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BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

5 The present invention relates to a glass substrate for a magnetic recording medium equipped on various magnetic recording apparatus such as external recording apparatus for computers, a production method thereof, and a magnetic recording apparatus using the substrate.

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DESCRIPTION OF THE RELATED ART

 A production method of glass substrate used as a substrate for a magnetic recording medium (hard disk)
15 generally includes a process for edge polishing of the glass substrate. Prior art edge polishing methods include two methods, a method in which a plurality of substrates are stacked, and the edge of the substrate is polished by pressing a brush against the edge while dropping a slurry
20 containing abrasive particles such as cerium oxide, and a method in which the substrate surface is clamped by means of a vacuum chuck in a single disk process, rigid polyurethane or the like is pressed against the substrate edge surface to polish the edge surface while dropping a
25 slurry containing abrasive particles such as cerium oxide.

 In association with recent requirements for increasing recording density of magnetic recording medium (hard disk), it is required to maintain the flying height of the magnetic head to a low value, from such requirements,
30 quality required for the substrate surface becomes

stricter. In the above-described conventional polishing method, since polishing is performed by stacking the substrates or clamping the substrate surface, there is a problem of occurrence of defects on the substrate surface.

5 This defect remains even in the process of polishing the substrate surface (for example, lapping or polishing), which finally has adverse effects on the surface of the magnetic recording medium. For example, this deteriorates flying of the magnetic head, which in the

10 worst case leads crashing of the magnetic recording apparatus.

Further, in the production of glass substrate for magnetic recording medium, the edge surface of the substrate is polished, the quality of the edge surface is

15 related directly to an amount of alkali elution of the glass substrate for magnetic recording medium, which is very important in reliability of the magnetic recording medium.

Therefore, a method for polishing a high-quality edge surface without generating a defect on the surface of the

20 glass substrate becomes necessary.

SUMMARY OF THE INVENTION

The present invention which solves the above problems

25 includes the following.

A first aspect of the present invention relates to a production method of a glass substrate for magnetic recording medium having an inner diameter and an outer diameter. One embodiment of the present invention is a

30 production method of a glass substrate for magnetic

recording medium comprising an edge polishing step of a glass substrate, wherein the edge polishing step is a step in which the inner diameter of the glass substrate is chucked, in a single disk process, and the edge surface
5 of the outer diametral side of the glass substrate is polished using a polishing tape or a grindstone.

Another embodiment of the present invention is a production method of a glass substrate for magnetic recording medium comprising an edge polishing step,
10 wherein the edge polishing step is a step in which the outer diameter of the glass substrate is chucked in a single disk process, and the edge surface of the inner diametral side of the glass substrate is polished using a polishing tape or a grindstone.

15 A still further embodiment of the present invention is a production method of a glass substrate for magnetic recording medium having an inner diameter and an outer diameter comprising steps of:

(a) forming a shape of a disk-shaped glass substrate
20 having a center hole,

(b) performing edge polishing of the disk-shaped glass substrate, and

(c) performing surface finishing of the disk-shaped glass substrate,

25 wherein the edge polishing step, above step (b), is a step in which the inner diameter of the glass substrate is chucked in a single disk process, and the edge surface of the outer diametral side of the glass substrate is polished using a polishing tape or a grindstone.

30 A yet further embodiment of the present invention is

a production method of a glass substrate for magnetic recording medium having an inner diameter and an outer diameter comprising steps of:

(a) forming a shape of a disk-shaped glass substrate
5 having a center hole,

(b) performing edge polishing of the disk-shaped glass substrate, and

(c) performing surface finishing of the disk-shaped glass substrate,

10 wherein the edge polishing step, above step (b), is a step in which the inner diameter of the glass substrate is chucked in a single disk process, and the edge surface of the inner diametral side of the glass substrate is polished using a polishing tape or a grindstone.

15 A yet further embodiment of the present invention is a production method of a glass substrate for magnetic recording medium having an inner diameter and an outer diameter comprising an edge polishing step of a glass substrate, wherein the edge polishing step comprises a step
20 in which the inner diameter of the glass substrate is chucked in a single disk process, and the edge surface of the outer diametral side of the glass substrate is polished using a polishing tape or a grindstone, and a step in which the outer diameter of the glass substrate is chucked in
25 a single disk process, and the edge surface of the inner diametral side of the glass substrate is polished using a polishing tape or a grindstone.

A yet further embodiment of the present invention is a production method of a glass substrate for magnetic
30 recording medium having an inner diameter and an outer

diameter comprising steps of:

(a) forming a shape of a disk-shaped glass substrate having a center hole,

(b) performing edge polishing of the disk-shaped glass substrate, and

(c) performing surface finishing of the disk-shaped glass substrate,

wherein the edge polishing step, above step (b), comprises a step in which the inner diameter of the glass substrate is 10
chucked in a single disk process, and the edge surface of the outer diametral side of the glass substrate is polished using a polishing tape or a grindstone, and a step in which the outer diameter of the glass substrate is 15
chucked in a single disk process, and the edge surface of the inner diametral side of the glass substrate is polished using a polishing tape or a grindstone.

Further, in the first aspect of the present invention the edge polishing step is a step in which polishing is performed using a polishing tape containing abrasive 20
particles selected from the group consisting of diamond, aluminum oxide, cerium oxide, silicon carbide, and colloidal silica. In using the above polishing tape, the edge polishing step employs a wet polishing method using a slurry, or a dry polishing method without using a slurry. 25
Still further, when the edge polishing step is the wet method, the edge polishing step is a step for polishing while dropping (or flowing) a slurry containing abrasive particles selected from the group consisting of diamond, aluminum oxide, cerium oxide, silicon carbide, and 30
colloidal silica, or a step for polishing while dropping

(or flowing) water or an aqueous solution not containing abrasive particles selected from the group consisting of water, an aqueous solution of alkali which is pH adjusted with alkali, and an aqueous solution containing a
5 surface-active agent.

