

DESCRIPTION

Title of Invention:

CARRIER, METHOD FOR MANUFACTURING MAGNETIC-DISK SUBSTRATE,
5 AND METHOD FOR MANUFACTURING MAGNETIC DISK

Technical Field

[0001]

The present invention relates to a carrier used to manufacture a
10 magnetic-disk glass substrate to be provided in a magnetic recording device
such as a hard disk drive (abbreviated as "HDD" hereinafter), and an aluminum
alloy substrate with a NiP film formed on the surface thereof, a method for
manufacturing a magnetic-disk substrate, and a method for manufacturing a
magnetic disk using the carrier.

15

Background Art

[0002]

Magnetic disks are one type of information recording medium provided
in magnetic recording devices such as HDDs. Magnetic disks are constituted
20 by forming a thin film such as a magnetic layer on a substrate, and
conventionally an aluminum substrate has been used as the substrate.
However, recently, in response to the pursuit of higher recording densities, glass
substrates with which the gap between the magnetic head and the magnetic disk
can be made narrower than with aluminum substrates have been increasingly
25 used. The glass substrate surface is precisely polished such that the flying
height of the magnetic head can be lowered as much as possible, and thus a
high recording density is achieved. In recent years, demand for HDDs with a
larger storage capacity and a lower cost has been increasing, and in order to

achieve this, further quality improvement of magnetic-disk glass substrates and cost reduction are also required.

[0003]

5 Magnetic-disk glass substrates are usually manufactured through a rough grinding step, a shape processing step, a precision grinding step, an edge surface polishing, step, main surface polishing steps (a first polishing step and a second polishing step), a chemical strengthening step, and the like.

[0004]

10 In the above-described main surface polishing steps, the surfaces of the glass substrate are polished to be mirror surfaces by bringing the glass substrate and the polishing pad into contact with each other, and moving the polishing pad and the glass substrate relative to each other while supplying a polishing liquid containing polishing abrasive particles, for example. In general, a planetary double-side polishing device as shown in FIG. 5, for example, is used in the
15 polishing steps. The double-side polishing device shown in FIG. 5 includes a sun gear 2, an internal gear 3 arranged concentrically on the outside of the sun gear 2, a carrier 10 that is engaged with the sun gear 2 and the internal gear 3 and revolves and rotates in response to the rotation of the sun gear 2 or the internal gear 3, an upper surface plate 5 and a lower surface plate 6 to which
20 polishing pads 7 that are capable of holding a product 1 to be polished that is held by the carrier 10 are respectively attached, and a polishing liquid supplying portion (not shown) that supplies the polishing liquid between the upper surface plate 5 and the lower surface plate 6.

[0005]

25 At the time of polishing processing, by using such a double-side polishing device, the product 1 to be polished, that is, the glass substrate, which is held by the carrier 10, is held between the upper surface plate 5 and the lower surface plate 6, and then both of the upper and lower surfaces of the product 1 to

be polished are polished while the polishing liquid is supplied between the polishing pads 7 of the upper and lower surface plates 5 and 6 and the product 1 to be polished, and the carrier 10 revolves and rotates in response to the rotation of the sun gear 2 or the internal gear 3.

5 In addition, in the above-described grinding step, processing is performed using a double-side grinding device having a configuration similar to that of the above-described double-side polishing device.

[0006]

As described above, the carrier is for holding a glass substrate when the
10 glass substrate, which is a workpiece, is ground or polished, and is made of a resin material, for example, and as shown in FIG. 2, the carrier 10 is a holding member 11 that has a plurality of holding holes 12 that holds the glass substrate and is disk-shaped overall.

[0007]

15 This carrier is a non-workpiece but, similarly to the workpiece, is used while rotated by the sun gear and the internal gear in a state in which the carrier is held between the upper and lower surface plates in the device. Therefore, when the glass substrate is ground or polished, the above-described holding holes of the carrier constantly come into contact with and are separated from the
20 outer circumferential edge surface of the glass substrate. There are cases where marks occur on the edge surface (in particular, a side wall surface) of the glass substrate due to the inner walls of the holding holes and the glass substrate rubbing together. If there are such marks, marks serve as dust generating sources not only partway through manufacturing of a magnetic-disk
25 glass substrate but also partway through manufacturing of a magnetic disk or HDD thereafter. Also, if the carrier is made of a resin material only, the strength of the carrier is not sufficient, and thus in order to increase the strength, a composite material of glass fibers and an epoxy resin or the like is usually used

as the base material of the carrier. If glass fiber protrudes from an inner wall of the holding holes or is exposed, when the glass fiber comes into contact with an edge surface of the glass substrate, the glass fiber makes marks on or damages the glass substrate.

5 [0008]

In view of this, for example, Patent Literature 1 discloses a technique of reducing impairment of the edge surface of the glass substrate by dissolving and removing glass fibers of the inner walls of the holding holes of a carrier by etching a carrier for polishing with hydrofluoric acid or the like to a certain depth,
10 and providing surface layer portions of the inner walls with a holding hole buffering region that has a plurality of recessed portions and is made of only a resin material.

Also, Patent Literature 2 discloses a technique of reducing impairment of the edge surface of the glass substrate by providing the inner wall with a
15 contacting portion that is made of resin and protrudes from an inner wall of the holding holes of a carrier for polishing and is formed to be thicker than fiber material.

Prior Art Document(s)

20 Patent Document(s)

[0009]

Patent Document 1: JP-A-2012-218103

Patent Document 2: JP-A-2008-000823

25 Summary of Invention

Problem to be Solved by the Invention

[0010]

According to studies conducted by the inventor of the present invention,

it was found that when polishing was performed on a glass substrate using a carrier for polishing disclosed in Patent Literature 1 above, abrasive particles or glass sludge was accumulated and coarsened in a plurality of recessed portions arranged in the inner walls of the holding holes and coarsened aggregates came out of the recessed portions during polishing, resulting in the occurrence of scratches and surface contamination on the main surfaces of the glass substrate. Also, the recessed portion (a portion called a buffering region) from which glass fibers are removed can reduce damages conventionally caused by glass fibers, but the strength decreases due to the removal of the glass fibers that serve as a core material. As a result of the recessed portion coming into contact with the glass substrate during processing, the periphery of the recessed portion is broken, and the fragments of the crushed recessed portion cause contamination, resulting in the scratches and surface contamination, which are similar to the above, on the main surfaces of the glass substrate. Furthermore, there is a risk that a level difference will occur on the inner wall of the holding holes due to the recessed portion being broken, causing new marks on the edge surface of the glass substrate, and the roundness of the inner diameter of the holding hole will decrease, also reducing the roundness of the glass substrate. These various problems often arise particularly at the time of mass production, and therefore the carrier lacks durability in the case where the carrier is used for a long period.

[0011]

Also, the magnetic-disk glass substrates, including a glass substrate at a stage partway through processing, are usually processed to have a thickness of 2 mm or less, and therefore the carrier holding the glass substrate and having a very thin thickness of 2 mm or less, is used.

