Title of the Invention

DISK SUBSTRATE INTERMEDIATE PRODUCT AND MANUFACTURING PROCESS THEREOF

Background of the Invention and Related Art Statement

The present invention relates to a non-aluminum intermediate product of a disk substrate formed by plating Ni-P (nickel-phosphor) layer for providing texture, and more particularly to an intermediate product of a disk substrate and its manufacturing process for easily and inexpensively manufacturing an inorganic material substrate such as a crystallized glass substrate, a glass substrate, etc. used for a hard disk.

A disk substrate currently used for a hard disk includes an aluminum substrate which is an aluminum plate plated with Ni-P layer, and a glass substrate made of crystallized glass formed by directly spattering a magnetic layer, etc. or glass (including tempered glass). The aluminum substrate is used as a substrate for a large hard disk with a diameter of 5.25 or 3.5 inches, while the glass substrate is used as a substrate for a small hard disk with a diameter of 2.5 inches or less.

The glass substrate is superior to the aluminum substrate for performance demanded for a hard disk substrate such as impact resistance (hardness), or rigidity (Young's modulus), and can provide better surface roughness. However, it has higher manufacturing cost because longer processing time is taken in the manufacturing process. In addition, since the manufacturing cost tends to increase as the glass substrate becomes larger in its size, the glass substrate is limited in use

for a substrate for a small hard disk with a diameter of 2.5 inches or less mounted on a portable personal computer which requires impact resistance.

As the surface characteristics of the glass substrate used for the hard disk, it is demanded to have high flatness, surface roughness, and no surface defect such as pit, etc. To produce a glass substrate which satisfies such demanded characteristics, a glass substrate material is currently ground. Since a resultant intermediate product of glass substrate generally has insufficient flatness and surface roughness for the demanded characteristics, a process is employed to further polish the intermediate product of glass substrate.

Polishing as the final finishing step in producing the glass substrate comprises the steps of holding the glass substrate intermediate product between the upper and lower surface plates, applying abrasive cloth made of polyurethane or sued on a polishing surface of the surface plate (contact surface with the glass substrate intermediate product), and rotating the upper and lower surface plates in the opposite directions to each other while supplying treating liquid to polish the surface of the glass substrate with fine abrasive grain of cerium dioxide (CeO_2) as free abrasive grain.

That is, the polishing step can be said to be a step for correcting minute irregularities generated in the previous grinding step to obtain a smooth and good surface roughness. Therefore, the polishing step takes over the flatness obtained in the previous grinding step as it is, so that it is virtually impossible (in production efficient) to correct the flatness in the polishing step.

A base material to be plated with Ni-P requires moderate irregularities. Since an aluminum base material is metal, there are no pits (grain marks) locally generated by polishing with a sponge grindstone, etc., whereby obtaining an aluminum base

material with desired surface roughness. However, since a glass base material and a crystallized glass base material are brittle materials, the sponge grindstone or the lapping with GC abrasive grain can attain desired surface roughness, but locally generate pits, thereby leaving the pits on the polished surface after the plating with Ni-P, and resulting in an insufficient glass disk. Thus, they are not adopted these days.

At present, as a process for manufacturing a disk substrate intermediate product from inorganic material including such glass substrate intermediate product, or a grinding method for a disk substrate material, there are a domain utilizing minute destruction, and a domain utilizing minute deformation. The former is used to increase treatment and removal action, and lapping with free abrasive grain is a typical example of it. On the other hand, the latter is used to process the surface with high accuracy, and a typical method includes grinding with a fixed grindstone.

The lapping is a typical method for grinding a disk substrate material, and frequently divided into a primary lapping (coarse lapping) step and a following secondary lapping (fine lapping) step. In either case, a carrier (place typically made of resin for holding a disk substrate material) fitted with a disk substrate material is set between the upper and lower lapping surface plates made of iron. The disk substrate material is press held on both sides. The upper and lower surface plates are rotated in the opposite directions to each other to lap both surfaces of the disk substrate while supplying free abrasive grain such as GC (SiC) and processing liquid between them and removing chips and splinters from the surface of the disk substrate material. It is advantageous that it provides high flatness, working accuracy, a working efficiency.

Here, the lapping causes minute brittle fracture on the disk substrate material surface due to collision (slide) between the disk substrate material and the abrasive grain, thereby grinding the surface of a disk substrate material with such fracture. Then, working distortion is caused on the surface of the resultant disk substrate intermediate product by the brittle fracture.

