

MANUFACTURING METHOD OF GLASS SUBSTRATE
FOR MAGNETIC DISC AND MANUFACTURING APPARATUS THEREOF,
GLASS SUBSTRATE FOR MAGNETIC DISC,
MANUFACTURING METHOD OF MAGNETIC DISC, AND MAGNETIC DISC

The present disclosure relates to subject matters contained in Japanese Patent Applications NO. 2006-237879 filed on September 1, 2006 and NO. 2007-225341 filed on August 31, 2007, which are expressly incorporated herein by reference in their entireties.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a glass substrate for a magnetic disc used as a recording medium of a computer or the like, a magnetic disc, and manufacturing method of them.

2. Description of the Related Art

[0002] Along with advancement of information technology, information recording technology, especially magnetic recording technology, is making significant progress. As a substrate for a magnetic recording medium such as a hard disc drive (HDD), an aluminum substrate has been widely used. However, along with miniaturization, conversion into a thin substrate, and high density recording of a magnetic disc, a glass substrate is gradually replacing an aluminum substrate due to its superiority in flatness of the surface of the

substrate and substrate strength in comparison with the aluminum substrate.

[0003] Moreover, as density growth of magnetic recording technology is progressed, a magnetic head has changed from a thin film head to a magnetoresistance head (MR head) to a giant magnetic resistance head (GMR head). Along with the change in the magnetic head, float amount of the head from a substrate of the magnetic head is narrowed to around 8mm. A magnetic head mounting such a magnetoresistance effect element may occur a head crash or thermal asperity as a unique trouble. Thermal asperity is a trouble and causes a reading error when a magnetoresistance element is heated by adiabatic compression of air or by contact by a magnetic head when the magnetic head is in float flight and passes above minute convexity or concave portion on a magnetic disc surface. Therefore, extremely high-level of smoothness and flatness are required on the surface of a magnetic disc of a magnetic head mounting a magnetoresistance element. Moreover, if a magnetic layer is formed with dust or a foreign object attached, a convex portion is formed. Therefore, it is required to prevent generation of dust by removing convexity and concave portion and also to carry out high level cleansing for removing a foreign object for a glass substrate.

[0004] In the above-mentioned condition, importance of smoothness of a substrate edge surface has been conventionally recognized. Among conventional methods, as a method to polish an edge surface on outer circumference of a glass substrate,

a polishing method using a rotary brush described in the Patent Document 1 (Japanese Published Unexamined Patent Application No. 2003-159639) has been known. In this conventional polishing method, as shown in FIG. 5 (a), a disc-shaped glass substrate 1 is laminated to form a column and is fixed to a rotatable fixing equipment 51. Then, a rotary brush 50 is adjoined to the outer circumference and the glass substrate 1 and the brush 50 are rotated while polishing solution is supplied so that the outer circumference edge surface is polished.

[Patent Document 1] Japanese Published Unexamined Patent Application No. 2003-159639

[Patent Document 2] Japanese Published Unexamined Patent Application No. 2002-219642

[0005] Meanwhile, for the purpose of mounting a high-capacity magnetic recording medium on a mobile device, size of a substrate has been reduced in recent years. Instead of a conventional 3.5-inch substrate or a 2.5-inch substrate, 1.8-inch substrate, 1-inch substrate, or a smaller substrate has been demanded. Along with such a tendency, there occurs a problem that material such as sodium, potassium, or the like is separated out from a glass substrate.

[0006] It is considered that sodium or potassium is separated out from a glass substrate. If crystals of such material are separated out, head crush of thermal asperity may occur, which may result in increase in number of reading error. Sodium or potassium tends to be separated out when there is uneven portion

on a magnetic layer or a protection layer outside of the magnetic layer and the uneven portion on a protection layer of the like is prone to be created when there is damage on the glass substrate such as a crack. On the contrary, it is known that sodium or potassium is not separated out from a portion of a glass substrate which is efficiently mirror polished.