Further, in the first aspect of the present invention the edge polishing step is a step in which polishing is performed using a polishing tape formed of a material selected from polyurethane, polyester and nylon while
10 dropping (or flowing) water or an aqueous solution not containing abrasive particles selected from the group consisting of water, an aqueous solution of alkali which is pH adjusted with alkali, and an aqueous solution containing a surface-active agent.

15 In the first aspect of the present invention, the edge polishing step is a step in which polishing is performed using a polishing tape formed of a material selected from polyurethane, polyester and nylon not containing abrasive particles while dropping (or flowing) a slurry containing
20 abrasive particles selected from the group consisting of diamond, aluminum oxide, cerium oxide, silicon carbide, and colloidal silica.

In the first aspect of the present invention, the edge polishing step is a step in which polishing is performed
25 using a grindstone containing a material selected from the group consisting of diamond, aluminum oxide, cerium oxide, silicon carbide, and colloidal silica. In using the above grindstone, the edge polishing step is a step in which polishing is performed while dropping (or flowing) water
30 or an aqueous solution not containing abrasive particles

selected from the group consisting of water, an aqueous solution of alkali which is pH adjusted with alkali, and an aqueous solution containing a surface-active agent. Further, in using the above grindstone, the edge polishing
5 step is a step in which polishing is performed while dropping (or flowing) a slurry containing abrasive particles selected from the group consisting of diamond, aluminum oxide, cerium oxide, silicon carbide, and colloidal silica.

10 A second aspect of the present invention relates to a glass substrate for magnetic recording medium produced by the above mentioned production method of glass substrate for magnetic recording medium.

A third aspect of the present invention relates to a
15 magnetic recording medium wherein at least a magnetic layer, a protective layer and a liquid lubricating layer are formed on the substrate and the substrate is the glass substrate for magnetic recording medium specified in the second aspect of the present invention.

20 According to the production method of the present invention, a glass substrate for magnetic recording medium having a high-quality edge surface can be provided without generating defects on the surface of the glass substrate.

Further, the glass substrate for magnetic recording
25 medium is a high reliability glass substrate for magnetic recording medium suitable for high-density recording because the quality of the surface and edge surface is superior.

Still further, since the magnetic recording medium
30 according to the present invention uses a substrate for

magnetic recording medium having superior quality of the surface and the edge surface, it is a highly reliable magnetic recording medium suitable for high-density recording.

5 The above and other objects, effects, features and advantages of the present invention will become more apparent from the following description of embodiments thereof taken in conjunction with the accompanying drawings.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic illustration for explaining an edge polishing step (polishing of outer diametral edge surface) of the production method of a glass substrate for magnetic recording medium according to the present invention;

Fig. 2 is a schematic illustration for explaining an edge polishing step (polishing of outer diametral edge surface) of the production method of a glass substrate for magnetic recording medium according to the present invention;

Fig. 3 is a schematic illustration for explaining an edge polishing step (polishing of inner diametral edge surface) of the production method of a glass substrate for magnetic recording medium according to the present invention;

Fig. 4 is a schematic illustration for explaining an edge polishing step (polishing of inner diametral edge surface) of the production method of a glass substrate for

magnetic recording medium according to the present invention;

Figs. 5A to 5D are optical microscopic photographs of an edge surface of a glass substrate before polishing (A) of a glass substrate for magnetic recording medium and
5 after polishing (Figs. 5B to 5D) using various materials;

Figs. 6A and 6B are diagrams of the outer diametral edge surface of a glass substrate and state of chamfer (Fig. 6A) compared to an amount of alkali elution (Fig. 6B) when
10 a magnetic recording medium is produced from various glass substrates, measured by ion chromatography;

Fig. 7 is a cross sectional diagram of partial structure of the magnetic recording medium according to the present invention.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention will be described in detail in the following.

20 The first aspect of the present invention is the production method of a glass substrate for magnetic recording medium. In particular, the production method of a glass substrate for magnetic recording medium according to the present invention has a feature in edge
25 polishing step for polishing an inner diameter and an outer diameter of the glass substrate.

As used herein, the term "outer diameter" means the outer edge part of the glass substrate for a doughnut-like disk-shaped magnetic recording medium which is
30 generally used in the magnetic recording medium. As used

herein the term "inner diameter" means the inner edge part of the glass substrate for the doughnut-like disk-shaped magnetic recording medium. Further, As used herein, the term "single disk process" means a method in which the
5 substrate is used sheet by sheet without piling up the glass substrate by overlaying the surface of the glass substrate on another.