In the case of the carrier for processing disclosed in Patent Literature 2 above, it is possible to provide a contacting portion by resin coating, for example, on the inner wall surface of a holding hole, but the inner wall surface of the

holding hole becomes a very narrow region since the substrate is thin, and the contacting portion has low adherence to the inner wall surface of the holding hole, and thus the contacting portion will be damaged or fall off due to coming into contact with the glass substrate during processing, as a result of which it is difficult to fundamentally resolve the problem of damaging resulting from glass fibers being exposed.

It should be noted that the above-described issues arise not only in the manufacturing of glass substrates but also in the manufacturing of aluminum alloy substrates with a NiP film formed on the surface thereof. In the case where main surfaces of an aluminum alloy substrate on which NiP films are formed are polished, the substrate is polished using a double-side polishing device while the substrate is held by the carrier. At this time, the NiP film has a lower hardness than that of the glass substrate, and thus marks easily occur on the outer circumferential edge surface. Also, sludge of NiP is produced by polishing.

[0012]

In view of this, the present invention has been made in order to resolve such conventional issues, and an object thereof is first to provide a carrier according to which the occurrence of scratches during processing can be reduced and that is used to process a magnetic-disk substrate having good durability. Also, a second object of the present invention is to provide a method for manufacturing a magnetic-disk substrate including processing for performing grinding or polishing processing on a magnetic-disk substrate using such a carrier, and a method for manufacturing a magnetic disk.

25

Means to Solve the Problem

[0013]

As a result of intensive studies, the inventor of the present invention

found that according to the invention having the following aspects, the above-described issues can be resolved, and accomplished the present invention.

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

[0014]

(Aspect 1)

A carrier that is made of a composite material including fibers and a resin material, and has a holding hole for holding a disk-shaped substrate when main surfaces of the substrate are polished or ground, in which an inner circumferential wall surface of the holding hole has a plurality of recessed portions that extend in a surface direction of the carrier and do not include fibers, and the plurality of recessed portions are filled with a resin.

[0015]

(Aspect 2)

The carrier according to Aspect 1, in which the resin with which the plurality of recessed portions are filled is a resin having a lower hardness than that of the resin material included in the composite material.

(Aspect 3)

The carrier according to Aspect 1 or 2, in which the resin with which the recessed portions are filled is a thermoplastic resin.

[0016]

(Aspect 4)

The carrier according to any of Aspects 1 to 3, in which with regard to a roughness of a surface of the inner circumferential wall surface of the holding hole, Ra is 1.0 μm or less.

(Aspect 5)

The carrier according to Aspects 1 to 4, in which a length, in the surface

direction of the carrier, of a region including the plurality of recessed portions filled with the resin is 100 μm or less.

[0017]

(Aspect 6)

- 5 The carrier according to any of Aspects 1 to 5, in which the resin with which the recessed portions are filled covers the inner circumferential wall surface of the holding hole.

(Aspect 7)

- A method for manufacturing a magnetic-disk substrate, including
- 10 processing for processing main surfaces of a disk-shaped substrate by horizontally holding the disk-shaped substrate in the holding hole of the carrier according to any of claims 1 to 6, pressing processing surfaces of surface plates against the main surfaces of the disk-shaped substrate, and moving the processing surfaces of the surface plates and the disk-shaped substrate relative
- 15 to each other.

[0018]

(Aspect 8)

- The method for manufacturing a magnetic-disk substrate according to Aspect 7, in which the processing is polishing processing for supplying a
- 20 polishing liquid containing polishing abrasive particles between polishing pads that are attached to surfaces of the surface plates and the main surfaces of the disk-shaped substrate, and polishing the main surfaces of the disk-shaped substrate.

(Aspect 9)

- 25 The method for manufacturing a magnetic-disk substrate according to Aspect 7, in which the processing is grinding processing for grinding the main surfaces of the disk-shaped substrate with surface plates to which fixed abrasive particles are attached.

[0019]

(Aspect 10)

The method for manufacturing a magnetic-disk substrate according to any of Aspects 7 to 9, in which a difference between a hole diameter of the
5 holding hole and an outer diameter of the disk-shaped substrate is in a range of 0.1 to 1.0 mm.

(Aspect 11)

The method for manufacturing a magnetic-disk substrate according to any of Aspects 7 to 10, in which the substrate is a glass substrate.

10 [0020]

(Aspect 12)

A method for manufacturing a magnetic disk, in which at least a magnetic recording layer is formed on a magnetic-disk substrate that is obtained with the manufacturing method according to any of Aspects 7 to 11.

15

Effect of the Invention

[0021]

With the carrier of the present invention having the above-described aspects, it is possible to provide a carrier that is used to process a magnetic-disk
20 substrate that has good durability and according to which it is possible to reduce occurrence of marks caused by aggregates resulting from abrasive particles or glass sludge being accumulated and coarsening in a recessed portion from which glass fibers that are present on an inner wall of a holding hole of a conventional carrier have been removed, fragments formed by the periphery of
25 the recessed portion being broken, or glass fibers exposed from the inner wall of the holding hole.

Also, it is possible to manufacture a high-quality magnetic-disk substrate according to which it is possible to reduce marks or the like on an edge surface

of a main surface of a substrate, which are factors inhibiting the realization of an increase in the recording density of a medium, by performing grinding or polishing processing on a magnetic-disk substrate using such a carrier.

Furthermore, it is possible to obtain a highly reliable magnetic disk that has no
5 defects and has stable characteristics, using this substrate.

Brief Description of Drawings

[0022]

FIG. 1 is an overall perspective view of a magnetic-disk glass substrate.

10 FIG. 2 is a plan view of a carrier according to the present invention.

FIG. 3 is a longitudinal cross-sectional view of the carrier of FIG. 2 showing an embodiment of the carrier according to the present invention.

FIG. 4 is a longitudinal cross-sectional view of the carrier of FIG. 2 showing another embodiment of the carrier according to the present invention.

15 FIG. 5 is a longitudinal cross-sectional view showing a schematic configuration of a double-side polishing device.

Mode for Embodying the Invention

[0023]

20 Hereinafter, an embodiment according to the present invention will be described in detail. The following embodiment mainly describes manufacturing of a magnetic-disk glass substrate.

Magnetic-disk glass substrates are usually manufactured through a rough grinding step, a shape processing step, a precision grinding step, an edge
25 surface polishing step, main surface polishing steps (a first polishing step and a second polishing step), a chemical strengthening step, and the like.

[0024]

he magnetic-disk glass substrate is manufactured by first molding a

disk-shaped glass substrate (glass disk) from molten glass by direct pressing. It should be noted that a glass substrate may be obtained by cutting plate glass manufactured with a downdraw method or a float method other than using direct pressing into a predetermined size.

