray inclined toward the corner. The scale is reduced from Fig. 35 but is still much larger than actual size.

Figs. 38a-38d are enlarged schematic views which illustrate additional steps of the method of this invention.

Figs. 39a-39f are also enlarged schematic views which illustrate additional steps of the method of this invention.

Detailed Description

Article of Manufacture- First Embodiment

The first embodiment of the present invention is a wear-resistant or abrasive article 36 (Figs. 1 and 2) which includes a square backing member 38 of plastic or metal that has a mounting surface 40 and a back surface 42. A plurality of single synthetic cubic crystals 50 of diamond have first portions 52 individually embedded in a backing member formation and second portions 54 projecting outwardly from the mounting surface.

The use of single, synthetic diamond crystals, 50 in Fig 3 and 60 in Fig 4, is important to the present invention, and thus reference is now made to certain details about such crystals. In general, these crystals are regular polyhedrons but are produced in various specific shapes, namely, perfect cubes (Fig. 3); a range of cubo-octahedrons where the crystal faces vary from predominately cubic and minimally octahedron (Fig. 4) to predominately octahedron and minimally cubic (not shown), and perfect octahedrons (not shown). It is preferred to use perfectly cubic crystals, as shown in Fig. 3, or predominately cubic crystals where the cubic faces predominate and the octahedral facets are minimal in size, as shown in Fig. 4. The principles of this invention, however, apply to other shapes of the cubic crystal system, to which diamond belongs, as will be understood in the subsequent description of the third embodiment of this invention using cubic boron nitride (CBN).

The cubic crystal 50 (Fig. 3) represents the described commercially available synthetic single diamond crystals which are up to about 1 mm in size. The crystal 50 has six side faces 64, twelve edges 70, and eight corners 74. These faces are of course square and are referred to in the art and herein as cubic faces or as being in cubic planes.

The cubo-octahedral crystal 60 (Fig. 4) also represents commercially available synthetic single diamond crystals and has six faces 82, which are commonly referred to as cubic faces since that is their predominate shape, and eight smaller octahedral facets 84 at the corners. Crystal 21 is thus referred to as a predominately cubic crystal since the octahedral facets are relatively small as compared to the cubic faces.

With reference to Fig. 5, a brief description is set forth of certain known crystallographic characteristics of a synthetic single diamond crystal, as 50 and 60, which are fully exploited in the present invention. Fig. 5 shows one of the faces 64 of the crystal 50. The crystal has crystallographic directions of maximum abrasive resistance or hardness in the plane of this cube face along the diagonal lines 90, 90 ' and 92, 92 ' of the face. It also has crystallographic directions of minimum abrasive resistance or hardness along lines 94, 94 ' and 95, 95 ' which are forty-five degrees from the diagonals or directions of maximum resistance. Therefore, the crystal exhibits degrees of directional hardness ranging from the diagonal maximum directional lines to the right-angular minimum directional lines. These lines of hardness may also be described as being tangential to their respective faces of the crystal. The appropriate Miller notations for the face and directional lines are denoted in Fig. 5. In view of the symmetry of the crystallographic structure of diamond crystals, each face of the crystal has the same crystallographic directions of hardness within the plane of its face.

Brief reference to certain nomenclature regarding the symmetry of crystals, as 50 or 60, (Figs. 3 and 4) will be useful in the subsequent description. As is known, the crystal has several planes of symmetry. One such plane is referred to in the art as a cubic plane which is an orthogonal plane which cuts through the crystal between and parallel to a pair of opposite faces, as 64. Another plane of symmetry is referred to in the art as a dodecahedral plane and is a diagonal plane that cuts through the crystal and contains a pair of opposite edges, as 70. The crystal also has several axes of symmetry one of which is represented, for example, by the letter y in Fig. 3 and passes through the center and

opposite faces of the crystal and is perpendicular to such faces. Reference will be made to these planes and axes in the following description and claims.

Having described known characteristics of single synthetic cubic diamond crystals 50, 60, the present invention is primarily concerned with the orientation of these crystals in a predetermined manner in the article 36, one embodiment of which is shown in Figs. 1 and 2. It is to be noted that Fig. 1 is drawn about four times actual size since the single synthetic cubic diamond crystals available are up to about 1 mm in size. It is also noted that for ease of illustration only perfectly cubic crystals are shown in Fig. 1 although in actual practice some of the crystals may be predominately cubic, as 60, and thus may have small octahedral facets 84.

In Figs. 1 and 2, each crystal 50 is individually mounted in the backing member 38, with its first or mounting portion 52 (Fig. 2), which is approximately half of the crystal, embedded in the backing member, and its second or abrading portion 54, which the other approximate half of the crystal, outside of the backing member. Another way of expressing the orientation of each crystal in the assembly is to state that each crystal is mounted in the formation with one of its cubic planes parallel to the mounting surface 40. The face 64 of each crystal at the extremity of the abrading portion 54 is referred to as an abrading face and is parallel to the mounting surface 40 and coplanar with the abrading faces of all the other crystals. These coplanar abrading faces thus define a working surface 96 for the article 36.

Incidentally, the amount of extension of the crystals 50 into or out of the backing member 38 is important to proper functioning of the article 36, but it is not a feature of the present invention. In the embodiment shown in Fig. 1, it is preferred that the mounting portions 52 of the crystals 50 are embedded in the backing member a distance of about 0.6 mm, sufficient to hold the crystals securely in the backing member so as to prevent their dislodgment when force is applied to the crystals upon workpiece engagement, while providing sufficient workpiece engaging surfaces. Specific techniques for bonding abrasive particles, such as the crystals 50, 60, in a plastic or metal backing member are well-known but are subsequently briefly generally described herein as a part of the subject method.

The crystals 50 in the embodiment of Fig. 1 are preferably uniformly distributed about the backing member 38 in a checkerboard pattern and for this reason are arranged in orthogonal rows, indicated by lines 97, 98, and diagonal rows indicated by lines 99,

100, relative to the square backing member. The rows are in spaced relationship, and adjacent crystals in each row are spaced from each other. It is to be understood that the specific square shape of the backing member, the specific checkerboard pattern or row formation, the specific crystal spacing, and the density or concentration of crystals shown in Fig. 1 are not essential to the invention and may be varied depending on the application of the article 36.

Of prime significance to the invention, however, is the orientation of the crystals 50 relative to each other. With reference to Fig. 1, the crystals are individually fixed in the backing member 38 with their maximum directions of crystallographic hardness, as 90, 90 ', aligned along parallel diagonals of the formation which run in NE/SW directions, to use a compass analogy. Likewise, the directions 92, 92 ' are aligned along the NW/SE diagonals. It will of course be apparent that orientation of the crystals is not limited to such specific compass directions nor to the orientation of the article on the drawing sheet. With such an orientation, the lines of maximum hardness directions of the crystals in each diagonal row 99 are aligned along common lines, as 101, 102, and these common lines of all the diagonal rows are parallel with each other. Stated otherwise, corresponding lines of maximum hardness directions of individual crystals are either in alignment, or parallel, with corresponding lines of maximum hardness of all the other crystals. Also, these lines 90, 90 ' and 92, 92 ' of maximum hardness are tangential to their respective face extremities 64, lie in the working surface 96, and are parallel to the mounting surface 40 of the backing member 38.

It is to be observed that as used herein and in crystallographic terminology, the words "align" and "aligned" mean pointing in the same direction, but can also mean being coincident with a single line. Thus, the lines of maximum hardness 90 of the crystals 50 in Fig. 1 are "aligned" in the sense that they all point in a NE direction in Fig. 1, whereas those directional lines 90 of the crystals in a given diagonal row are "aligned" in that they are coincident along a common line.

Conversely, corresponding lines, as 94, of minimum hardness directions of all the crystals 50 (Fig. 1) in each of the NS orthogonal rows 98 are in alignment, as represented by common lines, as 104 and 106, and all of the corresponding minimum hardness lines in each such row are parallel with those in the other NS rows. The same is true for the EW

rows. The lines of minimum hardness are thus also tangential to their respective face extremities 64, lie in the working surface 96, and are parallel to the mounting surface 40.

Therefore, it will be understood that the array, group, backing member, or formation of crystals 50 (Fig. 1) exhibits common directional lines, as 101 and 102, of maximum hardness which run diagonally of the backing member 38 and are parallel to the mounting surface 40. If the working surface 96 (Fig. 2) is moved across a workpiece (Figs. 29-32) in one of these diagonal directions, such as NE/SW, the crystals will exhibit their maximum hardness to the workpiece. Conversely, if the working surface is moved relative to a workpiece in the direction at forty-five degrees from common line 102, that is in a NS or EW direction, the surface will exhibit its minimum hardness to the workpiece. The working surface formed by the crystals thus exhibits common directions of maximum and minimum hardness and all the degrees of hardness in between, just like an individual crystal. With the present invention, then, the characteristics of an single crystal are imparted to the entire array of crystals.

With reference to Fig. 2, since the abrading portions 54 of the crystals 50 project outwardly of the backing member 38 equidistantly from the mounting surface 40 with their faces 64 defining the planar working surface 96, the crystals are able to contact a workpiece, not shown, simultaneously and thus apply force to the workpiece in an even manner. Wear on the crystals, and abrasion action on a workpiece, are therefore uniformly distributed.

Method of Making the First Embodiment of the Article

The method for making the first embodiment of the article 36 (Fig. 1) of the present invention is described with reference to Figs. 6-9. The method employs a template 120, only a portion of which is shown in Fig. 6. The template has a top surface or plate 122 and a plurality of half-cubic shaped recesses, wells, or pockets 124 extending downwardly into the body of the template from the top surface and serving as receptors for the crystals 50. Each recess may be described as having the shape of a part of a cube cut along one of its cubic planes. Since only a portion of the template 120 is shown, only a few of the recesses are shown. It will be understood, however, that a complete template is slightly larger than the abrasive article 36 and has the same number and formation of recesses as there will be crystals in the article to be made. Thus, a complete template for making the article shown in Fig. 1 includes fifty recesses in ten rows of five each, running

in both the length and the width of the template, with the recesses in adjacent rows offset from each other.

The recesses 124 (Fig 6) in the template 120 are of uniform shape and size. Each recess has a length and width (that is, the dimensions which lie in the plane of the surface 122) slightly greater than the edge dimensions of a cubic crystal 50, and a depth not quite as deep as such edge dimension. Thus, in this embodiment of the method, the recesses are slightly larger than 1 mm square and are about 0.6 mm deep. Each recess has a bottom wall 126, and side and end walls 128 and 130 which are at right angles to the bottom wall. The recesses may be configured with slightly beveled inside corners, not shown, similar to the shape of the facets 84 of the predominately cubic crystals 60 (Fig. 4) that have minor octahedral facets.

Significantly, the recesses 124 (Fig. 6) are oriented in the template 120 in positions which will orient the crystals 50, 60 so that their corresponding crystallographic maximum hardness directions, as 90, are aligned. Thus, all of the side walls 128 are parallel with each other, and all of the end walls 130 are parallel with the other end walls. To achieve equidistant projection of the crystals from the backing member mounting surface 40, all of the bottom walls 126 are in a common plane 138 (Fig. 8).

Alternatively, a modified template 120a (Fig. 7) with modified recesses 124a may be used. Here, the bottom wall 126a of each recess 124a is angled upwardly a few degrees from the common plane 138. More specifically, the bottom wall 126a is angled diagonally upwardly from one bottom corner of the recess to the diagonally opposite corner. It will be understood that corresponding corners, for example, all the NE corners, are similarly tilted upwardly so as to make the angulation uniform throughout the template 120a.

The templates 120 or 120a (Figs. 6 and 7) are made of plastic, such as polyethylene or tetrafluoroethylene, or of metal, such as steel or aluminum, and are shaped by casting the plastic or metal against a master form, not shown, having cube-shaped protrusions. Alternatively, the template is made by stamping or pressing plastic or metal stock with an appropriately shaped master multiple projection die or a single cube-shaped die, again not shown since such metal-working techniques are well known in the art.

In carrying out the method of the present invention, a supply of synthetic single diamond crystals 50, 60 of cubic or predominately cubic shapes and of approximately the

same size, currently about 1 mm, is selected. It is important to size the crystals by precision screening, preferably using screens with square openings. Further shape control by automated single crystal weighing or settling in a fluid using Stokes Law may be used.

With the top surface 122 (Fig. 6) of the template 120 maintained in a generally horizontal plane, crystals 50, 60 are deposited on the top surface and spread thereover and thus lie in random orientation about the top surface. More crystals are deposited than there are recesses 124 so as to insure a quantity sufficient to fill all the recesses. The template is vibrated or tapped and, if necessary, slightly tilted to cause the crystals individually to gravitate into and be received by the recesses. Because of the complementary shapes of the recesses and the crystals and the slightly larger recess size relative the crystal size, crystals are individually accommodated into the recesses where they each stabilize, with one bottom face 64 of each crystal lying flat on the bottom wall 126 of its recess and with its side faces 64 in adjacent parallel relation to the side and end walls 128 and 130. The crystals project from the top surface 122 of the template a distance less than their edge dimension, preferably about 0.4 mm in the illustrated embodiment. If the template 120a using inclined bottom walls 126a is employed, as shown in Fig. 7, corresponding top corners 74 of the crystals 50 are tipped up relative to their diagonally opposite top corners along a diagonal, as 99 (Fig. 1), of the template. While all of the recesses are being filled or after they are filled, the template is inclined slightly and again vibrated or tapped in order to remove excess crystals from between the rows, so that the top surface 122 is clean of crystals while maintaining the crystals in the recesses into which they were received and in their oriented positions therein.

Each recess 124 or 124a (Figs. 6 and 7) is thus temporarily filled with a crystal 50 or 60, and the crystals are thus oriented with all of their corresponding crystallographic directions of maximum hardness 90, 90 ′ and 92, 92 ′aligned and the corresponding directions of minimum hardness, as 94, 94 ′ and 96, 96 ′, likewise aligned. The bottom faces 64 of the crystals lie flat against the bottom walls 126 of their recesses and thus coplanar with plane 138, and the first or mounting portions 52 of the crystals protrude outwardly from the template.

The subject method next involves steps for fixing the crystals 50, 60 in the described orientation and for removing them from the template, as 120 (Fig. 6). The template used has a non-adhesive top surface 122 and non-adhesive recess walls 126, 128

and 130, which can be accomplished by making the template of polyethylene or tetrafluoroethylene as previously suggested. A layer 150 (Fig. 8) of uncured plastic, such as an epoxy resin, is applied over the top surface 122, covering and completely immersing the mounting portions 52 of the crystals in the plastic. This layer is then cured and upon curing, this overlay of plastic becomes the backing member 38 fixing the crystals in their positions of crystallographic alignment with the faces 64 resting against the bottom walls 126 of the recesses 124 in their coplanar relationship. The backing member and the array of crystals are then removed as a unit from the template thereby yielding the article 36 (Fig. 9).

In its basic form, the article 36 (Figs. 1, 2 and 9) comprises only one layer of crystals 50 and may be of any practical surface area with any practical number of crystals, limited only by the particular use or application of the article. By way of example only, the article 36 includes fifty crystals, each measuring about one millimeter square, in a backing member 38 measuring about 25 mm x 25 mm x 5 mm.

If desired for some applications, multiple articles, as 36, may be bonded together in edge-to-edge coplanar relation to form a much larger surface area, not shown. Also, multiple articles may be bonded together in stacked, layered relation, also not shown. In any case, all the crystals are positioned so that their crystallographic directions are oriented in the same direction, in accordance with the principles of this invention.

Article of Manufacture-Second Embodiment

The second embodiment of the article is identified by numeral 236 in Figs. 10 and 11. This article also conveniently includes a square backing member 238 having a mounting surface or area 240. Synthetic single diamond crystals 50, and/or 60, are used for this embodiment and are the same as used for the first embodiment in Fig. 1. As before, the crystals are preferably uniformly distributed about the mounting surface and are positioned in orthogonal and diagonal rows in a checkerboard pattern. The second embodiment differs from the first embodiment, however, in the orientation of the crystals, but this different orientation still aligns selected hardness directions.

Again, it is helpful to set forth certain crystallographic principles as a foundation for understanding the second embodiment. With reference to Fig. 12 and 13, it is known that the second hardest crystallographic direction of hardness of a diamond crystal 50 or 60 is along a line 248 which is tangential to an edge 70 of the crystal and also

perpendicular to the diagonal 249 (Fig. 13) of the crystal which intersects such edge. The appropriate Miller notation for this second hardness directional line is denoted in the drawings. It will be understood that there is a similar second hardest directional line tangential and perpendicular to each edge of the crystal. It is also to be noted that the crystal 50 has another axis of symmetry represented by the diagonal 249, and that this axis passes through one edge of the crystal, through the center of the crystal, and through the opposite edge and is perpendicular to such edges.

To take advantage of this second hardest direction, the crystals 50 (Figs. 10 and 11) are individually mounted in the backing member 238 so that a dodecahedral plane of each crystal is co-planar with the mounting surface 240, or is slightly on one side or the other of such mounting surface and parallel to it. It follows, then, as best visualized in Fig. 11, that the dodecahedral plane which is perpendicular to the first-mentioned dodecahedral plane is perpendicular to said mounting surface. With such mounting, the approximate half of each crystal on one side of the mounting surface is embedded in the backing member, and the other approximate half is outside the backing member. Of greatest significance, all the exposed edges 70a, which are referred to as abrading edges, of the crystal-halves are parallel to, or in alignment with, each other; are equidistant from and parallel to the mounting surface; and together define a working surface 250 (Fig. 11). Thus, the crystals are oriented in the backing member so that their crystallographic directions of hardness as indicated by the lines 248 (Fig. 10) are aligned with, or parallel to, such directional lines of all the other crystals, depending on whether their crystals are in the same EW row 252 or in a parallel EW row.

Thus, when the abrading edges 70a (Figs. 10 and 11) of the article 236 are in contact with and moved relatively to a workpiece, not shown, in the direction of the lines 253, 254 (that is, the EW direction in Fig. 10), the combined effect of aligned hardness directions of the crystals 50 is presented to the workpiece. Although the hardness direction 248 is not the hardest direction of the crystal, it is the next-to-the-maximum hardness direction and thus allows an improved abrasive force to be applied by the crystals, as contrasted with non-aligned directions of hardness of grits, particles or crystals which are randomly positioned with regard to crystallographic direction, as practiced by the prior art.

Method of Making the Second Embodiment of the Article

The article 236 (Fig. 10) is made in a manner similar to the article 36 (Fig. 1), except that a different template 260 (Fig. 14) is utilized to accommodate the different orientation of the crystals 50. In template 260, only a portion of which is shown in Fig. 14, recesses 264 are in the shape of an approximate cube-half, when the cube is cut along a dodecahedral or diagonal face-plane thereof. In other words, the recesses are V-shaped with a ninety degree included angle. In general, the parameters for constructing the template and the recesses are the same as for template 120 (Fig. 6). That is, the recesses are slightly larger than the crystals so as to facilitate accommodation of the crystals therein, and they have end walls 265 and side walls 266 that meet at bottom corners or edges 268 which are tangent to and lie in a common plane 270 (Fig. 15).

An alternative template 280 (Fig. 18) may be used with the second embodiment of the method. This template has V-shaped recesses, grooves or troughs 282 having side walls 284, end walls 286, and bottom edges 288, which are the same shape as the recesses 264 except that they extend almost the full length or width of the template, being enclosed by the end walls 286.

As with the method described with reference to Figs. 6-9, a similar method is followed to make the article 236 (Fig. 10). In brief, sorted, substantially uniformly sized crystals 50 are distributed in a random manner over the template 260, or 280, and the template is vibrated to cause the crystals to fall into the recesses 264, or 282. In the recesses 264, there is one crystal per recess, but with recesses 282, a line of crystals is accommodated with adjacent faces 64 of adjacent crystals preferably being in contact. Again, the templates 260 or 280 are inclined slightly and vibrated or tapped to remove excess crystals while maintaining the oriented crystals in the recesses.

Next, an uncured plastic layer 290 (Fig. 15) is placed over the template 260, or 280, to cover the protruding portions of the crystals 50 and then is allowed to cure and harden. When cured, the plastic layer becomes the backing member 238 with the crystals fixed therein and is removed from the template thereby resulting in the article 236 (Figs. 16 and 11).

Article of Manufacture- Third Embodiment

The third embodiment of this invention provides an article 336 (Figs. 19-21) similar in principle to the articles 36 and 236 of the first and second embodiments except

that the third embodiment uses single, synthetic crystals 350 of cubic boron nitride (CBN). The article includes a backing member or carrier 338 for the crystals which has a mounting surface 340 and a back surface 342.

Cubic boron nitride, like diamond, is in the cubic class of crystals, but, unlike diamond, has the sphalerite structure. The CBN crystal 350 (Fig. 22) is thus a regular polyhedron like diamond but, unlike diamond, has a tetrahedral shape. Individual crystals of CBN of good quality are commercially available, with planar triangular faces 352 meeting in sharp edges 354 and corners 356, and have dimensions of up to about 0.5 mm on an edge. It is important to emphasize that, like the embodiments 36 (Fig. 1) and 236 (Fig.11) of this invention utilizing diamond crystals, the CBN used for the third embodiment is in the form of single or individual crystals and not the CBN grains used in the prior art as abrasive grains or grit that are predominately crushed aggregates of intergrown, randomly-oriented crystals. Like the other embodiments, use of single, substantially uniform crystals allows predetermination of the crystallographic directions, manipulation of the crystals, and resultant orientation into the desired positions.

As is known, the tetrahedral crystal, as 350, has several planes and axes of symmetry. One such axis is referred to in Fig. 23 by the reference letter p and is useful in describing and claiming the present invention. The axis p passes through the center of one edge of the crystal, through its center and through the center of the edge opposite to the first edge, and is perpendicular to both such edges.

No careful work is known that has correlated the variation of abrasion-resistance of the CBN crystals, as 350 (Fig. 22), with crystallographic direction. The similarity, however, between the internal atomic configurations of CBN and diamond leads to the conclusion that the most abrasive-resistant direction of a CBN crystal is along a line, as 360 (Figs. 19, 22-24), which is perpendicular to an edge, as 354a, of the crystal. This directional line may also be described as tangential to the edge 354a and parallel to the opposite edge 354b, as best illustrated in Fig. 23. It is of course understood that the edge 354a is chosen by way of example only and that there is such a directional line of maximum hardness perpendicular and tangential to each of the edges 354. Miller notations for faces of a CBN crystal are shown in the Figs. 22-24.

The crystals 350 (Figs. 19-21) are mounted in the backing member 338 so that a plane cutting through each crystal and parallel to a pair of its opposite, perpendicularly related edges lies approximately in or close to the mounting surface 340 (Fig. 20) of the

backing member. Such a plane divides the crystal into two portions, so that with such a mounting, one of these portions is embedded in the backing member and the other portion is outside the backing member. In the preferred embodiment illustrated in Figs. 19-21, about sixty percent of each crystal is embedded in the backing member and the remaining forty percent protrudes out of the backing member. The important feature, however, is that the exposed edge 354a of said opposing pair of edges of each crystal is parallel with the corresponding exposed edges of all the other crystals, as is readily seen in Fig. 19, and with the mounting surface 340. Also, these edges 354a of crystals in the same NS row, as 366, are in alignment.

As previously mentioned with regard to the other embodiments, the third embodiment of the invention is not limited to the specific spacing or number of crystals 350 (Fig. 19) or rows, nor to the orthogonally formed rows, nor to the number or concentration of crystals. It is important to the invention, however, that the crystallographic lines 360 of maximum hardness of corresponding edges, as 354a, of all the crystals are in alignment, or are parallel, with each other. Such alignment or parallelism of the crystallographic lines follows from mounting the crystals with the exposed edges 354a in alignment or parallel with each other.

Method of Making the Third Embodiment of the Article

This embodiment of the method is similar to the other two method embodiments except that templates 390 and 392 (Figs. 25 and 28), similar to the templates 280 (Fig. 18) and 260 (Fig. 14), respectively, are constructed to accommodate the tetrahedral, CBN crystals. The article 336 illustrated in Fig. 19 is made using the template 390 in Fig. 25. The template 390 has elongated V-shaped recesses or troughs 394 with end walls 396, and side walls 398 meeting at predetermined angles in bottom corners or edges 400 which are all in a common plane 406 (Fig. 26).

As an example, the entire template 390, only a portion of which is shown in Fig. 25, may be approximately 32 mm x 15 mm x 5 mm in size and be made of high density polyethylene. The recesses 394 may be milled lengthwise of the template to a depth of about 0.5 mm and so that the side walls 398 have an included angle of about 70°32 ', ±5°.

With the template 390 (Fig. 25) maintained in a horizontal position, crystals 350 of CBN of pre-sorted, substantially uniform size are sprinkled on the template and thus

randomly positioned thereon. By vibrating and slightly tilting the template, the crystals are caused to drop into the recesses 394 with an edge 354a (Fig. 26) of each crystal fitting against the bottom edge 400 of a recess, and thus being tangent to the common plane 406, and with two opposite side faces 352 (Fig. 25) resting against the side walls 398 of the recess and with slightly less than half of each crystal protruding outwardly from the template. Tilting the template toward one end while vibrating and tapping the same also causes excess crystals on the top surface of the template and between the recesses to drop off the template.