The inventors, in the course of accomplishing the present invention, have investigated problems of the
10 conventional production method of glass substrate for magnetic recording medium. That is, cause of generating defects on the substrate surface in the edge polishing step for polishing the outer diameter or the inner diameter of glass substrate for magnetic recording medium has been
15 investigated. It has been found that in the conventional edge polishing step in which a plurality of substrates are stacked and polished with a brush, defects on the substrate surface are generated due to the fact that particles of glass or abrasive particles such as cerium oxide are
20 remained between the substrates and they and the substrate surface rub against each other. Further, it has been found that in the method in which the substrate surface is fixed by a vacuum chuck and edge surfaces of inner diameter and outer diameter (hereinafter referred to as inner diametral
25 edge surface and outer diametral edge surface, respectively) of the glass substrate are polished with rigid polyurethane, defects are generated from the fact that the substrate surface is rubbed with defects on the clamp surface, and, foreign matter such as abrasive
30 particles attached to the chuck clamp surface is rubbed

with the substrate surface to generate defects. As a solution method to eliminate such defect generation, it is considered that the substrate surface or the chuck clamp surface is highly cleaned, or the surface precision (surface roughness) of the chuck clamp surface is improved. Further, as another solution, since in the current production method of glass substrate, in general, a thick plate is formed by a floating method or a press formation method, edge polishing is then performed, thereafter a specified plate thickness is obtained by surface polishing step, it is considered that after the edge polishing, the surface of the glass substrate is polished to remove defects. However, in this method, there may be a case that surface defects cannot be sufficiently removed. That is, since, for the purpose of decreasing the production steps or cost reduction, it is considered to reduce the thickness of the initial thick plate, thickness allowance for surface polishing is decreased, and as a result, there may be a case that surface defects generated in the foregoing steps such as edge polishing cannot be sufficiently removed.

The inventors have found a method to eliminate defects generated in the conventional edge polishing method. That is, from the point of view that edge polishing is required in the method where the glass substrate surface is not contacted with the surface of the glass substrate during edge polishing (in the case where a plurality of glass substrates are stacked and polished), or in the method where the glass substrate surface is not contacted with the clamp surface of the vacuum chuck (in the case where the glass substrate is fixed by a vacuum chuck and polished),

in the present invention, the inner diameter is chucked when the outer diametral edge surface is polished, or the outer diameter is chucked when the inner diameter is polished.

5 Specifically, the present invention provides a production method of a glass substrate for magnetic recording medium comprising an edge polishing step of a glass substrate, wherein the edge polishing step is a step
10 in which the inner diameter of the glass substrate is chucked in a single disk process, and the edge surface of the outer diametral side of the glass substrate is polished using a polishing tape or a grindstone. Further, the present invention provides a production method of a glass
15 substrate for magnetic recording medium comprising an edge polishing step of a glass substrate, wherein the edge polishing step is a step in which the outer diameter of the glass substrate is chucked in a single disk process, and the edge surface of the inner diametral side of the glass substrate is polished using a polishing tape or a
20 grindstone. Further, the present invention provides a production method of a glass substrate for magnetic recording medium comprising an edge polishing step, wherein the edge polishing step comprises a step in which the inner diameter of the glass substrate is chucked in
25 a single disk process, and the edge surface of the outer diametral side of the glass substrate is polished using a polishing tape or a grindstone, and a step in which the outer diameter of the glass substrate is chucked in a single disk process, and the edge surface of the inner diametral
30 side of the glass substrate is polished using a polishing

tape or a grindstone.

In the production method according to the present invention, as the material for the glass substrate, those materials used in the conventional glass substrate for magnetic recording medium can be used. Specifically, glass containing metal oxide can be preferably used. Examples thereof include soda lime glass, borosilicate glass, aluminosilicate glass, aluminoborosilicate glass, aluminosilicate-aluminum composition glass and the like, however, the present invention is not limited to these examples.

In the present invention, a rough glass substrate is formed from the above glass material. The rough glass substrate may be produced by a conventional method. For example, when a thick plate of rough glass substrate is produced, a thick plate is produced by a floating method, a pressing method, a grinding method or the like, and a rough glass substrate may be produced through respective steps of coring and edge polishing. The present invention is not limited to the above steps, but any method or step can be adopted if it is a production method adapted to the desired rough glass substrate.

Next, in the present invention, the outer edge surface or the inner edge surface of the rough glass substrate is polished.

In the edge polishing step of the present invention, the outer diameter or the inner diameter of the glass surface is chucked, and in a single disk process, the outer diametral side edge surface of the glass substrate is polished using a polishing tape or a grindstone. The

method of the present invention may be any one of a method of polishing only the outer diametral edge surface, a method of polishing only the inner diametral edge surface, and a method of polishing both of the outer diametral edge surface and the inner diametral edge surface. When both of the outer diametral edge surface and the inner diametral edge surface are polished in the present invention, any one of the outer diametral edge surface and the inner diametral edge surface may be polished first.

10 In the present invention, it is preferable to use a polishing tape or a grindstone as an abrasive. This is because when performing polishing according to the method of the present invention, if a conventional brush or rigid polyurethane is used, a throughput problem or a problem of abrasive passing into the surface of the glass substrate occurs.

The polishing tape used in the edge polishing method of the present invention is not specifically limited if it is possible to polish the edge surface of the glass substrate into a high-quality without defects such as chipping and not to damage the glass substrate surface, and can be, as an example, a polishing tape containing abrasive particles selected from diamond, aluminum oxide, cerium oxide, silicon carbide, and colloidal silica.

25 Further, the grindstone used in the present invention is not specifically limited if it is possible to polish the edge surface of the glass substrate into a high-quality without defects such as chipping and not to damage the glass substrate surface, and can be, as an example, a grindstone containing one selected from diamond, aluminum oxide,

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cerium oxide, silicon carbide, and colloidal silica. Still further, it is also possible to use a polishing tape of a material such as polyurethane, nylon, or polyester not containing abrasive particles.

5 To polish the outer diameter of the glass substrate by a polishing tape or a grindstone, the inner diameter of the glass substrate is chucked, and while rotating the glass substrate, a polisher equipped with the polishing tape or the grindstone may be pressed against the outer
10 diameter of the glass substrate. Further, to polish the inner diameter of the glass substrate, the outer diameter of the glass substrate is chucked, and while rotating the glass substrate, a polisher equipped with the polishing tape or the grindstone may be pressed against the inner
15 diameter of the glass substrate.