If different amount of working distortion remains on the surface of the disk substrate intermediate product, the disk substrate intermediate product is warped, so that it becomes impossible to obtain good flatness. However, when both planes of the disk substrate material are simultaneously processed, so that the working deformation generated on the disk substrate intermediate product can be made uniform and substantially the same amount on each plane. Thus, since the lapping can provide a disk substrate with little warpage and high flatness, it is widely used as a process for manufacturing a disk substrate intermediate product for a hard disk.

However, since the lapping may cause partial abrasion when it is used for a prolonged interval of time, it could cause bias abrasion on the lapping surface, whereby the above-mentioned good flatness cannot be obtained any more, unless the lapping surface of the lapping surface plate is carefully managed. In addition, the lapping has a disadvantage that pits called grain marks are unavoidably generated because it is brittle fracture process.

These pits are minute depressions which are believed to be generated when relatively large grain (secondary grain) rolls on the surface of the disk substrate material during the lapping process. It is typically as deep as 20 through 30μm. This makes it required to remove these pits in the next polishing process, which is usually required to be continued for 40 through 60 minutes to polish both surfaces of the disk substrate intermediate product. The processing duration is about eight

through ten times as long as polishing duration in the manufacturing process for an aluminum substrate. Such long processing duration results in one of major causes to increase the manufacturing cost. It is now required to further provide an intermediate product of the disk substrate enabling the texture processing less expensively from the problems in the cost and working accuracy in texture processing in addition to the prolonged time for polishing.

A diamond pellet surface plate has been developed as a method to suppress such partial abrasion of the lapping surface plate during the lapping. However, the problem of pit generation is not yet solved. Therefore, it is necessary to grind both surfaces of the disk substrate intermediate product by at least 30 through 40μm to remove the pits in the following polishing process. Thus, cost is substantially same as that in the process employing the lapping.

On the other hand, grinding processing is a processing method to grind the surface of the disk substrate material by rotating a fixed grindstone at a high speed, the grindstone being formed by fixing abrasive grain such as diamond, CBN, or GC with metal, resin, or glass. According to the grinding processing, little pit is generated, and, even if it is generated has a very small depth, so that the time is significantly reduced for removing irregularity defect remaining on the plane of the disk substrate intermediate product in the polishing process.

However, when such grinding processing is continued, tips of abrasive grain are ground off to make impossible to perform grinding, thereby requiring periodic dressing. In addition, since it is necessary to process one surface of the disk substrate material after another, it is unable to provide uniform amount or distribution of working distortion generated on each plate of the disk substrate

material, so that irregular warpage or twist is generated in the disk substrate intermediate product and the flatness is degraded.

Since such warpage or twist cannot be removed or corrected in the polishing processing, as described above, such grinding processing has not been adopted as the process of manufacturing a disk substrate intermediate product for a hard disk. The applicant of the present invention provides a working surface plate by solidifying abrasive grains, locates the center of the rotation of the work surface plate on the circumference of the working surface plate, and performs a griding process by relatively sliding the working surface plate and the work surface plate such that loci of the contact portions between the disk substrate on the work surface plate and the working surface plate can be uniform. Thus, the applicant of the present invention found that an intermediate product of a disk substrate for a hard disk with desired flatness can be realized, even if it is larger than 2.5 inches in size, and filed Japanese Patent Application No. 9-183681 on July 9, 1997. However, application to this method and commercially available substrates (Ra $\leq$ 10Å) of plating with Ni-P, polishing, texturing, spattering of magnetic film, etc. generates too good surface roughness and causes scraped film due to a problem of adherence. As a result, it proved that the target intermediate product cannot be realized.

When the film scraping phenomenon does not occur, the texturing using a YAG laser can be performed by means of the existing technology. Furthermore, the media obtained by spattering a magnetic film on the plating with Ni-P excels the media obtained by spattering a magnetic film directly on a glass substrate in magnetic characteristics.

Summary of the Invention

The present invention is made in view of such problems in the prior art. The inventor has attempted to solve the above problems, and reached the present invention by incorporating a brittle fracture process and a plastic deformation process into a process for grinding one surface to be ground of a disk substrate material, the brittle fracture process being performed in the first step, the plastic deformation process being performed in the second step and a spark-out (flattening) process.