Epoxy resin (system three, phase two) is then poured over the template 390 so as to provide a layer 410 (Fig. 26) of about 5 mm depth covering the projecting portions of the crystals 350. The resin is then cured at about 60°C for about two hours, causing the resin to cure and harden and form the backing member 338. The crystals are thus individually fixed in the backing member in their oriented positions in the template. The backing member and its attached crystals are then removed from the template thus resulting in article 336 (Fig. 27) wherein all of the exposed edges 354a of the crystals are parallel to each other (Fig. 19), thereby causing the crystallographic directional lines 370 of maximum hardness to be either aligned or parallel to each other and lying in the common plane of the work surface 420 (Figs. 20, 21 and 27) defined by the edges 354a. It will be understood that the coplanar relation of the edges 354a results from the bottom edges 400 of the recesses 394 lying in a common plane 406 (Fig. 26).

It will now be understood how the template 392 (Fig. 28) having spaced V-shaped recesses or pockets 426 is used to create an article, not shown, with crystals 350 temporarily placed in the pockets, individually fixed in a backing member, not shown, and then removed, to produce such an article very similar to article 236 (Fig. 10), but with CBN crystals instead of diamond crystals.

The recesses, trough or grooves 394 and 426 (Figs 25 and 28) that act as receptors of the crystals 350 to align the crystals can be chosen to be of a length slightly longer than the length of an edge of a CBN crystal, in the case of the recesses of Fig. 28, or any multiple of this length in the case of the recesses of Fig. 25. Thus, the pattern and density of the crystals can be adjusted to make optimum use of the CBN crystals for workpiece treatment.

By now it will be understood that the template, as 120, 260, 280, 390, or 392, used in the present invention is not limited to the particular recess or well configurations

shown, but more broadly, the template is understood to have a receptor area shaped to accommodate and align the crystals 50 or 350, such receptor area including either a plurality of recesses or pockets or wells, as 124 or 264 or 426, or one or more troughs, as 282 or 426 or 394.

In all the embodiments of this invention, it will be understood that bonding agents other than epoxy resin or other plastic formulations may be used, as are well known in the art. Briefly, with the templates 120, 260, 280, 390, or 392 made of graphite, a powdered infiltration metal or a powdered infiltrator alloy with abrasion-resistant particles, such as tungsten carbide, can first cover the crystals 50 or 350. The assembly can then be heated to fuse the metal and create the backing member 38, 238 or 338, fixing the crystals in their oriented positions. Also, metal, such as nickel, can be electrodeposited over the crystals in the templates to serve as the backing member by a well known process. Still further, any of the templates may be made of a refractory material not bondable to fired ceramic bodies, such as graphite or silicon carbide. An unfired plastic ceramic could then be layered over the crystals in the template and subsequently heated to a temperature suitable to sinter the ceramic body, whereby a vitreous backing member embeds the crystals in their oriented positions.

Figs. 29 and 30 show one of the articles, as 336, constituting part of a tool 500 which moves relatively to a workpiece 510 along a linear path 520. It will be noted that the edges 354a contact the workpiece together since they are tangential to a common plane or work surface 420. Also, the crystals all move across the workpiece perpendicularly of the edges 354a or, in other words, along the common lines 360 (Fig. 30) of directional hardness of all of the crystals. Each individual crystal engages the workpiece so that its predetermined line of maximum hardness 360 is aligned with the path 520 of movement of the crystal. Therefore, a maximum amount of abrasive action is exerted by the crystals.

Figs. 31 and 32 illustrate the principles of the present invention for use in a tool 600 which surfaces a workpiece 610, shown in phantom outline in Fig. 31, along a rotary path 602. The tool comprises a sleeve 604 having an annular end 606, and a plurality of crystals, as 50, mounted on the end so that the sharp edges, as 70a, are oriented radially of the sleeve. In this manner, the crystals engage the workpiece so their individual lines 248 of high hardness are aligned with the rotary path 602 of the crystals. Although the drawing shows groups of crystals mounted at each quadrant at the end of the sleeve, the

crystals can be spaced or mounted in a continuous formation about the circumference. The important point is that the crystals are mounted so that each crystal contacts the workpiece with its line of high hardness aligned with the path of movement of the crystal.

Article of Manufacture- Fourth Embodiment

The fourth embodiment is useful as a bearing, heat sink or semiconductor. This embodiment provides an assembly 650 (Figs. 33 and 34) of synthetic single crystals 50 (or 60, although only the numeral 50 will be used in the following description) of diamond secured together in a formation by a binder 658 which forms a backing member. The crystals are oriented so as to provide the assembly with enhanced physical properties similar to what has been previously described. Full advantage of these properties cannot be realized with an individual crystal because of its minute size.

The assembly 650 of the synthetic single diamond crystals 50 shown in Figs. 33 and 34 as approximately twice actual size. In order to explain the principles of this invention as incorporated in the fourth embodiment, however, it is necessary to use illustrations considerably more enlarged from actual size than even Figs. 33 and 34. Such an enlarged assembly is indicated in Fig. 35 by reference numeral 660 and may be regarded as merely a segment of the assembly of Fig. 33.

The crystals 50 are placed in the assembly or formation 660 (Fig. 35) in an integrated, tightly packed mosaic pattern. The crystals are in side-by-side and edge-to-edge relationship with adjacent side faces 64 of adjacent crystals in mating congruent contact so as to eliminate or at least greatly reduce any gaps between the crystals and to restrict intrusion of contamination or foreign material. In the assembly, all the top faces 64 of the crystals are in a common plane which thus creates a top, outwardly directed surface 662 of the assembly, and all of the bottom faces 64 of the crystals are coplanar and define a bottom, outwardly directed surface 664.

The crystals 50 are integrated or bonded together in the formation 660 by one or more of several bonding techniques, as subsequently described in greater detail. One of these bonding techniques is an adhesive coating 666 over either the top surface 662, as shown in Fig. 36, or over the bottom surface, not shown.

Of greatest significance, the crystals 50 (Fig. 33), by virtue of their substantially same size and predominately cubic shape and by virtue of their described assembly 660, are oriented with their crystallographic directions of maximum abrasive resistance either

aligned with, or parallel to, each other. Alignment occurs because the crystallographic directions 90, 90' of each crystal (Fig. 5) are aligned with the corresponding directions 90, 90' of all the other crystals lying in a row along one of the principal diagonals 670 (Fig. 35) of the assembly. Likewise, the crystallographic directions 92, 92' (Fig. 5) of the crystals lying in a row along the other principle diagonal 672 (Fig. 35) of the assembly are aligned. Parallelism occurs because these directions, as 90, 90', are parallel to such directions of the crystals in other shorter, diagonal rows, one of which is indicated by line 674 in Fig. 35.

Furthermore, the directions of minimum abrasive resistance 94, 94' (Fig. 5) are aligned and parallel to each other in a similar manner and as represented by line 676 in Fig. 35, and this line is at forty-five degrees separation from the lines of maximum resistance 670, 672.

In its basic form, the assembly or formation 650 (Fig. 33), or 660 (Fig.35), comprises only one layer of crystals 50 and may be of any practical surface area, that is, any practical number of crystals, limited only by the assembly space and the particular use or application of the assembly. By way of example only, the assembly in Fig. 33 includes two-hundred twenty-five crystals with an actual size of approximately fifteen millimeters by fifteen millimeters square and slightly in excess of one millimeter thick allowing for the thickness of the binder 658. In contrast, the assembly of Fig. 35 includes sixty-four crystals and would measure about 8 by 8 by 1 mm in actual size.

The perimeter or outside edge of the assembly 650 need not be rectangular and may have other regular or irregular configurations since the principles of the invention still apply along the diagonals of the assembly as governed by the cubic crystal faces 64 (Fig. 35) within the margins of the assembly. Again, reference to top and bottom surfaces 662 and 664 does not imply use of the assembly in any particular orientation but is for convenience in describing the assembly of the crystals 50. If desired for some applications, multiple assemblies, not shown, may be bonded together in edge-to-edge coplanar relation to form a much larger surface area. Also, multiple assemblies may be bonded together in stacked, layered relation, also not shown. In any case, the crystals are assembled so that their crystallographic directions are oriented in the same direction, in accordance with the principles of this invention. Multiple layers also occur upon chemical vapor deposition, as subsequently described.

Method of Making the Fourth Embodiment of the Article

In general, the method of making the fourth embodiment may be divided into two parts for descriptive purposes, namely, initially assembling the crystals 50 so as to form the assembly 650, and secondly, binding the crystals in the assembly. Figs 37 illustrates the steps of assembling the crystals, and Figs. 38 and 39 illustrate two embodiments of binding the crystals in the assembly.

The initial part of the method, namely, placing the diamond crystals 50 in an assembly 660a is thus described by reference to Fig. 37. One of the first tasks is to select the crystals to be used. Synthetic single diamond crystals of substantially cubic shape, or of cubo-octahedral shape where the cubic faces predominate, are chosen. Also, the crystals used should be of substantially the same size. Currently, crystals are available up to about 1 mm on an edge, but as synthetic growing techniques improve, larger crystal sizes may become available. If not already accomplished, and as discussed above, the supply acquired should be sized to insure that the crystals used are of substantially the same size, preferably from 0.75 mm to 1 mm or larger if available. As previously noted, only perfectly cubic crystals 50 are shown in Fig. 37, but the method described is equally applicable to the cubo-octahedral crystals 60 with predominately cubic faces 82.

Synthetic, single diamond crystals 50 are dropped (Fig. 37) one at a time or in limited numbers into a tray or receptacle 680 having a planar bottom surface 682 and side walls 684 defining a corner 686 of the tray which has the shape of a corner of a cube. The tray is tilted toward the corner and is gently shaken, vibrated or tapped in the plane of the bottom surface. When the crystals land on the bottom surface 682, they attain a stable position on one of their faces 64. Stability occurs because of the cubic shape of each crystal, the angle of tilt of the tray, the mass of the crystal, and the material of the tray, more particularly the bottom surface 682. Then, because of the tilt and vibration of the tray, the crystals slide toward the corner. The angle of tilt of the tray and the vibrating action are adjusted to achieve this stabilization and sliding action. In the described embodiments, the tray is preferably made of high density polyethelene, PTFE, graphite, a refractory, or other material which has a coefficient of friction to promote the described stability and sliding action of the diamond crystals.

As the crystals 50 slide into the corner 686 of the tray 680 (Fig. 37), they align themselves with the side walls 684 of the tray or with the side faces 64 of crystals that are already in oriented positions in the corner and thereby build up the assembly 660a of

crystals in a layer, one crystal thick. Use of needle point tweezers, not shown but commonly available, may be used to reposition any errant crystals. The side faces of adjacent crystals are in congruent contact with each other, and the top faces of all the crystals in the assembly form the common planar surface 662. This results in all the crystals being oriented in the same crystallographic direction, as explained above in describing the assembly 660 in Fig. 35.

After the crystals 50 are positioned in the assembly 660a (Fig. 37), they are bound together in accordance with the second part of the method, now described with reference to the two embodiments shown in Figs. 38 and 39. In describing these embodiments, all of the crystals are shown as cubo-octahedral crystals 60 with predominately cubic faces 82, but it is understood that in actual use, the crystals may be a mixture of cubic crystals 50 and such cubo-octahedral crystals 60. Only cubo-octahedral crystals are shown in Figs. 38 and 39 because of illustrative convenience and because it facilitates description of the binding and grinding steps.

With reference first to Fig. 38a through 38d, the steps are described for binding crystals 50 in an assembly 660b which has utility for abrasion resistance in bearings and heat sink purposes. It is noted that Figs. 38 and 39 are schematic views involving only a few crystals and are intended primarily to show the principles of the method. Cubo-octahedral synthetic single diamond crystals 60 (Fig. 38a) with large cubic faces 82 and relatively small octahedral facets 84 and approximately one millimeter in size are contained and oriented in a tray 680b, for example in the manner discussed with reference to Fig. 37. The crystals in the tray are then covered with a metal infiltration powder 690, such as Macrofil, a product available from Kennametal Inc. of Latrobe, Pennsylvania, USA that is capable of wetting the crystals upon heating. The powder is then heated to melting temperature to fuse the metal to the surface of the crystals and to draw it by capillary action into interstices between the top corners or octahedral facets 84 of the crystals. It is to be understood that the tray is made of a heat-resistant material, such as graphite, which is not wetted by the metal. The molten metal is then allowed to cool and solidify to form a binder coating 692 (Fig. 38b), whereupon the crystal assembly is removed from the tray (Fig. 38c). Finally, the bottom surface 664b of the assembly is ground to remove the octahedral facets and to produce a smooth coplanar surface.

The embodiment of the method described and illustrated in Figs. 37 and 38a-38d produces the bearing surface 664b which has a maximum abrasive resistant direction along

the aligned diagonals of the crystals 60, as fully described above in discussing Fig. 35. Using the principles of Figs. 37 and 38a-38d, an article, as 650 (Fig. 33), is produced which is useful as a bearing member with an exceptionally high abrasion resistance along the defined direction. It is significant to note, however, that the method also causes, and the article exhibits, a direction of minimum abrasive resistance, and it is along this line that the grinding occurs in achieving the smooth planar surface 664b. Thus, by following the principles of this invention, both maximum and minimum abrasive directions are fully achieved and exploited.

In addition, the article of the fourth embodiment is useful as a heat sink since the cubic faces 82 of the crystals 60 are in intimate contact and allow maximum heat conductivity across the interfaces of the crystals. The metal binder 692 enters essentially only the interstices between the octahedral facets 84 of the crystals and thus does not contaminate the main body of the assembly and interfere with the excellent thermal conductivity of diamond. The bearing surface or heat sink can be enlarged by including more crystals in the assembly 650 or by duplicating the assembly and mounting the assemblies so provided in contiguous edge-to-edge generally coplanar relationship to form a larger assembly of crystals, as will be understood although not shown.

Figs. 39a through 39f are referred to in describing another embodiment of the binding part of the method of the present invention so as to provide an article of manufacture suitable for electronic, heat sink, or abrasion-resistant uses. In Fig. 39a, the crystals 60 are assembled as previously described in a tray or box 680e which is temperature resistant to about 1000° C and chemically resistant to chemical vapor deposition (CVD) of diamond. For this purpose a suitable tray material is refractory cement. A first coat 710 (Fig. 39b) of diamond is deposited by CVD on the upper surface 662d which binds the crystals 60 together in assembly 660e. While the assembly is still in the tray (Fig. 39c), a rigid backing 712, which may be made of plate glass or aluminum, is temporarily cemented, for example by lapidarist's cement such as stick shellac, to the first coat 710 of diamond to hold the assembly 660e rigidly together to allow grinding. Next, the assembly of diamond crystals as held together by the rigid backing is removed from the tray (Fig. 39d), and the lower surface 664e is finished by a grinding tool, by chemical milling, or by laser machining to provide a smooth coplanar surface 664e with any octahedral facets 84 destroyed.

In the next step (Fig. 39e), the backing 712 and the cement used to attach it are removed by dissolution with a solvent, such as alcohol, or by heating to a temperature of approximately 200°C. Many other temporary cements could also be used and dissolved. A second coat 715 (Fig. 39f) of diamond is then deposited by CVD over the planar surface 664e. It is to be understood that the diamond in both the first and second coats 710 and 715 inherits the orientation of the atomic arrangement of the oriented diamond crystals in the assembly 660e so that the final article is an assembly of pure, single crystal diamond, with all of the crystallographic directions oriented in the same direction. The article 660e is thus ideally suited for the semiconductor, heat sink and bearing purposes discussed herein.

In summary of the present invention and its advantages, each of the described embodiments comprises synthetic single crystals of diamond or CBN, as 50, 60 and 350, held in a formation with selected crystallographic directions of the crystals oriented in the same direction. In the first three embodiments, a plurality of single synthetic crystals of diamond or CBN of substantially uniform size and shape are mounted in a backing member, as 38, 238 and 338, so that all the crystals are oriented with corresponding hard-to-abrade directions aligned. With the first and third embodiments in Figs. 1 and 19, the hardest-to-abrade directions are aligned, whereas with the second embodiment of Fig. 10, the next-to-the hardest directions are aligned. In all four embodiments the exposed workpiece-engaging extremities, as 64, 70a, 354a, 64b of the crystals lie in a common plane for simultaneous workpiece engagement even though some of the crystals are of slightly differing sizes. With the second and third embodiments of Figs.10 and 19, sharp edges, as 70 and 354, are presented to a workpiece, and with the variation of the first embodiment (Fig. 7), sharp corners, as 74, are presented. In the embodiments of Figs. 7, 10, 19, therefore, the sharp edges or sharp corners are in a saw-tooth formation which together with the aligned hardness directions produce an especially effective abrading action. It is also to be noted that the spacing between the crystals facilitates removal of abraded material as a workpiece is being processed.

From the foregoing, the following advantages, inter alia, of the first three embodiments will be understood. Since only the hardest-to-abrade directions are presented to a workpiece, the abrasive article has increased life thus saving abrasive material; abrades faster; requires less frequent replacement of parts; maintains dimensional tolerances longer; minimizes adjustment for wear compensation; reduces dulling and

flatting, and allows variation of abrasive concentration and thus facilitates its optimization. Furthermore, since all of the workpiece-engaging extremities of the crystals lie in a common plane, even though the individual crystals may vary somewhat in length, the crystals engage the workpiece simultaneously and uniformly thereby enabling uniform removal of material from the workpiece and avoiding the problems of grains which stand high and slow the abrasive action. All of the above stated features and advantages have the effect of reducing cost, time and labor and improving abrasive action.

The terms "abrasive" and "abrading" are sometimes used in the art in a very specific sense to mean a very specific type of workpiece treating action. It is to be understood, however, that as used herein, these terms are not limited to such a specific meaning but include cutting, grinding, dressing, lapping, sawing, or otherwise treating or engaging workpieces in the multitude of ways in which a hard surface or tool is used. It is also to be noted that the principles of the invention are more broadly applicable to wear-resistant surfaces which are useful not only as workpiece-treating elements but as bearing elements.

In addition, it will be understood from the foregoing that the fourth embodiment yields the following advantages. The alignment of the hardest-to-abrade direction, that is the cube face diagonal of diamond crystals, gives superior wear surface, as compared to bonded aggregations of randomly oriented diamond crystals, because of the presentation of the one hundred percent hardest directions and the absence of a softer bonding agent. This is an advantage in sliding-surface bearings or thrust bearings especially in applications with abrasive contamination between the wear surfaces. The reduction in wear lengthens the time between bearing replacement or adjustment, retains the dimensional tolerances between bearing surfaces for longer periods, and retains the smoothness of bearing surfaces for longer periods of service. Friction values of the hardest-to-abrade diamond directions on each other are lower than friction values for random diamond directions. The result is less heat generation, lower power consumption, and less stress on the bearing parts.

The high heat conductivity of diamond makes a superior heat sink to conduct heat away from the heat source. The subject invention produces an extended assembly 650 with almost one hundred percent diamond content, and thus a continuous homogeneous content of diamonds without the diluting effect of binders used in binding diamond crystals.

The fourth embodiment produces an extended, voidless assembly 650 of diamond crystals with identical crystallographic directions. Chemical vapor deposition on the assembly results in a thin layer of diamond with one crystallographic direction because of the epitaxial relationship between the chemically-vapor deposited layer and the substrate of oriented diamond crystals. It is important to regognize that the assembly has one crystallographic direction yielding single crystal quality because the contacting adjacent crystals avoids spaces between the crystals which would otherwise produce defects at the growth boundaries.

Following the principles of the fourth embodimen thus makes possible improved exploitation of diamond's semiconductor properties. Chemically-vapor deposited single-crystal assemblies, as 660e, can be made insulating in character by using pure diamond or can be doped with impurities to yield P or N carriers to make diodes, transistors, radiation detectors, or photo conductor devices. The diamond substrate forms an integral heat sink to allow increased electric current capacity to the devices, and diamond's high temperature and chemical immunity permit devices to function in hostile environments.

In attrition grinding of hard materials to reduce particles to smaller sizes, the wear of machine surfaces by the abrasive action of the particles is costly because the parts wear rapidly and must be replaced, and the parts that wear produce particles that contaminate the product being ground. By applying to the wear surfaces, assemblies or layers 650 of aligned diamond crystals that present the hard-to-abrade directions of the crystals to the abrading directions of the particles being ground, machine wear can be drastically reduced thus saving the cost of new wear surfaces and the cost of replacing them. The great reduction of impurities from wear surfaces is often of critical importance in quality control, and the minuscule contamination by diamond wear surfaces is of a highly inert nature.

The present invention takes advantage of the inherent properties of diamonds and particularly synthetic diamond crystals in the manner described, but it is to be understood that the principles of this invention are equally applicable to other materials that have similar or equivalent crystalline properties.

In addition to the terms "assembly" and "formation," the terms "array," "sheet," "mosaic," "block," and "matrix" are used to describe the article of manufacture provided by the present invention. Other terms could be used without affecting the principles

described herein. It is understood that the use of these terms does not imply any particular surface area or size of the various assemblies shown in Figs. 1, 10, 19 or 33.

Furthermore, although preferred embodiments have been shown and described, various modifications and substitutions may be made thereto without departing from the spirit and scope of the invention. Accordingly, it is to understood that the present invention has been described by way of illustration and not limitation.

Claims

1. An article of manufacture comprising synthetic single crystals held in a formation with selected crystallographic directions of the crystals oriented in the same direction.

2. The article of claim 1 wherein the crystals are polyhedral in shape.

3. The article of claim 2 wherein the shapes are selected from the group consisting of cubic, cubo-octahedral and tetrahedral.

4. The article of claim 2 wherein the crystals are of uniform size and shape.

5. The article of claim 4 wherein the crystals are at least about 0.5 mm to 1 mm in size.

6. The article of claim 1 wherein the crystals are selected from the group consisting of diamond and cubic boron nitride.

7. The article of claim 6 wherein the crystals are of uniform size and shape, wherein each of the crystals has face portions and edge portions, wherein one of said portions of each crystal faces outwardly of the formation, wherein said selected crystallographic direction of each crystal lies along a line in contact with its outwardly directed portion, wherein all of said selected crystallographic directions have substantially the same degree of hardness, and wherein said outwardly directed portions thereby exhibit a common crystallographic direction of hardness.

8. The article of claim 7 wherein the crystals are spaced from each other.

9. The article of claim 8 wherein all of the outwardly directed portions project equidistantly outwardly from said formation.

10. The article of claim 8 wherein said outwardly directed portions are faces of the crystals.

11. The article of claim 8 wherein said outwardly directed portions are edges of the crystals.

12. The article of claim 11 wherein said outwardly directed edges are coplanar.

13. The article of claim 11 wherein said outwardly directed edges are at an angle to a common plane and terminate in sharp corners which are in said common plane.

14. The article of claim 7 wherein the crystals are closely packed together with said outwardly directed portions being faces of the crystals and forming a continuous common surface.

15. The article of claim 7 including a binder of plastic or metal holding the crystals in said formation.

16. The article as in any one of claims 7-13 or 15 wherein said outwardly directed portions are abrading portions whereby the article is an abrasive article.

17. The article of claim 14 wherein said continuous common surface is a bearing surface, a heat sink or a semiconductor substrate.

18. The article of claim 7 or 14 wherein the formation is a semiconductor substrate, and wherein a layer of diamond crystals is deposited on said outwardly directed portions by chemical vapor deposition whereby the deposited layer has the same crystallographic direction as the assemblage.

19. The article of Claim 18 wherein the deposited layer is doped with impurities to provide P or N carriers and wherein the formation is an integral heat sink for the doped layer.

20. The article of claim 7 wherein the formation is a layer of said crystals in a common plane.

21. A method for producing an article of oriented crystals comprising the steps of selecting synthetic single crystals of substantially uniform size and of polyhedral shape and wherein each of said crystals has at least one portion with a crystallographic direction which is substantially the same in all of the crystals, positioning the crystals in a formation so that all of said crystallographic directions are oriented in the same direction and said portions collectively exhibit a common crystallographic direction of hardness, and securing the crystals together in said formation.

22. The method of claim 21 wherein said selecting step involves selecting the crystals from the group consisting of diamond and cubic boron nitride.

23. The method of claim 21 or 22 wherein the crystals are positioned in said formation in spaced relation to each other.

24. The method of claim 21 or 22 wherein the crystals are positioned in said formation in contacting, closely packed relation to each other.

25. The method of claims 21 or 22 wherein said one portion of each crystal is an abrasive portion, wherein said positioning step includes introducing the crystals into a template having receptor means shaped to position and align said abrasive portions to collectively exhibit said common crystallographic direction of hardness and wherein said abrasive portion of each crystal protrudes from said template, said method including the further step of vibrating the template to stabilize the crystals in the receptor means and to remove excess crystals, wherein said securing step involves applying a binder to the crystals protruding from the template whereby the crystals are fixed in the positions in which they were aligned in the template and at least partially curing said binder, and including the additional step of removing the crystals and binder from the template.