In the present invention, the edge polishing step can be carried out by a wet method using a slurry or by a dry method not using a slurry. When using a slurry, the slurry may be one which is used in conventional polishing. In
20 the present invention, a slurry containing abrasive particles selected from diamond, aluminum oxide, cerium oxide, silicon carbide, and colloidal silica can be preferably used. Further, in the present invention, water or an aqueous solution, not containing abrasive particles,
25 selected from water, an aqueous solution of alkali which is pH adjusted with alkali, and an aqueous solution containing a surface active agent can also be used.

The glass substrate with inner and/or outer diameter polished in the above edge polishing step, is then
30 subjected to a surface finishing step. The surface

finishing step, for example, processes the glass substrate surface by lapping for a specified thickness and polishing for surface finishing. The method of these finishing steps can be one which is used in the conventional glass substrate finishing. Thus, the glass substrate for magnetic recording medium is produced.

The production method of a glass substrate for magnetic recording medium according to the present invention will be described further in detail by respective steps.

In the following description, a disk-shaped glass substrate having a center hole will be described as an example. However, the present invention is not limited to this.

The present invention is a production method of a glass substrate for magnetic recording medium having an inner diameter and an outer diameter comprising steps of:

(a) forming a shape of a disk-shaped glass substrate having a center hole,

(b) performing edge polishing of the disk-shaped glass substrate, and

(c) performing surface finishing of the disk-shaped glass substrate,

wherein the edge polishing step, above step (b), is a step in which the inner diameter of the glass substrate is chucked, in a single disk process, and the edge surface of the outer diametral side of the glass substrate is polished using a polishing tape or a grindstone. Further, the present invention can comprise the steps (a) to (c) above, wherein the edge polishing step, the step (b), is

a step in which the outer diameter of the glass substrate is chucked, in a single disk process, and the edge surface of the inner diametral side of the glass substrate is polished using a polishing tape or a grindstone. Still further, the present invention can comprise the steps (a) to (c) above, wherein the edge polishing step, the step (b), is a step in which the inner diameter of the glass substrate is chucked, in a single disk process, and the edge surface of the outer diametral side of the glass substrate is polished using a polishing tape or a grindstone, and a step in which the outer diameter of the glass substrate is chucked, in a single disk process, and the edge surface of the inner diametral side of the glass substrate is polished using a polishing tape or a grindstone. Still further, in the present invention, when both of the outer diametral side edge surface and the inner diametral side edge surface are polished, any one of the outer diametral side edge surface and the inner diametral side edge surface may be polished first.

The above step (a) is a step for producing a rough glass substrate.

The rough glass substrate, in the case of a thick plate of rough glass substrate, is produced through, for example, respective steps of producing a thick glass plate, coring and edge polishing. Conventional methods can be used as those steps. For example, a thick plate is produced by a floating method, a pressing method, a grinding method or the like; coring step can be performed by a method such as a grinding by a core drill; and the edge polishing step can be achieved by a polishing using a grindstone, or the

like. Requirements of this step such as a glass material and the like are as described above. This step of the present invention is not limited to the above-described method, but can be achieved by various production methods
5 or steps.

The above step (b) is a step for performing edge polishing.

The method of edge polishing is as described in the above edge polishing step, and for the requirements of an
10 abrasive slurry and the like, the above description is, as is, applied.

The edge polishing step will be described below with reference to the drawings. In the following description, the present invention is given by way of illustration, and
15 thus is not intended to be limitative of the present invention.

First, the case of polishing the edge surface of outer diametral side will be described with reference to Figs. 1 and 2. Figs. 1 and 2 show the case of polishing using
20 a polishing tape.

Fig. 1 is a schematic illustration showing an edge polishing step of the present invention as viewed from the upper surface direction of a glass substrate for magnetic recording medium. Further, Fig. 2 is a schematic
25 illustration showing the edge polishing step of the present invention as viewed from the direction of an outer diametral edge surface 22 of the glass substrate for magnetic recording medium. As shown in Fig. 1 and Fig. 2, a glass substrate 1 is fixed by an inner diametral chuck
30 10, and while rotating the substrate 1 the outer diametral

edge surface 22 is polished using a polisher 18. The inner diametral chuck 10 is to have a mechanism which is possible to fix the glass substrate 1 at the inner diametral edge surface 26 thereof and to rotate the glass substrate 1 at a predetermined rotational speed. For the case of polishing the outer diametral edge surface 22 of the glass substrate 1 having an already polished inner diametral edge surface 26, the inner diametral chuck preferably has a mechanism or an element so that it does not damage the inner diametral edge surface 26, and preferably a surface of the chuck is treated by smoothing treatment. The polisher 18 is not specifically limited if it does not damage the surface of the glass substrate and can form a high-quality outer diametral edge surface 22 using the polishing tape 16. A conventional apparatus satisfying such requirements may be used. The illustrative apparatus shown in Fig. 1 and Fig. 2 has at least the polishing tape 16, and a presser 19 for pressing the polishing tape against the outer diametral edge surface of the glass substrate.

In the method of the present invention, while rotating the glass substrate 1, by the presser 19 of the polisher 18 the polishing tape 16 is pressed against the outer diametral edge surface 22 of the glass substrate 1 (arrow 20 of Fig. 1 and Fig. 2) to polish the outer diametral edge surface 22. The presser 19, as shown in Fig. 2, presses the polishing tape against the outer diametral edge surface 22 of the glass substrate 1 so that a polishing portion of the polishing tape contacts in parallel to the outer diametral edge surface 22 (arrow 20 of Fig. 1 and Fig. 2).

