DESCRIPTION

Title of Invention:
METHOD FOR MANUFACTURING MAGNETIC-DISK SUBSTRATE, AND GRINDSTONE FOR GRINDING

Technical Field

[0001]

The present invention relates to a method for manufacturing a magnetic-disk substrate used to manufacture magnetic disks provided in magnetic recording apparatuses such as hard disk drives (hereinafter abbreviated as "HDDs"), and a grindstone for grinding to perform processing for grinding an edge surface of a magnetic-disk substrate.

Background Art

[0002]

Magnetic disks are one type of information recording media provided in magnetic recording apparatuses such as HDDs. Magnetic disks are configured with a thin film such as a magnetic layer formed on a disk-shaped substrate, and conventionally an aluminum alloy substrate or a glass substrate has been used as the substrate. The glass substrate is advantageous in that it is harder than the aluminum alloy substrate and has excellent impact resistance. Surfaces of these substrates are smoothened through high-precise polishing of the surfaces such that the flying height of the magnetic head can be lowered as much as possible to achieve a high recording density. In recent years, the demand for HDDs with a larger storage capacity at lower cost has been increasing, and in order to achieve this, further quality improvement and cost reduction of magnetic-disk substrates are also required.

[0003]

Magnetic-disk substrates are usually manufactured by sequentially

performing a shaping processing (edge surface grinding and chamfering) step, an edge surface polishing step, a main surface grinding step, a main surface polishing step, a chemical strengthening step, and the like on glass substrates formed in a disk shape.

Magnetic disks with which it is possible to achieve a high recording density at low cost as described above are required and high processing accuracy is required for the substrates in order to increase the recording density of the magnetic disks. The same applies to not only the main surfaces of the substrates but also to the shapes of the edge surfaces thereof.

[0004]

A conventional method for processing an edge surface of a disk-shaped substrate includes grinding processing in which a grindstone is rotated in contact with an outer circumferential side edge surface and an inner circumferential side edge surface of the substrate while a grinding liquid is brought into contact with edge surface portions of the substrate, and predetermined chamfering on the outer circumferential side edge surface and the inner circumferential side edge surface of the substrate (PLT1 and the like). In this case, in general, the grindstone is called a formed grindstone and has a groove shape for forming the shape of an edge surface of the substrate, and the groove shape of the grindstone is transferred to the edge surface of the substrate by bringing this grindstone into contact with the edge surface of the substrate. Also, it is known that the grinding processing is divided into rough grinding processing with a grindstone for rough grinding and precise grinding processing with a grindstone for precision grinding.

Prior Art Document(s)

Patent Literature

[0005]

Patent Document 1: JP 2000-296470A

Summary of Invention

Problem to be Solved by the Invention

[0006]

However, according to studies conducted by the inventor of the present invention, conventionally, if two-step processing, namely, rough grinding and precise grinding, was carried out on an outer circumferential side edge surface of a substrate by sequentially bringing the outer circumferential side edge surface of the substrate into contact with a groove for rough grinding and a groove for precise grinding that were formed on an inner circumference of a tubular grindstone, chipping such as blemishes sometimes appeared on the edge surface of the substrate resulting from the precision grinding processing.

[0007]

In view of this, from the viewpoint of ensuring reliability, a first object of the present invention is to provide a method for manufacturing a magnetic-disk substrate with which an edge surface of a disk-shaped magnetic-disk substrate can be finished to have a high quality. Also, a second object of the present invention is to provide a grindstone for grinding that can be suitably used to perform processing for grinding an edge surface of the above-described magnetic-disk substrate.

Means to Solve the Problem

[0008]

In order to resolve the above-described conventional issue, the inventor of the present invention conducted detailed studies on a method for performing grinding processing on an outer circumferential side edge surface of a substrate using a grindstone that is formed into a tubular shape and has a plurality of groove shapes for rough grinding and for precision grinding arranged side by side on an inner circumference of the tubular shape, by bringing an outer circumferential side edge surface of a disk-shaped substrate into contact with an inner circumference of this grindstone and moving the substrate and the

grindstones relative to each other (in this specification, for convenience in the description, in some cases, this processing method is referred to as "internal grinding processing" and a grindstone used in this processing is referred to as "grindstone for internal grinding" for convenience).

[0009]

As a result, the inventor of the present invention found the following phenomenon.

As shown in FIG. 3, for example, the groove shape of a conventional grindstone for internal grinding includes a rough grinding region 2A having a plurality of grooves 2a, 2a, ... and a precision grinding region 2B having a plurality of grooves 2b, 2b, ... The rough grinding region 2A and the precision grinding region 2B differ in abrasive particle diameter, and rough grinding can be first performed in the rough grinding region 2A with abrasive particles having large abrasive particle diameters (abrasive particles with coarse grit), and then precision grinding (finishing grinding) can be performed in the precision grinding region 2B with abrasive particles having small abrasive particle diameters (abrasive particles with fine grit).

[0010]

However, since the groove shapes of the grindstone are located inside the tubular shape in the internal grinding processing, if grinding chips formed when grinding is performed with the grooves 2a for rough grinding processing scatter around the periphery, the scattered grinding chips reach the grooves 2b for precision grinding processing in some cases (shown by the arrow in FIG. 3). Many grinding chips formed in the rough grinding processing are relatively larger than grinding chips formed in precision grinding processing. Also, such grinding chips accumulate in a groove 2b for precision grinding processing and form sludge in some cases. Thus, such foreign matter tends to attach to the groove due to a centrifugal force caused by the rotation of a grindstone. As a result, the grinding chips cause chipping and pit-shaped defects that occur during precision grinding processing, reducing the quality of an edge surface.

A problem arises in that the yield of the productivity decreases because the quality of edges of a glass substrate deteriorates in this manner.