AMENDED CLAIMS

[received by the International Bureau on 05 February 1996 (05.02.96); original claims 1,6,7,20 amended; new claim 21 added; original claims 21-25 renumbered as claims 22-26 remaining claims unchanged (2 pages)]

1. An article of manufacture comprising a formation of synthetic single crystals each having a predetermined crystallographic direction of hardness, said crystals being held in the formation with said predetermined crystallographic directions oriented in the same direction, said formation being created by physically moving the crystals from disoriented positions into their oriented positions in said formation.

2. The article of claim 1 wherein the crystals are polyhedral in shape.

3. The article of claim 2 wherein the shapes are selected from the group consisting of cubic, cubo-octahedral and tetrahedral.

4. The article of claim 2 wherein the crystals are of uniform size and shape.

5. The article of claim 4 wherein the size of the crystals ranges from about 0.5 mm to about 1 mm or more.

6. The article of claim 1 wherein the crystals are selected from the group consisting of diamond and cubic boron nitride.

7. The article of claim 6 wherein the crystals are of uniform size and shape, wherein each of the crystals has face portions and edge portions, wherein one of said portions of each crystal faces outwardly of the formation, wherein said predetermined crystallographic direction of each crystal lies along a line in contact with its outwardly directed portion, wherein said crystals have substantially the same degree of hardness along their respective predetermined crystallographic directions, and wherein said outwardly directed portions thereby exhibit a common direction of hardness.

8. The article of claim 7 wherein the crystals are spaced from each other.

9. The article of claim 8 wherein all of the outwardly directed portions project equidistantly outwardly from said formation.

20. The article of claim 7 wherein the formation is a coplanar layer of said crystals.

21. The article of Claim 1 wherein the formation is a matrix of rows and columns of crystals, each of said rows and columns being completely filled with crystals, said crystal formation having a common crystallographic direction of hardness.

22. A method for producing an article of oriented crystals comprising the steps of selecting synthetic single crystals of substantially uniform size and of polyhedral shape and wherein each of said crystals has at least one portion with a crystallographic direction which is substantially the same in all of the crystals, positioning the crystals in a formation so that all of said crystallographic directions are oriented in the same direction and said portions collectively exhibit a common crystallographic direction of hardness, and securing the crystals together in said formation.

23. The method of claim 22 wherein said selecting step involves selecting the crystals from the group consisting of diamond and cubic boron nitride.

24. The method of claim 22 or 23 wherein the crystals are positioned in said formation in spaced relation to each other.

25. The method of claim 22 or 23 wherein the crystals are positioned in said formation in contacting, closely packed relation to each other.

26. The method of claims 22 or 23 wherein said one portion of each crystal is an abrasive portion, wherein said positioning step includes introducing the crystals into a template having receptor means shaped to position and align said abrasive portions to collectively exhibit said common crystallographic direction of hardness and wherein said abrasive portion of each crystal protrudes from said template, said method including the further step of vibrating the template to stabilize the crystals in the receptor means and to remove excess crystals, wherein said securing step involves applying a binder to the crystals protruding from the template whereby the crystals are fixed in the positions in which they were aligned in the template and at least partially curing said binder, and including the additional step of removing the crystals and binder from the template.

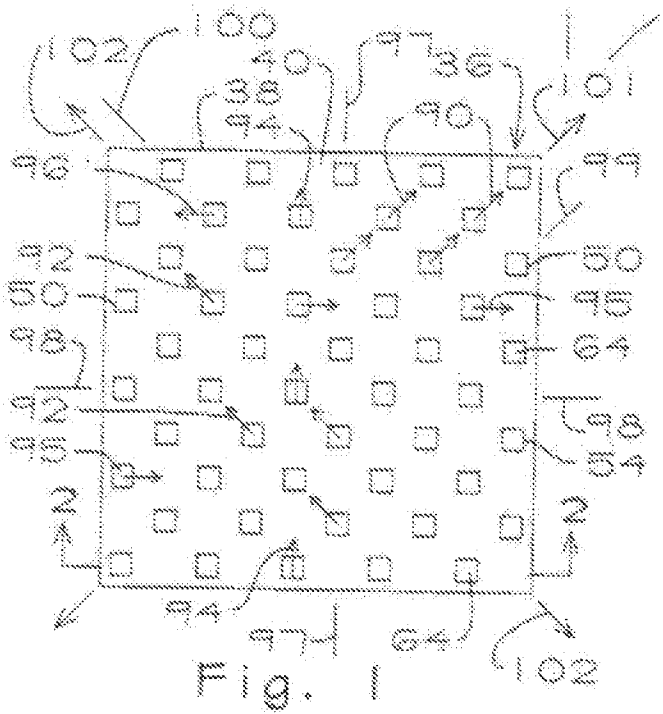


Fig. 1

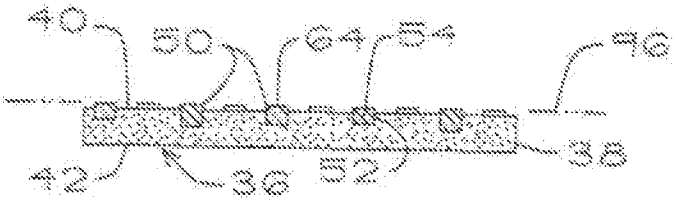


Fig. 2

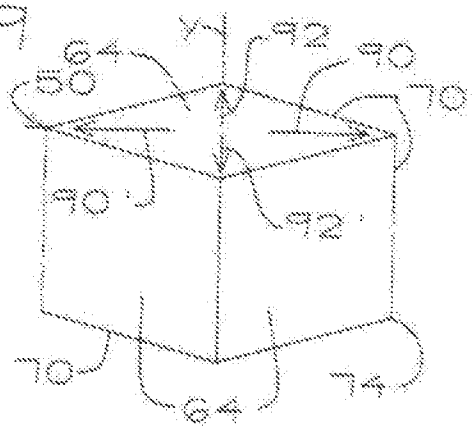


Fig. 3
PRIOR ART

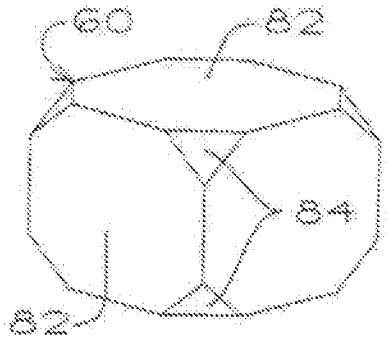


Fig. 4
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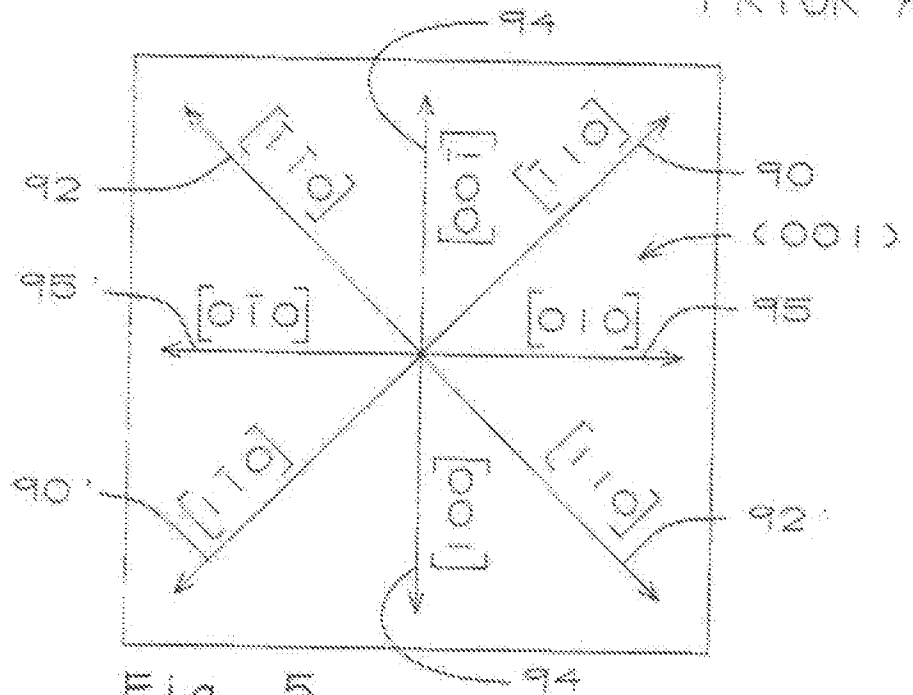


Fig. 5
PRIOR ART

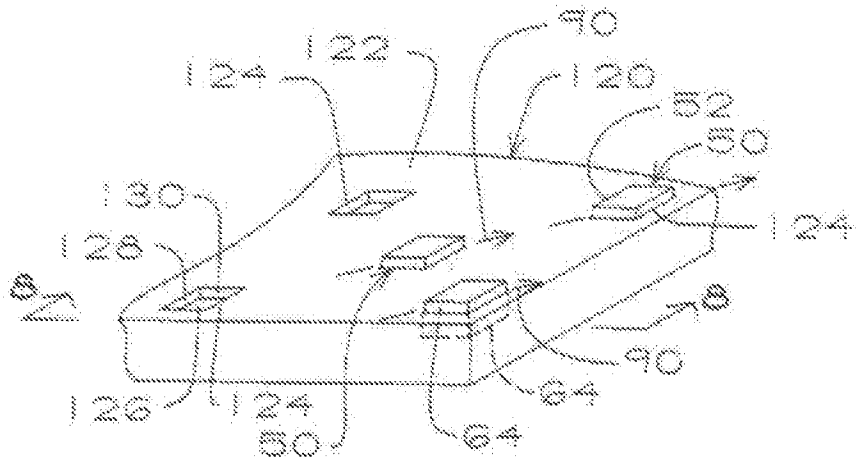


Fig. 6

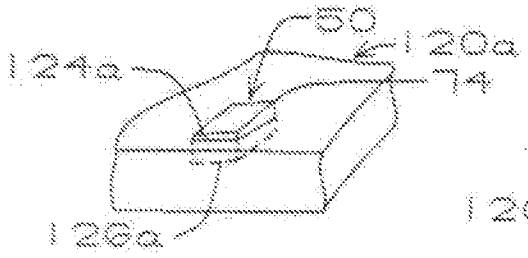


Fig. 7

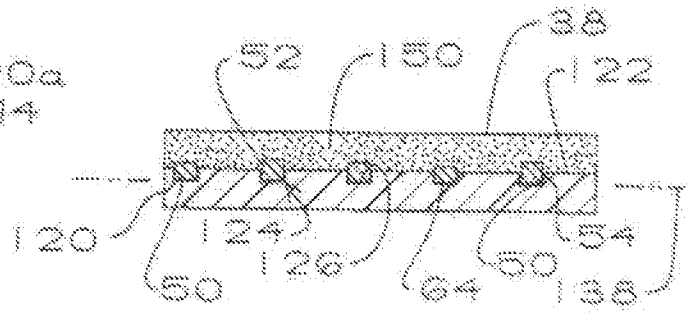


Fig. 8

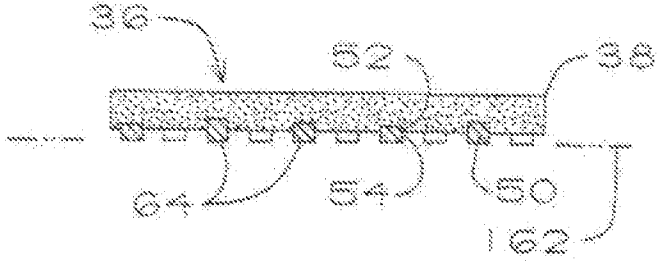


Fig. 9

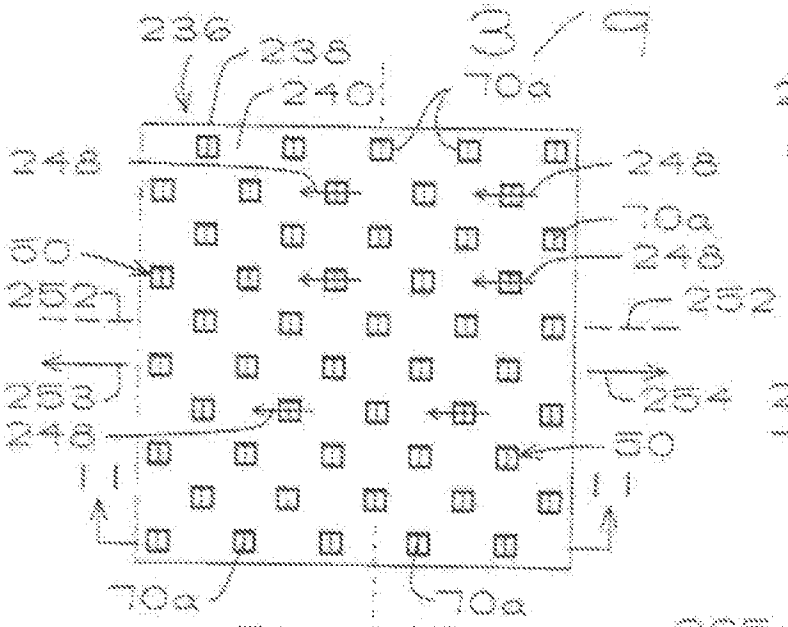


Fig. 10

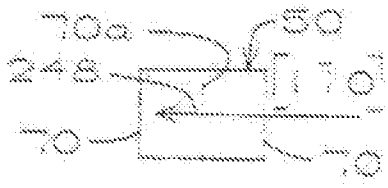


Fig. 12

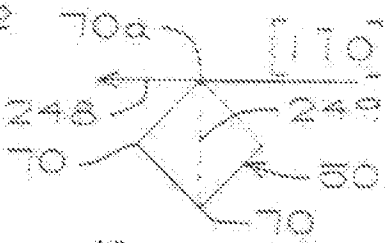


Fig. 13

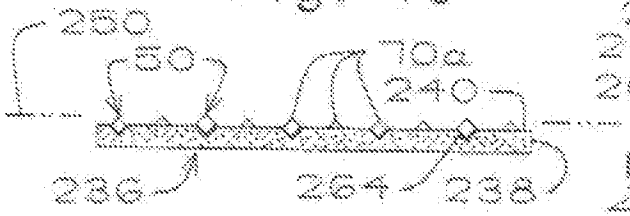


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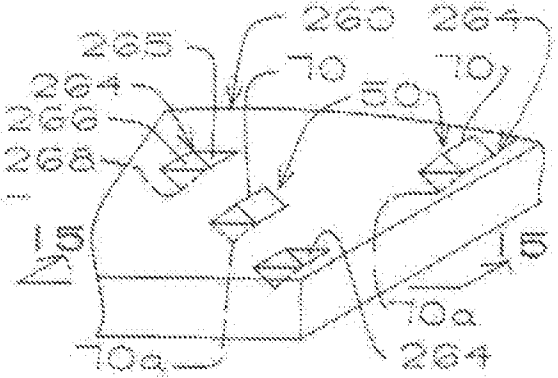


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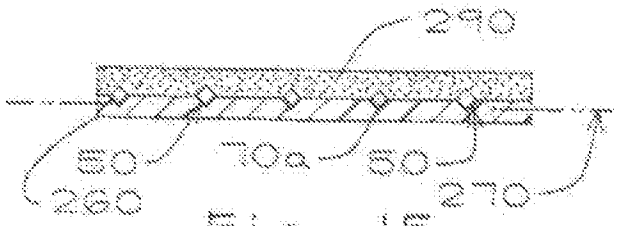


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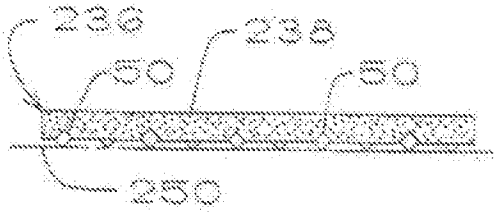


Fig. 16

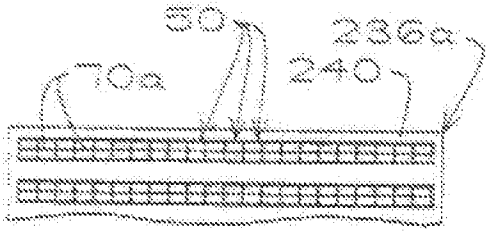


Fig. 17

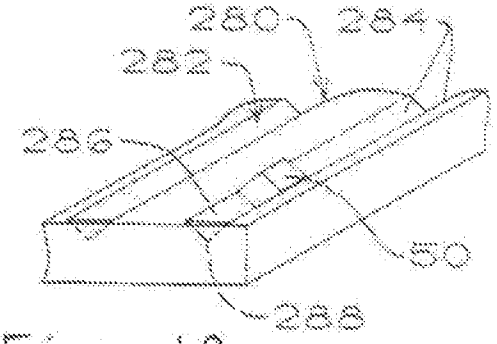


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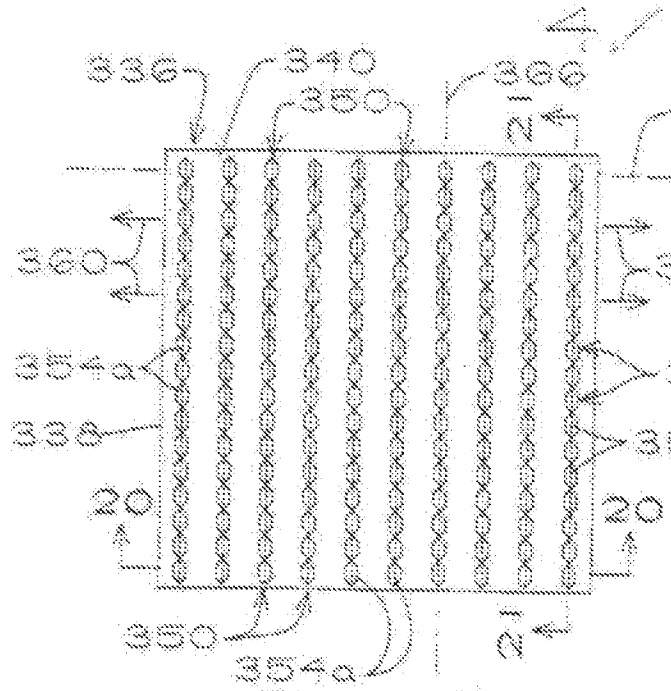


Fig. 19

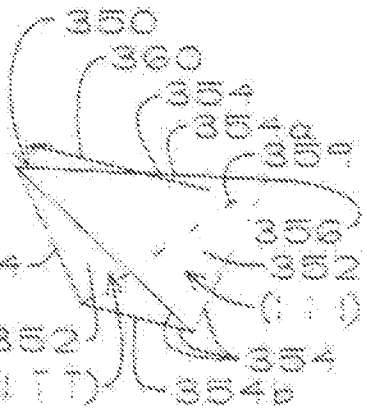


Fig. 22

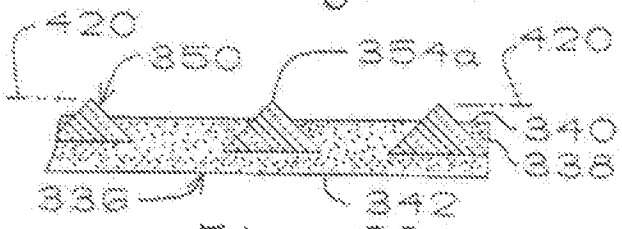


Fig. 20

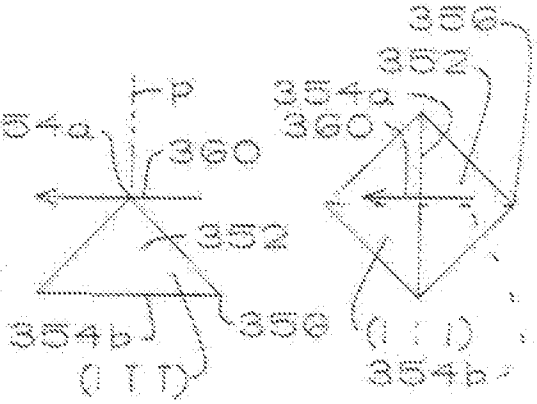


Fig. 23 Fig. 24

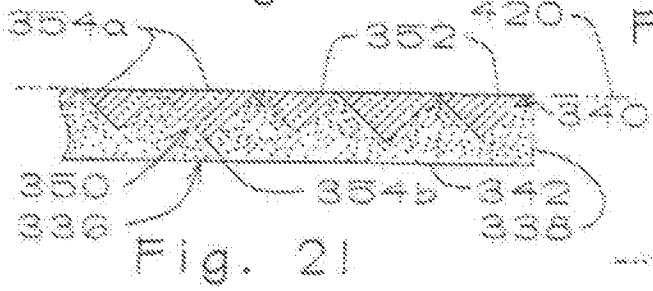


Fig. 21

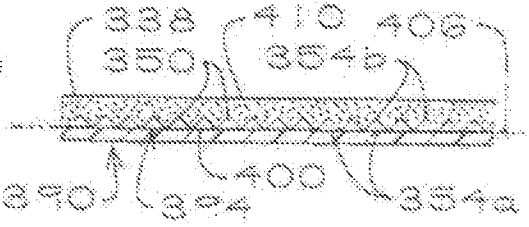


Fig. 26

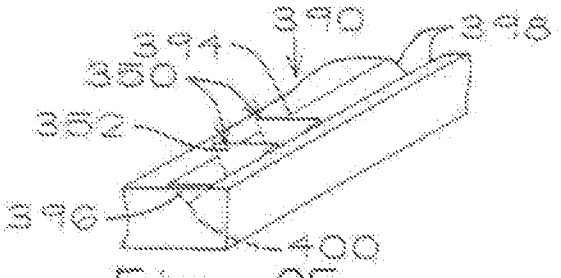


Fig. 25

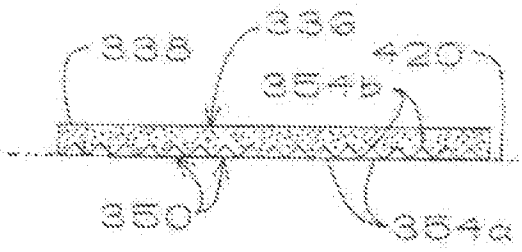


Fig. 27

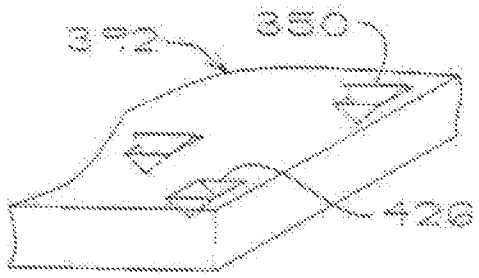


Fig. 28

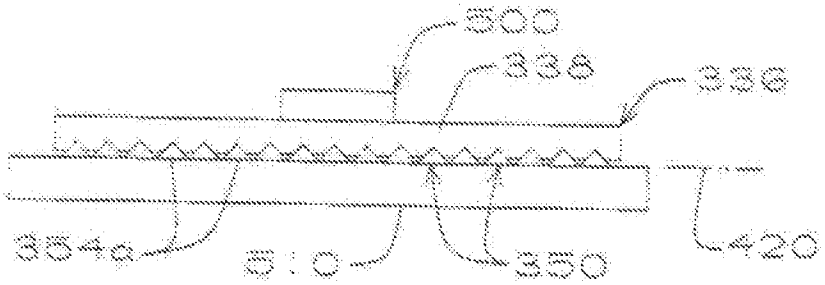


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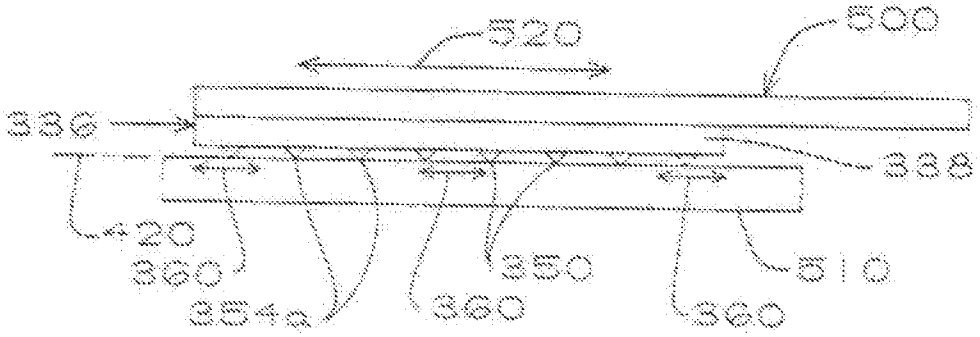


