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DESCRIPTION

MAGNETIC DISK SUBSTRATE AND PRODUCTION METHOD OF
MAGNETIC DISK

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CROSS-REFERENCES TO RELATED APPLICATIONS

This application is an application filed under 35 U.S.C. §111(a) claiming benefit pursuant to 35 U.S.C. §119(e) of the filing date of Provisional Application No. 60/606,886 filed September 3, 2004, pursuant to 35 U.S.C. §111(b).

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TECHNICAL FIELD

This invention relates to a magnetic disk substrate and a production method of a magnetic disk.

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BACKGROUND ART

Magnetic disk devices have made a remarkable progress as external storage devices for computers owing to their superior cost performance ratio and further progress is expected. An aluminum type substrate has been used in the past as a substrate for a magnetic disk which is mounted to the magnetic disk device, but glass substrates, such as chemically-tempered glass and crystallized glass have gradually gained wider application because they have high impact resistance and can be easily made flat. In other words, the aluminum type substrate can easily provide a magnetic disk having excellent magnetic characteristics but involves the problem of lack of flatness because it suffers plastic deformation during a mechanical process such as polishing. In contrast, the glass substrate can be easily made flat because it has high surface hardness and does not suffer the plastic deformation described above.

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To polish a surface of a glass substrate, it has been customary to fit glass substrates into a plurality of circular retaining holes of a polishing carrier, the

polishing carrier having, around its outer circumference, driving gears which mesh with the teeth of a polishing machine. Polishing is generally conducted as an upper plate and a lower plate of the polishing machine are reversely rotated while the glass substrate is clamped between a pair of polishing machine plates (upper plate and lower plate). Such a polishing carrier is obtained by stacking a predetermined number of prepregs made by causing a glass woven fabric to be impregnated with an epoxy resin and drying the woven fabric, for example, and by integrally heating and press-molding them. As described above, the polishing carrier is generally formed of a fiber reinforced resin in order to acquire high rigidity. When the glass substrate is polished by using such a polishing carrier, however, scratches occur due to contact between the outer end face of the glass substrate (that is, outer peripheral side surface) and the inner peripheral surface of the circular retaining holes of the polishing carrier.

The following problems have so far been pointed out regarding the scratches of the outer end face of the glass substrate.

In other words, when the glass substrate is taken out from, or put into, an accommodation case made of polycarbonate, or the like, the scratches on the outer end face of the glass substrate cause particles by contact with the inner peripheral surface of the accommodation case. The particles generated from the outer end face adhere to the surface of the glass substrate or magnetic disk, so that so-called "thermal asphericity" occurs.

Therefore, various studies have been made to solve this problem. For example, the inside of the polishing carrier can be formed of a material having hardness of 100 or below (Japanese Unexamined Patent Publication (Kokai) No. 2000-288922). The polishing carrier can have a notch shape (Japanese Unexamined Patent Publication

(Kokai) No. 2000-288921). The diameter of the retaining holes of the polishing carrier can be greater by 0.4 to 2.0 mm than the diameter of the glass substrate (Japanese Unexamined Patent Publication (Kokai) No. 2000-84834).

5 The ratio (R/r) of a radius R of the retaining holes of the polishing carrier to a radius r of the glass substrate is set to 1.030 or above (Japanese Unexamined Patent Publication (Kokai) No. 2002-326156), and so forth.

10 The following problem has also been pointed out regarding the scratches on the outer end face of the glass substrate.

Among the glass substrates used as the substrates of the magnetic disks, chemical tempered glass contains
15 sodium as a main alkali metal and crystallized glass contains lithium. Because the ion radius of these metal ions is small, the ions are easily mobile, particularly at a high temperature. Though this mechanism has not yet been clarified sufficiently, the sodium ions and the
20 lithium ions that have moved to the surface of the magnetic disk react with surrounding materials, form various chemical compounds such as hydroxides and carbonates and also form protrusions on the surface of the magnetic disk, and possibly impinge against the
25 flying head to cause a head crash. As these ions corrode the magnetic film, they invite deterioration of the characteristics of the magnetic film, cause errors during recording/reproduction and can also cause a head crash. Further, when these alkali metal ions adhere to the head,
30 there are the possibility of corrosion of the magnetic head device itself and the possibility of a head crash.