5 Next, rough grinding for enhancing the dimensional accuracy and shape accuracy is performed on the main surfaces of the molded glass substrate. A double-side lapping device is usually used to perform this rough grinding step and grind the main surfaces of the glass substrate with loose abrasive particles or fixed abrasive particles. It should be noted that the carrier of the present
10 invention may be used. By grinding the main surfaces of the glass substrate in this manner, the glass substrate is processed so as to have a predetermined substrate thickness and flatness and to obtain a predetermined surface roughness. This rough grinding step may be omitted as appropriate.

[0025]

15 After this rough grinding step ends, the shape processing (chamfering) step is performed.

 Thereafter, precision grinding step is performed as appropriate. A grinding method with fixed abrasive particles that uses a diamond pad, for example, is preferable in this precision grinding step. A diamond pad is a sheet
20 to which pellets are stuck, the pellet being formed by using a supporting material such as a resin (e.g., acrylic resin) to fix diamond particles or aggregates consisting of some diamond particles held together with a binder such as glass, ceramic, a metal or a resin. It should be noted that although the term "diamond pad" used here is not necessarily in common usage, "diamond pad" will be used
25 herein for the sake of convenience.

 In grinding with fixed abrasive particles using a diamond pad, the abrasive particles are uniformly present on the sheet surface, and thus the load is not concentrated. In addition, the abrasive particles are fixed to the sheet

using a resin, and therefore, even when a load is applied to the abrasive particles, cracks in the processed surface (layer altered by processing) are shallow due to the highly elastic nature of the resin that fixes the abrasive particles. Thus, the roughness of the processed surface can be reduced, the load (e.g., machining allowance) on subsequent steps is reduced. It should be noted that at the time of grinding with fixed abrasive particles, a coolant such as water is preferably supplied to the processed surface.

[0026]

Thereafter, after the edge surface polishing step is performed, processing for mirror-polishing main surfaces for obtaining high precision flat surfaces is performed. It is preferable to perform a mirror-polishing method on the glass substrate using a polishing pad made of polyurethane foam or the like while supplying a slurry (polishing liquid) containing an abrasive that is made of a metal oxide such as cerium oxide or colloidal silica.

[0027]

From the point of view of polishing efficiency, it is preferable to use a polishing liquid containing colloidal silica polishing abrasive particles having an average particle diameter of 1 to 50 nm. In particular, the polishing abrasive particles that are included in the polishing liquid and used in the finishing mirror-polishing step (second polishing step performed downstream) have an average particle diameter of 10 nm or more and less than 30 nm, and more preferably 10 to 20 nm.

[0028]

It should be noted that in the present invention, the above-described average particle diameter denotes a particle diameter at which a cumulative curve reaches 50% when the cumulative curve is derived by setting the total volume of powder particles in the particle size distribution measured by a light scattering method to 100% (referred to as "cumulative average particle diameter

(50% diameter)" hereinafter). In the present invention, specifically, the cumulative average particle diameter (50% diameter) is a value obtained by measuring the particle diameter using a particle diameter/particle size distribution measurement device.

5 [0029]

As the polishing method, it is sufficient that the surface of a glass substrate is polished to be a mirror surface by bringing the glass substrate and the polishing pad into contact with each other, and moving the polishing pad and the glass substrate relative to each other while supplying a polishing liquid
10 containing polishing abrasive particles.

[0030]

FIG. 5 is a longitudinal cross-sectional view showing a schematic configuration of a planetary double-side polishing device that can be used in the step of mirror-polishing a glass substrate. Although the configuration thereof
15 has been described, if the configuration is described again here, the double-side polishing device shown in FIG. 5 includes the sun gear 2, the internal gear 3 arranged concentrically on the outside of the sun gear 2, the carrier 10 that is engaged with the sun gear 2 and the internal gear 3 and revolves and rotates in response to the rotation of the sun gear 2 or the internal gear 3, the upper
20 surface plate 5 and the lower surface plate 6 to which the polishing pads 7 that are capable of holding a product 1 to be polished that is held by the carrier 10 are respectively attached, and a polishing liquid supplying portion (not shown) that supplies the polishing liquid between the upper surface plate 5 and the lower surface plate 6.

25 [0031]

At the time of polishing processing, by using such a double-side polishing device, the product 1 to be polished, that is, the glass substrate, held by the carrier 10 is held between the upper surface plate 5 and the lower surface

plate 6, and then both the upper and lower surfaces of the product 1 to be polished are polished while the polishing liquid is supplied between each of the polishing pads 7 of the upper and lower surface plates 5 and 6 and the product 1 to be polished and the carrier 10 revolves and rotates in response to the rotation of the sun gear 2 or the internal gear 3.

[0032]

The present invention relates to the above-described carrier 10 used to hold a glass substrate, which is a workpiece, in the above-described polishing processing.

10 The carrier according to the present invention is used when processing surfaces of surface plates are pressed against the main surfaces of the glass substrate, and the processing surfaces of the surface plates and the glass substrate are moved relative to each other so as to process the main surfaces of the glass substrate, and the carrier is for horizontally holding the glass substrate.

15 In addition, as described in Aspect 1 above, the carrier is made of a composite material including fiber and a resin material, and has a holding hole for holding the glass substrate when the main surfaces of a disk-shaped glass substrate are polished or ground. An inner circumferential wall surface of the holding hole has a plurality of recessed portions that extend in a surface direction of the

20 carrier, which is a direction substantially orthogonal to the inner circumferential wall surface, and do not include fibers, and the plurality of recessed portions are filled with a resin.

[0033]

FIGS. 2 and 3 indicate an embodiment of a carrier according to the present invention. FIG. 2 is a plan view of the carrier according to the present invention. Also, FIG. 3 is a longitudinal cross-sectional view of the carrier of FIG. 2 showing the embodiment of the carrier according to the present invention.

[0034]

As shown in FIG. 2, the carrier 10 according to the embodiment of the present invention is constituted by a holding member 11 that is disk-shaped overall, and includes a plurality of holding holes 12 for holding a glass substrate.

In order that the plurality of holding holes 12 evenly grind and polish main surfaces of a glass substrate and suppress the occurrence of marks resulting from local contact with the edge surface of the glass substrate, the plurality of holding holes have a circular shape, and desirably, have a perfect circular shape, as the present embodiment. From the above-described viewpoint, the roundness of a holding hole is preferably 20 μm or less, for example. The roundness of a holding hole can be measured with a roundness/cylindrical shape measurement device, for example. It is possible to create the above-described holding holes 12 by drilling a hole of a predetermined size in a base material for the disk-shaped holding member 11, for example.

[0035]

Regardless of the size of a glass substrate, usually, a difference between a hole diameter of a holding hole 12 and an outer diameter of a glass substrate held inside the holding hole 12 is preferably 0.1 to 1.0 mm. If the difference is greater than 1.0 mm, there are cases where the tracking performance of the glass substrate for carrier movement (planet gear movement) deteriorates, and there are cases where irregularity of grinding or polishing occurs on a main surface. Also, if the difference is less than 0.1 mm, there are cases where the degree of freedom of movement of a glass substrate in a holding hole decreases excessively and force is concentrated in the same portion of the edge portion, resulting in the occurrence of marks. Also, it will be difficult to detach the substrate from the carrier.