Fig. 30

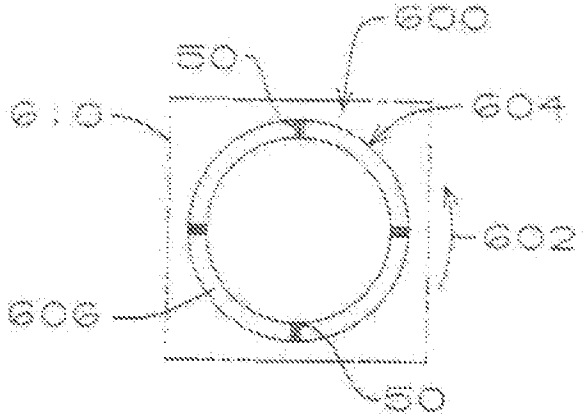


Fig. 31

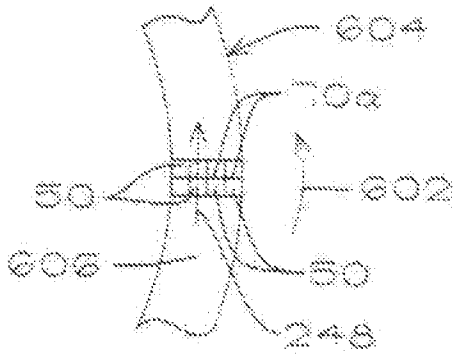


Fig. 32

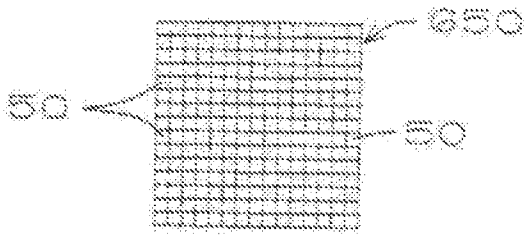


Fig. 33



Fig. 34

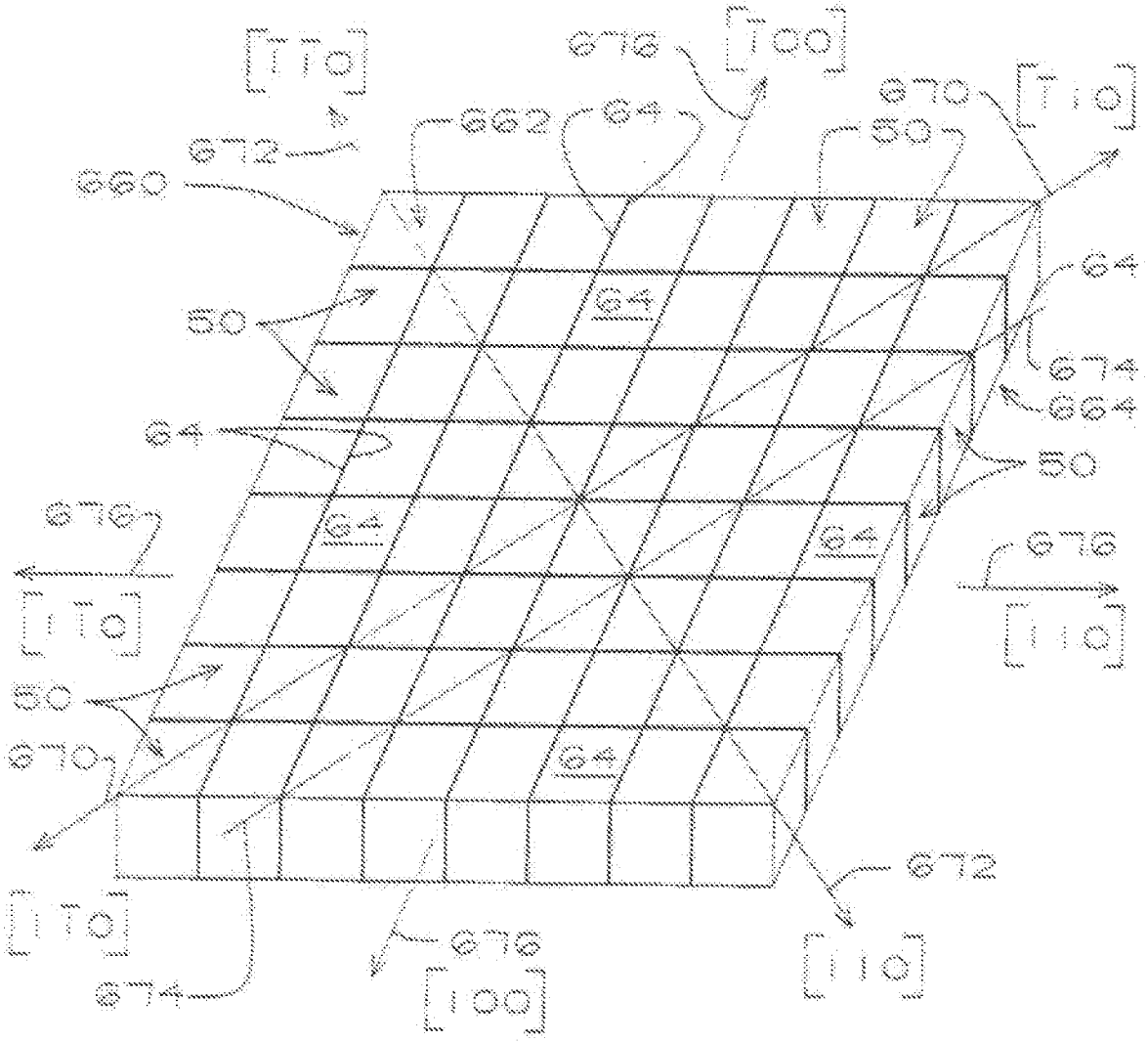


Fig. 35

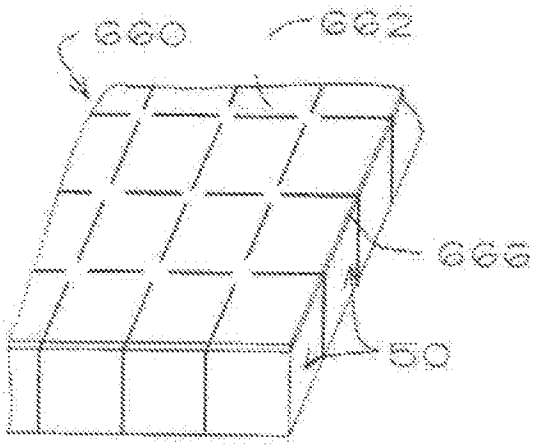


Fig. 36

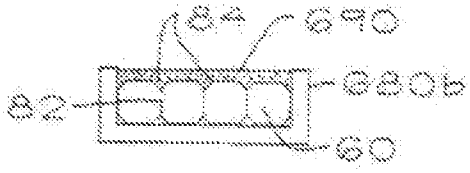


Fig 38a

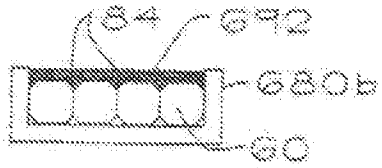


Fig 38b

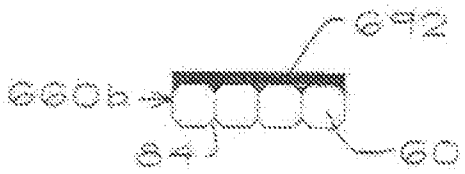


Fig 38c

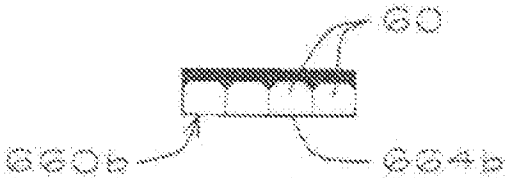


Fig 38d

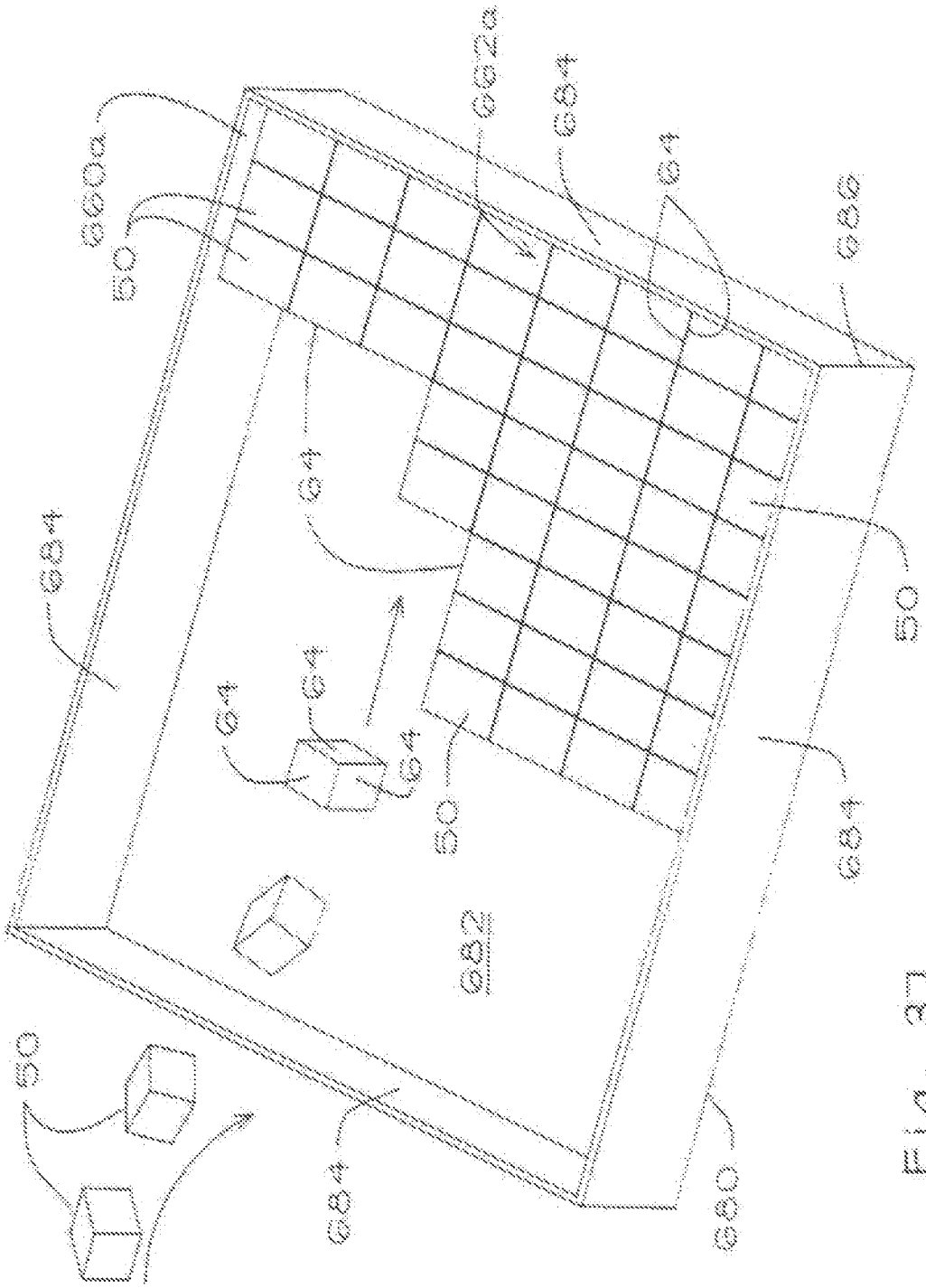


Fig. 8J

9/9

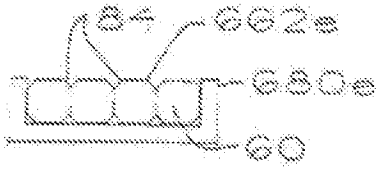


Fig 39a

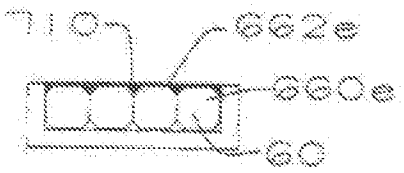


Fig 39b

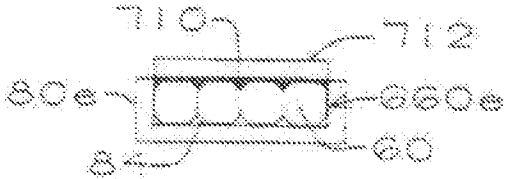


Fig 39c

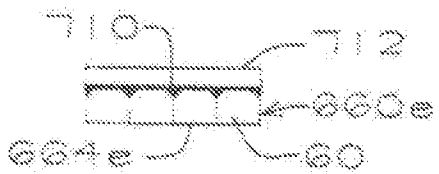


Fig 39d

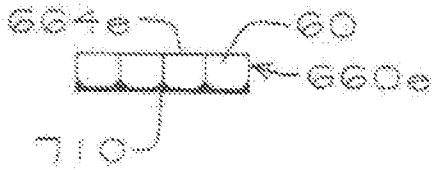


Fig 39e

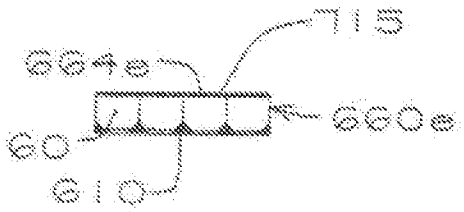


Fig 39f

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/10195

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6): Please See Extra Sheet.
US CL: 428/141, 143, 217, 323, 408; 51/295, 307; 257/64, 77, 627, 628; 117/84, 95, 101

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. : 428/141, 143, 217, 323, 408; 51/295, 307; 257/64, 77, 627, 628; 117/84, 95, 101, 902, 924

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: diamond, orientation, heat sink, abrasive.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO, A, 92/01827 (MASSACHUSETTS INSTITUTE OF TECHNOLOGY) 06 February 1992, see entire document.	1-4, 6-7, 14, 17-22, 24
Y	Applied Physical Letters, Volume 58, Number 22, issued 03 June 1991, Geis et al, "Large-area Mosaic diamond films approaching single-crystal quality", pages 2485-2487, see pages 2485-2487.	1-4, 6-7, 14, 17-18, 20-22, 24
Y	US, A, 3,895,313 (SEITZ) 15 July 1975, see Figure 8; columns 3-4; column 7, line 63 - column 8, line 60.	1-4, 6-7, 14, 17, 20-22, 24
Y, P	US, A, 5,371,383 (MIYATA ET AL) 06 December 1994, see column 2, lines 34-68; column 4, lines 38-45; column 5, lines 20-23.	1-4, 6-7, 14, 17-22, 24

[X] 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 part of particular relevance

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"&" 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 OCTOBER 1995	07 DEC 1995

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/10195

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,925,457 (DEKOK ET AL) 15 May 1990, see entire document.	2, 6-13, 15-16, 22-23, 25
Y	US, A, 5,107,626 (MUCCI) 28 April 1992, see Figure 1; column 1, line 60 to column 2, line 50.	1-4, 6-13, 15-16
Y	US, A, 5,304,223 (PIEPER ET AL) 19 April 1994, see column 2.	1-4, 6-13, 15-16
Y	US, A, 5,152,917 (PIEPER ET AL) 06 October 1992, see column 2.	1-4, 6-13, 15-16
A	US, A, 5,296,207 (LUX) 22 March 1994, see entire document.	17

Form PCT/ISA/210 (continuation of second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

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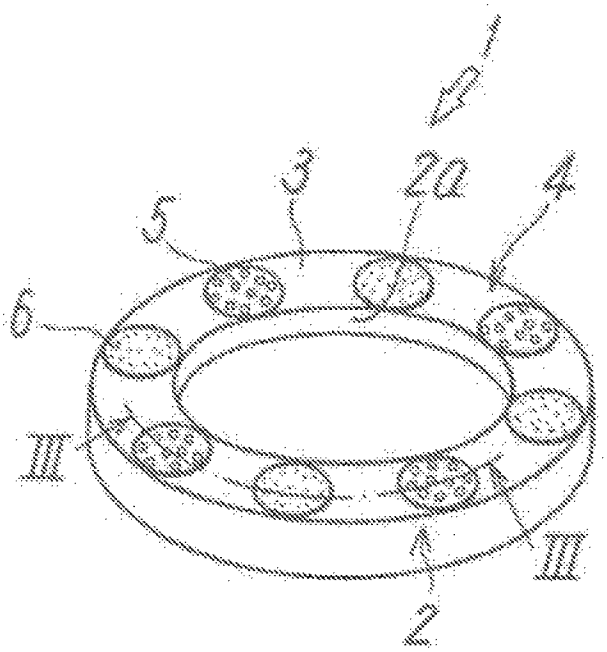
Bibliographic data: CN1494984 (A) — 2004-05-12

Sander for polishing cloth and polishing cloth sanding method using said sander

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Classification: - **International:**	***B24B37/00; B24B37/04; B24B53/02; B24B53/12; B24D13/14; B24D3/10; B24D7/06; H01L21/304;*** (IPC1-7): B24B53/00; B24B53/12
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Abstract of corresponding document: US2004048557 (A1)

An abrasive cloth dresser is provided which is capable of adjusting the state of its dressing face so as to give an abrasive cloth a uniform polishing surface, and capable of giving the surfaces of an abrasive cloth a suitable polishing capability according to polishing objects, even if the dressing face state exhibits individual differences in, for example, the end shapes of abrasive grains. The abrasive cloth dresser 1 includes a base metal 2 having a ring-shaped dressing face 4 in the outer region of the base metal 2. First abrasive grain units 5 and second abrasive grain units 6 formed of abrasive grains with different grain sizes from each other are alternately arranged on the dressing face 4. The base metal 2 includes adjusters 7 for arbitrarily adjusting the height difference delta between reference planes S1 and S2 of the respective abrasive grain units 5 and 6. The reference planes S1 and S2 each include the ends of the abrasive grains with the largest grain size.



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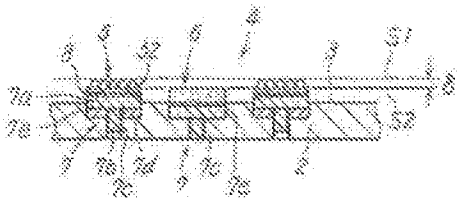
代理人 韩登营

权利要求书2页 说明书12页 附图4页

[54] 发明名称 抛光布用打磨器和使用该打磨器的抛光布的打磨方法

[57] 摘要

本发明提供一种抛光布用打磨器和使用该打磨器的抛光布的打磨方法，使可调整抛光布用打磨器中的打磨面的状态，即使在颗粒的前端形状等打磨面的状态中产生个体差异，也可以造成均一的抛光布表面，而且能够对抛光布表面赋予适应被加工物的适当的抛光性能。上述打磨器构成为，在金属基体(2)的圆盘状上备有打磨面(4)的抛光布用打磨器(1)中，在该打磨面(4)上分别交互地并列设置由被此不同的粒度的磨粒组成的第1、第2磨粒群(5)、(6)，在上述金属基体(2)上，设置能够任意调节这些各磨粒群(5、6)中包含的粒度最大的磨粒的前端的基准面(S1)、(S2)间的高低差(δ)的调节机构(7)。



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1. 一种抛光布用打磨器，是在能够转动的金属基体的表面上形成打磨面而成的抛光布用打磨器，其特征在于，

在上述打磨面上，在其圆周方向上并列设置多个磨粒群，

在上述金属基体上，对全部或一部分磨粒群，设置能够调节由多个磨粒的前端分别形成的基准面的上述打磨面上的高低差的调节机构。

2. 如权利要求1中所述的抛光布用打磨器，其特征在于，有上述调节机构的磨粒群，分别固定于构成与上述金属基体分开形成的上述调节机构的基台上，沿着上述打磨面中的金属基体的周缘部各磨粒群环状地并列设置。

3. 如权利要求1中所述的抛光布用打磨器，其特征在于，上述磨粒群分别形成为从与上述打磨面的周缘平行的环形片形状、与上述打磨面的周缘成一定的角度的螺旋片形状，小圆形状之中选择的一种或两种的平面形状。

4. 如权利要求3中所述的抛光布用打磨器，其特征在于，上述磨粒群分别形成为从上述平面形状之中选择的两种平面形状，

这些平面形状不同的两种磨粒群在打磨面的圆周方向上交互地并列设置。

5. 如权利要求1或2中所述的抛光布用打磨器，其特征在于，并列设置在打磨面上的各磨粒群是由彼此同一粒度的磨粒所形成的磨粒群、或者，由不同的粒度的磨粒所形成的两种磨粒群来构成。

6. 如权利要求5中所述的抛光布用打磨器，其特征在于，并列设置在打磨面上的磨粒群，由彼此不同的粒度的磨粒所形成的第1磨粒群和第2磨粒群来构成，

这些第1磨粒群和第2磨粒群在打磨面的圆周方向上交互地并列设置。

7. 如权利要求6中所述的抛光布用打磨器，其特征在于，上述

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第 1 磨粒群由同一粒度的磨粒或者两种粒度的磨粒来形成。

8. 如权利要求 1 或 2 中所述的抛光布用打磨器，其特征在于，在各磨粒群中，各磨粒颗粒在前述打磨面上二维地具有规律性地排列，相互邻接的磨粒颗粒形成的最小格子为三三角形或者平行四边形地排列。

9. 一种抛光布的打磨方法，是用权利要求 1～8 中所述的任何一项抛光布用打磨器打磨抛光布的方法，其特征在于，

借助上述调节机构，在相互邻接的磨粒群的上述基准面间设置一定的高低差，打磨上述抛光布。

10. 一种抛光布的打磨方法，是用权利要求 6～8 中所述的任何一项抛光布用打磨器打磨抛光布的方法，其特征在于，

借助上述调节机构，上述打磨面中的第 1 磨粒群的基准面的高度调节成比第 2 磨粒群的基准面的高度高出一定量，打磨上述抛光布。

抛光布用打磨器和使用该打磨器的抛光布的打磨方法

技术领域

本发明涉及在机械的化学抛光（Chemical Mechanical Polishing；以下简称 CMP）中在进行抛光布的布网孔堵塞或异物去除之际使用的抛光布用打磨器和用它的抛光布的打磨方法。

背景技术

一般来说在硅晶片基板上制造半导体硅晶片基板或集成电路等微细电子电路的过程中，出于去除存在于基板表面上的凹凸或结晶缺陷的目的用 CMP 加工。在此一 CMP 加工中，一边以规定的载荷把晶片基板压住粘贴于抛光装置的固定盘的由泡沫聚氨酯构成的抛光布上，一边供给称为浆液的抛光液，使晶片与抛光布两方旋转而进行抛光。

作为上述 CMP 加工中的浆液，用使氧化铈、碳酸钡、氧化钛、氧化铝、胶态二氧化硅等的抛光颗粒悬浮于氢氧化钾、稀盐酸、稀硝酸、过氧化氢水溶液、硝酸铁等抛光液中的浆液，这些是根据抛光速度和晶片或晶片基板上的前述被加工物的种类适当选择。

此一 CMP 加工，为了用同一抛光布多张或者多次重复地抛光晶片，随着 CMP 加工的次数的增大，所去除的被加工物的碎屑或凝集的抛光颗粒进入抛光布的微细的孔而引起堵塞，晶片的抛光速度降低。因此有必要经常或者定期地进行去除布网孔堵塞后的抛光布的表层，再生抛光布表面的面粗糙性而恢复抛光速度的被称为打磨的作业，在此一作业中使用被称为抛光布用打磨器的工具。

因为金刚石磨粒在抛光布的打磨中是优良的材料，故研究了利用金刚石磨粒的抛光布用打磨器，通过镀镍在不锈钢上电沉积金刚石磨粒的方法一般被实用化了。除此以外提出了借助金属纤料把金刚

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石磨粒钎焊于不锈钢上的方法（例如，参照特开平 10－012579 号公报），通过烧结使金刚石磨粒与保持材反应烧结而固定的方法（例如，参照特开 2001－179638 号公报）。此外出于得到稳定的抛光布的表层去除能力的目的，还提出了均等间隔地排列磨粒的 CMP 抛光布打磨器（例如，参照特开 2000－141204 号公报，特开 2002－127017 号公报）。

可是，在上述这种现有技术中的抛光布用打磨器中，因为在其结构上，无法避免因磨粒的前端形状等在打磨面的方式上产生个体差异，故即使使用同一抛光布用打磨器也难以造成均一的抛光布表面，此外，抛光布的表面状态有必要根据被加工物进行调整，例如，对在硅晶片表面形成层间氧化膜的晶片，通过抛光布的表面状态成为粗糙状态，抛光布引起的机械去除加工的因素增强而抛光速度提高，此外，对于 Cu 配线，由于使存在于抛光布表面的抛光液（浆液）的化学反应引起的因素比抛光布引起的机械去除加工的因素更强的目的，有必要维持某种程度的一定的抛光布的表面粗糙度，因此，关于打磨该抛光布的表面的抛光布用打磨器也是，有必要准备需要数量的、打磨面的状态适应上述被加工物的，存在着成本提高这样的问题。

发明内容

本发明将要解决的技术课题，在于提供一种通过能够调整抛光布用打磨器中的打磨面的状态，即使在磨粒的前端形状等打磨面的状态中产生个体差异，也可以通过该打磨面的调整造成均一的抛光布表面，或者，能够对抛光布表面赋予适应被加工物的适当的抛光性能的抛光布用打磨器和用它的抛光布的打磨方法。

为了解决上述课题，本发明的抛光布用打磨器是在能够旋转的金属基体的表面上形成打磨面而成的抛光布用打磨器，其特征在于，在上述打磨面上，在其圆周方向上并列设置多个磨粒群，在上述金属基体上设有对全部或一部分磨粒群，能够调节由多个磨粒的前端