The protrusions that presumably result from these sodium ions and lithium ions exist mostly on the inner and outer peripheral end faces of the magnetic disk,
35 particularly on the scratches on the outer end face. In other words, it has been clarified that the scratches on the outer end face of the glass substrate may deteriorate

the reliability of the magnetic disk apparatus.

As means for solving this problem, a method that applies at least one of an alkali metal ion insolubilizing treatment and a treatment for reducing the alkali metal content at the outer end face of the glass substrate, and polishes the main surface of the glass substrate after the insolubilizing treatment or the reducing treatment, has been disclosed (Japanese Unexamined Patent Publication (Kokai) No. 2001-23155).

DISCLOSURE OF THE INVENTION

The inventor of this invention has found that the polishing carriers disclosed in the first to fourth patent documents mentioned above provide certain effects in reducing the scratches of the outer end face of the glass substrate and in reducing the particles occurring upon contact with the inner peripheral surface of the accommodation container but these polishing carriers do not provide the number of scratches that can completely eliminate the protrusions that may result from the movement of the sodium ions and the lithium ions described above.

These polishing carriers limit the shape, material and hardness of the carriers, become unusable due to wear in the course of repetition of use and impede a decrease in the polishing cost.

The method disclosed by the fifth patent document '155 first applies an insolubilization treatment at the outer end face of the glass substrate or a treatment for reducing the alkali metal content and then conducts polishing. Therefore, it has been found that scratches develop due to the contact between the outer end face of the glass substrate and the inner peripheral surface of circular retaining holes of the polishing carrier during polishing and the number of scratches is not reduced to the number of scratches that can completely eliminate the protrusions that may result from the movement of the

sodium ions and the lithium ions described above.

When the glass substrate is polished using a polishing carrier, this invention provides a production method for a magnetic disk substrate that can be applied
5 irrespective of the shape, material and hardness of the polishing carrier and can prevent the occurrence of scratches on an outer end face of the glass substrate as well as the occurrence of protrusions that may presumably result from the movement of sodium ions and lithium ions,
10 a magnetic disk glass substrate obtained by such a method and having excellent characteristics, a production method for a magnetic disk characterized in that a magnetic recording layer is formed on such a magnetic disk glass substrate, and a magnetic disk.

15 To solve the problems described above, the present invention provides the following inventions.

(1) A production method for a magnetic disk substrate which polishes a glass substrate by holding the glass substrate in a polishing carrier, characterized in that
20 polishing is carried out by using a polishing carrier in which an inner surface capable of coming into contact with an outer end face of the glass substrate is coated with a resin.

(2) The production method for a magnetic disk substrate as described in (1), wherein the resin is a thermoplastic
25 or thermosetting resin.

(3) The production method for a magnetic disk substrate as described in (2), wherein the thermoplastic resin is a polyester, polyamide, polyolefin, ABS or polystyrene
30 resin.

(4) The production method for a magnetic disk substrate as described in (2), wherein the thermosetting resin is an epoxy, phenol, unsaturated polyester or polyimide
resin.

35 (5) The production method for a magnetic disk substrate as described in (1) through (4), wherein the resin is not fiber reinforced.

(6) The production method for a magnetic disk substrate as described in any of (1) through (5), wherein the thickness of the resin coating is 10 μ m to 1 mm.

5 (7) The production method for a magnetic disk substrate as described in any of (1) through (6), wherein the polishing carrier is formed of a fiber reinforced resin.

(8) The production method for a magnetic disk substrate as described in (1) through (7), wherein glass of the glass substrate is glass containing an alkali metal.

10 (9) The production method for a magnetic disk substrate as described in (8), wherein the alkali metal is lithium.

(10) A production method for a magnetic disk characterized in that a magnetic recording layer is formed on the magnetic disk substrate as described in any
15 of (1) through (9).

(11) A glass substrate polishing carrier formed of a fiber reinforced resin, characterized in that an inner surface thereof capable of coming into contact with an outer end face of a glass substrate is resin coated.