[0036]

Also, a plurality of gear teeth 13 that are engaged with the sun gear 2 and the internal gear 3 of the double-side polishing device are formed in an outer

circumferential portion of the above-described holding member 11.

[0037]

As shown in the longitudinal cross-sectional view of FIG. 3, the above-described holding member 11 is made of a composite material including a glass fiber 30 and a resin material A (an epoxy resin, for example) 31, excluding a region A1, which will be described later. Specifically, the holding member 11 is formed by a base material (or a stack of a plurality of base materials) in which glass fibers are stacked in an epoxy resin, for example.

It should be noted that a metal fiber may also be used, for example, instead of glass fiber. This embodiment describes a case where the holding member is made of a composite material including glass fibers and a resin material, as an example.

It should be noted that for convenience of illustration, an internal cross-sectional structure (a region constituted by the above-described composite material, in particular) of the holding member 11 is depicted merely as an image in FIG. 3, and the actual internal structure is not necessarily depicted accurately.

[0038]

Also, as shown in FIG. 3, the inner circumferential wall surface of the holding hole 12 has a plurality of recessed portions 20 that extend in a surface direction of the carrier, which is a direction orthogonal to the inner circumferential wall surface, and do not include glass fibers, and the plurality of recessed portions 20 are filled with a resin material B21 that is the same as or different from the above-described resin material A31. In addition, a region A1 formed by the above-described resin material A31 including the plurality of recessed portions 20 and the above-described resin material B21 is included in the surface direction of the main surface of the carrier, which is the direction extending from the inner circumferential wall surface of the holding hole 12

toward the outside of the holding hole. That is, a predetermined region A1 extending from the inner circumferential wall surface of the holding hole 12 toward the outside is formed by the plurality of recessed portions 20 filled with the resin material B21 that is the same as or different from the resin material A31.

5 In addition, as described above, a region excluding the above-described region A1, or in other words, a region A2 on the outer circumferential side of the region A1 of the carrier, is made of a composite material including the glass fiber 30 and the resin material A31. It should be noted that in the present invention, glass fibers extending in a direction parallel to the inner circumferential wall
10 surface of the holding hole 12 may be present in the above-described region A1.
[0039]

Glass fibers, which are exposed from the inner circumferential wall surface of the holding hole 12 formed by drilling a hole having a predetermined size in a base material for the holding member 11 made of the composite
15 material, are dissolved to a certain depth (corresponding to the above-described region A1) and the dissolved glass fibers are removed, thereby the above-described recessed portion 20 included in the region A1 can be formed. An example of a method for dissolving and removing glass fibers in this case is a method of etching the carrier in which the holding holes 12 are formed, with
20 hydrofluoric acid or the like. In addition, a recessed portion formed by dissolving and removing glass fibers to a certain depth in this manner is filled with the resin material B21, and thus the region A1 including a plurality of recessed portions 20 filled with the resin material A31 and a resin material B21 that is the same as or different from the resin material A31 can be formed.

25 [0040]

As described above, an epoxy resin is usually used as the resin material A31 included in a composite material of glass fibers and a resin fundamentally constituting the carrier 10 of the present invention, and in addition to this, phenol

resins, bismaleimide resins, silicone resins, diallyl phthalate resins, unsaturated polyester resins, polyphenylene sulfide resins, or the like may be used, for example.

[0041]

5 Also, in the case where the resin material B21 is the same resin as the resin material A31, an epoxy resin may be used as the resin material B21 that fills the recessed portion 20 and is included in the region A1 of the carrier 10 of the present invention. Also, although there is no particular limitation on the resin material B21 as long as the resin material is different from the resin
10 material A31, from the point of view of a filling method, which will be described later, a thermoplastic resin is particularly preferable, and it is preferable to use at least one selected from resins such as polycarbonates, polyoxymethylenes, polypropylenes, polyphenylene sulfides, polyamides, polyethylenes, polystyrenes, acrylic resin, polyethylene terephthalates, polyphenylene ethers, polyacetal, polybutylene terephthalates, polyphenylene sulfides, polyether ether
15 ketones, fluorocarbon resins, urethane resins, liquid crystal polymers, elastomers, and the like.

[0042]

20 For convenience in the manufacturing steps, in general, a thermosetting epoxy resin is used as a resin material for a carrier base material. Therefore, if the recessed portion 20 is filled with a thermosetting epoxy resin that is the same as the thermosetting epoxy resin, even in the case where frictional heat is generated locally due to strong friction between the wall surface of a holding
25 hole and the edge portion of the glass substrate during processing, the thermosetting epoxy resin does not particularly deform, and therefore edge surface marks are likely to occur on the glass substrate. On the other hand, in the case where the recessed portion 20 is filled with a thermoplastic resin that is

different from the resin material of the carrier base material, for example, the recessed portion 20 slightly deforms due to frictional heat, and therefore edge surface marks are unlikely to occur on the glass substrate. Also, if a resin having a lower hardness than that of the epoxy resin of the carrier base material is used, the resin serves as a cushion, and thus edge surface marks are unlikely to occur on the glass substrate.

[0043]

Therefore, the resin with which the recessed portion 20 is filled is preferably a thermoplastic resin.

Also, it is preferable that the resin with which the recessed portion 20 is filled is a resin having a lower hardness than that of a resin material included in a composite material, which is the carrier base material. In this case, the resin filling the recessed portion preferably has a Rockwell hardness of less than M80. By setting the hardness in this range, the hardness of the resin filling the recessed portion can be made smaller than that of the epoxy resin of the base material, and thus it is possible to make it less likely that edge surface marks on the glass substrate will occur. In general, with regard to the hardness of an epoxy resin, an epoxy resin has a Rockwell hardness of M80 to 100.

[0044]

The following method can be used as a method for filling the recessed portion 20 with the resin material B21, for example.

After the resin material B21 is applied to the inner circumferential wall surface of the holding hole 12, filling is performed by heating and dissolving the resin material B21. At this time, it is more desirable to reduce the pressure of the inside of a recessed portion of a filling portion, because the recessed portion can be filled up to the bottom portion of the recessed portion. For example, it is sufficient that the resin material B21 is applied in a reduced pressure environment, and heating is then performed at normal pressure. It is preferable

to apply a hot plate welding method, a vibration welding method, an ultrasonic welding method, a laser transmission welding method, or the like as a heating method. It should be noted that the above-described filling work can be efficiently performed in a state in which many holding members 11 of the carrier are stacked. It should be noted that after filling processing, resin coming out of the recessed portion may be removed. A rotary blade can be used to remove the resin, for example.