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分别形成的基准面的上述打磨面中的高低差的调节机构。

如果用上述抛光布用打磨器，则由于借助上述调节机构可以任意调节多个磨粒群中的上述各基准面的高低差，所以即使在磨粒的前端形状等打磨面的状态中产生个体差异也可以通过调节上述多个磨粒群中的基准面的高低差，调整打磨面的状态，造成均一的抛光布表面，或者，可以对抛光布表面即抛光布的抛光面，赋予适应被加工物的适当的抛光性能。在此一场合，基准面高的磨粒群主要用于抛光布表面的磨耗，基准面低的磨粒群主要用于抛光布的表面粗糙度的调整。

在上述抛光布用打磨器中，也可以取为有上述调节机构的磨粒群，分别固定于与上述金属基体分开形成的构成上述调节机构的基台上。沿着上述打磨面中的金属基体的周缘部各磨粒群环状地并列设置。

如果上述磨粒群分别以从与上述打磨面的周缘平行的环状片形状、与上述打磨面的周缘成一定的角度的螺旋片形状、小圆形状之中选择的一种或两种的平面形状形成，则最好由打磨所去除的抛光布的切削屑或凝集的浆液容易向外部排出。

在上述磨粒群分别形成为从上述平面形状之中选择的两种平面形状的场合，这些平面形状不同的两种磨粒群在打磨面的圆周方向上交互地并列设置是适当的。

此外，并列设置在打磨面上的各磨粒群也可以由彼此同一粒度的磨粒所形成的同一的磨粒群，或者，由不同的粒度的磨粒所形成的两种磨粒群来构成。

而且，在并列设置在上述打磨面上的磨粒群，由彼此不同的粒度的磨粒所形成的第1磨粒群和第2磨粒群来构成的场合，把这些第1磨粒群和第2磨粒群在打磨面的圆周方向上交互地并列设置是适当的。在此一场合，可以由同一粒度的磨粒或者不同的两种粒度的磨粒来形成上述第1磨粒群。

这里，虽然在上述各磨粒群中，磨粒颗粒在前述打磨面上二维地

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具有规律地排列，相互邻接的磨粒颗粒造成的最小格子如果成为正三角形或者平行四边形地排列，则可以进一步提高打磨的稳定性和均匀性。

进而，上述课题可以通过拿上述调节机构，在相互邻接的磨粒群的上述基准面间设置一定的高低差，打磨上述抛光布的抛光布的打磨方法来解决。

在上述抛光布的打磨方法中，在多个磨粒群由上述第1磨粒群和第2磨粒群来构成的场合，借助上述调节机构，上述打磨面中的第1磨粒群的基准面的高度调节成比第2磨粒群的基准面的高度高出一定量，打磨上述抛光布是合适的。

如果用这种本发明的抛光布用打磨器和用它的抛光布的打磨方法，则由于可以借助调节机构任意调节在各磨粒群中由磨粒的前端分别形成的磨粒基准面的上述打磨面上的高低差，所以即使磨粒的前端形状等打磨面的状态中产生个体差异，也可以造成均一的抛光布表面，而且，对抛光布表面也可以赋予适应被加工物的适当的抛光性能。

附图说明

图1A～图1D是表示使本发明的抛光布用打磨器的磨粒群的配置形状不同的第1实施方式的立体图。

图2A～图2D是表示使本发明的抛光布用打磨器的磨粒群的配置形状不同的第2实施方式的立体图。

图3是图1A中的III－III剖视图。

图4是图2A中的IV－IV剖视图。

图5是表示第1磨粒群5中的磨粒的排列状态的示意图。

图6是图3中的局部放大图。

具体实施方式

图1A～图1D示出本发明的抛光布用打磨器的磨粒群的配置形状

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不同的第 1 实施方式。抛光布用打磨器 1 由在其表侧的中心有圆形的凹部 2a，和在其周围的金属基体表面 3 上形成环状的打磨面 4 而成的圆盘状的金属基体 2 来构成。在上述打磨面 4 上，分别环状地并列设置多个沿着其圆周方向独立的第 1 和第 2 磨粒群 5、6。换句话说，沿着金属基体表面 3 即上述金属基体 2 的周缘部环状地并列设置多个磨粒群 5、6 形成上述打磨面 4。

而且，如图 3 中所示，在上述金属基体 1 上设有调节机构 7，以使在各磨粒群 5、6 中以包含粒度最大的磨粒的前端的平面为基准面 S1、S2 时，可以任意调节在打磨面 4 上，上述多个磨粒群 5、6 中的各基准面 S1、S2 间相互的高低差 δ。

这里，没有必要一定在上述金属基体 2 上设置上述凹部 2a。

具体地说，上述调节机构 7 由基台 7a、调节用螺栓 7b 和垫片 7d 构成，其中，基台 7a 的表面上固定磨粒群 5 或 6，上下滑动自如地嵌入开口于上述金属基体 2 的表面 3 的凹部 7e；调节用螺栓 7b 设在该基台 7a 的背面，螺纹配合于从上述金属基体 2 的凹部 7e 的底面向该金属基体 2 的背面侧贯通的螺纹孔 7c；当调节固定于上述基台 7a 的磨粒群 5、6 处的基准面的高度位置时，垫片 7d 夹在上述基台 7a 的背面与上述凹部 7b 的底面之间。而且，分别固定于上述调节机构 7 的基台 7a 的表面上的多个磨粒群 5、6 沿着上述金属基体 2 的周缘部环状地并列设置，形成上述打磨面 4。

因而，为要调节上述磨粒群 5、6 的基准面 S1、S2 的高度位置把具有所需厚度的垫片 7d 放入上述金属基体 2 的凹部 7e 内，通过借助上述调节用螺栓 7b 夹持于该凹部 7e 的底面与上述基台 7a 的背面之间，可以调节上述各磨粒群 5、6 处的基准面 S1、S2 对金属基体表面 3 的高度位置，即多个磨粒群 5、6 处的各基准面 S1、S2 间相互的高低差 δ，可以调整打磨面 4 的状态。再者，在本实施方式中，借助调节机构 7，上述基准面 S1、S2 对金属基体表面 3 的高度可以在 0～300 μm 的范围内调节。

上述磨粒群当中，基准面高的磨粒群主要用于抛光布的磨耗，基

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准面低的磨粒群主要用于抛光布的表面粗糙度的调整，即，因为通过加在打磨器总体上的载荷集中地作用于基准面高的磨粒群，每单位面积的负载载荷增大，故它们主要用于抛光布的磨耗，另一方面，基准面低的磨粒群负担载荷到某种程度，使上述基准面高的磨粒群引起的抛光布的磨耗速度降低。再者，在基准面间相互的高低差 D 变得较大的场合，因为成为基准面低的磨粒群完全不负担载荷，故成为它们不发挥使抛光布的磨耗速度降低的效果。此一基准面低的磨粒群还在抛光布的切削屑的排出中有效地起作用。

此外，在抛光布用打磨器 1 中，上述多个磨粒群 5、6 由彼此粒度不同的磨粒所形成的第 1 磨粒群 5 与第 2 磨粒群 6 来构成。这两种磨粒群 5、6 沿着上述金属基体 2 的周缘部在其圆周方向上交互地并列设置形成打磨面 4。

具体地说，上述第 1 磨粒群 5，如图 5、图 6 中所示，由大小两种粒度的磨粒 50、51 来形成。这些磨粒 50、51，如图 5 中所示，在基台 7a 的表面上即前述打磨面 4 上二维地有规则性地均等地排列，相互邻接的磨粒颗粒彼此连成的最小格子成为正三角形或者平行四边形地排列着。再者大的磨粒颗粒 50 彼此的间隔比小的磨粒颗粒 51 彼此的间隔要宽。

通过像这样把大小两种粒度的磨粒有规则性地均等地排列，可以进一步提高打磨的稳定性和均匀性。

另一方面，在上述第 2 磨粒群 6 中，虽然也可以以粒度与上述第 1 磨粒群 5 的磨粒不同的同一粒度的磨粒或者多种粒度的磨粒这两种形式中的任何一种来形成，但是最好是与上述第 1 磨粒群 5 同样，磨粒二维地有规则性地均等地排列。

这里，作为形成上述磨粒群 5、6 的磨粒，可以用例如金刚石磨粒、该磨粒的粒度，一般来说，最好是 JIS B 4130 中规定的#325／#400～#60／#80 的范围。

此外，形成上述第 1 磨粒群 5 的磨粒，没有必要一定如上所述是大小两种粒度的磨粒 50、51，也可以是同一粒度的磨粒（参照图 2A～

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图 2D 的实施方式）。此外，上述调节机构 7 没有必要一定在第 1 磨粒群 5 和第 2 磨粒群 6 的两方中设置，也可以仅在磨粒群的一部分，即第 1 磨粒群 5 或第 2 磨粒群 6 的一方中设置。在此一场合，未设置调节机构 7 的磨粒群，基台 7a 直接固定于金属基体 2 的周缘部。

这样一来，如果每个磨粒群用不同粒度的磨粒，或者在各磨粒群中使不同粒度的磨粒混合，大粒度的磨粒主要用于抛光布的磨耗，小粒度的磨粒主要用于抛光布的表面粗糙度的调整，通过它们的粒度的调整，可以把抛光布的表面粗糙度养成适合特定对象物的 CMP 加工的状态。

进而，如图 1A－图 1D 中所示，在抛光布用打磨器 1 中，上述第 1 磨粒群 5 和第 2 磨粒群 6 的平面形状可以从小圆形状、成为与上述金属基体 2 的周缘即打磨面 4 的周缘平行的环形片形状、与上述金属基体 2 的周缘即打磨面 4 的周缘成一定角度的螺旋片形状之中选择一种或两种。图 1A 示出两个磨粒群 5、6 都是小圆形状的场合，图 1B 示出第 1 磨粒群 5 是小圆形状而第 2 磨粒群 6 是螺旋片形状的场合，图 1C 示出两个磨粒群 5、6 都是环形片形状的场合，图 1D 示出两个磨粒群 5、6 都是螺旋片形状的场合。通过把形成为这种平面形状的磨粒群 5、6 沿着金属基体表面 3 即金属基体 2 的周缘部排列成环状，形成打磨面 4，因打磨而去除的抛光布的切削屑或凝集的浆液容易向打磨器外部排出，此外可以调整其排出性能。

再者，上述磨粒群 5、6，如图 3、图 6 中所示，磨粒靠保持材 52 保持而形成，通过借助粘接剂 8 等把保持该磨粒的保持材 52 固定于上述调节机构 7 中的基台 7a 的表面，磨粒群 5、6 固定于上述基台 7a。

此外，作为上述保持材 52，虽然在磨粒为金刚石的场合，可以利用和金刚石磨粒反应结合的硅和／或硅合金，但是只要是适合于磨粒的保持的保持材没有特别限制，靠一般的电镀镍或借助纤料的接合来保持也是可能的。

接下来就对由上述抛光布用打磨器 1 进行的抛光布的打磨方法进行说明，借助上述调节机构 7，在交互邻接的第 1 磨粒群 5 和第 2

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磨粒群 6 的各基准面 S1、S2 间，设定对金属基体表面 3 的一定的高低差 δ，打磨上述抛光布。换句话说，借助上述调节机构 7，调节成上述第 1 磨粒群 5 的基准面 S1 一方比上述第 2 磨粒群 6 的基准面 S2 上述金属基体表面 3 的垂直方向的高度高出一定量 δ，通过适当调整上述打磨面 4 的状态，可以把上述抛光布表面打磨成适应被加工物的想要的状态。

像这样如果用上述抛光布用打磨器 1，则因为通过调节基准面 S1、S2 的高低差 δ，可以把打磨面 4 的状态调节成可以发挥想要的抛光性能，故不仅即使在打磨面 4 的状态中产生个体差异，也可以达成均一的抛光布表面，而且可对抛光布表面赋予适应被加工物的适当的抛光性能。

图 2A－图 2D 示出本发明的抛光布用打磨器的磨粒群的配置形状不同的第 2 实施方式。在本实施方式的抛光布用打磨器 10 中，多个磨粒群仅由上述第 1 磨粒群 5 组成。通过把这些同一的磨粒群 5 沿着金属基体 2 的周缘部并列设置成环状而形成打磨面 4。

此外，该磨粒群 5 的平面形状，与上述第 1 实施方式的场合同样，可以从小圆形状，成为与上述打磨面 4 的周缘平行的环形片形状，与上述打磨面 4 的周缘成一定角度的螺旋片形状之中选择。图 2A 示出磨粒群 5 全都是小圆形状的场合，图 2B 示出磨粒群 5 为小圆形状和螺旋片形状，具有这两种不同的平面形状的磨粒群 5 在打磨面 4 的圆周方向上交互地并列设置的场合。图 2C 示出磨粒群 5 全都是环形片形状的场合，图 2D 示出磨粒群 5 全都是螺旋片形状的场合。

关于包含调节机构 7 的其他构成，因为与上述第 1 实施方式共同，所以为了避免重复这里省略说明。

而且，在用上述抛光布用打磨器 10 打磨抛光布时，如图 4 中所示，借助调节机构 7 在相互邻接的上述磨粒群 5 的基准面 S1 间设定对金属基体表面 3 的一定的高低差 δ 并进行打磨。

像这样如果用上述抛光布用打磨器 10，则与上述抛光布用打磨器 1 同样，因为可以适当调节上述邻接的磨粒群 5 的基准面 S1 间的

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高低差δ而把打磨面 4 的状态调整成想要的状态，这不仅即使在打磨面 4 的状态中产生个体差异，也可以造成均一的抛光布表面，而且可对抛光布表面赋予适应被加工物的适当的抛光性能。

再者，上述调节机构 7 本身的构成，不限于参照图说明的上述构成，可以采用在微细的范围内可以上下调整磨粒群的基准面的各种机构。

以下与比较例一起具体地示出本发明的抛光布用打磨器和使用该打磨器的抛光布的打磨方法的实施例。但是，本发明不受这些实施例的任何限定。

〔第 1 实施例〕

作为第 1 磨粒群 5 的磨粒，分别用相当于粒度#120／#140 的处于 150～170 μm 的范围的金刚石磨粒 50，与相当于粒度#325／#400 的处于 55～65 μm 的范围的金刚石磨粒 51，通过把这些磨粒 50、51 与保持料 52 反应烧结，得到磨粒 50、51 被保持于保持料 52 的烧结体。

此时，把上述两种磨粒 50、51 在磨粒排列面上排列成，包含粒度#120／#140 的磨粒 50 的前端的平面，与包含粒度#325／#400 的磨粒 51 的前端的平面的纵差为 40～60 μm，并且邻接的磨粒 50、51 彼此造成的最小格子为正三角形，粒度#120／#140 的磨粒 50 的间隔为 2.0 mm 的等间隔，粒度#325／#400 的磨粒 51 的间隔为 0.4 mm 的等间隔。

另一方面，作为第 2 磨粒群 6 的磨粒，用相当于粒度#60／#80 的处于 250～320 μm 范围的金刚石磨粒，把这些排列成 0.8 mm 的等间隔。

而且，在把这样做所得到的烧结体通过机械加工，加工成规定的尺寸·形状，形成第 1 磨粒群 5 和第 2 磨粒群 6 后，把这些磨粒群 5、6 分别用环氧树脂粘接于调节机构 7 中的 SUS316L 不锈钢制的直径 φ 100 mm 的基台 7a 上。再者，在本实施例中，把上述第 1 磨粒群 5 和第 2 磨粒群 6 的平面形状取为图 1D 中所示的与打磨面 4 的周缘成

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一定角度的螺旋片形状。

把这样做成的抛光布用打磨器以 19.6kPa 的压力压在以 100 rpm 旋转的泡沫聚氨酯制抛光布上，与该抛光布同一方向以 80 rpm 旋转，同时一边供给每分 25 ml 包含湿二氧化硅的抛光浆液（キャボット制 SS－25）一边进行抛光布的研磨。

此时，借助上述调节机构 7 把前述打磨面 4 上的前述第 1 磨粒群 5 的磨粒前端基准面 S1 与前述第 2 磨粒群 6 的磨粒前端基准面 S2 对金属基体表面 3 的高低差 δ 调节成 15、30、60μm 三个水准，测定打磨速度（抛光布的磨耗速度）与抛光布的表面状态（抛光布的表面粗糙度）后，测定用该抛光布的晶片的抛光速度，这些测定结果示于表 1。

再者，在本实施例中，n 数即取样数取为 20，算出在各试样中所测定的上述各测定值的平均值（Ave）示于表 1。而且表 1 中 σ_{n-1} 表示各测定结果的标准偏差。此外，在晶片的抛光速度的测定中用 ADE 公司制的晶片平坦度测定器（ultragage 9800），根据抛光前后的测定结果算出平均抛光速度。

表 1

			实施例		
磨粒间隔	第 1 磨粒群	#120/#140	2.0 mm		
		#320/#400	0.4 mm		
	第 2 磨粒群	#60/#80	0.8 mm		
磨粒基准面的高低差 δ（μm）			15	30	60
抛光布的磨耗速度（μm/Hour）		Ave.	69.2	108	122
		σ_{n-1}	1.33	1.25	1.78
抛光布的表面粗糙度 Ra（μm）		Ave.	4.12	4.05	4.19
		σ_{n-1}	0.12	0.15	0.14
晶片抛光速度（nm/min）		Ave.	126	129	121
		σ_{n-1}	6.7	7.2	5.6
划痕发生率（%）			0.00	0.00	0.00

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如此一来1中所示，如果用本发明的抛光布用打磨器，则可以调节多个磨粒群中的磨粒的粒度或各磨粒群基准面间的高低差δ，把打磨面调整成想要的状态，特别是，弄清了通过上述磨粒群的基准面的高低差δ磨耗速度有很大差别，因此，借助一个抛光布用打磨器可以在种种条件下进行稳定的抛光布的打磨。

此外，如果用上述实施例的测定值，则与以下说明的比较例的测定值相比总体上性能提高，而且因为各种测定值的标准偏差非常小，所以所得到的抛光布中离散权小，可以给抛光布用打磨器赋予稳定的抛光性能。

〔第1比较例〕

用把粒度相当于#80／#100的处于210～250 μm的范围的金刚石磨粒以磨粒间隔0.25 mm的等间隔地排列的状态，使用由电镀固定而成的现有技术中的CMP抛光布打磨器，在与第1实施例同一条件下研磨泡沫聚氨酯制抛光布，其研磨结果示于表2。

〔第2比较例〕

用把粒度相当于#120／#140的处于150～170μm的范围的金刚石磨粒，在烧结体的磨粒排列面上，排列成邻接的第1磨粒彼此连成的最小格子为正三角形，其一边的磨粒间隔成为2.1 mm的等间隔，使用由这磨粒组成的磨粒群的平面形状为，如图2C中所示的，与打磨面的周缘平行的环形片形状的抛光布用打磨器，在与第1实施例同一条件下研磨泡沫聚氨酯制抛光布，其研磨结果与第1比较例一起示于表2。

〔第3比较例〕

与第1实施例的第1磨粒群同样，分别用粒度相当于#120／#140的处于150～170 μm的范围的金刚石磨粒，和粒度相当于#325／#400的处于55～65 μm的范围的金刚石磨粒，而且，把这些磨粒，在烧结体的磨粒排列面上排列成包含粒度#120／#140的磨粒的前端的平面，与包含粒度#325／#400的磨粒的前端的平面的级差成为

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40～60 μm，并且邻接的磨粒彼此连成的最小格子为正三角形、粒度#120／#140 的磨粒的间隔为 2.0 mm 的等间隔、粒度#325／#400 的磨粒的间隔为 0.4 mm 的等间隔。而且，用具有这种磨粒排列的磨粒群，形成为图 2C 中所示的成为与打磨面的周缘平行的环形片形状，在打磨面中沿着金属基体的周缘部环状地排列而成的抛光布用打磨器。在与第 1 实施例同一条件下研磨泡沫聚氨酯制抛光布。其研磨结果与第 1、2 比较例一起示于表 2。

表 2

		第 1 比较例	第 2 比较例	第 3 比较例
金刚石粒度		#80／#100	#120／#140	①#120／#140 ②#325／#400
磨粒间隔		0.25 mm	2.1 mm	①2.1 mm ②0.4 mm
磨粒保持方法		电镀	烧结	
抛光布的磨耗速度	ave.	63.6	189	138
（μm／Hour）	σn－1	2.84	14.6	2.43
抛光布的表面粗糙度	ave.	3.01	3.32	3.45
Ra（μm）	σn－1	0.36	0.36	0.13
晶片研光速度	ave.	105	98.3	120
（nm／min）	σn－1	33.2	23.3	9.6
刮痕发生率（%）		0.52	0.00	0.00

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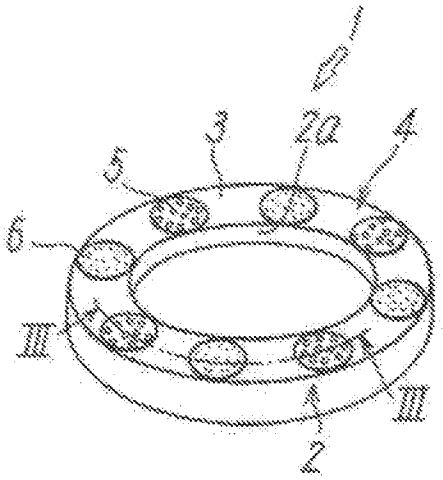


图 1A

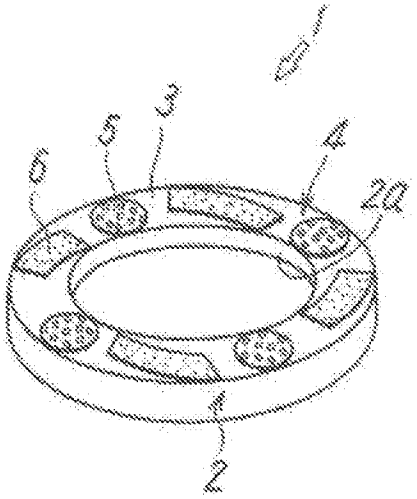


图 1B

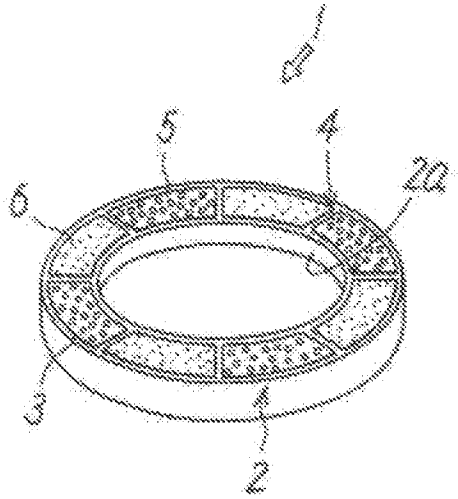


图 1C

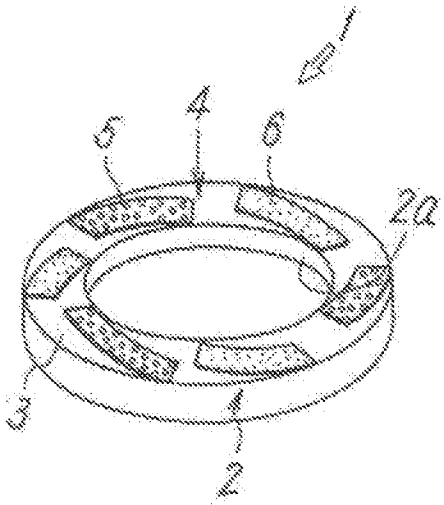


图 1D

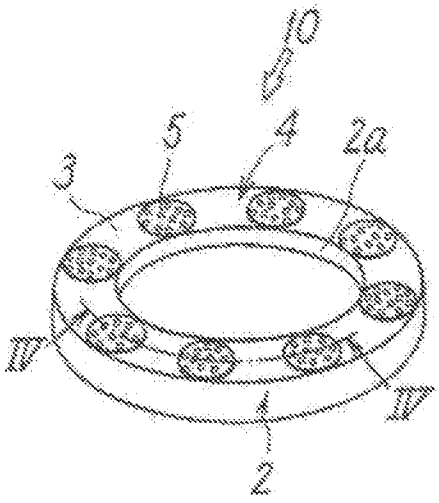


图 2A

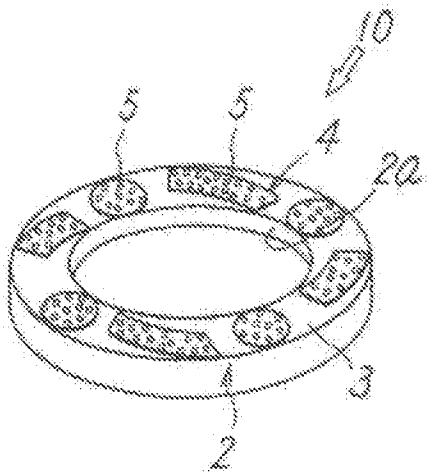


图 2B

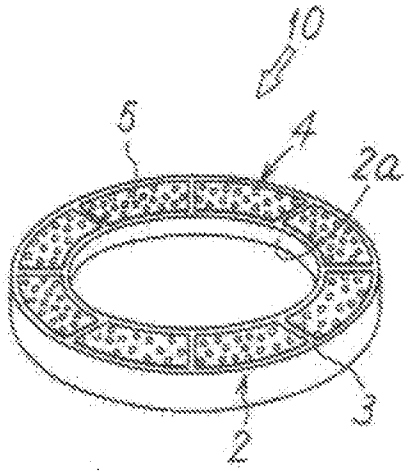


图 2C

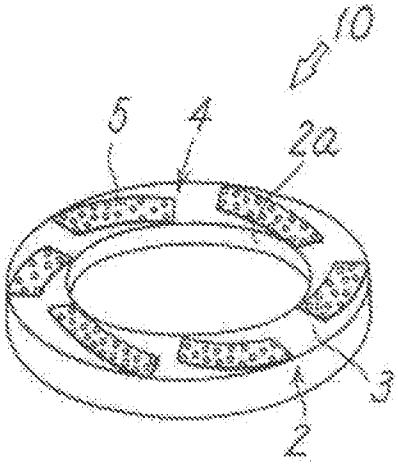


图 2D

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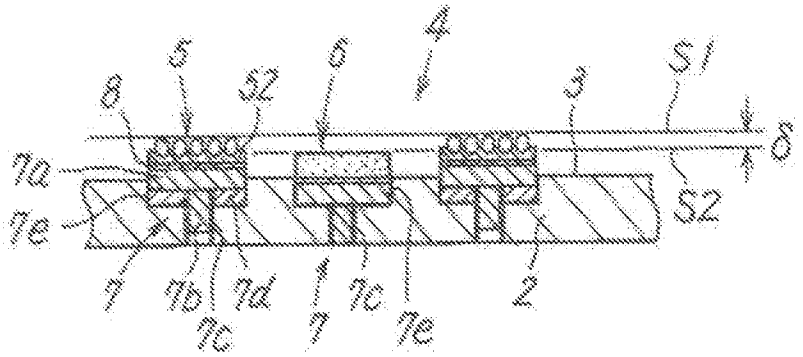