20 (12) A magnetic disk substrate produced by using a production method of a magnetic disk substrate as described in any of (1) through (10), wherein the total number of scratches of an outer end face observed when an entire circumference of the outer end face is observed
25 through an optical microscope having a magnification of 120X is not greater than 100.

When glass substrate is polished by using the polishing carrier, this invention provides a production method for a magnetic disk substrate capable of
30 preventing the occurrence of scratches on an outer end face of the glass substrate, a magnetic disk glass substrate obtained by such a method and having excellent characteristics, a production method of a magnetic disk characterized in that a magnetic recording layer is
35 formed on such a magnetic disk glass substrate, and a magnetic disk.

BEST MODE FOR CARRYING OUT THE INVENTION

In the production method of the magnetic disk substrate according to the invention, polishing is carried out by using a polishing carrier in which the inner surface can come into contact with an outer end face of the glass substrate and is coated with resin when the glass substrate is held and polished by the polishing carrier.

Amorphous, chemically tempered or crystallized glass that has generally been used for the magnetic disk substrate can be used as the glass substrate in the invention. Examples are glasses such as soda lime, aluminosilicate, lithium silicate, lithium aluminosilicate, aluminoborosilicate, and so forth. As the chemical tempered glass, glass that is brought into contact with a molten salt at a high temperature to cause ion exchange of alkali ions in the glass with different kinds of alkali ions in the molten salt and is tempered by the compressive stress is suitable. Examples of the crystallized glass are those which are obtained by reheating glass under a controlled condition and precipitating and growing a large number of fine crystals. Concrete examples are an $\text{Al}_2\text{O}_3\text{-SiO}_2\text{-Li}_2\text{O}$ type, a $\text{B}_2\text{O}_3\text{-Al}_2\text{O}_3\text{-SiO}_2\text{-Li}_2\text{O}$ type, and so forth. The invention can prevent the occurrence of the scratches of the outer end face of the glass substrate and the occurrence of protrusions on a magnetic film, a protective film, etc, that may presumably result from the movement of sodium ions and lithium ions when glass of the glass substrate contain the alkali metal. The thicknesses of such glass substrates are generally selected from the range of about 0.1 to about 2 mm.

Polishing in the invention can include lapping and polishing as long as they can be carried out by using the polishing carrier. Lapping is defined as pre-process for polishing. In the case of amorphous and chemical tempered glass, lapping is generally carried out by

abrading the surface of the glass substrate and a plate through a polishing slurry prepared by dispersing free abrasives in water, or the like. In the case of polishing, the polishing slurry is used for all of
5 amorphous, chemically tempered and crystallized glasses. Examples of the abrasives are cerium oxide, zirconium oxide, silicon dioxide, and so forth, but cerium oxide is suitable from the aspect of a polishing speed.

These polishing operations can be carried out in a customary manner in the invention but it is necessary that polishing is carried out by using the polishing carrier in which the inner surface capable of coming into contact with the outer end face of the glass substrate is coated with resin. The resin used for resin coating is a
15 thermoplastic resin such as polyester, polyamide, polyolefin, ABS or polystyrene resin or a thermosetting resin such as epoxy, phenol, unsaturated polyester or polyimide resin, but an epoxy resin is most suitable. Preferably, these resins are not fiber reinforced. The
20 thickness of the resin coating is in the range of about 10 μm to about 1 mm.

On the other hand, the polishing carrier itself, that is resin coated in the invention, is generally formed of a fiber reinforced resin. Examples of the resin in this fiber reinforced resin include
25 thermoplastic resins such as polyester, polyamide, polyolefin, ABS or polystyrene resin or thermosetting resins such as epoxy, phenol, unsaturated polyester or polyimide resin, but the resin need not be same as the resin in the resin coating. The resin in the fiber
30 reinforced resin is generally a glass fiber, a carbon fiber or an aramide fiber.

The invention further provides a glass substrate polishing carrier formed of the fiber reinforced resin and a glass substrate polishing carrier in which the
35 inner surface can come into contact with an end face of the glass substrate and is coated with resin (preferably

with a resin that is not fiber reinforced).