As a result of further intensive studies, the inventor of the present invention found that the above-described problem can be solved by providing a means for suppressing a case in which grinding chips formed when grinding processing is performed with grooves for rough grinding processing move to grooves for precision grinding processing, and accomplished the present invention.

That is, in order to resolve the above-described issue, the present invention has the following aspects.

[0011]

(Aspect 1)

A method for manufacturing a magnetic-disk substrate including processing in which an edge surface of a disk-shaped substrate is subjected to grinding processing by bringing a grinding liquid into contact with an edge surface portion of the substrate, bringing a grindstone into contact with an outer circumferential side edge surface of the substrate, and moving the outer circumferential side edge surface and the grindstone relative to each other,

in which the grindstone is formed into a tubular shape, a plurality of groove shapes arranged side by side are included on an inner circumference of the tubular shape, the plurality of groove shapes include a groove for rough grinding processing and a groove for precision grinding processing, and the grindstone has a means for suppressing a case in which grinding chips formed when the grinding processing is performed with the groove for rough grinding processing move to the groove for precision grinding processing, and

the outer circumferential side edge surface of the substrate is subjected to the grinding processing by sequentially bringing the outer circumferential side edge surface of the substrate into contact with the groove for rough grinding processing and the groove for precision grinding processing.

[0012]

(Aspect 2)

The method for manufacturing a magnetic-disk substrate according to Aspect 1, in which the means for suppressing a case in which the grinding chips move to the groove for precision grinding processing is a means for providing a wall between the groove for rough grinding processing and the groove for precision grinding processing.

[0013]

(Aspect 3)

The method for manufacturing a magnetic-disk substrate according to Aspect 1 or 2, in which the means for suppressing a case in which the grinding chips move to the groove for precision grinding processing is a means for changing a diameter of the grindstone by providing a level difference serving as a wall between the groove for rough grinding processing and the groove for precision grinding processing, arranging the groove for rough grinding processing in a region of the grindstone with a larger diameter, and arranging the groove for precision grinding processing in a region of the grindstone with a smaller diameter.

[0014]

(Aspect 4)

A method for manufacturing a magnetic-disk substrate including processing in which an edge surface of a disk-shaped substrate is subjected to grinding processing by bringing a grinding liquid into contact with an edge surface portion of the substrate, bringing a grindstone into contact with an outer circumferential side edge surface of the substrate, and moving the outer circumferential side edge surface and the grindstone relative to each other,

in which the grindstone is formed into a tubular shape, a plurality of groove shapes arranged side by side are included on an inner circumference of the tubular shape, the plurality of groove shapes include a groove for rough grinding processing and a groove for precision grinding processing, and the grindstone has a protrusion between the groove for rough grinding processing

and the groove for precision grinding processing, and

the outer circumferential side edge surface of the substrate is subjected to the grinding processing by sequentially bringing the outer circumferential side edge surface of the substrate into contact with the groove for rough grinding processing and the groove for precision grinding processing.

[0015]

(Aspect 5)

A method for manufacturing a magnetic-disk substrate including processing in which an edge surface of a disk-shaped substrate is subjected to grinding processing by bringing a grinding liquid into contact with an edge surface portion of the substrate, bringing a grindstone into contact with an outer circumferential side edge surface of the substrate, and moving the outer circumferential side edge surface and the grindstone relative to each other,

in which the grindstone is formed into a tubular shape, a plurality of groove shapes arranged side by side are included on an inner circumference of the tubular shape, and the plurality of groove shapes include a groove for rough grinding processing and a groove for precision grinding processing,

the inner circumference of the grindstone has a plurality of regions having different diameters due to a level difference being provided on the inner circumference of the grindstone, the groove for rough grinding processing is arranged in a region with a larger diameter, and the groove for precision grinding processing is arranged in a region with a smaller diameter, and

the outer circumferential side edge surface of the substrate is subjected to the grinding processing by sequentially bringing the outer circumferential side edge surface of the substrate into contact with the groove for rough grinding processing and the groove for precision grinding processing.

[0016]

(Aspect 6)

The method for manufacturing a magnetic-disk substrate according to any of Aspects 1 to 5, in which an electrodeposition grindstone is used as the

grindstone.

[0017]

(Aspect 7)

A grindstone for grinding that is to be used in processing in which an edge surface of a disk-shaped magnetic-disk substrate is subjected to grinding processing by bringing a grinding liquid into contact with an edge surface portion of the substrate, bringing a grindstone into contact with an outer circumferential side edge surface of the substrate, and moving the outer circumferential side edge surface and the grindstone relative to each other,

in which the grindstone for grinding is formed into a tubular shape, a plurality of groove shapes arranged side by side are included on an inner circumference of the tubular shape, the plurality of groove shapes include a groove for rough grinding processing and a groove for precision grinding processing, and the grindstone for grinding has a means for suppressing a case in which grinding chips formed when the grinding processing is performed with the groove for rough grinding processing move to the groove for precision grinding processing.

[0018]

(Aspect 8)

A grindstone for grinding that is to be used in processing in which an edge surface of a disk-shaped magnetic-disk substrate is subjected to grinding processing by bringing a grinding liquid into contact with an edge surface portion of the substrate, bringing a grindstone into contact with an outer circumferential side edge surface of the substrate, and moving the outer circumferential side edge surface and the grindstone relative to each other,

in which the grindstone is formed into a tubular shape, a plurality of groove shapes arranged side by side are included on an inner circumference of the tubular shape, the plurality of groove shapes include a groove for rough grinding processing and a groove for precision grinding processing, and the grindstone has a protrusion between the groove for rough grinding processing

and the groove for precision grinding processing.