In the method of the present invention, the rotational

speed of the glass substrate 1 is 100 to 500 revolutions per minute (r.p.m.), preferably 200 to 300 r.p.m., most preferably 300 r.p.m. Although pressing pressure of the polishing tape 16 by the presser 19 may vary depending on
5 the type of the polishing tape, it is preferably 0.5 kgf/cm² to 3 kgf/cm², more preferably 0.5 kgf/cm² to 2.0 kgf/cm². The polishing time, though varying with the type of the polishing tape, is 10 sec to 1 min, preferably 20 sec to 40 sec.

10 In the present invention, the edge polishing step can be carried out by a wet method using a slurry, or by a dry method not using a slurry. When using a slurry, the slurry containing abrasive particles selected from diamond,
aluminum oxide, cerium oxide, silicon carbide, and
15 colloidal silica can be preferably used. Further, in the present invention, water or an aqueous solution, not containing abrasive particles, selected from water, aqueous solution of alkali which is pH adjusted with alkali, and an aqueous solution containing a surface-active agent
20 can also be used. Such a slurry or aqueous solution is introduced from a slurry introduction opening 12, and while dropping (or flowing) from the vicinity of the outer diametral edge surface 22, polishing is performed by the polishing tape 16.

25 Further, in the method of the present invention, the edge polishing step can be performed, using a tape not containing abrasive particles made of a material selected from polyurethane (for example, a polyurethane buff containing silicon), polyester and nylon, and while
30 dropping (or flowing) water or an aqueous solution selected

from water, aqueous solution of alkali which is pH adjusted with alkali, and an aqueous solution containing a surface-active agent.

Further, in the present invention, it is possible to
5 perform polishing using a tape not containing abrasive particles made of a material selected from polyurethane (for example, a polyurethane buff containing silicon), polyester and nylon, and while dropping (or flowing) a slurry containing abrasive particles selected from the
10 group consisting of diamond, aluminum oxide, cerium oxide, silicon carbide, and colloidal silica.

In the outer diametral edge polishing step, a grindstone can be used as an abrasive other than polishing tape. When a grindstone is used, the polishing tape 16
15 and the presser 19 shown in Fig. 1 and Fig. 2 are replaced with the grindstone, and polishing may be performed without using the polishing tape. Polishing conditions and the like are the same as in the case of polishing using the polishing tape.

20 Next, the case of polishing an inner diametral edge surface 26 will be described with reference to Fig. 3 and Fig. 4. Fig. 3 and Fig. 4 show a case where polishing is performed using a polishing tape.

Fig. 3 is a schematic illustration showing an edge
25 polishing step of the method of the present invention as viewed from the upper surface direction of a glass substrate for magnetic recording medium. Further, Fig. 4 is a schematic illustration showing the edge polishing step of the method of the present invention as viewed from
30 the direction of an outer diametral edge surface 22 of the

glass substrate for magnetic recording medium. As shown in Fig. 3 and Fig. 4, a glass substrate 1 is fixed by an outer diametral chuck 24, and while rotating the substrate 1 the inner diametral edge surface 26 is polished using a polisher 18. The outer diametral chuck 24 is to have a mechanism which is possible to fix the glass substrate 1 at the outer diametral edge surface 22 thereof and to rotate the glass substrate 1 at a predetermined rotational speed so that the center of the glass substrate 1 or the outer diameter is not deviated. In consideration of the case of polishing the inner diametral edge surface 26 of the glass substrate 1 having an already polished outer diametral edge surface 22, the outer diametral chuck 24 preferably has a mechanism or an element so that it does not damage the outer diametral edge surface 26, and preferably a surface of the chuck is treated by smoothing treatment. The polisher 18 is not specifically limited if it does not damage the surface of the glass substrate and can form a high-quality inner diametral edge surface 26 using the polishing tape 16. A conventional apparatus satisfying such requirements may be used. The illustrative apparatus shown in Fig. 3 and Fig. 4 has at least the polishing tape 16, and the presser 19 for pressing the polishing tape against the inner diametral edge surface of the glass substrate.

In the method of the present invention, while rotating the glass substrate 1, by the presser 19 of the polisher 18, the polishing tape 16 is pressed against the inner diametral edge surface 26 of the glass substrate 1 (arrow 20 of Fig. 3 and Fig. 4) to polish the inner diametral edge

surface 26. The presser 19, as shown in Fig. 4, presses the polishing tape against the inner diametral edge surface 26 of the glass substrate 1 so that a polishing portion of the polishing tape contacts in parallel to the inner
5 diametral edge surface 26 (arrow 20 of Fig. 3 and Fig. 4).

In the method of the present invention, the rotational speed of the glass substrate 1 is 100 to 500 revolutions per minute (r.p.m.), preferably 200 to 300 r.p.m., most preferably 300 r.p.m. Although pressing pressure of the
10 polishing tape 16 by the presser 19 may vary depending on the type of the polishing tape, it is preferably 0.5 kgf/cm² to 3 kgf/cm², more preferably 0.5 kgf/cm² to 2.0 kgf/cm². The polishing time, though varying with the type of the polishing tape, is 10 sec to 1 min, preferably 20 sec to
15 40 sec.

In the present invention, as described in the above edge polishing of the outer diametral edge surface 22, polishing can be performed by a wet method using a slurry, or by a dry method without using a slurry. Polishing
20 conditions such as the type of the polishing tape 16, the type of the slurry and the like are the same as described in polishing the outer diametral edge surface.