The resulting magnetic disk substrate is polished.
(When the polishing is lapping, the end face on the inner
peripheral side facing inner diameter holes and the end
5 face on the outer peripheral side are chamfered,
respectively, the resulting inner peripheral side end
face and outer peripheral side end face are polished to
mirror surface and the main surface of the glass
substrate is polished). Thereafter, the magnetic disk
10 substrate is washed and dried in a customary manner and
is used for the production of a magnetic disk. For
example, texturing for forming texture grooves in a head
traveling direction is first applied to the substrate,
whenever necessary. Next, a base film made of a Cr alloy
15 is formed by sputtering on this substrate. A magnetic
recording layer made of a Co base alloy is formed to a
thickness of about 10 to 100 nm on this base film, for
example. A protective film of carbon, or the like, is
preferably formed further on this magnetic recording
20 layer to improve corrosion resistance, sliding
resistance, etc. Hydrogenated carbon, by sputtering, or
diamond-like carbon, by CVD, as examples, are formed to a
film thickness of about 1 to about 50 nm on the carbon.
Perfluoropolyether or a product obtained by esterifying
25 or amidating the terminals of the former is diluted with
a solvent and is applied by spraying, dipping, spin
coating, etc to a film thickness of about 0.5 to 5 nm, as
a lubrication layer, to the surface of this carbon
protective film, and the durability, the reliability, etc
30 can be further improved.

The magnetic glass substrate obtained by the method
of the invention has a small number of scratches on the
outer end face and can prevent the occurrence of
protrusions on the magnetic film and the protective film
35 that may result from the movement of sodium ions and
lithium ions when the magnetic disk is produced by using
this glass substrate.

Though the invention will be explained in further detail with reference to Examples thereof, the invention is not limited to these Examples unless the invention exceeds the gist thereof.

5 I. In the Example and the Comparative Examples, the occurrence of scratches on the end face of the glass substrate is determined by setting magnification of an optical microscope to 120X and observing the entire periphery of the outer end face through the optical
10 microscope.

II. The occurrence of the protrusions on the surface of the magnetic disk is confirmed in the following way.

(1) The glass substrates are charged into a magnetic disk production process and magnetic disks are obtained.

15 (2) The magnetic disks are accommodated inside a magnetic disk drive and are left standing under a constant temperature/constant humidity condition of 85°C and 90%.

(3) After left standing for 240 hours, the magnetic
20 disks are taken out from the magnetic disk drive.

(4) The outer peripheral portion of each magnetic disk taken out is inspected and measured by eye and with halogen light. The outer peripheral portions of the protrusions occurring on the surfaces of the magnetic
25 disk appear slightly opaque when observed by eye under halogen light. The degree of occurrence of a slightly opaque portion is judged in the following five levels:
Level 0: No opaque portion.

Level 1: Up to two slightly opaque portions of 5 mm or
30 less in the circumferential direction per surface.

Level 1.5: Three to four slightly opaque portions of 5 mm or less in the circumferential direction per surface.

Level 2: Five to ten slightly opaque portions of 5 mm or less in the circumferential direction per surface.

35 Level 3: Eleven or more slightly opaque portions of 5 mm or less in the circumferential direction per surface, or slightly opaque portions greater than 5 mm in the

circumferential direction occur in less than 1/3 of entire circumference.

Level 4: Slightly opaque portions greater than 5 mm in the circumferential direction occur in more than 1/3 to less than 4/5 of entire circumference.

Level 5: Slightly opaque portions greater than 5 mm in the circumferential direction occur in more than 4/5 of entire circumference.

Example 1:

10 A 2.5-in. lithium silicate-type crystallized glass substrate was polished by using a polishing carrier (material: glass fiber reinforced epoxy resin) in which the inner surface was resin coated. The resin coating (without reinforcing fiber) was formed of an epoxy resin
15 (Konishi Bond E set: two-component mixing chemical reaction-type epoxy resin adhesive) to a thickness of 50 μm . In polishing, cerium oxide polishing slurry (concentration 10 mass%) was supplied and polishing was carried out at a rate of revolution of the plates of 35
20 rpm and a processing pressure of 70 g/cm^2 (about 6,864 Pa) for 40 minutes. After the glass substrate was washed and dried, the occurrence of scratches on the outer end face of the resulting glass substrates was observed. As a result, the number of scratches was 17.