图 3

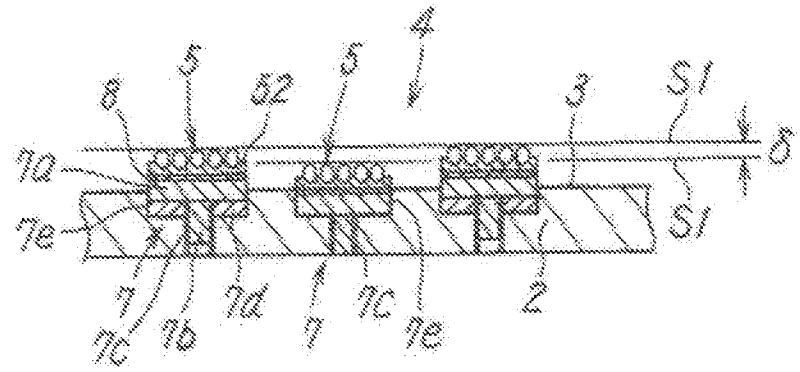


图 4

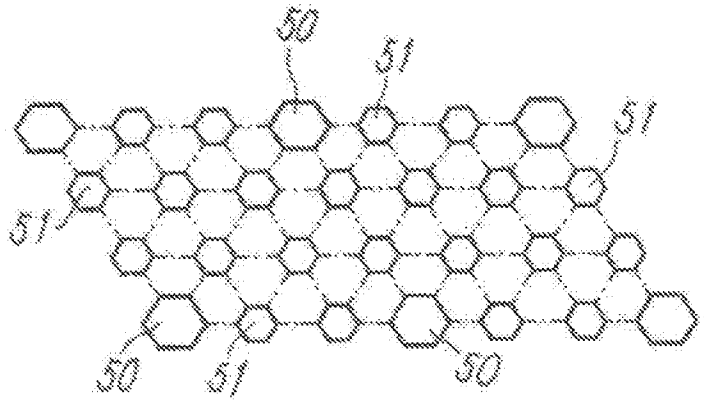


图 5

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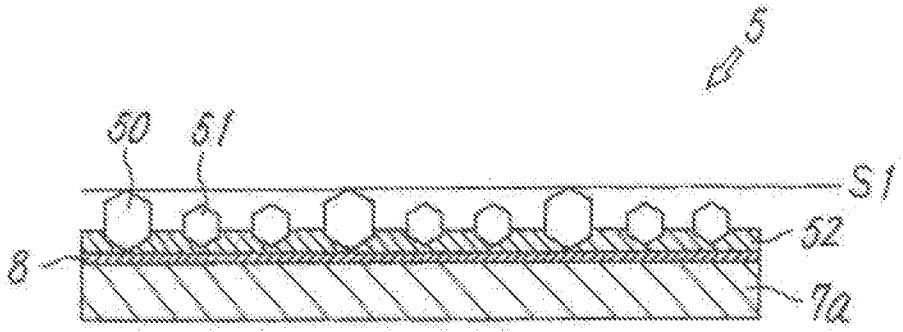


图 6

Espacenet

Bibliographic data: CN1351922 (A) — 2002-06-05

Reparing and milling device for chemical-mechanical polishing soft pad and its producing method

Inventor(s):	LIN XINZHENG [CN]; SONG JIANMIN [CN] +
Applicant(s):	CHINA EMERG WHEEL ENTPR CO LTD [CN] +
Classification:	- **International:** ***B24B53/12;*** (IPC1-7): B24B53/12 - **European:**
Application number:	CN20001028301 20001107
Priority number(s):	CN20001028301 20001107
Also published as:	CN100344410 (C)

Abstract of CN1351922 (A)

The present invention is one kind of chemical and mechanical polishing soft pad trimmer with great amount of uniformly spaced diamonds or isometric boron nitride grains. The granular abrasive is brazed to a substrate and coated with an anticorrosive layer containing diamond or diamond-like graphite to prevent the corrosion of chemical grinding paste to the brazed alloy. The structure makes it possible to trim the soft pad while using the soft pad to polish. In addition, the abrasive grains protruding beyond the substrate in the same height makes the soft pad trimmed homogeneously in both vertical and horizontal directions.

Last updated: 14.02.2012 Worldwide Database 5.7.39.32p

[19]中华人民共和国国家知识产权局

[51]Int. Cl.⁷
B24B 53/12

[12]发明专利申请公开说明书

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[22]申请日 2000.11.7 [21]申请号 00128301.4

[71]申请人 中国砂轮企业股份有限公司
地址 中国台湾

[72]发明人 林心正 宋健民

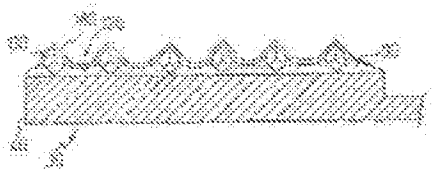
[74]专利代理机构 上海专利商标事务所
代理人 张民奎

权利要求书4页 说明书8页 附图页数4页

[54]发明名称 化学-机械抛光软垫的修整器及其制造方法

[57]摘要

一种化学—机械抛光软垫的修整器及一种制造这种软垫修整器的方法，该修整器表面有大量均匀间隔的磨料颗粒，颗粒是电为金刚石或立方氮化硼等。磨料颗粒钎焊于基底，再覆以一层含有金刚石或仿金刚石石墨的防腐层，以防钎焊料合金受化学研磨膏的腐蚀。这种结构使修整器得以在软垫进行抛光工作的同时修整软垫。此外，磨料颗粒还基本等高地突出基底，使垂直、水平两方向均得以均匀地修理或修整软垫。



1351922A 2002.06.05

权 利 要 求 书

1. 一种化学一机械抛光软垫的修磨器，包括尺寸在所需范围内且固接于基底的大量磨料颗粒，其特征在于：磨料颗粒在基底上固接成相互均匀间隔，并以一种预定的高度突出基底。

2. 根据权利要求 1 的化学一机械抛光软垫的修磨器，其特征在于：其中磨料颗料为金刚石或立方氮化硼晶体颗粒，单晶或多晶状态不论。

3. 根据权利要求 1 的化学一机械抛光软垫的修磨器，其特征在于：其中该尺寸范围为介于 50 至 250 微米之间。

4. 根据权利要求 1 的化学一机械抛光软垫的修磨器，其特征在于：其中磨料颗粒尺寸大抵均匀，各颗粒的尺寸差在 10%之内。

5. 根据权利要求 1 的化学一机械抛光软垫的修磨器，其特征在于：其中均匀间隔的磨料颗粒依照一种预定图形进行分布，使任何两粒颗粒间保持预定的距离。

6. 根据权利要求 5 的化学一机械抛光软垫的修磨器，其特征在于：其中各颗粒间预定距离为颗粒尺寸的 1.5 至 10 倍。

7. 根据权利要求 5 的化学一机械抛光软垫的修磨器，其特征在于：其中该预定图形为一栅格。

8. 根据权利要求 1 的化学一机械抛光软垫的修磨器，其特征在于：其中该预定高度为一均匀高度，对此所有磨料颗粒的突出偏差在 50 微米之内。

9. 根据权利要求 1 的化学一机械抛光软垫的修磨器，其特征在于：其中磨料颗粒具有自形的形状。

10. 根据权利要求 1 的化学一机械抛光软垫的修磨器，其特征在于：其中磨料颗粒具有预定的形状。

11. 根据权利要求 1 的化学一机械抛光软垫的修磨器，其特征在于：其中磨料颗料具有背向基底的尖点。

12. 根据权利要求 1 的化学一机械抛光软垫的修磨器，其特征在于：其中基底由金属材料制成。

13. 根据权利要求 12 的化学一机械抛光软垫的修磨器，其特征在于：其中金属材料为不锈钢。

14. 根据权利要求 1 的化学一机械抛光软垫的修磨器，其特征在于：其中磨

料颗粒藉助于钎焊料合金固定于基底上。

15. 根据权利要求 14 的化学一机械抛光软垫的修磨器，其特征在于：其中该钎焊料合金包括一种铬含量至少约为 2%重量百分比的镍合金。

16. 根据权利要求 14 的化学一机械抛光软垫的修磨器，其特征在于：其中该钎焊料合金以一种预定的厚度覆于基底的表面，并使各磨料颗料约有 10—90%露出。

17. 根据权利要求 1 的化学一机械抛光软垫的修磨器，其特征在于：其中该软垫修磨器覆以一防腐层。

18. 根据权利要求 17 的化学一机械抛光软垫的修磨器，其特征在于：其中该防腐层含有金刚石的石墨。

19. 根据权利要求 17 的化学一机械抛光软垫的修磨器，其特征在于：其中该防腐层含有仿金刚石的石墨。

20. 根据权利要求 17 的化学一机械抛光软垫的修磨器，其特征在于：其中防腐层的厚度约小于 3 微米。

21. 根据权利要求 18 的化学一机械抛光软垫的修磨器，其特征在于：其中仿金刚石的石墨的原子碳含量至少约为 95%。

22. 一种制造化学一机械抛光软垫修磨器的方法，其诸步骤包括 a ）提供一基底，其特征在于：该法的步骤还包括：

b ）于基底的某一表面均匀地间隔大量磨料颗粒，以及

c ）将磨料颗料固定于基底成，使各磨料颗粒以一种预定的高度突出基底。

23. 根据权利要求 22 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中磨料颗粒为金刚石。

24. 根据权利要求 22 所述的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中磨料颗粒为立方氮化硼质地的晶体颗粒，单晶或多晶不论。

25. 根据权利要求 22 所述的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中步骤 b ）与 c ）尚包括下列步骤：

a ）将一形成有预定孔图形的模板置于一钎焊料合金片上，使磨料颗粒的放置可受孔位置的控制，

b ）于模板的各孔内充填磨料颗粒，

c ）去除任何未进入模板孔内的磨料颗粒，

d ）将滞留于模板孔内的磨料颗粒压入钎焊料合金片中，使磨料颗粒部份埋

置于钎焊料合金内，

e）除去模板，使磨料颗粒留在钎焊料合金片上，以及

f）使带磨料颗粒的钎焊料合金片固接于基底。

26. 根据权利要求 25 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中各孔的尺寸为仅足以容置一粒磨料颗粒。

27. 根据权利要求 26 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中各孔具有预定的尺寸，可容纳预定尺寸的磨料颗粒。

28. 根据权利要求 22 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中该等磨粒颗的尺寸各在大约 50 至 250 微米的范围内。

29. 根据权利要求 22 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中磨料颗粒的尺寸大致均匀，使所有磨料颗粒的尺寸差在 10%之内。

30. 根据权利要求 25 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中成预定图形的各孔之间间隔成足以在任何两粒颗粒间产生预定的距离。

31. 根据权利要求 30 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中各颗粒间该预定的距离为颗粒尺寸的 1.5 至 10 倍。

32. 根据权利要求 25 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中该预定图形为一栅格。

33. 根据权利要求 22 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中该高出基底的预定高度为一均匀高度，对此所有磨料颗粒的突出偏差在 50 微米之内。

34. 根据权利要求 22 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中磨料颗粒具有自形的形状。

35. 根据权利要求 22 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中磨料颗粒具有一种预定的形状。

36. 根据权利要求 22 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中各磨料颗料具有一背向基底的尖点。

37. 根据权利要求 22 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中基底由金属材料制成。

38. 根据权利要求 37 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中该金属材料为不锈钢。

39. 根据权利要求 25 的化学一机械抛光软垫修磨器的制造方法，其特征在于：

其中钎焊料合金片的制造步骤为，以一种有机结合剂将钎焊料合金颗粒结合在一起，并使这些相结合的颗粒形成一片厚度符合需要的片体。

40. 根据权利要求 39 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中使钎焊料合金颗粒形成片体的步骤为经滚轧法进行。

41. 根据权利要求 39 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中使钎焊料合金颗粒形成片体的步骤为经挤压法进行。

42. 根据权利要求 39 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中使钎焊料合金颗粒形成片体的步骤为经带条铸造法进行。

43. 根据权利要求 25 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中钎焊料合金包括一种铬含量至少约为 2%重量百分比的镍合金。

44. 根据权利要求 25 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中钎焊料合金片具有隆起的钎焊厚度，足以让各磨料颗粒约 10—90%露出钎焊料合金。

45. 根据权利要求 22 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中尚括包括一步骤：即对磨料颗粒以及钎焊料合金覆以一防腐层。

46. 根据权利要求 45 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中该防腐层含有金刚石的石墨。

47. 根据权利要求 45 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中该防腐层含有仿钻石的石墨。

48. 根据权利要求 45 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中防腐层的厚度小于约 3 微米。

49. 根据权利要求 45 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中仿金刚石的石墨的原子碳含量至少约为 95%。

50. 根据权利要求 49 的化学一机械抛光软垫修磨器的制造方法，其特征在于：其中该覆层步骤是使用阴极电弧法进行。

说　明　书

化学一机械抛光软垫的修磨器及其制造方法

本发明涉及一种修磨或调理化学一机械抛光软垫的修磨器及其方法，特别是一种含有超硬材料（如金刚石或立方氮化硼），供修磨或调理化学一机械抛光软垫的修磨盘。

许多任务业今使用化学一机械方法抛光某些工件。尤其是计算机制造业已充分依靠化学一机械抛光法来抛光陶、硅、玻璃、石英以及金属质的芯片。这种抛光方法通常需要将芯片压于一由耐用的有机物质，如聚亚胺脂制成的旋转软垫上。并对该软垫添加一种研磨膏，内含可切削芯片物质的化学品，以及一定量的磨料颗粒，其作用是以物理方法刻蚀芯片表面。研磨膏持续地加于旋转中的软垫上，而得以有双重的化学兼机械力施加于芯片上，使之以所需的方式抛光。

对所产生的抛光品质尤为重要的，乃是软垫各处磨料颗粒的分布状况。软垫的顶部通常藉空穴之类卡持颗粒。挠性的软垫顶部可提供所需的支承，让磨料得以作用于芯片。

对软垫顶部进行保养，此问题归因于来自工件、研磨膏、以及修磨盘的抛光污膜的堆积。这种堆积会造成软垫顶部的发亮或硬化，使软垫不太能吸附研磨膏中的磨料颗粒。

因此，人们已作出诸多尝试，以各种装置“梳理”软垫顶部来修复，此法现已称之为“修磨”或“调理”化学一机械抛光软垫。为此，已使用多种装置及方法。这些装置中的一种为一圆盘，其表面或基底上固定大量的超硬晶体颗粒，例如固接于其某一表面或基底上的金刚石颗粒。

但是，这种由传统方法制成的金刚石盘表现出种种问题。首先，金刚石会自该盘的基底上脱落并沾附在化学一机械抛光软垫表面。其次，此种旧式生产方法有可能使生产出的圆盘上金刚石成多组簇集，即非均匀地散布于基底的表面。这种非均匀的成组现象，使该软垫的某些部位被过度修磨，造成磨损区域，而其它部位修磨不足，造成光亮层。另一种情况是，软垫的抛光效率降低，并出现抛光不匀现象。最后，这些圆盘的金刚石不能以一种均匀的高度突出圆盘表面。这种非均匀性又造成对该软垫的不均匀修磨，因为仅是那些足够突出的颗粒方可接触

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软垫。

金刚石自圆盘基底脱落，是因为它们被固接的方法不当。当金刚石是由电镀的镍加以固定于基底上时，无结合力惟有对金刚石的机械锁紧作用。因此一旦摇松，这些颗粒即会脱落。此种脱落现象又因化学品，即化学研磨膏中的酸对电镀材料的化学侵蚀而加剧。

另一方面，当金刚石是钎焊于基底上时，化学力会更牢固地固定金刚石。然而，化学研磨膏的酸性会快速溶化钎焊料而使金刚石脱落。因此，为使钎焊料曝露于化学品的程度降至最小，抛光过程需时时暂停，期间进行修磨，而后方可再度开始抛光。这种依次交替地抛光与修磨，浪费大量时间，而且极度低效。

鉴于上述，故需要一种可对化学一机械抛光软垫提供调理作用的软垫修磨器。此外，非常需要一种可将化学一机械抛光软垫调理至均匀深度的软垫修磨器。再者，很需要一种不易使金刚石颗料脱落的修磨器。最后，极需要一种可防化学研磨膏的酸性侵蚀，而且甚至可在以酸性研磨膏进行抛光的同时，连续修磨化学一机械抛光软垫的软垫修磨器。

本发明的目的是提供一种使用磨料颗粒来均匀修磨化学一机械抛光软垫的软垫修磨器。

本发明的另一目的是提供一种不易让磨料颗粒脱落的软垫修磨器。

本发明的又一目的是提供一种防腐的软垫修磨器，使之可以恒定地修磨化学一机械抛光软垫，纵然该软垫正于酸性研磨膏中进行研磨时亦然。

本发明的再一目的提供一种化学保持层，以防修磨盘元素溶解而污染研磨中的芯片。

本发明的另一目的是提供一种均匀修磨化学一机械抛光软垫的方法。

本发明的又一目的是提供一种方法，以降低软垫修磨器的磨料颗粒脱落的可能性，纵然当该软垫浸润酸性研磨膏时亦然。

按照本发明的一个方面，本发明的技术方案在于提供一种化学一机械抛光软垫的修磨器，其包括尺寸在所需范围内且固接于基底的大量磨料颗粒。其特点在于，磨料颗粒在基底上固接成相互均匀间隔，并以一种预定的高度突出基底。

而且，上述的修磨器上还可覆以一防腐层。

按照本发明的另一方面，本发明的技术方案在于提供一种制造上述修磨器的方法，其诸步骤包括：

a）提供一基底；b）于基底的某一表面均匀地间隔大量磨料颗粒；以及，

c）将磨料颗料固定于基底成，使各磨料颗粒以一种预定的高度突出基底。

而且，上述方法还可包括一步骤：即对磨料颗粒以及钎焊料合金覆以一防腐层。

本发明与已有技术相比优点和积极效果非常明显。由以上的技术方案可知，本发明的软垫修磨器可均匀地修磨抛光软垫，而且磨料颗粒不易脱，特别是可以在软垫进行抛光的同时，对软垫进行修磨，从而大大提升软垫的工作效率，并延长其使用寿命。

以下结合附图进一步说明本发明的具体结构特征及目的。其中，请附图为：

图 1 是一种现有的软垫修磨器的侧视图，该修磨器使用电镀法将金刚石固定于盘状基底上。

图 2 是另一种现有的软垫修磨器的侧视图，该修磨器经使用传统钎焊法将金刚石颗粒固定于盘状基底上而制成。

图 3 是本发明的软垫修磨器的侧视图。

图 4 是本发明的钎焊料合金片，以及将磨料颗粒置于其表面的模板的侧视图。

图 5 是钎焊料合金片表面覆以模板，且磨料颗粒充填该模板的各孔的侧视图。图中显示依照本发明的原理，有一平面将磨料颗料压入钎焊料合金片。

图 6 是钎焊料合金片中已依据本发明的原理压入磨料颗粒的侧视图。

图 7 表示了作为本发明实例一制作的两个软垫修磨盘对一个 28 英寸的化学一机械抛光软垫进行修磨的情况。

图 8 表示了作为本发明实例二制作的两个金刚石修磨盘修磨一个用于研磨 8 英寸硅芯片的化学一机械抛光软垫的情况。

请注意，在说明书及权利要求书中，下列技术术语使用时将依照以下提出的定义。如文中所使用的“磨料颗粒”或“砂粒”，或者相似的词，表示任何超硬质的晶体或多晶体物质，或者这些物质的混合物，而且包括（但不限于）金刚石、多晶体金刚石、立方氮化硼、以及多晶体立方氮化硼。再者，“磨料颗粒”、“砂粒”、“金刚石”、“多晶体金刚石”、“立方氮化硼”、以及“多晶体立方氮化硼”等各词可互换使用。如文中所使用的“基底”，表示修磨器中表面可固定磨料颗粒的基础部份。该基础部份可为任何形状、厚度、或者材料，而且包括（但不限于）金属、合金、陶瓷及其混合物。如文中所使用的“自形”，表示自然形状，即未被人为变更的天然形状。如文中所使用的“尖锐点”，表示晶体中可能出现的任何尖锐顶峰，而且包括（但不限于）角、棱、尖峰以及其它突起。如文中所使用的“金属”，表

示任何类型的金属、金属合金、或者它们的混合物，尤其包括（但不限于）钢、铁、以及不锈钢。

现参阅图 1，图中显示一现有的软垫修磨器 10，该修磨器中有大量金刚石颗粒 50 电镀于一基底 40。电镀材料 60 通常为经酸液沉淀而出的镍。这种电镀法不仅成本高且费时，而且亦因该法所产生的残留物质而对环境有害。

由图 1 可看出，电镀而成的软垫修磨 10 有许多缺点。首先，电镀材料 60 不能与金刚石颗粒 50 形成任何化学结合。因此，仅有微弱的机械力将金刚石颗粒 50 固定于基底 60 上。当该软垫修磨器压在化学一机械抛光软垫上旋转时，这种机械力会被作用于金刚石颗粒 50 上的较大摩擦力快速克服，使之易于自电镀材料 60 松落，于电镀材料 60 上留下孔穴，例如空隙 70。此种孔穴会被快速充填以工件上磨下的残留物，以及来自研磨膏的化学品及磨粒颗粒，为此进一步削电镀材料 60。由于电镀材料 60 所产生的机械力是唯一将金刚石颗粒 50 固定于基底 40 上的手段，使金刚石颗粒 50 露出电镀材料的高度必须保持最小。因此，电镀材料 60 与化学一机械抛光软垫的接触不可避免。这种接触会磨损电镀材料，而易使金刚石颗粒 50 脱落。此外，电镀材料 60 易在各金刚石 50 四周的凹部 80 等处起泡。这些气泡，加之过低的露出高度以及金刚石颗粒 50 间的紧密间距，即使能也难以使金刚石颗粒 50 深深戳入软垫纤维。无此种戳入，则对修磨过程大为有碍。

现参见图 2，图中显示现有的软垫修磨器 20，其基底 40 有金刚石颗粒 50 用钎焊材料 190 及传统的钎焊技术钎焊于基底 40。钎焊材料通常含有一种混以碳化物形成元素的合金。这种碳化物形成元素可让金刚石颗粒 50 得以以化学方式结合于钎焊料，后者则进而结合于基底 40。这种结合方式可大为增加修磨器 20 的强度，但会伴随某些副作用。钎焊材料 90 必须保持最低之量，以免完全覆盖金刚石颗粒 50。因此，金刚石颗粒 50 仅被包以薄薄一层钎焊材料 90。此问题偏遇典型的钎焊材料机械性能非常弱。这种机械性能的弱抵销了金刚石颗粒 50 与钎焊材料间的化学结合强度，因为钎焊材料本身会随金刚石颗粒的脱落而被割断。

另一个与钎焊材料 90 有关的问题是，其非常易受研磨膏的化学腐蚀。这种化学腐蚀会促成金刚石颗粒 50 的脱落，因为其使原已机械性能弱的钎焊材料 90 变得更弱。因此，为减少软垫修磨器 20 接触化学研磨膏的时间，软垫修磨器 20 应用前，对工件的抛光必须暂停，而让化学研磨膏得离软垫而去。这种抛光过中的暂停使精加工产品的时间大为增加，因而低效。