[0019]

(Aspect 9)

A grindstone for grinding that is to be used in processing in which an edge surface of a disk-shaped magnetic-disk substrate is subjected to grinding processing by bringing a grinding liquid into contact with an edge surface portion of the substrate, bringing a grindstone into contact with an outer circumferential side edge surface of the substrate, and moving the outer circumferential side edge surface and the grindstone relative to each other,

in which the grindstone is formed into a tubular shape, a plurality of groove shapes arranged side by side are included on an inner circumference of the tubular shape, the plurality of groove shapes include a groove for rough grinding processing and a groove for precision grinding processing, and

the inner circumference of the grindstone has a plurality of regions having different diameters due to a level difference being provided on the inner circumference of the grindstone, the groove for rough grinding processing is arranged in a region with a larger diameter, and the groove for precision grinding processing is arranged in a region with a smaller diameter.

Effects of the Invention

[0020]

According to the method for manufacturing a magnetic-disk substrate according to the present invention, it is possible to suppress the occurrence of chipping and finish an edge surface of a magnetic-disk substrate to have a high quality. Moreover, stable grinding processing is possible. Here, use of a grindstone for grinding according to the present invention in the above-described processing for grinding an edge surface of a substrate makes it possible to suppress the occurrence of chipping and finish the edge surface of a magnetic-disk substrate to have a high quality.

Brief Description of Drawings

[0021]

FIG. 1 is a cross-sectional view showing the shape of an edge surface of a glass substrate.

FIG. 2 is a cross-sectional view showing an embodiment of a step of grinding the edge surface of the glass substrate in the present invention, in a plane including a circle formed by a groove shape of a grindstone.

FIG. 3 is a cross-sectional view showing one example (conventional example) of a groove shape of the grindstone used in the above-described edge surface grinding step.

FIG. 4 is a cross-sectional view showing one embodiment of the grindstone of the present invention used in the above-described edge surface grinding step.

FIG. 5 is a cross-sectional view showing another embodiment of the grindstone of the present invention used in the above-described edge surface grinding step.

FIG. 6 is a cross-sectional view showing another embodiment of the grindstone of the present invention used in the above-described edge surface grinding step.

FIG. 7 is a cross-sectional view showing another embodiment of the grindstone of the present invention used in the above-described edge surface grinding step.

Mode for Embodying the Invention

[0022]

Hereinafter, an embodiment for carrying out the present invention will be described in detail. Although aluminum alloy-based substrates also exist as magnetic-disk substrates as described above, a glass substrate will be described as one example herein. The present invention can be modified as appropriate and applied to an aluminum alloy-based substrate as well.

FIG. 1 is a cross-sectional view of an outer circumferential side edge portion of a magnetic-disk glass substrate 1 to which the present invention is applied. Although not shown in FIG. 1, the glass substrate 1 having a circular hole in its central portion is formed into a disk shape overall (see FIG. 2), and has a front main surface 1a, a back main surface 1a, and an outer circumferential side edge surface and an inner circumferential side edge surface that are formed between these main surfaces 1a and 1a.

[0023]

The outer circumferential side edge surface of the above-described glass substrate 1 is formed into a shape constituted by a side wall surface 1b orthogonal to the main surface 1a and two chamfered surfaces 1c and 1c (surfaces that have been subjected to chamfering) that are respectively formed between this side wall surface 1b and the front and back main surfaces 1a and 1a. Also, similarly to the outer circumferential side edge surface, the inner circumferential side edge surface of the above-described glass substrate 1, although not shown, is formed into a shape constituted by a side wall surface orthogonal to the main surface 1a and two chamfered surfaces that are respectively formed between this side wall surface and the front and back main surfaces 1a and 1a.

[0024]

Thus, the present invention can be preferably applied to a nominal 1.8-inch disk (an outer diameter of 48 mm) or more. For example, in case of a nominal 2.5-inch disk, the glass substrate 1 is finished to have an outer diameter of 65 mm and an inner diameter of 20 mm. Also, for example, in the case of a nominal 3.5-inch disk, the glass substrate 1 is finished to have an outer diameter of 95 mm and an inner diameter of 25 mm. Here, the inner diameter refers to an inner diameter of the circular hole in the central portion of the glass substrate 1. Note that the thickness is about 0.6 to 1.5 mm at any size.

[0025]

The main surfaces 1a, the outer circumferential side edge surface, and

the inner circumferential side edge surface of the magnetic-disk glass substrate 1 are all finally polished (mirror-polished) so as to have predetermined surface roughnesses. The outer circumferential side edge surface and the inner circumferential side edge surface of the glass substrate 1 are each finished to an edge surface shape as described above, and usually need to be finished to a mirror surface having a surface roughness Rmax of 1 μm or less and a surface roughness Ra of 0.1 μm or less.

[0026]

The magnetic-disk glass substrate 1 is manufactured by sequentially performing an edge surface grinding and polishing (mirror polishing) step, a main surface grinding and mirror-polishing step, a chemical strengthening step, and the like on a disk-shaped glass substrate 1 obtained by processing a glass plate, which is obtained with a direct press method or a float method, into a predetermined disk shape, for example.

Note that in this specification, for convenience in the description, a glass disk (glass blank) obtained by processing a glass plate, which is obtained with a direct press method, a float method, or the like, into a predetermined disk shape and a glass substrate, which is a final product that is produced by performing processing, a treatment, and the like on this glass substrate are both called glass substrates or magnetic-disk glass substrates.

First, the above-described steps of grinding and polishing an edge surface of the glass substrate 1 will be described.