[0007] Separation of sodium or potassium has become a problem because it is difficult to carry out mirror polishing on a chamfering portion of a disc having a smaller radius.

[0008] Specifically, for example, as shown in FIG. 5 (b), along with reduction in scale of radius of the glass substrate 1, thickness thereof is also reduced and a groove formed by chamfering portions 2b next to the laminated glass substrates 1 is narrowed. Therefore, by the conventional brush polishing, an edge surface 2a can be sufficiently polished, though it is difficult to sufficiently mirror polish inside of the groove. Then, if separation of sodium or potassium occurs in the chamfering portion 2b, the separated crystal moves to main surface 1a and causes reading error. As another reason, there is a problem that a perpendicular magnetic recording magnetic disc which enables to improve recording density is more easily affected by the aspect of a substrate than an in-plane magnetic disc.

[0009] Here, as shown in FIG. 5 (c), if it is tried to sufficiently mirror polish the chamfering portion 1b by conventional brush polishing, it is required to polish the edge surface 2a more than conventional method and also more cutting

stock than conventional one is required. However, if time for processing is increased, productivity is lowered and it becomes difficult to carry out mass-production with low cost. Moreover, shape of the edge surface 2a becomes unstable and there is a possibility that circularity is worsened or quality of the chamfering portion 2b (both in size and shape) is varied. Further, if the cutting stock is increased, a range for polishing is drooped and its effect reaches the main surface 1a. Therefore, saving area may be reduced and dimension of the main surface 1a becomes smaller than design value, leading to a possibility that the disc cannot be used as a magnetic disc.

SUMMARY OF THE INVENTION

[0010] Therefore, the present invention is aimed at providing a glass substrate for a magnetic disc and a magnetic disc with improved reliability and durability enabled by mirror polishing a chamfering portion with high precision and small cutting stock to prevent separation of sodium or potassium, and manufacturing methods thereof.

[0011] To solve the above-mentioned problem, a manufacturing method of a glass substrate for a magnetic disc including an edge surface polishing step for polishing a chamfering portion provided on outer circumference portion of a disc-shaped glass substrate is characterized by that by use of an abrasive cloth which can be simultaneously in contact with the whole

circumference of a chamfering portion on one surface side of the glass substrate, the abrasive cloth and the glass substrate are relatively moved in the edge surface polishing step while the abrasive cloth is simultaneously pressed to the whole circumference of the chamfering portion on the one surface side of the glass substrate.

[0012] Thus, it is possible to simultaneously polish the whole circumference of a chamfering portion on one surface side. In other words, polishing can be carried out in a condition where the abrasive cloth is in surface contact with the chamfering portion and therefore it is possible to make the surface condition of the chamfering portion to be mirror surfaced and at the same time to equalize the roughness of the chamfering portion. Moreover, because only the chamfering portion can be polished, in comparison with the conventional configuration of polishing both the edge surface and the chamfering surface simultaneously with a brush, the chamfering portion can be highly precisely mirror polished with. Here, "relatively move" means that either of the abrasive cloth or the glass substrate may be moved or both of them may be moved. Polishing in the present invention is not batch polishing that laminates glass substrates (batch process) but single polishing that carries out polishing one by one.

[0013] Further, a manufacturing method of a glass substrate for a magnetic disc including an edge surface polishing step for polishing a chamfering portion provided on an outer circumference of the disc-shaped glass substrate is

characterized by that an abrasive cloth, which has a shape of inner surface of a body of rotation with a circular cross section that gradually changes from a circular cross section having a size smaller than a circle of an outer circumference to a circular cross section having a larger size as a portion which comes into contact with the chamfering portion on one surface side of the glass substrate, is used, and the abrasive cloth and the glass substrate are relatively moved to polish the chamfering portion in the edge surface polishing step while the abrasive cloth is simultaneously pressed to the whole circumference of the chamfering portion on one surface side of the glass substrate.