传统钎焊法的另一缺点为，当加请于基底 40 时，融熔状金属合金的表面张

力易使磨料颗粒聚集成簇状。此种簇状标以 100，间隔为 110。其总体表现为金刚石颗粒 20 的非均匀分布，为此使调理效率较低。此低效率应当归因于间隔 110，因为其使化学一机械抛光软垫的部份区域依然保持为未调理前的状态。这种非均匀的调理使软垫的一部份区域磨损较他处快，总体结果为工件接受一种非均匀的抛光，因为已磨损的区域抛光效率低于经正确调理的区域。

磨料颗粒的簇状所产生的另一效应，是会于纤焊材料 90 中形成大量隆起。隆起的形成会提升某些磨料颗粒相对基底 40 的高度，使之高于其它磨料颗粒。因此，最高凸的磨料颗粒会深深嵌入软垫的纤维，妨碍不甚高凸的磨料颗粒发挥任何梳理作用。此举亦造成调理效果的低效与不合理。

与现有的软垫修磨器相反，本发明得以均匀地修磨化学一机械抛光软垫。

现参见图 3，图中显示一以本发明原理制成的软垫修磨器。该软垫修磨器有大量磨料颗粒 180 以纤焊材料 90 固定于一基底 40。磨料颗粒 180 可为任何超硬质的材料。较佳的材料包括（但不限于）金刚石、多晶体金刚石、立方氮化硼以及多晶体立方氮化硼。

同时示于图 3 的，为一防腐层 130。此防腐层形成于软垫修磨器表面之前，磨料颗料先以下述方法固定于基底 40 上。防腐层 130 为另一种超硬质材料，如金刚石、仿金刚石的石墨、或者立方氮化硼，而且是可以匹配磨料颗粒 180 的材料。在一较佳实施例中，防腐层 130 约含有至少为 90一95％的金刚石，或者仿金刚石的石墨。防腐层 130 可为任何厚度，但通常在 0.5 至 5μm的范围内。在一较佳实施例中，防腐层 130 的厚度约为 1 至 3μm。这种防腐薄层 130 可采用物理气相淀积法（PVD）产生。物理汽相淀积法，如使用石墨电弧及石墨阴极的，已为业界所知，而且可用以产生防腐层 130。

由防腐层 130 产生的优点是可有效密封工件表面，而且也可密封化学一机械抛光软垫上易受化学侵蚀的其它所需表面。作为密封层，防腐层 130 可保护纤焊材料 90，使之免受沾于该软垫上的化学研磨膏的侵蚀。这种保护作用甚至于软垫正研磨工件之时，让软垫修磨器 30 得以连续修磨该软垫，从而可消除过去用以延长现有软垫修磨器寿命的生产停顿。对化学一机械抛光软垫的连续与均匀修磨，使得可有较高的产量，并且可延长该软垫的寿命与效率。

图 4 至 6 显示一种将磨料颗粒 180 固定于基底 40 上的方法。首先，将具有大量孔 150 的模板 140 置于纤焊料合金片 190 上。使用该模板可让磨料颗粒 180 的放置得以通过将模板的各孔设计成所需的分布图形而加以控制。用于磨料颗粒

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放置的分布图形，可由熟悉该项技术的普通技术人员加以选定，以满足该软垫修整器的特定使用要求。

作为本发明的一个方面，这些孔的分布将呈一种栅格图形，且孔距预定为可使钎焊料合金片 190 上的磨料砂粒 180 间产生所需的间隔。在一较佳实施例中，该等砂粒均匀间隔，间距为各砂粒尺寸的 1.5 至 10 倍。当模板 140 置于钎焊料合金片 190 后，各孔 150 即被充填以磨料颗粒 180。孔 150 有预定的尺寸，使各孔中仅可容纳一粒磨料颗粒。任何尺寸的磨料颗粒或砂粒均可使用，但作为本发明的一个方面，颗粒尺寸为直径约 50 至 250 微米之间。

作为本发明的另一方面，模板中各孔的尺寸也可定制，以使所获得分布图形为令各磨料颗粒尺寸不一，或者尺寸大抵均一。在一较佳实施例中，该模板的各孔为足以仅选择相互尺寸差在 10%微米内的砂粒。这种砂粒尺寸的均匀性有助于对化学一机械抛光软垫修整的均匀性，因为各磨粒颗粒的工作负荷均匀分布。进而，该均匀的工作负荷分布可减小各磨料颗粒的应力，而延长软垫修磨器 30 的有效寿命。当模板 150 的各孔被充填以砂粒 180 后，将任何多余的磨料颗粒除去，并将平面 160 加诸于磨料颗粒 180。平面 160 必须是质地为极强固的刚性材料，因为其必须能将磨料颗粒 180 下压至钎焊料合金片 190 内。典型材料包括（但不限于）钢、铁，以及它们的合金等。

图 6 显示磨料颗粒 180 埋置于钎焊料合金片 190 中。由于表面 160 为平面状，故磨料颗料 180 以一种均匀的距离突出基底 40。这种距离取决于模板 140 的厚度，并且在较佳实施例中，各磨料颗粒将突出成使此距离在 60 微米之内。

图 4 至 6 中所示的磨料颗粒为圆形，而图 3 中的为尖形。本发明的范围包罗任何形状的磨料颗粒，包括自形即天然形状的颗粒。不过在较佳实施例中，磨粒颗粒 180 有一背向基底 40 的尖点。

当磨料颗粒 180 埋置于钎焊料合金片 190 中后，即可将该片固定于基底 40，如图 3 所示。所使用的钎焊料合金可为业内所知的任何钎焊材料，但最好为镍合金，且铬含量大于 2%重量百分比。此种成份的钎焊料合金自身质地超硬，而且不易受内含磨料的研磨膏的化学侵蚀。因此，当使用一种超硬的钎焊材料时，防腐层 130 为最佳。

由于磨料颗料 180 埋置于钎焊料合金片 190 中，故液态钎焊料合金的表面张力不足以使颗粒聚集。此外，钎焊料厚度以远为薄的程度出现，且无隆起形成。再者，钎焊料于各磨料颗粒间形成一种凹面，为此提供强大支承。最后，在较佳

实施例中，钎焊料合金片 190 的厚度选定成可让各磨料颗粒有大约 10 至 90%突出钎焊材料 190 的外表面。

由于本法先将磨料颗粒理置于钎焊料合金片 190 内之故，遂形成均匀的间隔。此外，磨料颗粒 180 可突出基底 40 均匀的高度或距离，此举意味着当应用于化学一机械抛光软垫时，它们将突入软垫纤维内同一深度。均匀的间隔及匀一的突入使软垫得以被均匀地修磨或梳理，进而提升该软垫的研磨效率并延长其使用寿命。

为便于更好地理解本发明，以下将提供两实例。不过这些实例绝非意味着用作限制本发明的范围。

（实例 1）

以下制作两个软垫修磨盘。即通过滚轧金属粉末混合物以及两轧辊间的有机结合剂，预制一钎焊料合金片。再藉助于一模板，将通用电子公司(General Electric Company)生产、平均尺寸为 135 及 225 微米的 MBS970 号金刚石砂粒埋入该钎焊料合金片。所使用的模板使金刚石砂粒形成一种令各金刚石砂粒距离为 900 微米的栅格图形。当金刚石砂粒置入钎焊料合金片后，采用丙烯酸凝胶将该片胶合于一金属基底。所形成的组件随后于真空炉内 1000° 的温度下进行钎焊。所产生的产品为两个直径约 100 毫米、厚度约 6.5 毫米的平盘。再将两盘与一个以随机方式放置两倍金刚石颗粒量的修磨盘进行对比试验。具体为修磨一个 28 英寸的化学一机械抛光软垫（该软垫以碱性研磨膏研磨 8 英寸的硅芯片）。试验结合显示在图 7 中。表中 DG135—900 是颗粒为 135 微米的盘，而 DG225 是颗粒为 225 微米的盘。

由图 7 可看出，颗粒均匀放置的两盘均大大优于金刚石随机放置的盘。此外，颗粒为 135 微的盘，性能几乎高达该随机颗粒盘的两倍。

（实例 2）

以实例 1 的方法再制两金刚石修磨盘。不过，金刚石尺寸采用 225 微米及 275 微米。此外，各盘覆以 1 微米厚的仿金刚石的石墨层，以保护钎焊料合金。仿金刚石的石墨膜以阴极电弧法加以沉积。这些盘然后与一传统的金刚石修磨盘进行比较，具体方法是修磨一个用于研磨 8 英寸硅芯片的化学一机械抛光软垫。该软垫浸调 P H 值为 3.0 的酸性研磨膏。修磨过程于研磨进行的同时就地完成。其结果显示在图 8 内。表中 DG275—900 是含有尺寸为 275 微米且均匀间隔的砂粒的盘。DG225—900 是含有尺寸为 225 微米且均匀间隔的砂粒的盘，而 A T 是该传统式金刚石盘。

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由图 8 可看出，以传统方式生产出的金刚石盘，于研磨膏的酸性环境中不能保持 1 小时以上。然而，本发明的两盘可保持 30 小时以上。这种寿命期使得有大为良好的修磨效果，并且对现有技术构成重大改进。当然，应理解上述实施例仅是对应用本发明原理的例示性说明。

熟悉这项技术的人员自可在不偏离本发明范围的条件下，设计出大量的变形形态及变更形态，本案附录的权利要求意在涵盖这种变形形态能及变更形态。因此，尽管以上本发明已结合目前看最实用且最佳的本发明实施例，以特别情形加以详细描述，然对熟悉该项技术的普通人士而言，可在不偏离本文中所提出的原理及概念的条件下作出大量变形形态，包括（但不限于）在尺寸、材料、形状、形式、功能、操作方式、组合以及使用方面的变更。

说 明 书 附 图

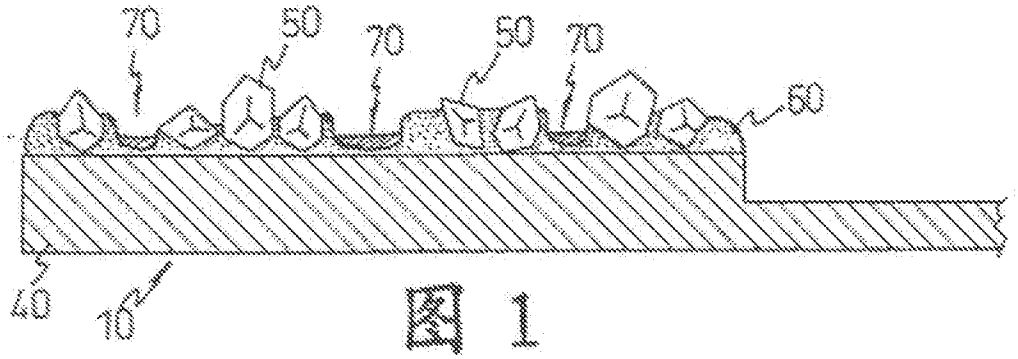


图 1

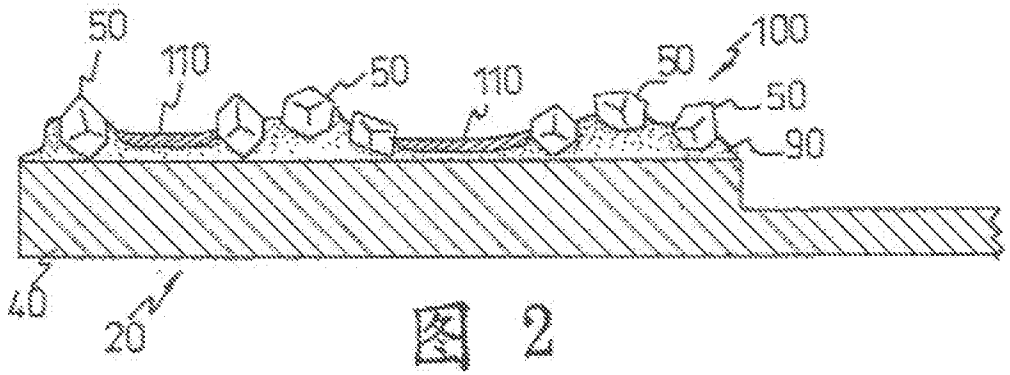


图 2

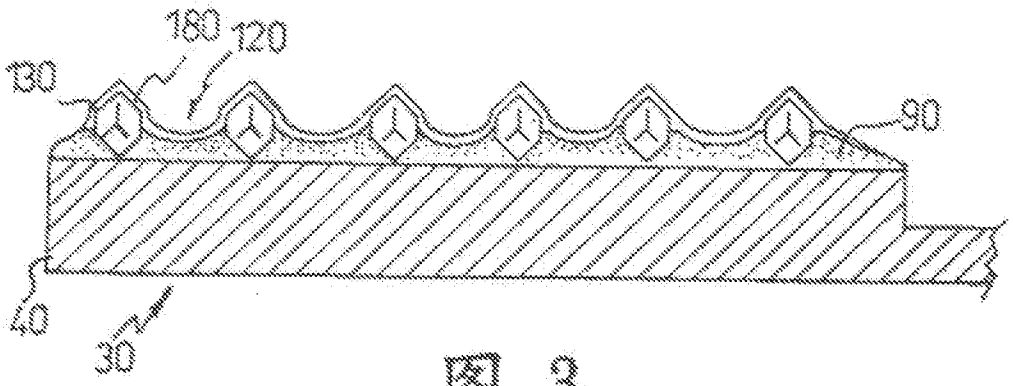


图 3

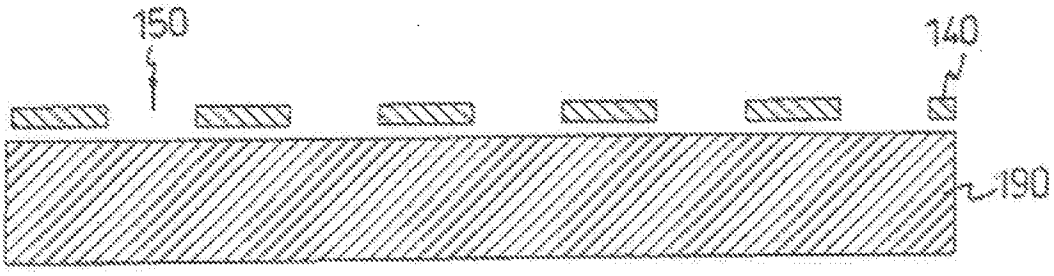


图 4

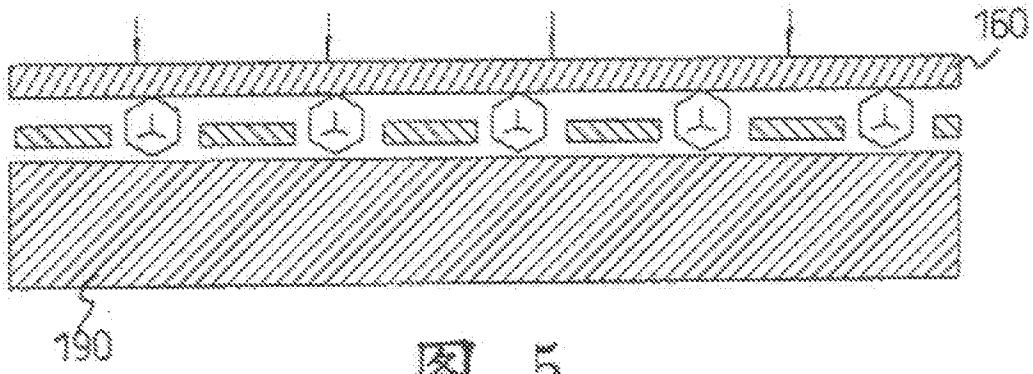


图 5

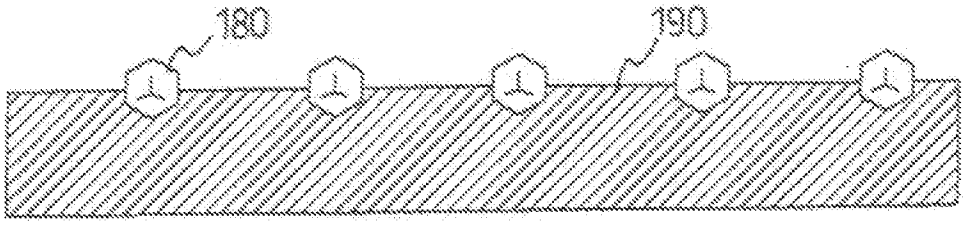


图 6

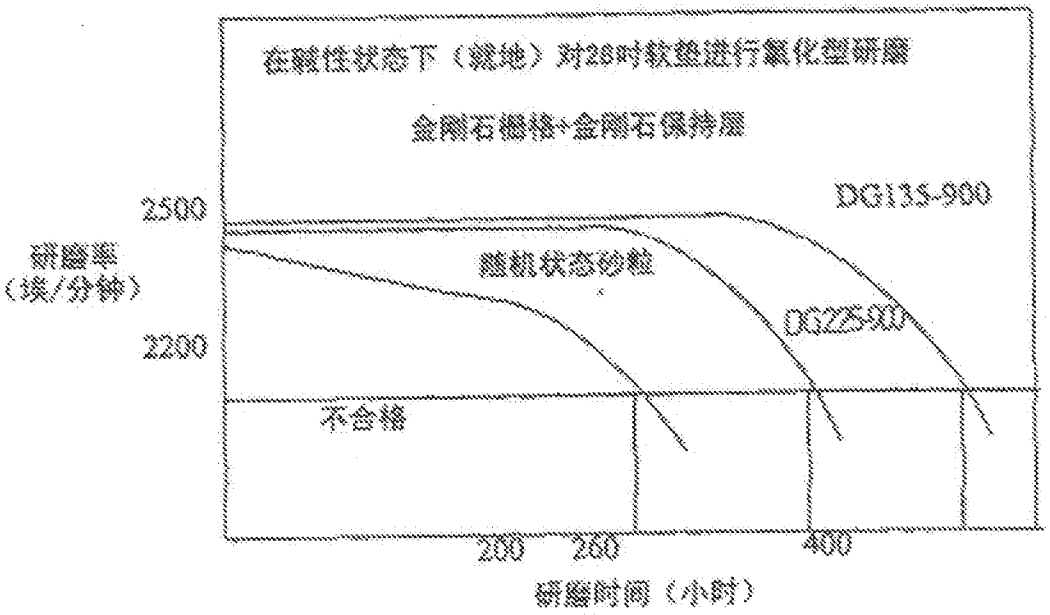

在碱性状态下（就地）对28吋软垫进行氧化型研磨
金刚石栅格+金刚石保持器
DG135-900
2500
研磨率
（埃/分钟）
随机状态砂粒
DG225-900
2200
不合格
200
260
400
研磨时间（小时）

图 7

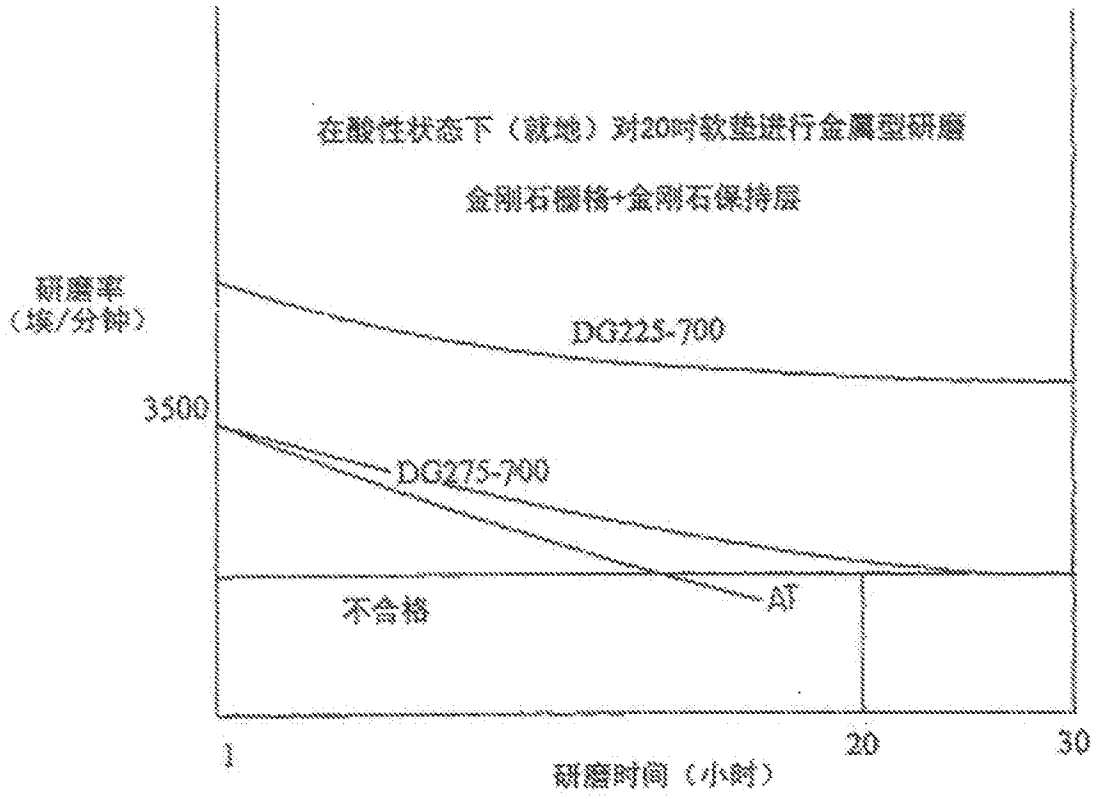

在酸性状态下（就地）对20吋软垫进行金属型研磨
金刚石栅格+金刚石保持座
研磨率
（埃/分钟）
DG225-700
3500
DG275-700
AT
不合格
1
20
30
研磨时间（小时）

图 8

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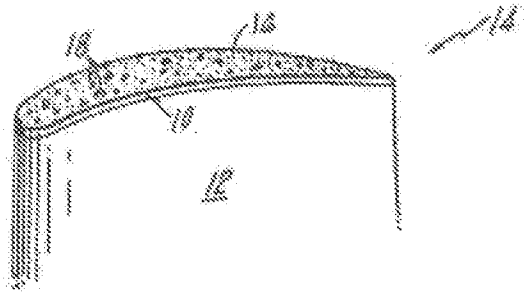
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(54) Method for depositing a layer of abrasive material on a substrate.

(57) Techniques are described for the formation of an abrasive surface layer (14) on an article (12). The surface layer (14) is characterized by a single layer of particles (16) which are evenly spaced apart, in a high density arrangement, within a metallic matrix (18). In the deposition of the particles (16) on the article (12), a vacuum is drawn through a perforated plate (42), wherein the location of each perforation (44) corresponds to the desired location of one particle (16) on the article surface (11). The vacuum holds one particle (16) over each perforation (44) in the plate (42), then the plate (42) is positioned over the article (12) and the vacuum level adjusted so that the particles (16) fall onto the article (12). The matrix (18) is then deposited by plasma arc spraying a superalloy powder. The invention is particularly suited to the formation of an abrasive layer on the tip surface of a blade used in a gas turbine engine.

FIG. 1



EP 0 238 434 A2

Description

Method for Depositing a Layer of Abrasive Material on a Substrate

Cross Reference

This invention is related to the copending and commonly assigned application "Abrasive Surface Coating Process for Superalloys", U.S. Serial No. 624,446, to Eaton et al. filed June 25, 1984.

Technical Field

The present invention relates to a method for depositing particulate material on a substrate. More specifically, it relates to a method for depositing a surface layer containing spaced apart abrasive particulate on the tip surface of a turbine engine component.

Background

Gas turbine engines and other turbomachines have rows of rotating blades contained within a generally cylindrical case. As the blades rotate, their tips move in close proximity to the case. To maximize engine operating efficiency, the leakage of the gas or other working fluid around the blade tips should be minimized. As has been known for some time, this may be achieved by blade and sealing systems in which the blade tips rub against a seal attached to the interior of the engine case. Generally, the blade tip is made to be harder and more abrasive than the seal; thus, the blade tips will cut into the seal during those portions of the engine operating cycle when they come into contact with each other.

One type of blade tip is described in U.S. Patent No. 4,249,913 to Johnson et al, entitled "Alumina Coated Silicon Carbide Abrasive", of common ownership herewith. In the Johnson et al invention, silicon carbide abrasive particles of 0.20-0.76 mm average diameter are coated with a metal oxide such as alumina and incorporated by powder metal techniques in nickel or cobalt base matrix alloys. A powder metal compact containing up to about 45 volume percent particulate may be made which is then bonded to the tip of the blade. The resulting abrasive blade tip is particularly well suited for rubbing metal as well as ceramic abseals; the latter type of seals have found wide use in modern gas turbine engines.

As described in greater detail in the copending and commonly assigned application "Abrasive Surface Coating Process for Superalloys" to Eaton et al, U.S. Serial No. 624,446, which is incorporated by reference, improved techniques for the fabrication of blade tips, relative to the type of methods described in Johnson et al, are desired. Specifically, the blade tip should be as thin as possible, yet still provide the required abrasive characteristics. The quantity of abrasive silicon carbide should be minimized, due to its high expense.