[0027]

As described in Aspect 1 above, a method for manufacturing a magnetic-disk glass substrate according to the present invention is a method for manufacturing a magnetic-disk substrate including processing in which an edge surface of a disk-shaped substrate is subjected to grinding processing by moving the substrate and a grindstone relative to each other while a grinding liquid is brought into contact with an edge surface portion of the substrate and the grindstone is brought into contact with an outer circumferential side edge surface

of the substrate, and the grindstone is formed into a tubular shape, and a plurality of groove shapes arranged side by side are included on an inner circumference of the tubular shape. The plurality of groove shapes include grooves for rough grinding processing and grooves for precision grinding processing, the grindstone has a means for suppressing a case in which grinding chips formed when the grinding processing is performed with the grooves for rough grinding processing move to the grooves for precision grinding processing, and the outer circumferential side edge surface of the substrate is subjected to grinding processing by sequentially bringing the outer circumferential side edge surface of the substrate into contact with the grooves for rough grinding processing and the grooves for precision grinding processing.

The edge surface grinding processing performed in the present invention is internal grinding processing. Also, the grindstone used in the edge surface grinding processing of the present invention is a grindstone for internal grinding processing. Hereinafter, edge surface grinding processing according to the present invention will be described in detail.

[0028]

The edge surface grinding processing performed in the present invention has a configuration in which an outer circumferential side edge surface of the glass substrate is subjected to grinding processing by bringing the outer circumferential side edge surface of the glass substrate into contact with the inner circumference of the grindstone formed into a tubular shape and moving the glass substrate and the grindstone relative to each other. For example, as shown in FIG. 2, specifically, a grindstone (rotary grindstone) 3 that processes the outer circumference of the substrate comes into contact with an outer circumferential side edge surface of the glass substrate 1 in the direction of an arrow 13 (direction of cut) in FIG. 2. Also, the glass substrate 1 may be brought into contact with the grindstone in the direction of the arrow 12 (direction of cut) in FIG. 2.

[0029]

The above-described grindstone 3 is formed into a tubular shape, and a plurality of groove shapes arranged side by side for forming the shape of an edge surface of the glass substrate are included on an inner circumference of the tubular shape. Specifically, the grindstone 3 has groove shapes that can transfer shapes of both a side wall surface and a chamfered surface to the outer circumferential side edge surface of the glass substrate, for example. That is, the above-described grindstone 3 is formed into a shape with predetermined dimensions, with consideration given to shapes with finishing target dimensions of surfaces of the glass substrate 1 that are subjected to grinding processing.

[0030]

In this case, it it preferable to perform processing while the grindstone 3 and the glass substrate 1 are rotated, and their circumferential speeds and a circumferential speed ratio may be set as appropriate so as to be suitable for the processing on the outer circumferential side edge surface. Also, in FIG. 2, although the glass substrate 1 is rotated in the direction of an arrow 10 and the grindstone 3 is rotated in the direction of an arrow 11, there is no particular limitation on the rotation direction. The rotation directions of the grindstone 3 and the glass substrate 1 may be the same direction (down-cutting direction) or different directions (up-cutting direction) at a processing position (contact position).

[0031]

From the viewpoint of grindability and processing efficiency, it is suitable that the circumferential speed of the grindstone 3 is 300 to 3000 m/min, and the circumferential speed of the glass substrate 1 at a processing position is about 3 to 100 m/min, for example.

Also, a water-soluble grinding liquid with a high cooling effect and high safety at a production site is suitable as the grinding liquid (coolant) used in such grinding processing.

[0032]

Incidentally, the above-described grindstone 3 has a cross-sectional

shape as shown in FIG. 4. FIG. 4 is a cross-sectional view showing one embodiment of a grindstone of the present invention used in the above-described edge surface processing step.

That is, the grindstone 3 is formed into a tubular shape overall, a plurality of groove shapes arranged side by side are included on its inner circumference, and the plurality of groove shapes include grooves for rough grinding processing and grooves for precision grinding processing. Specifically, as shown in FIG. 4, the grindstone 3 includes a rough grinding region 3A and a precision grinding (finishing grinding) region 3B, and the rough grinding region 3A has a plurality of grooves 3a, 3a, ... and similarly, the precision grinding region 3B has a plurality of grooves 3b, 3b, ... The plurality of groove shapes of the grindstone 3 may be each formed to be able to simultaneously perform grinding processing on the side wall surface and the chamfered surfaces of the outer circumferential side edge surface of the glass substrate 1.

[0033]

The rough grinding region 3A and the precision grinding region 3B have different abrasive particle diameters, and rough grinding can be first performed in the rough grinding region 3A with abrasive particles having large abrasive particle diameters (abrasive particles with coarse grit), and then precision grinding (finishing grinding) can be performed in the precision grinding region 3B with abrasive particles having small abrasive particle diameters (abrasive particles with fine grit).

The above-described grindstone 3 according to the present invention has a means for suppressing a case in which grinding chips formed when grinding processing is performed with the grooves 3a for rough grinding processing move to the grooves 3b for precision grinding processing.

[0034]

Specifically, as is understood with reference to FIG. 4, in the present embodiment, the diameter of the grindstone changes due to a level difference 31 serving as a wall being provided between the rough grinding region 3A including

the plurality of grooves 3a for rough grinding processing and the precision grinding region 3B including the plurality of grooves 3b for precision grinding processing. Thus, the grooves 3a for rough grinding processing are arranged in a region of the grindstone with a larger diameter, and the grooves 3b for precision grinding processing are arranged in a region of the grindstone with a smaller diameter. With such a configuration, even if grinding chips formed when the grinding processing is performed with the grooves 3a for rough grinding processing scatter around the periphery, the level difference 31 serving as the wall is provided between the rough grinding region 3A and the precision grinding region 3B, and thus the grinding chips formed with the grooves 3a for rough grinding processing are blocked by the level difference 31, as a result of which it is possible to suppress a case in which the grinding chips reach and accumulate in the grooves 3b for precision grinding processing. In this manner, the present embodiment suppresses a case in which grinding chips formed when grinding processing is performed with the grooves 3a for rough grinding processing move to the grooves 3b for precision grinding processing, and thus can effectively reduce the occurrence of chipping in precision grinding, caused by the influence of sludge that is formed through rough grinding and accumulated in the grooves 2b for precision grinding processing as with a conventional configuration (see FIG. 3).