[0045]

It should be noted that it is not necessary to completely fill the recessed portion to the bottom portion thereof with the above-described resin material B21. If an entrance to the recessed portion is blocked, it is possible to prevent abrasive particles or sludge from entering the recessed portion. It should be noted that the depth of the resin material B21 that fills the recessed portion from the entrance thereof is preferably 1 μm or more, because the resin material B21 is unlikely to fall off and the durability increases due to the thickness. The depth is more preferably 2 μm or more, and even more preferably 5 μm or more. It should be noted that it is preferable that the recessed portion is completely filled with the resin material B21 because the adherence to the carrier increases to the maximum.

[0046]

It is preferable that in the carrier 10 of the present invention, the length of the region A1 constituted by (including) the resin material A31 and the plurality of recessed portions 20 filled with the resin material B21 that is the same as or different from the resin material A31 is 100 μm or less. If the distance exceeds 100 μm , there is a risk that the strength of the holding hole in a region near the inner wall will decrease and the roundness of the holding hole will deteriorate. On the other hand, if the distance is less than 1 μm , there are cases where the effect of the present invention may not be sufficiently obtained.

[0047]

In the carrier 10 of the present invention, with regard to the roughness of the surface of the inner circumferential wall surface of the holding hole, the arithmetic mean roughness Ra is preferably 1.0 μm or less. If the arithmetic mean roughness is in this range, it is possible to suppress the occurrence of marks on the edge surface of the glass substrate during processing.

[0048]

As described above, the carrier 10 of the present invention according to the present embodiment has, on the inner circumferential wall surface of the holding hole 12, a plurality of recessed portions 20 filled with the resin material B21 that is the same as or different from the resin material A31, and includes the region A1 including the recessed portions 20 filled with a resin in a direction from the inner circumferential wall surface toward the outside of the holding hole, and thus the carrier is only made of a resin material in the region A1 near the inner circumferential wall surface of the holding hole 12 and does not include glass fibers extending in a direction orthogonal to at least the inner circumferential wall surface. Therefore, the edge surface of the glass substrate can be protected by elastic deformation of the resin material of the region A1, and marks that conventionally occur due to protrusion or exposure of glass fibers do not occur in the edge surface of the glass substrate.

[0049]

Also, the plurality of recessed portions 20 of the inner wall of the holding hole 12 are filled with the resin material B21, and thus abrasive particles and glass sludge does not stay in these recessed portions 20, and it is possible to resolve the problem of the conventional technique that abrasive particles or glass sludge accumulated in the recessed portions coarsens and comes out of the recessed portions, causing scratches or surface contamination on a main surface of the glass substrate. Also, by filling the recessed portions 20 with the

resin material B21, it is possible to suppress a decrease in the strength of the periphery of the recessed portions and resolve the problem of the periphery of the recessed portions being broken and the fragments causing contamination, resulting in occurrence of scratches or surface contamination on a main surface of the glass substrate.

[0050]

Furthermore, it is also possible to resolve a conventional problem of a level difference occurring in the inner wall of the holding holes due to the recessed portion being broken, causing new marks on the edge surface of the glass substrate, and the roundness of the inner diameter of the holding hole decreasing, reducing the roundness of the glass substrate as well.

The carrier 10 of the present invention can resolve various problems of the conventional technique, which often occur particularly at the time of mass production, and therefore the carrier 10 is excellent in durability in the case where the carrier is used for a long period.

[0051]

Also, FIG. 4 is a longitudinal cross-sectional view of the carrier of FIG. 2 showing another embodiment of the carrier according to the present invention.

As shown in FIG. 4, in the present embodiment, the surface of the inner circumferential wall surface of the holding hole 12 is covered by the resin material B21 filling the recessed portion 20, and the recessed portions 20 filled with the resin material B21 and a surface portion of the inner circumferential wall surface covered by the resin material B21 are continuous.

[0052]

In the present embodiment, although there is no particular limitation on a thickness t of the resin material B21 covering the inner circumferential wall surface of the holding hole 12 in a surface direction of the carrier, the thickness t is preferably in a range of about 1 μm to 2 mm. The thickness or surface

properties can be adjusted by performing grinding with a rotary blade or the like after being formed thick.

[0053]

Also, according to the carrier of the present embodiment, in addition to
5 the effect of action of the carrier of the embodiment as shown in FIG. 3
described above, the entire surface of the inner circumferential wall surface of
the holding hole 12 is covered by the resin material B21, and thus the effect of
improving the surface roughness of the inner circumferential wall surface of the
holding hole 12 can be also obtained. Specifically, it is possible to set Ra to 0.5
10 μm or less.

[0054]

It should be noted that the thickness of the carrier is thin, and therefore
the inner wall surface of the holding hole is a very narrow region, but the surface
portion of the inner circumferential wall surface of the holding hole covered by
15 the resin material B21 is similarly continuous to the recessed portions 20 filled
with the resin material B21, and therefore failure such as damages or falling off
of the carrier due to the surface portion covering the inner circumferential wall
surface of the holding hole coming into contact with the glass substrate during
processing can be prevented from occurring.

20 [0055]

Conventionally, in the case where the inner circumferential wall surface
of a holding hole as disclosed in Patent Literature 2 described above, for
example, is covered by a resin material in a carrier for a magnetic-disk glass
substrate having a thin thickness of 2 mm, a method of applying the resin
25 material has been used, but the thickness could only be increased by only about
50 μm substantially in the surface direction with this method. This is because
the contacting surface is small due to the carrier being thin, and thus if the
thickness increases, the resin material will peel off of the inner circumferential

5 wall surface. Also, although there is a method of fitting a ring-shaped member other than the carrier in the inside of the holding hole, the member is not fixed or even if the member is fixed, the adhesive strength is weak and the member is often disengaged from the holding hole during processing, and thus the member is not suitable for mass production.

10 However, with the present embodiment, the resin material is in a mode such that it has roots (protruding portions formed in recessed portions) on the inner circumferential wall surface of the holding hole, and thus the adhesive strength can be increased more than with the conventional method, as a result of which the above-described thickness t can be significantly increased. For example, the thickness t can be set to 100 μm or more, or 0.5 mm or more. The thickness can be increased more in this manner, and thus it is possible to stably obtain the effect of preventing marks on the edge surface for a long period.

[0056]

15 It should be noted that in the processing for mirror-polishing a glass substrate using the carrier of the present invention as described above, it is preferable to apply the load (processing surface pressure) in a range of 10 gf/cm^2 or more to 300 gf/cm^2 or less. The lower limit is more preferably 50 gf/cm^2 or more. Also, the upper limit is more preferably 200 gf/cm^2 or less.

20 A load of less than 10 gf/cm^2 is not preferable because there are cases where the processability (polishing rate) of the glass substrate decreases. Also, a load of more than 250 gf/cm^2 is not preferable because there are cases where marks such as scratches occur on the surface of the glass substrate.