The object of the present invention is to provide a process of manufacturing the intermediate product of the disk substrate, which can prevent generation of minute pits and irregular warpage of a material to be ground in the grinding process, maintain good flatness of the disk substrate material by keeping constant grinding resistance on the surface of the disk substrate material and loci of fixed abrasive grains, and contribute to improve working accuracy and efficiency and to reduce the cost.

That is, according to the present invention, there is provided an intermediate product of a disk substrate both surfaces of which are ground by a grindstone, wherein flatness on each plane is 10μm or less, and wherein height difference of irregularities produced by the grinding is 0.05 through 1.0μm. It is also preferable that loci or the grinding process formed on each plane of the disk substrate intermediate product are radial curves extending outward from the center.

In addition, according to the present invention, there is provided a process of manufacturing an intermediate product of a disk substrate comprising the steps of sequentially grinding both planes of a disk substrate material to be worked one after another to provide substantially the same amount of working distortion remaining on each ground plane, whereby flatness of the disk substrate intermediate product after

the grinding is maintained at 10μm or less, and the height difference of irregularities produced by said grinding is in a range of 0.05 through 1.0μm which is the surface roughness enough to form an Ni-P layer with plating.

Here, in the process of manufacturing an intermediate product of a disk substrate according to the present invention, when each plane of the disk substrate material is ground by a rotating grindstone, it is preferable to set such a working conditions that abrasive grains forming the grindstone are broken or fall out from the grindstone for the first grinding step that grinds major part of predetermined amount. In addition, it is preferable that the first grinding step comprises the steps of securing the disk substrate material on a work table, and rotating both the work table and the grindstone, the number of revolution of the work table being in a range of 60 through 80% or 20 through 40% of that of the grindstone.

Furthermore, it is preferable that the second grinding step is performed following the first grinding step, and in a working condition in which abrasive grains forming the grindstone are not substantially broken or do not substantially fall out. If flatness of each plane of the disk substrate material is 10μm or less, the process of manufacturing according to the present invention becomes more effective. The disk substrate material is an inorganic material substrate in view of the processing mechanism, and more preferably, a glass substrate or a crystallized glass substrate.

Still further, according to the present invention, there is provided a grinding machine for grinding each plane of a disk substrate material by mounting and securing the disk substrate material to be worked on a work surface plate, and relatively sliding a working cup grindstone and the work surface plate, the cup grindstone being formed by solidifying abrasive grains, wherein the center of rotation of the work surface plate is located on the circumference of the working cup

grindstone, the machine comprising a slide driving control mechanism for relatively sliding the cup grindstone and the work surface plate so that loci of contact portions between the disk substrate material on the work surface plate and the working cup grindstone are uniform.

The disk substrate material for the intermediate product of a disk substrate according to the present invention is preferably glass or crystallized glass, and abrasive grain used for the grindstone is preferably any one of diamond, CBN, or vitrified grains having a specific grain size. Particularly, diamond is the most preferable.

Brief Description of the Drawings

Fig. 1 shows a schematic sectional view of an example of a grinding machine for manufacturing an intermediate product of a disk substrate according to the present invention.

Detailed Description of Preferred Embodiment

Since an intermediate product of a disk substrate according to the present invention has good flatness, and small height difference of irregularities on the surface, load is small in a polishing process compared to the conventional glass substrates, the cost for manufacturing the disk substrate can be reduced. In addition, according to the process of manufacturing a disk substrate intermediate product of the present invention, no pits and irregular warpage are generated on the disk substrate material during the grinding process, whereby good flatness of the material

to be ground can be maintained, while the process can contribute to improve working accuracy and efficiency and to reduce the cost.

Embodiments of the present invention are described below with reference to the drawings, but the present invention is not limited thereto.

First, the process of manufacturing an intermediate product of a disk substrate according to the present invention comprises the steps of forming a working cup grindstone by solidifying abrasive grains of #600 through #3000 in grain size, preferably #800 through 1200, locating the center of rotation of a work surface plate so that it is on the circumference of the working cup grindstone, relatively sliding the working cup grindstone and the work surface plate so that loci of contact areas between the disk substrate material on the work surface plate and the working cup grindstone are uniform, and successively and continuously a brittle fracture grinding process and a plastic deformation grinding process to make substantially the same working distortion caused in the upper and lower surfaces of the disk substrate intermediate product.