[0035]

In the embodiment in FIG. 4, the diameter of the grindstone in the precision grinding region 3B (hereinafter referred to as "diameter of precision grinding grindstone") including the plurality of grooves 3b for precision grinding processing is preferably as follows.

That is, when the diameter of the glass substrate 1 that is to be processed is L (mm), the diameter of the precision grinding grindstone is preferably L+1 (mm) or more and 300 mm or less. More preferably, it is desirable that the diameter thereof is L+5 (mm) or more and 2L (mm) or less.

[0036]

If the diameter of the precision grinding grindstone is smaller than L+1 (mm), the grindstone will wear away quickly, and there is a possibility that the productivity will deteriorate. On the other hand, if the diameter of the precision grinding grindstone is larger than 300 mm, the dimension of the grindstone will become large, and there is a possibility that the cost will increase. Also, there is a possibility that it will be difficult to precisely move the grindstone.

[0037]

Note that the diameter of the grindstone herein refers to the diameter at a position of a bottom surface of a groove of the grindstone. Also, the bottom surface of the groove of the grindstone refers to the deepest bottom surface of the groove, and is usually a processing surface for performing grinding processing on the side wall surface of the edge surface of the substrate. The bottom surface thereof is used similarly hereinafter.

[0038]

Also, in the embodiment in FIG. 4, a difference between the diameter of the grindstone in the rough grinding region 3A (hereinafter referred to as "diameter of rough grinding grindstone") including the plurality of grooves 3a for rough grinding processing and the diameter of the precision grinding grindstone is preferably as follows.

A value obtained by subtracting the diameter of the precision grinding grindstone from the diameter of the rough grinding grindstone, that is, the difference between the diameter of the rough grinding grindstone and the diameter of the precision grinding grindstone is preferably 0.4 mm or more and 60 mm or less. More preferably, it is desirable that the difference is 4 mm or more and 20 mm or less.

[0039]

If the difference between the diameter of the rough grinding grindstone and the diameter of the precision grinding grindstone is smaller than 0.4 mm, the effect of suppressing a case in which grinding chips formed when grinding processing is performed with the grooves for rough grinding processing move to

the grooves for precision grinding processing cannot be obtained sufficiently. On the other hand, if the difference between the diameter of the rough grinding grindstone and the diameter of the precision grinding grindstone is larger than 60 mm, the cost will increase due to difficulty in processing and the movement distance of the glass substrate that is to be processed will increase, and thus there is a possibility that the productivity will deteriorate.

[0040]

Note that the grinding chips formed in the precision grinding processing do not cause defects in precision grinding. That is, if the sizes of grinding chips that depend on the abrasive particle diameter in grinding processing are larger than the sizes of grinding chips to be formed in the grinding, defects appear on the glass substrate. In short, accumulation of grinding chips formed in rough grinding in the grooves for precision grinding processing is problematic, and accordingly, defects such as chipping appear on a glass substrate in precision grinding.

[0041]

A so-called electrodeposition grindstone obtained by electrodepositing, for example, diamond, Al_2O_3, SiC, CBN, or the like, which are highly-rigid materials, or composite abrasive particles thereof, a so-called metal grindstone obtained by fixing abrasive particles with a metallic binding agent, or the like is suitable as the above-described grindstone 3 of the present invention that is used in internal edge surface grinding processing. In particular, the electrodeposition grindstone is preferably used because an abrasive particle layer can be made relatively thin with respect to a base metal and the shape of transferring groove shapes can be kept relatively accurate over the entire period during which the grindstone can be used. Also, a metal grindstone is preferably used because a grinding effect is obtained by abrasive particles protruding from a metallic bond layer and roughness can be suppressed. For example, as the particle diameters of abrasive particles, abrasive particles with #200 to #800 grit is suitable for rough grinding, and for example, #800 to #4000 grit is suitable for

precision grinding.

[0042]

Also, as shown in FIG. 5, as another embodiment of the grindstone of the present invention used in the above-described edge surface processing step, a protrusion 41 serving as a wall is provided between a rough grinding region 4A including a plurality of grooves 4a for rough grinding processing and a precision grinding region 4B including a plurality of grooves 4b for precision grinding processing.

[0043]

In the embodiment in FIG. 5, the height of the protrusion 41 is preferably 0.2 mm or more and 30 mm or less. More preferably, it is desirable that the height is 2 mm or more and 10 mm or less.

Note that the height of the protrusion herein refers to a length from a lower end (a position of a surface of the grindstone having no grooves) of the protrusion to a tip (apex) thereof. The term height is used similarly hereinafter.

If the height of the above-described protrusion 41 is smaller than 0.2 mm, the effect of suppressing a case in which grinding chips formed when grinding processing is performed with the grooves for rough grinding processing move to the grooves for precision grinding processing cannot be obtained sufficiently. On the other hand, if the height of the above-described protrusion 41 is larger than 30 mm, the cost will increase due to difficulty in processing and the movement distance of a glass substrate that is to be processed will increase, and thus there is a possibility that the productivity will deteriorate.

[0044]

In the present embodiment, even if grinding chips formed when the grinding processing is performed with the grooves 4a for rough grinding processing scatter toward the precision grinding region 4B, the grinding chips are blocked by the protrusion 41 provided between the rough grinding region 4A and the precision grinding region 4B, and thus it is possible to suppress a case in which the grinding chips formed in the grooves 4a for rough grinding processing

reach and accumulate in the grooves 4b for precision grinding processing.