In the inner diametral edge polishing step, a grindstone can be used as an abrasive other than polishing
25 tape. When a grindstone is used, the polishing tape 16 and the presser 19 shown in Fig. 3 and Fig. 4 are replaced with the grindstone, and polishing may be performed without using the polishing tape. Polishing conditions and the like are the same as in the case of polishing using the
30 polishing tape.

The production method of a glass substrate for magnetic recording medium according to the present invention can include three types as the step (b): one is the type which uses the outer diametral edge polishing
5 step; second is the type which uses the inner diametral edge polishing step; and third is the type which uses both of the outer diametral edge polishing step and the inner diametral edge polishing step.

As shown in Figs. 1 to 4, the production method of the
10 present invention uses a single disk process for polishing sheet by sheet without stacking the surface of the glass substrate.

A step (c) is a surface finishing step. In this step, for example, surface lapping, polishing for surface
15 finishing or the like is performed. These steps can be performed using the conventional method. Specifically, surface lapping can use a procedure such as lapping by diamond pellet, free abrasive particles and cast iron surface plate, and polishing for surface finishing can be
20 achieved by polishing a glass substrate obtained from step (b) to a predetermined roughness using an abrasive such as cerium oxide, colloidal silica and the like, then rubbing the polished glass substrate using a neutral detergent and polyvinylalcohol (PVA) sponge.

25 Next, a second aspect of the present invention will be described.

The second aspect of the present invention is a glass substrate produced by the first aspect of the present invention. The glass substrate for magnetic recording
30 medium of the present invention is produced by the first

aspect of the present invention, and has high-quality inner diametral edge surface and outer diametral edge surface without defects on the glass substrate surface. Since the glass substrate for magnetic recording medium of the present invention is produced by the first aspect of the present invention, it is formed using the glass material described in the first aspect of the present invention.

In the following, evaluation of the thus obtained glass substrate will be described.

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Evaluation of glass substrate for magnetic recording medium

Results of inspecting the glass substrate obtained as above by an optical microscope are shown in Figs. 5A to 5D. In Fig. 5A shows the state of edge surface before polishing, Figs. 5B to 5D show states of edge surfaces in the case of polishing by the production method of the present invention using the abrasive shown in respective figures. Under the conditions of abrasive shown in Figs. 5A to 5D, the glass substrate for magnetic recording medium produced according to the production method of the present invention is found to have high-quality inner and outer diametral edge surfaces same as or better than those polished by the conventional method.

25 Further, the states of edge surfaces of the glass substrate for magnetic recording medium and comparison of the amount of alkali elution between those states by ion chromatography (I.C.) analysis are shown in Figs. 6A and 6B. Fig. 6A is an optical microgram of the state of each edge surface. Fig. 6A shows optical micrograms of an

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unprocessed glass substrate, a glass substrate having a chipping (when processed for 20 sec using an aluminum oxide #4000 tape and a slurry of cerium oxide) and the method of the present invention (when processed for 40 sec using an aluminum oxide #4000 tape and a slurry of cerium oxide). In the substrate with chipping, edge surface grind chipping remains due to insufficient polishing. In Fig. 6A, the edge surface represents the outer diametral edge surface. Further, "chamfer" means a portion which, when the portion of crossing the outer diametral edge surface of the glass substrate with the substrate surface (edge portion of outer diametral edge surface) is cut at a bevel, is its beveled portion. Fig. 6B is a graph showing the results of alkali amount eluted from the glass substrate of each state measured by I.C. analysis. As can be seen from the results, in the unprocessed glass substrate, the amount of alkali elution from the edge surface is more than that of the processed glass substrate. In the case of glass substrate with chipping, the elution amount is decreased from the unprocessed substrate, however, it is still in an insufficient level for glass substrate for use in high-density recording. By optimizing the edge polishing conditions, that is, performing edge polishing by the method of the present invention, the amount of alkali elution can be reduced to a level sufficient as a glass substrate for use in high-density recording.

Next, a third aspect of the present invention will be described. The third aspect of the present invention relates to a magnetic recording medium using the glass substrate for magnetic recording medium of the present

invention.

Fig. 7 shows an example of the magnetic recording medium according to the present invention. Fig. 7 is a partial structural sectional view of the magnetic

5 recording medium of the present invention.

In the present invention, the glass substrate produced according to the first aspect of the present invention (that is, the glass substrate according to the second aspect of the present invention) is used as a substrate

10 1. On surface of the substrate, a nonmagnetic metal layer 2, a nonmagnetic underlayer 3, a magnetic layer 4, a protective layer 5 and a liquid lubricating layer 6 are successively formed to construct the magnetic recording medium. The nonmagnetic metal layer 2, the nonmagnetic
15 underlayer 3, the magnetic layer 4, the protective layer 5 and the liquid lubricating layer 6 can be formed using conventional materials. Specifically, the nonmagnetic metal layer 2 is a metal layer comprising, for example, Ni-Al. The nonmagnetic underlayer 3 is an underlayer
20 comprising, for example, Cr, the magnetic layer 4 is a Co alloy, for example, a ferromagnetic alloy such as Co-Cr-Pt or Co-Cr-Ta, the protective layer 5 is, for example, a carbon protective layer or the like, further, the liquid lubricating layer 6 is a fluorinated lubricant or the like
25 such as perfluoropolyether type lubricants.

The magnetic recording medium of the present invention has been described with reference to Fig. 7, however, this structure is an example, and various modifications are possible according to the purpose of the magnetic recording
30 medium.

Next, the method of producing the magnetic recording medium will be described. The method of producing the magnetic recording medium of the present invention includes at least a step for polishing the edge surface
5 of the glass substrate to obtain the glass substrate for magnetic recording medium, and a step for forming the above layer structure on surface of the glass substrate for enabling recording.