Fig. 1 is a schematic sectional view showing an example of a grinding machine for a disk substrate material which is suitably used in manufacturing an intermediate product of a disk substrate according to the present invention. As shown in Fig. 1, in the grinding machine for the disk substrate material 30 of the present invention, the center of rotation I' of a disk-shaped work surface plate 6 is arranged so that it is on the circumference of a disk-shaped working cup grindstone 2.

The number of work surface plate 6 is not limited to a specific number. However, a plurality of work surface plates 6 are preferably selected in view of necessity for interlocking respective work surface plate 6, and the size of the disk

substrate material 30 to be ground. In addition, the disk substrate material 30 is wax secured on the work surface plate 6, or mounted on the work surface plate 6 by means of a vacuum chuck or the like so that the center of rotation P of the work surface plate 6 aligns the center of rotation Q of the disk substrate material 30.

The working cup grindstone 2 is rotatably driven by a rotating shaft 4 connected to a motor (not shown). The work surface plates 6 are rotatably driven by interlocking respective rotating shafts 8 with a belt pulley (not shown) from the motor, whereby the working cup grindstone 2 and the work surface plate 6 are relatively slid by controlling with a slide driving control mechanism (not shown) the spacing between the working cup grindstone 2 and the work surface plate 6 and the number of respective rotation of the working cup grindstone 2 and the work surface plate 6 so that the grinding surface 20 which is a contact area of the disk substrate material 30 on the work surface plate 6 to the working cup grindstone 2 constantly describes loci of radial curves from the center to the outer periphery using the center of rotation P on the work surface plate 6 as the axis.

Thus, when compared with a conventional revolution type rotary flat grinding method using a cop grindstone, since this enables it to keep uniform loci of the grinding plane of the working cup grindstone to the grinding resistance and the disk substrate material 30 on the work surface plate, even if the disk substrate material is ground from one surface to another, the grinding mechanism mainly performs brittle fracture, so that working distortion generated on each surface of the disk substrate material 30 can be made substantially equal as in the lapping described above. Consequently, the resultant intermediate product of the disk substrate is prevented from irregular warpage, so that good flatness can be maintained.

To mainly perform such brittle fracture, it is necessary to set working conditions such that abrasive grains constituting the grindstone used for the grinding are broken or fall out. To this end, the present invention performs grinding by rotating both the rotatable work surface plate 6 secured with the disk substrate material 30 thereon and the working cup grindstone 2 secured with abrasive grains. In this case, the number of rotation of the work surface plate 6 is preferably within a range of 20 through 40% or 60 through 80% of that of the working cup grindstone 2. This enables it to constitute a grinding mechanism mainly performing brittle fracture.

As conditions for performing such brittle fracture, it is also necessary to take into account a speed for feeding the working cup grindstone 2 toward the disk substrate material 30. The feed speed can be easily conditioned within the range of the number of rotation of the work surface plate 6.

In the grinding method described above, grinding resistance can be reduced because the grinding surface per unit time is small, so that generation of grinding heat can be suppressed, while the disk substrate material 30 can be ground at a high speed. However, while, in the grinding method for mainly performing brittle fracture, very high flatness can be obtained, height difference of irregularities on the grinding surface reaches up to about 8μm only with the brittle fracture process. It is preferable to add a process with plastic deformation following the brittle fracture process as a method for further reducing height difference of irregularities.

Here, when plastic deformation is generated in the grinding step, working distortion may sometimes significantly increase. To suppress generation of such working distortion, it is preferable to suppress the amount of grinding with the plastic deformation at 5μm or less at the largest. Then, as a method for preventing

the flatness of the disk substrate material 30 from being degraded by the plastic deformation, it is preferable that a grinding locus left on the grinding surface of the disk substrate intermediate product describes a radial curve spreading from the center to the outer periphery.

Mainly performing the plastic deformation in the grinding process step can be attained by lowering the feed speed of the working cup grindstone 2. By combining the brittle fracture process with the plastic deformation process and performing them as a sequential operation, it becomes possible to enhance the flatness and to suppress height difference of irregularities in a range of 0.05μm to 1μm. That is, according to the manufacturing process for the disk substrate material of the present invention, grinding process with brittle fracture is first surely performed, whereby the working cup grindstone 2 is suppressed for clogging of grindstone, and the following plastic deformation can be efficiently performed.