[0045]

Also, as shown in FIG. 6, as another embodiment of the grindstone of the present invention that is used in the above-described edge surface processing step, a level difference 51 is provided between a rough grinding region 5A including a plurality of grooves 5a for rough grinding processing and a precision grinding region 5B including a plurality of grooves 5b for precision grinding processing, and similarly to the above-described embodiment shown in FIG. 4, the diameter of the grindstone changes.

In the present embodiment, even if grinding chips formed when the grinding processing is performed with the grooves 5a for rough grinding processing scatter toward the precision grinding region 5B, the grinding chips are blocked by the level difference 51 provided between the rough grinding region 5A and the precision grinding region 5B, and thus it is possible to suppress a case in which the grinding chips formed in the grooves 5a for rough grinding processing reach and accumulate in the grooves 5b for precision grinding processing.

[0046]

Moreover, as shown in FIG. 7, as another embodiment of the grindstone of the present invention, a level difference 61 having a cross-sectional shape as shown in FIG. 7 is provided between a rough grinding region 6A including a plurality of grooves 6a for rough grinding processing and a precision grinding region 6B including a plurality of grooves 6b for precision grinding processing, and similarly to the above-described embodiment shown in FIG. 4, the diameter of the grindstone changes.

In the present embodiment as well, even if grinding chips formed when grinding processing is performed with the grooves 6a for rough grinding processing scatter toward the precision grinding region 6B, the grinding chips are blocked by the above-described level difference 61, and thus it is possible to suppress a case in which the grinding chips formed in the grooves 6a for rough

grinding processing reach and accumulate in the grooves 6b for precision grinding processing.

[0047]

Note that in the above-described embodiments shown in FIGS. 4, 6, and 7, cases are described in which there is one level difference and there are regions in which the grindstone has two different diameters in total, but the present invention is not limited to this and encompasses an embodiment in which a plurality of regions in which the grindstone has different diameters due to a plurality of level difference being provided are present. In this case, among the plurality of regions in which the grindstone has different diameters, the grooves for rough grinding processing are arranged in a region of the grindstone with a larger diameter, and the grooves for precision grinding processing are arranged in a region of the grindstone with a smaller diameter. For example, if there are regions in which the grindstone has three different diameters in total, the grooves for rough grinding processing are arranged in a region in which the grindstone has the largest diameter, the grooves for precision grinding processing are arranged in a region in which the grindstone has the smallest diameter, and for example, grooves for a second stage of rough grinding processing are arranged in a region in which the grindstone has an intermediate diameter.

[0048]

Note that in the above-described edge surface grinding processing in the present invention, grinding processing may be performed while a tubular grinding grindstone and a glass substrate are rotated in a state in which a rotation axis of the glass substrate is inclined with respect to a rotation axis of the grinding grindstone. Accordingly, the path of the grindstone that comes into contact with the edge surface of the glass substrate 1 is not fixed and protruding portions (abrasive particles) of the grindstone come into contact with and act on the edge surface of the substrate at random positions, and thus the substrate is not damaged significantly and the surface roughness of a surface that is

subjected to grinding processing and variation in the surface are reduced, as a result of which the surface that is subjected to grinding processing can be finished into a highly smooth surface.

Also, in addition to the above-described edge surface grinding processing of the present invention, conventional brush polishing processing and the like may be performed as needed.

[0049]

Also, although there is no particular limitation on the type of glass used in a magnetic-disk glass substrate, an example of the material for the glass substrate is glass ceramics such as aluminosilicate glass, soda-lime glass, soda aluminosilicate glass, aluminoborosilicate glass, borosilicate glass, quartz glass, chain silicate glass, and crystallized glass. Among these, aluminosilicate glass is particularly preferable due to having excellent impact resistance and vibration resistance.

As described above, the magnetic-disk glass substrate 1 as shown in FIG. 1 is obtained by sequentially performing a mirror-polishing step, a chemical strengthening step, and the like on a main surface of a glass substrate whose outer circumferential side and inner circumferential side edge surfaces have undergone a grinding step and a polishing step.

[0050]

Although a glass substrate has been described above as one example of a magnetic-disk substrate, an aluminum alloy-based substrate is also present as the magnetic-disk substrate as described above, and the above-described edge surface grinding processing of the present invention can be preferably applied to edge surface grinding processing performed on this aluminum alloy-based substrate, as a result of which the quality of a processed edge surface of the substrate can be improved. Note that examples of the above-described aluminum alloy-based substrate include an aluminum alloy substrate and an aluminum alloy substrate having a surface provided with a NiP-based alloy.

[0051]

Also, provided is a method for manufacturing a magnetic disk in which at least a magnetic layer is formed on a main surface of a magnetic-disk glass substrate manufactured with the above-described method for manufacturing a magnetic-disk glass substrate according to the present invention.

That is, for example, a magnetic disk can be obtained by forming at least a magnetic layer on the magnetic-disk glass substrate obtained by the above-described embodiment according to the present invention. Usually, a magnetic disk is suitably obtained by providing an adherent layer, a soft magnetic layer, a base layer, a magnetic layer, a protecting layer, a lubricant layer, and the like on a glass substrate.

[0052]

An example of the magnetic layer is an alloy having a Co-based hcp crystal structure to be used a perpendicular magnetic recording medium.

Also, a preferred example of the protecting layer is a carbon-based protecting layer. Also, examples of the lubricant that forms the lubricant layer on the protecting layer include PFPE (perfluoropolyether)-based compounds.

A known sputtering method or the like can be used as the method for forming the above-described layers on the glass substrate. A plasma CVD method is also preferably used for forming the carbon-based protecting layer. Also, a dipping method or the like can be used for forming the lubricant layer.

[0053] Manufacturing a magnetic disk using a magnetic-disk glass substrate manufactured with the method for manufacturing a magnetic-disk glass substrate according to the present invention makes it possible to finish an edge surface of the substrate to have a high quality, prevent the occurrence of failure caused by a surface state of an edge surface of the substrate, and provide a magnetic disk with which a further increase in recording density and a high reliability can be realized.