The step for obtaining a glass substrate for magnetic
10 recording medium uses a method described in the production method of a glass substrate for magnetic recording medium.

In the step for forming the layer structure for enabling magnetic recording on the surface of the obtained glass substrate, the nonmagnetic metal layer 2 is formed
15 by sputtering or the like on the glass substrate obtained by the production method of the present invention, then, the nonmagnetic underlayer 3 is coated on the nonmagnetic metal layer 2, then the magnetic layer 4 on the nonmagnetic underlayer 3, and the protective layer 5 are formed on the
20 magnetic layer 4. Thereafter, the lubricant diluted with a solvent is coated on the surface of the protective layer 5.

In the present invention, it is preferable that the nonmagnetic metal layer 2 is Ni-Al, the nonmagnetic
25 underlayer 3 is a Cr layer, and the magnetic layer 4 is a Co-Cr-Pt alloy layer.

The nonmagnetic underlayer 3, the magnetic layer 4 and the protective layer 5, when these are, for example, a Cr nonmagnetic underlayer 3, a Co-Cr-Pt magnetic alloy layer
30 and a carbon protective layer, respectively, can be formed

by sputtering. Further, when the protective layer 5 is a carbon protective layer, it may be a carbon protective layer mainly comprising ordinary graphite or a DLC protective layer. Still further, the lubricating layer 5 6 can be formed by a dip coating method, a spin coating method or the like.

Thicknesses of these nonmagnetic metal layer 2, nonmagnetic underlayer 3, magnetic layer 4, protective layer 5 and lubricating layer 5 are those used in the 10 ordinary magnetic recording medium. The above structure is not limitative of the present invention. For example, in the above magnetic recording medium, a case where a recording layer is formed only on one surface of the glass substrate, however, alternatively, the recording layer 15 may be formed on both surfaces of the glass substrate.

Example

The present invention will be described further in detail with reference to the examples, however, the 20 following examples are not intended to limit the present invention.

Example 1

The inner diameter of a glass substrate for magnetic 25 recording medium, obtained through formation of a thick plate glass, coring and edge surface grinding, was chucked, and the glass substrate was rotated at 300 r.p.m. Against the outer diametral edge surface of the glass substrate, a polishing tape of aluminum abrasive particles (#4000) 30 was pressed with a pressing pressure of 1 kgf/cm² through

a pressing member of rubber hardness 60 σ , and polishing was performed for 20 seconds while dropping a slurry containing cerium oxide abrasive particles. When the surface of the obtained substrate was measured for strain
5 or displacement of the surface using laser light and inspected by a surface defect inspection apparatus for measuring presence of defects, no surface defects were detected. As for the quality of outer diametral edge surface, a quality same as or better than the case of
10 polishing by the conventional method was obtained.

Example 2

The inner diameter of a glass substrate for magnetic recording medium, obtained through formation of a thick
15 plate glass, coring and edge surface grinding, was chucked, and the glass substrate was rotated at 300 r.p.m. Against the outer diametral edge surface of the glass substrate, a polishing tape of diamond (#8000) was pressed with a pressing pressure of 1 kgf/cm² through a pressing member
20 of rubber hardness 60 σ , and polishing was performed for 20 seconds by dry polishing without using a slurry. When the surface of the obtained substrate was inspected as in Example 1, no surface defects were detected. As for the quality of outer diametral edge surface, a quality same
25 as or better than the case of polishing by the conventional method was obtained.

Example 3

The inner diameter of a glass substrate for magnetic
30 recording medium, obtained through formation of a thick

plate glass, coring and edge surface grinding, was chucked, and the glass substrate was rotated at 300 r.p.m. Against the outer diametral edge surface of the glass substrate, a cerium oxide grindstone was pressed with a pressing
5 pressure of 0.5 kgf/cm² and polishing was performed for 20 seconds while dropping a slurry containing cerium oxide abrasive particles. When the surface of the obtained substrate was inspected as in Example 1, no surface defects were detected. As for the quality of outer diametral edge
10 surface, a quality same as or better than the case of polishing by the conventional method was obtained.

Example 4

The inner diameter of a glass substrate for magnetic
15 recording medium, obtained through formation of a thick plate glass, coring and edge surface grinding, was chucked, and the glass substrate was rotated at 300 r.p.m. Against the outer diametral edge surface of the glass substrate, a grindstone of diamond (#4000) was pressed with a pressing
20 pressure of 0.5 kgf/cm², and polishing was performed for 20 seconds while dropping a coolant containing surface-active agent. When the surface of the obtained substrate was inspected as in Example 1, no surface defects were detected. As for the quality of outer diametral edge
25 surface, a quality same as or better than the case of polishing by the conventional method was obtained.

Example 5

The inner diameter of a glass substrate for magnetic
30 recording medium, obtained through formation of a thick

plate glass, coring and edge surface grinding, was chucked, and the glass substrate was rotated at 300 r.p.m. Against the outer diametral edge surface of the glass substrate, a polyurethane buff containing silicon was pressed with
5 a pressing pressure of 2.0 kgf/cm², and polishing was performed for 20 seconds while dropping a slurry containing cerium oxide abrasive particles. When the surface of the obtained substrate was inspected as in Example 1, no surface defects were detected. As for the quality of outer
10 diametral edge surface, a quality same as or better than the case of polishing by the conventional method was obtained.