[0057]

25 In general, the mirror-polishing processing is performed through two stages, namely a first polishing step for removing marks and distortion remaining from the lapping step and a second polishing step for finishing the surface roughness of the main surface of the glass substrate into a smooth mirror

surface while maintaining a flat surface obtained in the first polishing step (it should be noted that there are cases in which multi-stage polishing having three or more stages may be performed). In this case, it is preferable to perform first polishing and second polishing using the same polishing device, and therefore it is preferable to apply the carrier of the present invention in both first polishing and second polishing.

[0058]

It should be noted that although the case in which the carrier according to the present invention is applied in the processing for polishing a glass substrate has been described above, the processing is performed using a double-side grinding device having a configuration similar to that of the above-described double-side polishing device also in the step of grinding the main surfaces of the glass substrate, and thus the above-described carrier according to the present invention can also be applied to the processing for grinding the glass substrate using the double-side grinding device.

The carrier of the present invention is particularly preferable in grinding processing using fixed abrasive particles (precision grinding using diamond pads described above, for example). This is because the purity of glass sludge is likely to increase because only glass sludge is produced in a large amount in precision grinding using fixed abrasive particles, and therefore the glass sludge is likely to be accumulated in the recessed portions and crystallize in the conventional carrier, as a result of which the conventional issues arise often.

[0059]

Also, in the present invention, it is preferable that the (type of) glass constituting the glass substrate is aluminosilicate glass containing SiO_2 as a main component and alumina. Mirror-polishing the surface of a glass substrate made of such glass can yield a smooth mirror-finished surface, and the post-processing strength is favorable. Also, the strength can be increased by

chemical strengthening.

Also, the above-described glass may be crystallized glass or amorphous glass. Using amorphous glass to prepare a glass substrate can further reduce surface roughness of a main surface of the glass substrate.

5 [0060]

Aluminosilicate glass containing SiO_2 in an amount of 58 wt% or more to 75 wt% or less, Al_2O_3 in an amount of 5 wt% or more to 23 wt% or less, Li_2O in an amount of 3 wt% or more to 10 wt% or less, and Na_2O in an amount of 4 wt% or more to 13 wt% or less as main components (it should be noted that

10 aluminosilicate glass that does not contain phosphorus oxide) can be used as such aluminosilicate glass. Furthermore, it is possible to use phosphorus oxide-free amorphous aluminosilicate glass that contains an oxide of an alkaline earth metal in an amount of 5 wt% or more and, as main components, SiO_2 in an amount of 62 wt% or more to 75 wt% or less, Al_2O_3 in an amount of 5 wt% or

15 more to 15 wt% or less, Li_2O in an amount of 4 wt% or more to 10 wt% or less, Na_2O in an amount of 4 wt% or more to 12 wt% or less, and ZrO_2 in an amount of 5.5 wt% or more to 15 wt% or less, and has an $\text{Na}_2\text{O}/\text{ZrO}_2$ weight ratio of 0.5 or more to 2.0 or less and an $\text{Al}_2\text{O}_3/\text{ZrO}_2$ weight ratio of 0.4 or more to 2.5 or less, for example.

20 [0061]

In the present invention, the surface of the glass substrate that has undergone the mirror-polishing processing is preferably finished to a mirror surface having an arithmetic mean surface roughness R_a of 0.20 nm or less measured using an AFM in a range of $1\ \mu\text{m} \times 1\ \mu\text{m}$ at a resolution of 256×256

25 pixels. In the present invention, R_a of the present invention refers to roughness calculated in conformity with Japanese Industrial Standard (JIS) B0601.

[0062]

According to the present invention, it is possible to manufacture a

high-quality glass substrate according to which it is possible to reduce marks or the like on the main surfaces or the edge surface of the glass substrate, which are factors inhibiting the realization of an increase in the recording density of a medium, and the magnetic-disk glass substrate that is manufactured by the present invention is favorable for a glass substrate that is used in a magnetic disk that is provided in a HDD provided with a DFH magnetic head that can realize an extremely low flying height.

It should be noted that although the above-described embodiment describes a case where the present invention is applied mainly to manufacturing of a magnetic-disk glass substrate, the present invention can be similarly applied to manufacturing of not only such glass substrates but also aluminum alloy substrates with NiP films formed on the surfaces thereof, and a similar effect of the present invention can be obtained.

[0063]

In addition, the present invention provides a method for manufacturing a magnetic disk using the above-described magnetic-disk glass substrate, for example.

The magnetic disk is manufactured by forming at least a magnetic recording layer (magnetic layer) on the magnetic-disk glass substrate according to the present invention. Also, it is preferable to form a protective layer and a lubricant layer in this order on the magnetic layer.

[0064]

Use of a glass substrate obtained according to the present invention makes it possible to obtain a highly reliable magnetic disk having stable properties in which problems such as head crash do not occur even when recording and reproduction are performed using a DFH head, for example. Therefore, the present invention is preferable to manufacture a magnetic disk having a higher recording density than previously available, such as a recording

density exceeding 500 gigabytes, for example.

Working Examples

[0065]

5 Hereinafter, embodiments of the present invention will be described in detail by way of working examples. It should be noted that the present invention is not limited to the following working examples.

(Working Examples 1, Comparative Example 1)

10 A magnetic-disk glass substrate was manufactured through (1) a rough grinding step, (2) a shape processing step, (3) a precision grinding step, (4) an edge surface polishing step, (5) a main surface polishing step (first polishing step), (6) a chemical strengthening step, and (7) a main surface polishing step (second polishing step), that will be described below.

[0066]

15 (1) Rough grinding step

First, a disk-shaped glass substrate made of aluminosilicate glass and having a diameter of 66 mm ϕ and a thickness of 1.0 mm was obtained from molten glass by direct pressing using upper, lower, and drum molds. It should be noted that a glass substrate may be obtained by cutting plate glass,
20 manufactured with a downdraw method or a float method other than using direct pressing, into a predetermined size.

In order to improve dimensional accuracy and shape accuracy, the rough grinding step was performed on this glass substrate. The rough grinding step was performed using a double-side grinding device.

25 [0067]

(2) Shape processing step

Next, a cylindrical grindstone was used to create a hole in the central portion of the glass substrate and an outer circumferential edge surface was

ground to have a diameter of 65 mm ϕ , and predetermined chamfering was then performed on the outer circumferential edge surface and an inner circumferential edge surface.

(3) Precision grinding step

5 The precision grinding step was performed using a double-side grinding device by performing grinding processing with the above-described fixed abrasive particles.

[0068]

(4) Edge surface polishing step

10 Next, the edge surfaces (inner and outer circumferential edge surfaces) of the glass substrate were polished by brushing while the glass substrate was rotated. After undergoing edge surface polishing described above, the surface of the glass substrate was cleaned.

[0069]

15 (5) Main surface polishing step (first polishing step)

Next, the first polishing step was performed on the main surfaces using a double-side polishing device. In the double-side polishing device, the glass substrate held by a carrier is tightly placed between the upper and lower surface plates to which polishing pads are attached, the carrier is engaged with the sun gear and the internal gear, and the glass substrate is pressed between the upper and lower surface plates.