The slide driving control mechanism (not shown) of the grinding machine of the present invention is preferable to perform closed-loop control which measures spacing between the working cup grindstone and the work surface plate, the number of rotation of the working cup grindstone and the work surface plate, or the like, and feeds back the result to a slide drive unit (not shown).

On the other hand, since distortion remaining in the disk substrate intermediate product depending on the condition of the chucking to the work surface plate or due to grinding heat significantly affects work accuracy, it is necessary to pay sufficient attention to control on installation of the disk substrate material and a method for removing grinding heat so as to obtain the intermediate product of the disk substrate with uniform thickness and warpage, and highly accurate flatness.

Thus, grinding is usually performed in a wet manner, so that there is provided facilities such as a nozzle for supplying grinding liquid to an area being ground and a recirculation pipe or the like. The grinding liquid varies depending on the type of abrasive grains forming the working cup grindstone. For example, water soluble grinding liquid with good cooling capability is preferable for a diamond or vitrified grindstone, while water insoluble grinding liquid is preferable for a CBN grindstone.

Here, the working cup grindstone used in the present invention preferably has high rigidity to grind with high accuracy a disk substrate material having much higher tangential grinding resistance than normal grinding resistance. Therefore, abrasive grains forming the working cup grindstone is preferably any one of diamond, CBN, or vitrified grains. Among other things, diamond grains are more preferable to use. In addition, the working cup grindstone used in the present invention is preferable to be any one of a porous, pellet, or segment grindstone to make easy removal of chips and supply of grind liquid to an area being ground.

Thus, since the intermediate product of the disk substrate is produced by the process of the present invention to have grinding loci of radial curves on the surfaces thereof, prevents pit generation on the grinding surface, and has height difference of irregularities in a range of about 0.05 through 1.0μm, it becomes possible to suppress the amount of grinding in the following polishing step to about 10μm on both sides.

Thus, since the amount of grinding can be reduced in the polishing step, the polishing can be performed inexpensively while maintaining flatness of the disk substrate intermediate product without causing roll-off or scratch. Then, the disk substrate intermediate product made of, for example, ground glass or crystallized

glass is suitably used as a precursor of a disk substrate with a diameter of 3 inches or more for a hard disk.

Now, the present invention will be described in further detail with reference to embodiments and comparative examples. It is a matter of course that these embodiments do not limit the present invention.

Grinding was performed by using, as a disk substrate material to be ground, under grinding conditions listed on Table 1, a crystallized glass substrate material which is a donut-shaped glass substrate (diameter: 65mm, thickness: 0.83mm) crystallized by heating at 750°C for two hours, and using the abrasive grain size described below. Then, polishing is performed by using cerium oxide for control.

[Table 1]

	Process conditions		
Diameter of grindstone	180ϕ		
Number of rotation of grindstone	2880 r.p.m.		
Number of rotation of work surface plate	2000 r.p.m.		
Abrasive grain size	#400 #600	#800 #1000 #1500	#2000 #3000
First grinding	150μm/min	70μm/min	30μm/min
Second grinding	30μm/min	12μm/min	5μm/min
Spark-out	5 sec	5 sec	5 sec

Then, after the surface roughness is checked using a glass substrate intermediate product obtained by grinding using each size of abrasive grain, the surface is plated with Ni-P layer in the normal method. After performing an aftertreatment, a texture forming process is performed. At this time, the adherence of the Ni-P layer is checked. Table 2 shows the check results with the general evaluation of the entire process. Table 2 also shows the results of the measurement of the amount of grinding in the grinding process. In the evaluation results, ○ indicates no problem in practical use; × indicates an actual problem, that is, unsatisfactory result; and △ indicates that the result is possibly acceptable, but not completely satisfactory.

[Table 2]

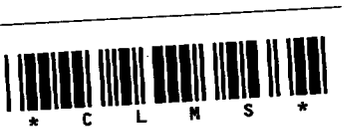
	Grindstone	Ry	Adherence	Amount of polishing	Evaluation
Example 1	#400	4.8μm	○	×	×
Example 2	#600	1.2μm	○	△	△
Example 3	#800	0.7μm	○	○	○
Example 4	#1000	0.4μm	○	○	○
Example 5	#1500	0.2μm	○	○	○
Example 6	#2000	0.1μm	○	○	○
Example 7	#3000	0.05μm	○	○	○
Example 8	CeO_2 polishing	0.001μm	×	○	×

NOTE: Examples 1 and 8 refer to comparison, and examples 2 through 7 refer to the embodiments of the present invention.