25 Next, the resulting substrate was subjected to texture processing by using diamond slurry and a non-woven fabric and was fitted to a sputtering apparatus. A base film of a chromium alloy and a magnetic film of a cobalt alloy were formed by sputtering on both surfaces
30 of the substrate. After a diamond-like carbon film was formed by sputtering on both surfaces and "Fonblin Z-Tetraol" (product of Solvay Solexis Co.) as a lubricant was further coated to form a magnetic disk. The total thickness of the films formed was 90 nm and the thickness
35 of the film formed by CVD was 10 nm.

 This disk was Level 0 and protrusions were not observed on the surfaces of the magnetic disk.

Comparative Example 1:

A glass substrate and a magnetic disk were produced in the same way as in Example 1 with the exception that a polishing carrier with notches that could come into
5 contact with the glass substrate was used. When the occurrence of the scratches on the outer end face of the resulting glass substrate was observed, the number of scratches was 198. The resulting magnetic disk had a Level 2 to 3 and protrusions were observed on the
10 surfaces of the magnetic disk.

Comparative Example 2:

A glass substrate and a magnetic disk were produced in the same way as in Example 1 with the exception that a polishing carrier in which the inner surface was not
15 resin coated was used. When the occurrence of scratches on the outer end face of the resulting glass substrate was observed, the number of scratches was 376. The resulting magnetic disk had the Level 4 to 5 and protrusions were observed on the surfaces of the magnetic
20 disk.

INDUSTRIAL APPLICABILITY

When glass substrate is polished by using the polishing carrier, this invention provides a production
25 method for a magnetic disk substrate that can be applied irrespective of shape, material and hardness of a polishing carrier and can prevent the occurrence of scratches on an outer end face of the glass substrate, a magnetic disk glass substrate obtained by such a method
30 and having excellent characteristics, a production method of a magnetic disk characterized in that a magnetic recording layer is formed on such a magnetic disk glass substrate, and a magnetic disk.

CLAIMS

1. A production method of a magnetic disk substrate by polishing a glass substrate by holding said glass substrate by a polishing carrier, characterized in that polishing is carried out by using a polishing carrier in which an inner surface capable of coming into contact with an outer end face of the glass substrate is coated with a resin.
2. The production method of a magnetic disk substrate according to claim 1, wherein said resin is a thermoplastic or thermosetting resin.
3. The production method of a magnetic disk substrate according to claim 2, wherein said thermoplastic resin is a polyester, polyamide, polyolefin, ABS or polystyrene resin.
4. The production method of a magnetic disk substrate according to claim 2, wherein said thermosetting resin is an epoxy, phenol, unsaturated polyester or polyimide resin.
5. The production method of a magnetic disk substrate according to any of claims 1 through 4, wherein said resin is not fiber reinforced.
6. The production method of a magnetic disk substrate according to any of claims 1 through 4, wherein a thickness of said resin coating is 10 μm to 1 mm.
7. The production method of a magnetic disk substrate according to claim 1, wherein said polishing carrier is formed of a fiber reinforced resin.
8. The production method of a magnetic disk substrate according to any of claims 1 through 4, wherein glass of said glass substrate is glass containing an alkali metal.
9. The production method of a magnetic disk substrate according to claim 8, wherein said alkali metal is lithium.
10. A production method of a magnetic disk characterized in that a magnetic recording layer is

formed on said magnetic disk substrate according to any of claims 1 through 4.

11. A glass substrate polishing carrier formed of a fiber reinforced resin, characterized in that an inner
5 surface thereof capable of coming into contact with an outer end face of a glass substrate is resin coated.

12. A magnetic disk substrate produced by using a production method of a magnetic disk substrate according to any of claims 1 through 4, wherein the total of
10 scratches on an outer end face, observed when an entire circumference of the outer end face is observed through an optical microscope having a magnification of 120X, is not greater than 100.