20

[0070]

A carrier according to the above-described embodiment of the present invention shown in FIGS. 2 and 3 was applied as the carrier. This carrier is
 25 obtained by using a composite material including glass fibers and an epoxy resin as a carrier base material, dissolving and removing glass fibers of the inner wall of a holding hole through etching with hydrofluoric acid to a depth of 10 μ m, and filling a formed recessed portion with a polycarbonate resin. Specifically, the

polycarbonate resin was applied under a reduced pressure condition, the recessed portion was completely filled with the resin by heating after the pressure was returned to normal pressure, and the polycarbonate resin coming out of the recessed portion was removed with a rotary blade after the processing.

- 5 The polycarbonate resin has a Rockwell hardness of M78. It should be noted that the diameter of the holding hole was set to 65.5 mm so as to be suitable to process a 2.5-inch glass substrate. The roundness of the holding hole was 15 μm . The thickness of the carrier was 0.5 mm.

[0071]

- 10 Then, a polishing liquid is supplied between the polishing pads and polishing surfaces of the glass substrate, and the device is rotated, and thereby the glass substrate revolves while rotating on the surface plates so that both surfaces of the glass substrate are polished simultaneously. A hard polisher (hard urethane foam) was used as a polisher, and a liquid in which cerium oxide
15 having an average particle diameter of 1.5 μm was dispersed as an abrasive was used as the polishing liquid. After undergoing the above-described first polishing step, the glass substrate was cleaned and dried.

- It should be noted that in the above-described first polishing step, in the case where a plurality of carriers are used in one polishing, the carriers of the
20 same type were used, and processing was performed on 100 batches without replacing the carrier. It should be noted that 50 substrates are processed per batch.

[0072]

(6) Chemical strengthening step

- 25 Next, after undergoing the above-described cleaning, the glass substrate was subjected to the chemical strengthening.

[0073]

(7) Main surface polishing step (second polishing step)

Next, the second polishing step was performed using the same double-side polishing device as used in the above-described first polishing step, and polishing pads (polyurethane foam) with a soft polisher (suede) were used instead as the polisher. Also, the same type of carrier as that used in the
5 above-described first polishing step was applied as the carrier used in the second polishing step. This second polishing step is mirror-polishing processing for finishing the main surfaces of the glass substrate to smooth mirror surfaces each having a surface roughness Ra of about 0.2 nm or less. A liquid in which colloidal silica having an average particle diameter of 20 nm was
10 dispersed in water was used as the polishing liquid. After undergoing the second polishing step, the glass substrate was cleaned and dried.

[0074]

A magnetic-disk glass substrate was produced through the above-described steps. As shown in FIG. 1, the obtained glass substrate was
15 a disk-shaped glass substrate 100 that has a circular hole 103 in the center and that includes both main surfaces 101 and 102, an inner circumferential edge surface 104, and an outer circumferential edge surface 105 located between both main surfaces, and the outer diameter, the inner diameter, the substrate thickness, and the roundness thereof were respectively 65 mm, 20 mm, 0.635
20 mm, and 1.5 μm .

[0075]

When the outer circumferential edge surfaces of the glass substrates in the 100th batch in the above-described first polishing step were observed visually with a converging lamp applied thereto in a dark room and the presence
25 or absence of marks resulting from contact with the carrier was checked, marks were not found. Also, when measured with an optical surface analyzer, the main surfaces did not have any scratches in particular.

[0076]

Also, as Comparative Example 1 for Working Example 1 above, a magnetic-disk glass substrate was produced similarly to Working Example 1, except that in the above-described first polishing step and second polishing step, a carrier obtained by using a composite material including glass fibers and an epoxy resin as a carrier base material, and dissolving and removing glass fibers in the inner wall of a holding hole through etching with hydrofluoric acid to a predetermined depth (10 μm) (that is, a recessed portion formed in the inner wall is not filled with anything) was applied.

When the outer circumferential edge surface and main surfaces of the glass substrates in the 100th batch in the first polishing step were observed similarly to Working Example 1 above, six marks on average per substrate resulting from contact with the carrier were found in the outer circumferential edge surface, and five scratches or pit defects on average per surface of the substrate were observed in the main surfaces.

[0077]

(Working Example 2, Comparative Example 2)

Furthermore, in (3) precision grinding step above, similarly to the above, grinding processing was performed on 100 batches using the same carriers as those of Working Example 1 and Comparative Example 1, the glass substrates on the 100th batch were cleaned and dried, and the main surfaces and the outer circumferential edge surfaces were observed (Working Example 2 and Comparative Example 2). It should be noted that the main surfaces were observed through visual examination. As a result, in the above-described precision grinding step, in the case where the same carrier as that of Comparative Example 1 was used, on average, 13 marks were found in the outer circumferential edge portion and three long scratches were found in the main surface. On the other hand, in the case where the same carrier as that of Working Example 1 was used, neither marks nor scratches were found.

[0078]

As is understood from the above-described result, in the case where the carrier of this working example of the present invention was applied and a double-side polishing device is used to perform processing for mirror-polishing or grinding main surfaces of glass substrates, the occurrence of surface defects such as marks was not also found in the glass substrates in the 100th batch, and a favorable result was obtained. Also, when the carrier that produced 100 batches of glass substrates was observed in detail, impairment of the inner wall of the holding hole and the like was not found.

10 [0079]

On the other hand, in the case where the carrier of the comparative example was applied and a double-side polishing device was used to perform processing for mirror-polishing or grinding the main surfaces of a glass substrate, with regard to the glass substrates in the 100th batch, surface defects such as marks were observed in both the main surfaces and outer circumferential edge surfaces. Also, when the carrier that produced 100 batches of glass substrates was observed in detail, it was found that the inner walls of holding holes was damaged.

15

[0080]

20 In this manner, for reasons such as the following, surface defects such as marks occurred in the glass substrates in the case where the carrier of the comparative example was applied.

1. Aggregates resulting from abrasive particles or glass sludge being accumulated and coarsening in recessed portions of the inner wall of a holding hole came out of the recessed portion during polishing and caused scratches and surface contamination on the edge surface or main surfaces of the glass substrate.

25

2. The inner wall of the holding hole did not include glass fibers, had a

plurality of recessed portions that are not filled with anything, and had a low strength, and thus the inner wall was damaged due to contact with the glass substrate during processing and the fragments thereof caused contamination, resulting in occurrence of scratches or surface contamination on the edge surface or main surfaces of the glass substrate, similarly to 1 above.

[0081]

(Working Example 3)

A carrier according to the above-described embodiment shown in FIG. 4 was applied to this working example. A carrier obtained by using a composite material including glass fibers and an epoxy resin as a carrier base material, dissolving and removing glass fibers in the inner wall of a holding hole through etching with hydrofluoric acid to a depth of 10 μm , and filling the formed recessed portion with a polycarbonate resin, and then adjusting a removing amount with a cutting blade such that a thickness t in a surface direction of the carrier from the inner wall of the holding hole was 1 mm. In that state, the diameter of the holding hole was adjusted to 65.5 mm.