Components having thin layers of abrasive particles which are randomly distributed in a matrix material are known. For example, coated abrasives made from alumina, silica and silicon carbide are common products, as are metal bonded diamond and cubic boron nitride grinding tools. Such tools are often made by electrodeposition techniques. In U.S. Patent No. 4,227,703, such techniques are used to deposit an abrasive layer on a turbine blade tip. However, the limited composition of electrodeposited matrix alloys limits the usefulness of this method. Sprayed deposits containing metal and ceramic abrasives are also well known. See, e.g., commonly assigned U.S. Patent No. 4,366,112. However, such processes for spraying abrasive and matrix metal particles are inherently inefficient in that only a fraction of the sprayed material actually hits and adheres to the surface. These difficulties are especially significant in light of the relatively small size, e.g., about 6 by 50 mm, and curved shape of a typical turbine blade tip.

When an abrasive layer is provided on a superalloy turbine blade tip, its method of application must be metallurgically compatible with obtaining or maintaining the desired properties of the superalloy substrate. Since turbine blade alloys reflect a highly refined metallurgical art, there are limits on the techniques used with abrasive layer fabrication. Also, the abrasive layer is not a structural material and its weight imposes stresses on the blade substrate during use, i.e., when the blade rotates at high speed. Thus it is highly desirable that the minimum thickness abrasive layer be applied. Since blades are finished to length tolerances of 0.05 mm or less, this means that both the preparation of the substrate and the application of the abrasive layer must be carried out with high precision. All these considerations place severe restraints on the kinds of materials and processing techniques which are useful.

Disclosure of the Invention

An object of the invention is a method for providing a single layer of spaced apart particles on the surface of an article. Another object of the invention is to deposit such particles in a high concentration and uniform distribution on a turbine blade tip. Yet another object of the invention is to provide an abrasive layer having high temperature operating capability on the tip surface of a turbine blade.

According to the invention, a method for depositing a single layer of particles in a desired pattern on the surface of an article comprises the steps of (a) drawing a vacuum through a transfer tool having a plurality of apertures arranged in said desired pattern, the size of each aperture being such that the vacuum holds only one particle in overlying relation to each aperture; (b) positioning the tool and the particles held thereto over the article surface; and (c) decreasing the vacuum level such that the particles fall onto the surface, their position on the surface substantially corresponding with the position of the apertures. Preferably, a layer of adhesive is present on the surface so that when the

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particles drop onto it, they are adhesively attached to the surface. Most preferably, the particles have a metal cladding thereon, and the article is then heated to volatilize the adhesive and sinter bond the clad particles to the surface.

The invention is particularly useful in the fabrication of an abrasive layer on the tip surface of a rotor blade used in a gas turbine engine. For desired operating characteristics, the particle density per unit area of blade tip surface must be maximized, while at the same time the interparticle contact must be minimized. Also, the particles must be securely bonded to the blade tip to withstand the stresses of engine operation. To fabricate such an abrasive layer on a blade tip, after the metal clad particles are sinter bonded to the tip surface, a matrix alloy material is deposited on the surface so as to cover the particles and to fill in the spaces between the particles. The particulate bearing matrix is then simultaneously heated and pressed to eliminate any voids in the matrix material and securely bond the matrix to the substrate and, by interdiffusion, to the cladding on each particle. The abrasive layer is then machined to a relatively flat surface, and then part of the matrix is chemically removed to cause portions of the particles to project into space when blades having such an abrasive layer are installed in an engine, these exposed particles will rub the seal during engine operation, and minimize the leakage of working fluids around the blade tips, thus improving engine operating efficiency.

The abrasive particles are particularly sized with respect to the matrix layer thickness. Control over the particle sizing and aspect ratio are necessary to insure that a portion of most of the particles projects into space, while at the same time, all of the particles are securely bonded to the blade tip surface. Particles sized between Nos. 35-40 U.S. Sieve Series (0.42-0.50 mm nominal openings) are used when the matrix layer thickness is about 0.38 mm. Most preferably, the particles are uniformly spaced apart in a regular pattern on the blade tip surface. Depending on the expected interaction between the abrasive layer and the seal during engine operation, the particle density may be varied between about 35 to 110 particles per cm^2. This relatively close spacing necessitates using particles with aspect ratios less than 1.3 to 1, so that less than about 10% of the particles will contact one another after they are bonded to the tip surface.

The abrasive layer produced according to the invention is economical in the use of materials and has good durability when interacting with ceramic seals.

The foregoing and other subjects, features and advantages of the present invention will become more apparent from the following description of preferred embodiments and accompanying drawings.

Brief Description of the Drawings

Figure 1 generally shows the radially outer portion of a typical gas turbine blade having an abrasive layer made according to the invention;

Figure 2 shows in side view the appearance of a prior art abrasive layer;

Figure 3 shows in side view the appearance of an abrasive layer produced according to the teachings of the present invention;

Figures 4-7 show simplified, schematic views of the method by which abrasive particles are placed on the surface of a turbine blade tip according to the present invention;

Figure 8 shows a perspective view of Figure 6;

Figure 9 shows in side view the appearance of the abrasive particles enveloped in a matrix material;

and

Figure 10 shows the abrasive layer machined to a flat surface.

Best Mode for Carrying Out the Invention

In an example of the practice of the invention, and referring to Figures 1 and 3, an abrasive layer 10 is formed on the tip surface 11 of the airfoil portion 12 of a gas turbine blade 14. The blade 14 is preferably made of a nickel base superalloy (such as the single crystal alloy of U.S. Pat. No. 4,209,348), while the abrasive layer 10 is comprised of a nickel base superalloy matrix 16 and alumina coated silicon carbide particles 18. As will be evident, other materials may be used in the practice of the invention.

The abrasive layer 10 is subjected to very high stresses during engine operation, and therefore it is important that the layer 10 have a certain configuration and properties to perform its function. In particular, the particles 18 must be disposed on the tip surface 11 in a certain manner to obtain optimum performance.

In a prior art abrasive layer 20 for a turbine blade 21 shown in Figure 2, there are randomly disposed abrasive particles 22 within a matrix metal 24. A braze type bond joint 26, such as described in U.S. Patent No. 3,678,570, holds the layer 20 on the blade tip 32. In such a prior art abrasive layer 20, there sometimes tends to be a brick of particles 22 at the blade leading and trailing edges, 34, 36, respectively. Some of the particles 22 touch each other, which results in the inefficient use thereof.

Referring to Figs. 1 and 3, the abrasive layer 10 made according to the invention is characterized by a single layer of abrasive particles 18 surrounded by matrix material 16. Use of a single layer of abrasives 18 minimizes the mass of the entire layer 10, thus reducing the centripetal force on the blade 14 as it rotates during engine operation. The matrix metal 16 has a thickness W less than the overall thickness T of the particles 18. As a result, a portion of each particle 18 projects into space, thereby enabling favorable rubbing interaction with metal or ceramic seals during engine operation. For optimum performance, the unexposed portion of the particles 18 must be surrounded by matrix metal 16, and the particles 18 must be closely spaced apart from each other. Further, the matrix metal 16 as well as particles 18 must be securely bonded to the blade tip 11. In the invention, at least about 50-60% of the particulate surface area (excluding that surface area

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exposed at the blade tip) is surrounded by matrix metal 16 rather than being in contact with another particle 18. Also, the particles 18 are, in general, evenly and densely spaced on the blade tip 11. Densities of about 35-110 particles per cm^2 of tip surface 11 are obtained with the invention method of application, with about 50 particulates per cm^2 being preferred.

As shown in Fig. 3, the particles 18 have a thickness (length), T, and the matrix thickness W is about 50-90 percent of the particle thickness T. Silicon carbide particles of No. 35-40 U.S. Sieve Series Size (nominally 0.42-0.50 mm) have been found useful in the practice of the invention; up to U.S. No. 20 (0.83 mm) size also appears useful.

Figures 5-8 show how the particulates 18 are laid on the blade tip surface 11 where they will be subsequently permanently adhered. Prior to placing the silicon carbide particulates on the surface 11, they are first coated with about 0.010 mm of vapor deposited alumina according to the aforementioned Johnson et al patent, and then clad with a layer of metal, such as vapor or electrodeposited nickel, to a thickness of about 0.002-0.050 mm. Procedures for applying nickel coatings to ceramic particulates are commercially available and also are revealed in U.S. Patent Nos. 3,920,410, 4,291,088 and 4,374,173. If the ceramic particulate material is inherently resistant to reaction with the matrix material then the alumina coating is not necessary. (Neither the alumina coating nor metal cladding are shown in the Figures).

Just before the particles 18 are laid on the surface of the blade tip 11, a polymer adhesive 48 which is capable of being volatilized at less than about 540°C is applied to the surface 11. The purpose of the adhesive 48 is to hold the abrasive particles 18 in place after they are deposited on the blade tip 11. A 1-20 volume percent polystyrene in toluene solution is preferred.

As noted above, the particles 18 in the abrasive layer 10 should be densely arranged on the blade tip 11 in a uniformly spaced apart pattern. As shown in Figs. 4-8, to deposit the particles 18 in such a manner, a vacuum (suction) is drawn through a transfer tool having a plurality of apertures which are arranged to correspond with the desired, spaced apart pattern of particles on a blade tip. As is shown in Fig. 8, which shows the preferred means for depositing the particles, the apertures are perforations 44 in a rigid plate 42. The size of each perforation 44 or aperture is such that when the plate 42 is brought near a source of the particles 18, the vacuum draws the particles 18 against the plate 42, and only one particle 18 is held over each aperture. While not shown in the Figures, some particles 18 may be attracted to the plate 42 or to other particles 18 by, e.g., electrostatic forces, rather than held thereto by the vacuum. Such excess particles are dislodged from the plate 42 by gently tapping the plate 42, taking care not to dislodge the particles 18 held by the vacuum. The perforations 44 are particularly dimensioned relative to the particle size. The diameter of each perforation 44 must be large enough such that the force of the vacuum is sufficient to draw the particles 18 against the plate 42. At the same time, the perforations 44 must be small enough to prevent the particles 18 from passing therethrough. Preferably, the diameter of each perforation 44 is about 3/4 of the particle size.

As is seen in Fig. 8, the area of the plate 42 covered by the particles 18 is slightly larger than the actual blade tip surface 11. This is accomplished by constructing the container 46, which holds the loosely lying particles, in the shape of an oversized blade tip; once the plate 42 is brought near the container and the vacuum turned on, the particles 18 will be attracted to the plate 42 in the pattern shown in Fig. 8. Preferably, the base 49 of the container 46 is a screen or mesh type material.

Once the particles 18 are securely held by the vacuum to the plate 42 as shown in Figs. 5 and 8, the plate 42 is positioned over the blade tip 11 so that the perforations 44 (and the particles 18 overlying them) are aligned with the desired position of the particles 18 on the blade tip 11, as shown in Figure 8. As noted above, the tip 11 is coated with a layer 48 of adhesive. Once the plate 42 is properly positioned over the blade tip 11, the vacuum level is adjusted so that the particles 18 drop onto the adhesive coated tip 11 (Fig. 7). The distance A between the particles 18 and the tip 11 should be minimized so that when the particles 18 are released from the plate 42, they do not bounce off of the tip 11, or stray significantly from their intended position on the tip 11.

Of course, when the particles 18 are released from the plate 42, it is possible that a few particles 18 will stray from the spaced apart relation they had when held to the plate 42, and as a result, there may be some slight agglomeration of particles 18 on the blade tip 11. Also, when the vacuum is drawn on the plate, it is possible that not every perforation 44 will be overlaid by a particle 18. However, use of the plate 42 as described above allows the deposition of a single layer of generally spaced apart particles 18 on the tip surface 11, in sufficient densities (i.e., particles per cm^2) required for turbine blade tip applications. While interparticle contact on the blade tip surface 11 is undesired, experience has shown that there are typically only a few particles 18 (less than about 15%), which touch each other.

After the particles 18 are deposited on the blade tip surface 11, the blade 14 is heated to volatilize the adhesive 48, which also causes solid state bonding (sintering) of the metal cladding to the tip surface 11. For nickel clad particles, the heat treatment is preferably carried out at about 1080° C for 2 hours, in a vacuum or inert gas atmosphere. Use of such a protective atmosphere precludes oxidation of the cladding and blade tip 11.

Next, the particles 18 are oversprayed with a layer of matrix material 16 deposited by plasma arc spraying to a thickness T' as shown in Fig. 9. A nickel base superalloy of the type generally described in the aforementioned Johnson et al patent may be used. The preferred matrix composition is, by weight percent, about 25 Cr, 8 W, 4 TA, 6 Al, 1.0 Hf, 0.1 Y, 0.23 C, balance Ni. The blade 14 is positioned with respect to the plasma arc device so that the tip cross section is generally perpendicular to the axis

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along which the molten matrix particles travel. The blade 14 is suitably masked around its periphery that errant spray does not deposit on the sides of the blade 14. The matrix material 16 is applied to a thickness of about 0.6-1.3 mm, preferably 1.1-1.3 mm.

Although the sprayed layer of matrix material 16 will have about 95 percent theoretical density, it will nonetheless be characterized by some porosity or voids. The voids are characteristic of the metal spraying process, and would be produced by any such "line of sight" deposition process. Metal spraying is used because it is one of the few processes capable of applying a superalloy, with all its diverse constituents. Another process that may be used is a physical vapor deposition process, since such process has been shown to be capable of applying MCrAlY coatings and the like. See U.S. Pat. No. 4,153,005 to Norton et al.

Next, the blade is subjected to a hot isostatic pressing procedure. Generally, this comprises deforming the matrix material 16 beyond its yield or creep-limit point at an elevated temperature. Preferably, the part is subjected to argon pressure while at elevated temperature, to close the aforementioned pores and voids, and to enhance the bond between the matrix 16, particles 18, and blade tip 11. For the specific superalloy matrix material described above, a temperature of about 1,100°C and a gas pressure of about 138 MPa applied for two hours is sufficient. Other hot pressing procedures may be used to consolidate the matrix material 16 and achieve the object of densification and bonding.

Next, the rough surface of the abrasive layer 10, as shown in Fig. 9, is machined using a conventional procedure such as grinding to produce a smooth, planar suface, as shown in Fig. 10. After the machining process, the thickness of abrasive particles 18 and matrix material 16 is T. Finally, the surface of the abrasive layer 10 is contacted with an etchant or other substance which will attack and remove some of the matrix material 16, causing the particles 18 to project into space. For example, electrochemical machining can be used, as is described in U.S. Patent No. 4,522,692 to Joslin. This step reduces the matrix thickness to a dimension W, which is about 50-90 percent of the dimension T, and results in the shape schematically shown in Fig. 3.

While Figures 4-8 show the preferred embodiment of the invention, i.e., the use of a perforated plate 42 to deposit the particles 18 on the blade tip 11, the apertures in the transfer tool may be defined by other means. One arrangement within the scope of the invention are hollow cylinders such as tubes or needles, which are spaced apart relative to each other such that the apertures (the cylinder ends) are arranged in the same pattern as the perforations in the plate. When a vacuum is drawn through the cylinders, only one particle will overlie each cylinder end. The particles are dropped from the cylinders in the same manner as they are dropped from the plate, as described above.

It has been found that there is a criticality in the aspect ratio of the particles 18, relevent to obtaining an abrasive layer 10 which contains a high density of uniformly spaced apart particles 18. When the particles are long and thin (i.e., have a high aspect ratio), they will of course tend to lie on their sides either when laid on the blade tip surface 11 initially or in the interval between the volatilization of the adhesive agent and the attainment of a metallic bond. Such laying-at-length disrupts the uniformity of placement and causes undue interparticle contact. Thus, the invention is best practiced when the aspect ratio of the particulates is less than about 1.8 to 1 and preferably is about 1.5 to 1 or less. The aspect ratio is defined herein as the average ratio of the longest particle dimension to the cross sectional dimension, as such is measured on a Quantimet Surface Analyzer (Cambridge Instruments, Cambridge, England).

The present invention is especially useful in providing a more effective abrasive layer (after the matrix is partially chemically milled away) compared to abrasive layers of the prior art. Suppose abrasive layers having the same volume percent of identically sized and shaped particles are made, first using the invention technique and second, using the prior art powder metal technique, as represented in Fig. 2. The area of abrasive particulate exposed at the surface of the invention and prior art layers, after the grinding operation, will be approximately the same. But the particulate deposited according to the invention will be distributed considerably more uniformly. And when the matrix is partially removed from the invention abrasive layer by electrochemical machining, about the same amount of surface area will be exposed on each particle, and the particles will all be about equally well-bonded to the blade tip. In contrast, owing to the non-uniform distribution of particles in prior art structures, when the matrix is electrochemically machined, those particles which were mostly contained in the matrix which is removed will of course be lost. The net result is that there will be less area of abrasive particles remaining at the free surface, and the prior art abrasive layer will be less effective in wearing the ceramic seal it rubs during engine operation.

While in the preferred embodiment of the invention the abrasive particles are placed in a uniform distribution on the blade tip, applications are contemplated in which there need be a greater or lesser concentration of particles at one or another portion of the tip. To achieve such a distribution of particles, the pattern of perforations in the plate is modified accordingly.

Although this invention has been shown and described with respect to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail thereof may be made without departing from the spirit and scope of the claimed invention.

Claims

1. A method for depositing a single layer of particles on the surface of an article, wherein the particles are spaced apart from each other

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on said surface in substantially noncontacting relation in a desired pattern, comprising the steps of:

(a) drawing a vacuum through transfer tool means having a plurality of apertures spaced apart from each other in said desired pattern while the tool means is adjacent to a container of the particles, wherein the vacuum holds one particle over each aperture;

(b) positioning the article relative to the apertures such that each particle substantially overlies its desired location on the article surface; and

(c) adjusting the vacuum level such that the particles are released from the tool means and drop onto the article surface to form said desired pattern.

2. The method of claim 1, further comprising the step of applying an organic adhesive to the surface of the article prior to said step of adjusting, such that when the particles drop onto the surface from the plate, they are held on the surface of the article by the adhesive.

3. The method of claim 2, wherein the particles are metal clad ceramic, and further comprising the step of heating the article having the particles thereon to an elevated temperature to remove the adhesive and to bond the particles to the article surface.

4. The method of claim 2, wherein between about 35-110 particles per cm^2 are deposited on the article surface, the particle size being between about Nos. 20 and 40 U.S. Sieve Series.

5. The method of claim 4 wherein the aspect ratio of the particles is less than about 1.9:1.

6. The method of claim 1, wherein the article is a blade for a gas turbine engine.

7. A method for depositing a single layer of particles on the tip surface of a turbine blade, wherein the particles are spaced apart from each other on said tip surface in substantially noncontacting relation in a desired pattern, comprising the steps of:

(a) drawing a vacuum through transfer tool means having a plurality of apertures spaced apart from each other in said desired pattern while said tool means is adjacent to a container of the particles, wherein the vacuum holds one particle over each aperture;

(b) positioning the blade tip relative to the apertures such that each particle substantially overlies its desired location on the blade tip surface;

(c) adjusting the vacuum level through the tool means such that the particles drop onto the blade tip surface to form said desired pattern;

(d) depositing on the blade tip surface article a layer of matrix material to fill in the spaces between the particles; and

(e) removing a portion of the matrix material such that the thickness of the matrix material is less than the thickness of the particles.

FIG. 1

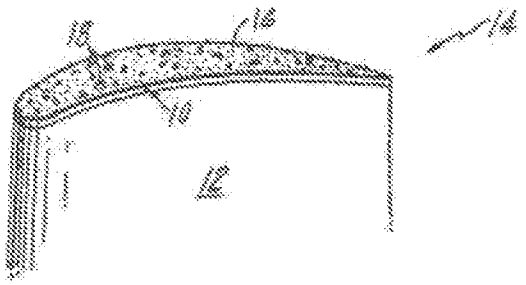
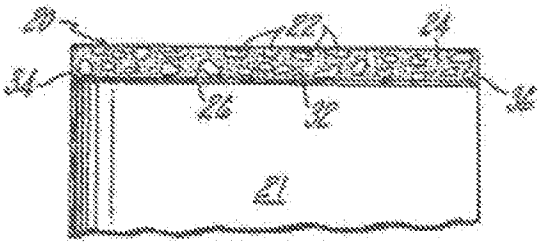


FIG. 2 PRIOR ART



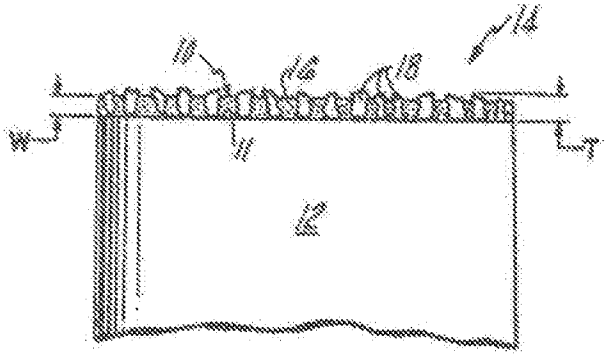


FIG. 3

FIG. 4

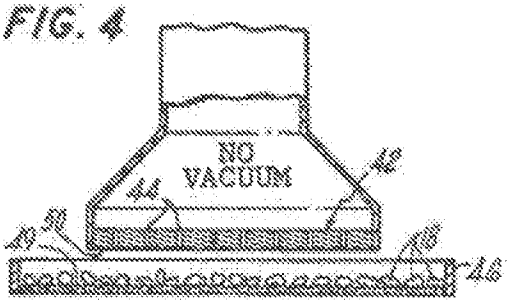


FIG. 5

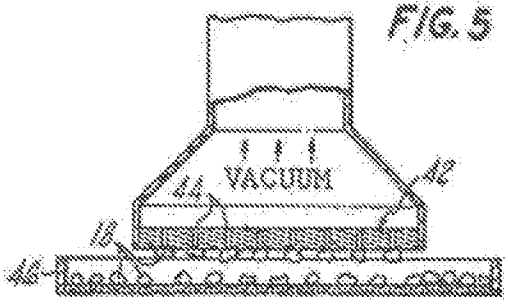


FIG. 6

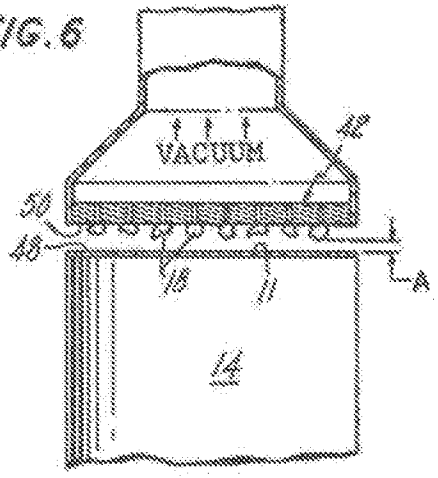
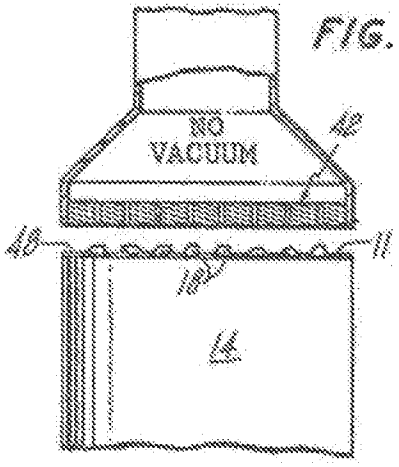


FIG. 7



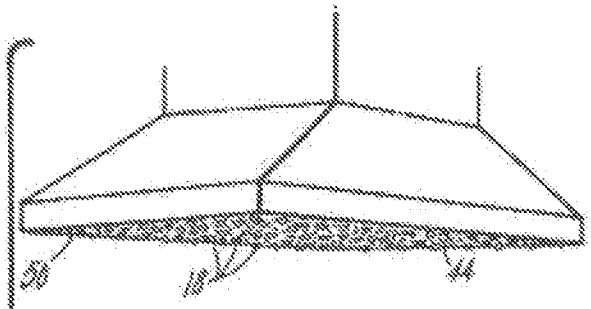
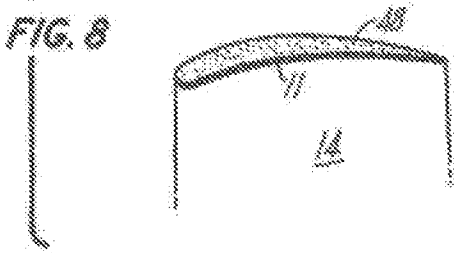


FIG. 8



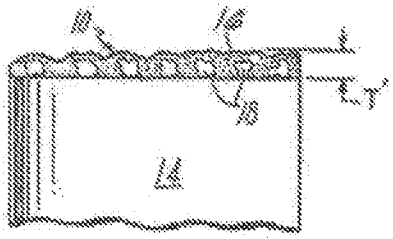


FIG. 9

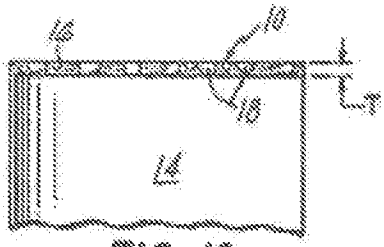


FIG. 10