From the result shown on Table 2, it is obvious that a glass substrate intermediate product can be obtained with higher adherence of the Ni-P layer formed by plating and a smaller amount of process difference generated in the grinding process when any of the abrasive grain size #600 through #3000 is used. The polishing with cerium oxide cannot produce high adherence.

Therefore, it is desired to develop an intermediate product of a disk substrate plated with Ni-P layer with the smallest possible amount of polishing process in view of a large and inexpensive disk substrate. As clearly shown on Table 2, the process according to the present invention is an excellent grinding process satisfying all the listed requirements.

As described above, the intermediate product of a disk substrate of the present invention can reduce the amount of polishing in the subsequent step and produce high adherence of plated Ni-P layer. Therefore, the present invention significantly reduces time necessary for polishing and saves the cost of the texturing process, and exhibits an excellent advantage in saving the cost of a disk substrate. In addition, a large glass substrate larger than 2.5 inches, which has not been provided, can be provided at a low cost. Furthermore, since, according to the process of manufacturing an intermediate product of a disk substrate of the present invention, pit and irregular warpage are prevented from being generated during grinding by maintaining uniform grinding resistance and loci of fixed abrasive grains for a surface of a disk substrate material or the material to be ground, an intermediate product of a disk substrate with good flatness maintained can be obtained.



What is claimed is:

1. An intermediate product of a disk substrate both surfaces of which are ground by a grindstone, wherein

flatness on each plane is 10μm or less; and

height difference of irregularities produced by said grinding is in a range of 0.05 through 1.0μm.

2. The intermediate product of a disk substrate according to claim 1, wherein

loci of said grinding process formed on each plane of the disk substrate intermediate product are radial curves extending outward from the center.

3. A process of manufacturing an intermediate product of a disk substrate, comprising the step of sequentially grinding both planes of a disk substrate material to be worked one after another to provide substantially the same amount of working distortion remaining on each ground plane, wherein

flatness of the disk substrate intermediate product after said grinding is maintained at 10μm or less.

4. The process of manufacturing an intermediate product of a disk substrate according to claim 3, wherein

when each plane of said disk substrate material is ground by a rotating grindstone, abrasive grains forming said grindstone are preferably broken or fall out from said grindstone in a first grinding step which grinds major part of predetermined amount.

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5. The process of manufacturing an intermediate product of a disk substrate according to claim 3 or 4, wherein

said first grinding step comprises the steps of securing said disk substrate material on a worktable, and rotating both said worktable and said grindstone and grinding each plane of said disk substrate material, a number of revolution of said worktable being in a range of 60 through 80% or 20 through 40% that of revolution of said grindstone.

6. The process of manufacturing an intermediate product of a disk substrate according to any one of claims 3 through 5, wherein

a second grinding step is performed following said first grinding step under a working condition in which abrasive grains forming said grindstone are not substantially broken or do not substantially fall out.

7. The process of manufacturing an intermediate product of a disk substrate according to any one of claims 3 through 6, wherein:

flatness of each plane of said disk substrate material is 10μm or less; and

surface roughness (Ry) is 0.05 through 1.0μm.

8. The process of manufacturing an intermediate product of a disk substrate according to any one of claims 3 through 7, wherein

said disk substrate material is an inorganic material substrate.

9. The process of manufacturing an intermediate product of a disk substrate according to claim 8, wherein

said inorganic material substrate is a glass substrate or a crystallized glass substrate.

10. The process of manufacturing an intermediate product of a disk substrate according to claim 8, wherein

said intermediate product of a disk substrate is manufactured by a disk substrate material grinding machine for grinding each plane of a disk substrate material, comprising:

a work surface plate;

means, provided on said work surface plate, for mounting and securing said disk substrate material to be worked on said work surface plate;

a working cup grindstone formed by solidifying abrasive grains; and

means for relatively sliding said work surface plate and said working cup grindstone, wherein:

a center of rotation of said work surface plate is located on a circumference of said working cup grindstone;

said means for relatively sliding said working cup grindstone and said work surface plate comprises a drive control mechanism such that loci of contact portions between said disk substrate material on said work surface plate and said working cup grindstone can be uniform; and

said abrasive grains are #600 through 3,000.

11. The process of manufacturing an intermediate product of a disk substrate according to claim 10, wherein

said abrasive grains are diamond, CBN, or vitrified grains.