Working Example

[0054]

Embodiments of the present invention will be specifically described by way of working examples below. Note that the present invention is not limited to the following working examples.

(Working Example 1)

First, a disk-shaped glass substrate (a glass blank) that had a diameter of 66 mm□, a thickness of 0.9 mm, and was made of aluminosilicate glass was obtained using molten glass with a direct press method.

[0055]

Next, in order to improve the dimensional accuracy and shape accuracy of the glass substrate, a lapping step was performed. That lapping step was performed using a double-side lapping apparatus.

[0056]

Next, a hole was formed in a central portion of the glass substrate using a tubular grindstone. Next, grinding processing was performed on an outer circumferential edge surface of the substrate.

An electrodeposition grindstone having a difference in diameter as shown in FIG. 4 above was selected as the used grindstone. The diameter of a precision grinding grindstone was 110 mm and the diameter of a rough grinding grindstone was 116 mm. The definition of the diameter of the grindstone are as stated. Also, the depth of a groove of the grindstone was 0.5 mm, the width of the bottom surface of the groove was 0.5 mm, an opening angle of the groove was 45 degrees, and the rough grinding region and the precision grinding region had the same groove shape. Note that the abrasive particle size (grit) for rough grinding was #500, and the abrasive particle size (grit) for precision grinding was #1000.

The grinding processing was performed with the above-described relationship, shown in FIG. 2, in which the glass substrate and the grindstone were arranged. The rotation rate of the glass substrate was 200 rpm, the rotation rate of the grindstone was 6000 rpm, and rotation directions of the glass substrate and the grindstone were opposite to each other in the present working

example, but the circumferential speeds and the rotation directions of the glass substrate and the grindstone, and a cutting speed can be set as appropriate.

[0057]

As described above, processing was performed on edge surfaces of 100 glass substrates.

The obtained 100 glass substrates were subjected to visual observation and microscopy in order to survey whether or not chipping occurred at a corner portion A formed between a side wall surface and a chamfered surface and a corner portion B formed between a main surface and a chamfered surface (see FIG. 1).

[0058]

(Working Example 2)

Grinding processing was performed similarly to Working Example 1 above, except that an electrodeposition grindstone having a cross-sectional shape as shown in FIG. 5 above was used.

The diameter of the precision grinding grindstone and the diameter of the rough grinding grindstone were 110 mm and the height of the protrusion was 3 mm. The definition of the height of the protrusion were as the above. Also, the depth of a groove of the grindstone was 0.5 mm, the width of the bottom surface of the groove was 0.5 mm, an opening angle of the groove was 45 degrees, and the rough grinding region and the precision grinding region had the same groove shape.

Processing was performed on edge surfaces of 100 glass substrates, and similarly to Working Example 1, the obtained 100 glass substrates were subjected to visual observation and microscopy in order to survey whether or not chipping occurred at the corner portion A formed between a side wall surface and a chamfered surface and the corner portion B formed between a main surface and a chamfered surface (see FIG. 1).

[0059]

(Comparative Example)

Also, as a comparative example, grinding processing was performed similarly to Working Example 1 above, except that an electrodeposition grindstone having a cross-sectional shape as shown in FIG. 3 above was used.

The diameter of the precision grinding grindstone and the diameter of the rough grinding grindstone were 110 mm. Also, the depth of a groove of the grindstone was 0.5 mm, the width of the bottom surface of the groove was 0.5 mm, an opening angle of the groove was 45 degrees, and the rough grinding region and the precision grinding region had the same groove shape.

Processing was performed on edge surfaces of 100 glass substrates, and similarly to Working Example 1, the obtained 100 glass substrates were subjected to visual observation and microscopy in order to survey whether or not chipping occurred at the corner portion A formed between a side wall surface and a chamfered surface and the corner portion B formed between a main surface and a chamfered surface (see FIG. 1).

[0060]

As a result, chipping percentages of Working Example 1 and Working Example 2 were 3% or less, whereas a chipping percentage of the comparative example was 60%, which is very high. In particular, a large amount of chipping occurred on the 20th substrate and onward.

Also, when grooves for precision grinding processing of the grindstones after the processing ended were observed in detail, the accumulation of sludge was hardly recognized in the grindstones used in Working Example 1 and Working Example 2, but the accumulation of sludge was recognized in the grindstone used in the comparative example.

[0061]

As is clear from this result, according to the present invention, use of a grinding grindstone having a means for suppressing a case in which grinding chips formed when grinding processing was performed with the grooves for rough grinding processing move to the grooves for precision grinding processing made it possible to suppress the occurrence of chipping and perform grinding

processing so as to produce a substrate having a finished surface with good quality.

In contrast, in processing with a conventional internal grinding grindstone, sludge of grinding chips formed in rough grinding is accumulated in the grooves for precision grinding processing, and thus the incidence rate of chipping is high and the yield decreases significantly.

Note that in Working Example 2 above, there is a possibility that the flow of a grinding liquid will be blocked by the protrusion of the grindstone, and thus in order to deliver the grinding liquid sufficiently to a processing surface, there is a possibility that a method for supplying the grinding liquid will be complicated. In contrast, in Working Example 1 above, the grinding liquid is preferably supplied from the precision grinding grindstone side because the grinding liquid is also sufficiently supplied to the rough grinding grindstone side and the supplying method will not be complicated.