Example 6

15 The inner diameter of a glass substrate for magnetic recording medium, obtained through formation of a thick plate glass, coring and edge surface grinding, was chucked, and the glass substrate was rotated at 300 r.p.m. Against the inner diametral edge surface of the glass substrate,
20 a cerium oxide grindstone was pressed with a pressing pressure of 0.5 kgf/cm², and polishing was performed for 20 seconds while dropping a slurry containing cerium oxide abrasive particles. When the surface of the obtained substrate was inspected as in Example 1, no surface defects
25 were detected. As for the quality of outer diametral edge surface, a quality same as or better than the case of polishing by the conventional method was obtained.

Example 7

30 The outer diameter of a glass substrate for magnetic

recording medium, obtained through formation of a thick plate glass, coring and edge surface grinding, was chucked, and the glass substrate was rotated at 300 r.p.m. Against the inner diametral edge surface of the glass substrate, 5 a fabric made of polyester was pressed with a pressing pressure of 2.0 kgf/cm², and polishing was performed for 20 seconds while dropping a slurry containing cerium oxide abrasive particles. When the surface of the obtained substrate was inspected as in Example 1, no surface defects 10 were detected. As for the quality of outer diametral edge surface, a quality same as or better than the case of polishing by the conventional method was obtained.

Results of the above Examples 1 to 7 are summarized in the following table. In the column of evaluation in 15 the table, "good" means that the produced glass substrate has excellent characteristics. Specifically, it means that the glass substrate produced by the method of the present invention has no defects on the surface, and the quality of the outer diametral edge surface is same as or 20 better than the case of polishing by the conventional method.

Table

	Presence of defects on the glass substrate surface	Quality of outer diametral edge surface	Evaluation
Example 1	None	Better than quality by the conventional method	Good
Example 2	None	Better than quality by the conventional method	Good
Example 3	None	Better than quality by the conventional method	Good
Example 4	None	Better than quality by the conventional method	Good
Example 5	None	Better than quality by the conventional method	Good
Example 6	None	Better than quality by the conventional method	Good
Example 7	None	Better than quality by the conventional method	Good

The present invention has been described in detail
5 with respect to preferred embodiments, and it will now be
apparent from the foregoing to those skilled in the art
that changes and modifications may be made without
departing from the invention in its broader aspect, and
it is the intention, therefore, in the apparent claims to
10 cover all such changes and modifications as fall within
the true spirit of the invention.



CLAIMS

1. A production method of a glass substrate for a magnetic recording medium having an inner diameter and an outer diameter, characterized by comprising an edge polishing step of a glass substrate,

wherein said edge polishing step is a step in which at least one of said inner and outer diameters of said glass substrate is chucked, in a single disk process, and an edge surface of at least one of the outer and inner diametral sides of said glass is polished.

2. A production method of a glass substrate for a magnetic recording medium having an inner diameter and an outer diameter characterized by comprising steps of:

- (a) forming a shape of a disk-shaped glass substrate having a centre hole,
- (b) performing edge polishing of said disk-shaped glass substrate, and
- (c) performing surface finishing of said disk-shaped glass substrate,

wherein said edge polishing step, the step (b), is a step in which at least one of said inner and outer diameters of said glass substrate is chucked, in a single disk process, and an edge surface of at least one of the outer and inner diametral sides of said glass substrate is polished.

3. A method according to claim 1 or 2, wherein in said edge polishing step said inner diameter of said glass substrate is chucked, and the edge surface of



the outer diametral side of said glass substrate is polished.

4. A method of a glass substrate according to any
5 one of the preceding claims, wherein in said edge
polishing step said outer diameter of said glass
substrate is chucked and the edge surface of the inner
diametral side of said glass substrate is polished.
- 10 5. A method according to claim 1 or 2, wherein in
said edge polishing step said inner diameter of said
glass substrate is chucked, in a single disk process,
and the edge surface of the outer diametral side of
said glass substrate is polished, said outer diameter
15 of said glass substrate is chucked in a single disk
process, and said edge surface of the inner diametral
side of said glass substrate is polished.
6. A method according to any one of the preceding
20 claims, wherein in said edge polishing step, the
polishing uses a polishing tape or a grindstone.
7. The method according to any one of the preceding
claims, characterized in that said edge polishing step
25 is a step for polishing by polishing tape containing
abrasive particles selected from the group consisting
of diamond, aluminium oxide, cerium oxide, silicon
carbide, and colloidal silica.
- 30 8. The method according to one of claims 1 to 6,
characterized in that said edge polishing step is a
step for polishing using a polishing tape made of a



material selected from polyurethane, polyester and nylon not containing abrasive particles.

9. The method according to any one of claims 1 to 6,
5 characterized in that said edge polishing step is a step for polishing using a grindstone containing a material selected from the group consisting of diamond, aluminium oxide, cerium oxide, silicon carbide, and colloidal silica.
- 10
10. The method according to any one of the preceding claims, characterized in that said edge polishing step further comprises polishing by a wet method using a slurry.
- 15
11. The method according to any one of claims 1 to 9, characterized in that said edge polishing step further comprises polishing by a dry method without using a slurry.
- 20
12. The method according to any one of claims 1 to 10, characterized in that said edge polishing step further comprises polishing while dropping a slurry containing abrasive particles selected from the group
25 consisting of diamond, aluminium oxide, cerium oxide, silicon carbide, and colloidal silica.
- 30
13. The method according to any one of claims 1 to 10, characterized in that said edge polishing step further comprises polishing while dropping water or an aqueous solution not containing abrasive particles and selected from the group consisting of water, an aqueous solution of alkali which is pH adjusted with



alkali, and an aqueous solution containing a surface-active agent.

14. A glass substrate for a magnetic recording medium
5 produced by the method according any one of the preceding claims.
15. A magnetic recording medium comprising at least a
magnetic layer, a protective layer and a liquid
10 lubricating layer formed on a substrate as defined in claim 14.