Similarly to Working Example 1, 200 batches of glass substrates were processed using the carrier in the first and second polishing. When the outer circumferential edge surfaces and main surfaces of the glass substrates in the 200th batch were observed similarly to Working Example 1 above, scratches, marks, and the like were not found on the outer circumferential edge surfaces or main surfaces.

[0082]

(Comparative Example 3)

A conventional carrier (a carrier obtained by using a composite material including glass fibers and an epoxy resin as a carrier base material, without dissolving and removing glass fibers in the inner wall of a holding hole through etching with hydrofluoric acid) was coated by a polycarbonate resin such that the

inner wall of the holding hole had a resin coating having a thickness of 1 mm.

In that state, the diameter of the holding hole was adjusted to 65.5 mm.

Similarly to Working Example 3, 200 batches of glass substrates were processed using this carrier in first and second polishing. When the outer

5 circumferential edge surfaces and main surfaces of the glass substrates in the 200th batch were observed, on average, 25 marks per substrate resulting from contact with the carrier were found on the outer circumferential edge surfaces, and 11 scratches or pit defects per surface of the substrate were observed on the main surfaces.

10 [0083]

(Comparative Example 4)

A ring-shaped polycarbonate resin member having a thickness of 1 mm was fitted into the inner wall of a holding hole of the above-described conventional carrier (no etching processing). In that state, the diameter of the

15 holding hole was adjusted to 65.5 mm. When the glass substrates were processed using the carrier in first and second polishing, the ring-shaped member was disengaged partway through polishing, and 200 batches could not be processed.

[0084]

20 According to the results above, use of the carrier of the embodiment shown in FIG. 4 enables stable production without the occurrence of marks or the like on the outer circumferential edge surfaces or main surfaces of glass substrates for a long period.

[0085]

25 (Manufacturing magnetic disk)

A magnetic disk for perpendicular magnetic recording was obtained by performing the following film forming step on the magnetic-disk glass substrates obtained in Working Example 1 above.

Specifically, an adherent layer constituted by a Ti-based alloy thin film, a soft magnetic layer constituted by a CoTaZr alloy thin film, a base layer constituted by a Ru thin film, a perpendicular magnetic recording layer made of a CoCrPt alloy, a carbon protective layer, and a lubricant layer were sequentially
 5 formed on the glass substrate. The protective layer is for preventing degradation of the magnetic recording layer caused by contact with the magnetic head, and the protective layer is composed of hydrogenated carbon and yields wear resistance. Also, the lubricant layer was formed by a dipping method using an alcohol-modified perfluoropolyether liquid lubricant.

10 [0086]

As a result of integrating the obtained magnetic disk into a HDD along with a DFH head and performing a long-term operation test, failure such as head crash or the like did not occur and favorable results were obtained.

15 Descriptions of Reference Numerals

[0087]

- | | | |
|----|----|--|
| | 1 | Product to be polished (glass substrate) |
| | 2 | Sun gear |
| | 3 | Internal gear |
| 20 | 5 | Upper surface plate |
| | 6 | Lower surface plate |
| | 7 | Polishing pad |
| | 10 | Carrier |
| | 11 | Holding member |
| 25 | 12 | Holding hole |
| | 13 | Gear tooth |
| | 20 | Recessed portion |
| | 21 | Resin material B |

	30	Glass fiber
	31	Resin material A
	100	Magnetic-disk glass substrate
	101,102	Main surfaces
5	103	Circular hole
	104	Inner circumferential edge surface
	105	Outer circumferential edge surface

1. A carrier that is made of a composite material including fibers and a resin material and has a holding hole for holding a disk-shaped substrate when main surfaces of the substrate are polished or ground, wherein:

an inner circumferential wall surface of the holding hole has a plurality of recessed portions formed in a predetermined region that extends in a surface direction of the carrier orthogonal to the inner circumferential wall surface toward the outside of the holding hole to a certain depth and the plurality of recessed portions do not include fibers,

the plurality of recess portions are formed by removing the fibers exposed from the inner circumferential wall surface to the certain depth, and

the plurality of recessed portions are filled with a resin so as to block at least an entrance to the recessed portions.

2. A carrier that is made of a composite material including fibers and a resin material and has a holding hole for holding a disk-shaped substrate when main surfaces of the substrate are polished or ground, wherein:

an inner circumferential wall surface of the holding hole has a plurality of recessed portions,

the plurality of recessed portions are formed by removing the fibers exposed from the inner circumferential wall surface,

the plurality of recessed portions extend in a surface direction of the carrier orthogonal to the inner circumferential wall surface toward the outside of the holding hole and have concave shapes when they were regarded as a section, and

the plurality of recessed portions are filled with a resin so as to block at least an entrance to the recessed portions.

3. The carrier according to claim 1 or 2, wherein the resin with which the plurality of recessed portions are filled is a resin having a lower hardness than that of the resin material included in the composite material.

4. The carrier according to any of claims 1 to 3, wherein the resin with which the plurality of recessed portions are filled is a thermoplastic resin.

5. The carrier according to any of claims 1 to 4, wherein, with regard to a roughness of a surface of the inner circumferential wall surface of the holding hole, Ra is 1.0 μm or less.

6. The carrier according to any of claims 1 to 5, wherein a length, in the surface direction of the carrier, of the predetermined region is 100 μm or less.

7. The carrier according to any of claims 1 to 6, wherein the resin with which the recessed portions are filled covers the inner circumferential wall surface of the holding hole.

8. A method for manufacturing a magnetic disk substrate, comprising processing for processing main surfaces of a disk-shaped substrate by horizontally holding the disk-shaped substrate in the holding hole of the carrier according to any of claims 1 to 7, pressing processing surfaces of surface plates against the main surfaces of the disk-shaped substrate, and moving the processing surfaces of the surface plates and the disk-shaped substrate relative to each other.

9. The method for manufacturing a magnetic-disk substrate according to claim 8, wherein the processing is polishing processing for supplying a polishing liquid containing polishing abrasive particles between polishing pads that are attached to surfaces of the surface plates and the main surfaces of the disk-shaped substrate, and polishing the main surfaces of the disk-shaped substrate.

10. The method for manufacturing a magnetic-disk substrate according to claim 8, wherein the processing is grinding processing for grinding the main surfaces of the disk-shaped substrate with surface plates to which fixed abrasive particles are attached.

11. The method for manufacturing a magnetic-disk substrate according to any of claims 8 to 10, wherein a difference between a hole diameter of the holding hole and an outer diameter of the disk-shaped substrate is in a range of 0.1 to 1.0 mm.

12. The method for manufacturing a magnetic-disk substrate according to any of claims 8 to 11, wherein the substrate is a glass substrate.

13. A method for manufacturing a magnetic disk, in which at least a magnetic recording layer is formed on a magnetic-disk substrate that is obtained with the manufacturing method according to any of claims 8 to 12.