Descriptions of Reference Numerals

[0062]

1	Magnetic-disk glass substrate
2 to 6	Grindstone for grinding outer circumferential side edge surface
1a	Main surface of glass substrate
1b	Side wall surface
1c	Chamfered surface
31	Level difference
41	Protrusion (wall)

CLAIMS

1. A method for manufacturing a magnetic-disk substrate comprising processing in which an edge surface of a disk-shaped substrate is subjected to grinding processing by bringing a grinding liquid into contact with an edge surface portion of the substrate, bringing a grindstone into contact with an outer circumferential side edge surface of the substrate, and moving the outer circumferential side edge surface and the grindstone relative to each other,

wherein the grindstone is formed into a tubular shape, a plurality of groove shapes are included on an inner circumference of the tubular shape, the plurality of groove shapes include a groove for rough grinding processing and a groove for precision grinding processing, and the grindstone has a means for suppressing a case in which grinding chips formed when the grinding processing is performed with the groove for rough grinding processing move to the groove for precision grinding processing, and

the outer circumferential side edge surface of the substrate is subjected to the grinding processing by sequentially bringing the outer circumferential side edge surface of the substrate into contact with the groove for rough grinding processing and the groove for precision grinding processing.

2. The method for manufacturing a magnetic-disk substrate according to claim 1, wherein the means for suppressing a case in which the grinding chips move to the groove for precision grinding processing is a means for providing a wall between the groove for rough grinding processing and the groove for precision grinding processing.

3. The method for manufacturing a magnetic-disk substrate according to claim 1 or 2, wherein the means for suppressing a case in which the grinding chips move to the groove for precision grinding processing is a means for changing a diameter of the grindstone by providing a level difference serving as a wall between the groove for rough grinding processing and the groove for precision grinding processing, arranging the groove for rough grinding processing in a region of the grindstone with a larger diameter, and arranging the

groove for precision grinding processing in a region of the grindstone with a smaller diameter.

4. A method for manufacturing a magnetic-disk substrate comprising processing in which an edge surface of a disk-shaped substrate is subjected to grinding processing by bringing a grinding liquid into contact with an edge surface portion of the substrate, bringing a grindstone into contact with an outer circumferential side edge surface of the substrate, and moving the outer circumferential side edge surface and the grindstone relative to each other,

wherein the grindstone is formed into a tubular shape, a plurality of groove shapes are included on an inner circumference of the tubular shape, the plurality of groove shapes include a groove for rough grinding processing and a groove for precision grinding processing, and the grindstone has a protrusion between the groove for rough grinding processing and the groove for precision grinding processing, and

the outer circumferential side edge surface of the substrate is subjected to the grinding processing by sequentially bringing the outer circumferential side edge surface of the substrate into contact with the groove for rough grinding processing and the groove for precision grinding processing.

5. A method for manufacturing a magnetic-disk substrate comprising processing in which an edge surface of a disk-shaped substrate is subjected to grinding processing by bringing a grinding liquid into contact with an edge surface portion of the substrate, bringing a grindstone into contact with an outer circumferential side edge surface of the substrate, and moving the outer circumferential side edge surface and the grindstone relative to each other,

wherein the grindstone is formed into a tubular shape, a plurality of groove shapes are included on an inner circumference of the tubular shape, and the plurality of groove shapes include a groove for rough grinding processing and a groove for precision grinding processing,

the inner circumference of the grindstone has a plurality of regions having different diameters due to a level difference being provided on the inner

circumference of the grindstone, the groove for rough grinding processing is arranged in a region with a larger diameter, and the groove for precision grinding processing is arranged in a region with a smaller diameter, and

the outer circumferential side edge surface of the substrate is subjected to the grinding processing by sequentially bringing the outer circumferential side edge surface of the substrate into contact with the groove for rough grinding processing and the groove for precision grinding processing.

6. The method for manufacturing a magnetic-disk substrate according to any of claims 1 to 5, wherein an electrodeposition grindstone is used as the grindstone.

7. A grindstone for grinding that is to be used in processing in which an edge surface of a disk-shaped magnetic-disk substrate is subjected to grinding processing by bringing a grinding liquid into contact with an edge surface portion of the substrate, bringing a grindstone into contact with an outer circumferential side edge surface of the substrate, and moving the outer circumferential side edge surface and the grindstone relative to each other,

wherein the grindstone for grinding is formed into a tubular shape, a plurality of groove shapes are included on an inner circumference of the tubular shape, the plurality of groove shapes include a groove for rough grinding processing and a groove for precision grinding processing, and the grindstone for grinding has a means for suppressing a case in which grinding chips formed when the grinding processing is performed with the groove for rough grinding processing move to the groove for precision grinding processing.

8. A grindstone for grinding that is to be used in processing in which an edge surface of a disk-shaped magnetic-disk substrate is subjected to grinding processing by bringing a grinding liquid into contact with an edge surface portion of the substrate, bringing a grindstone into contact with an outer circumferential side edge surface of the substrate, and moving the outer circumferential side edge surface and the grindstone relative to each other,

wherein the grindstone is formed into a tubular shape, a plurality of

groove shapes are included on an inner circumference of the tubular shape, the plurality of groove shapes include a groove for rough grinding processing and a groove for precision grinding processing, and the grindstone has a protrusion between the groove for rough grinding processing and the groove for precision grinding processing.

9. A grindstone for grinding that is to be used in processing in which an edge surface of a disk-shaped magnetic-disk substrate is subjected to grinding processing by bringing a grinding liquid into contact with an edge surface portion of the substrate, bringing a grindstone into contact with an outer circumferential side edge surface of the substrate, and moving the outer circumferential side edge surface and the grindstone relative to each other,

wherein the grindstone is formed into a tubular shape, a plurality of groove shapes are included on an inner circumference of the tubular shape, the plurality of groove shapes include a groove for rough grinding processing and a groove for precision grinding processing, and

the inner circumference of the grindstone has a plurality of regions having different diameters due to a level difference being provided on the inner circumference of the grindstone, the groove for rough grinding processing is arranged in a region with a larger diameter, and the groove for precision grinding processing is arranged in a region with a smaller diameter.