[0014] That is, using an abrasive cloth having a shape of a body of rotation with a circular cross section which gradually becomes large, for example, a conical shape, a fusiform shape, a spherical shape, or the like, the chamfering portion is polished. Thus, it is possible to polish only the chamfering portion and therefore, it is possible to mirror polish the chamfering portion with small cutting stock.

[0015] It is preferable that a portion which comes into contact with the chamfering portion on the one side surface of the glass substrate has spherical concave shape forming an inner surface of a sphere. Thus, even if relative positions of an axis of rotation of the glass substrate and an axis of rotation of the abrasive cloth are changed, it is possible to maintain a condition where the abrasive cloth is simultaneously in contact with the whole circumference of the chamfering portion on the

one side surface of the glass substrate. Here, it is sufficient that only a portion which comes into contact with the chamfering portion has a spherical concave shape and, for example, tip or back of the abrasive cloth does not need to have spherical concave shape.

[0016] It is preferable that when the abrasive cloth is pressed to the chamfering portion on the one side surface of the glass substrate, the normal line of the chamfering portion passes through virtually the center of the spherical portion including the spherical concave portion. The chamfering portion is provided with a predetermined angle to the main surface (or the axis of rotation) of the glass substrate. Therefore, when the normal line of the chamfering portion passes the center of spherical shape including the spherical concave surface, it is possible to have the largest contacting area of the abrasive cloth and the chamfering portion. Therefore, the chamfering portion can be equally polished, polishing rate is improved and productivity can be improved.

[0017] Further, at least the abrasive cloth may be rotated and the perpendicular passing through the center of main surface of the glass substrate and the axis of rotation of the abrasive cloth may be crossed with a predetermined angle. For the rotation of the abrasive cloth, the abrasive cloth itself may be rotary driven or the glass substrate may be rotated to cause the abrasive cloth rotary driven. In the glass substrate, only the chamfering portion comes into contact with the abrasive cloth. However, according to the above-mentioned

configuration, it is possible to expand a portion of the abrasive cloth which comes into contact with the glass substrate. Therefore, it is possible to prevent decrease in polishing rate and at the same time to improve durability of the abrasive cloth.

[0018] Further, the perpendicular may pass through the center of the spherical shape including the spherical concave surface of the abrasive cloth and at least either one of the glass substrate or the abrasive cloth may be moved while the abrasive cloth is in contact with the whole circumference of the chamfering portion on the one surface side of the glass substrate. That is, a trajectory of movement of the axis of rotation becomes cone-shaped or sector foam with the center of the spherical portion as tip of the trajectory. According to this configuration, an area of the abrasive cloth which can be in contact with the glass substrate can be expanded to prevent decrease in polishing rate and to improve durability of the abrasive cloth.

[0019] On a plain surface including one of axis of rotation of the glass substrate and the abrasive cloth enabled to rotate, another axis of rotation may be repeatedly wobbled while maintaining the axis of rotation to pass through the center of the spherical portion of the abrasive cloth including the spherical concave surface. This is an example where trajectory of the axis of rotation becomes sector foam.

[0020] Either the glass substrate or the abrasive cloth may be supported being enabled to freely rotate, while rotary driving the other so that one follows the other and moves relatively.

This is a configuration example of relative move of the glass substrate and the abrasive cloth. Due to the load, the other follows and rotates in a delayed manner so that polishing is carried out by relative move and is carried out equally on every portion by changing the position.

[0021] Here, in the present invention, "relatively move" means that at least either one of the abrasive cloth or the glass substrate is rotated, moved, rotated and moved, or at least either one of the glass substrate or the abrasive cloth may be rotated while the other is moved. Moreover, the "move" includes "wobble".

[0022] A polishing apparatus for a glass substrate for a magnetic disc to polish a chamfering portion on an outer circumference of a disc-shaped glass substrate is characterized by including a substrate supporting unit for supporting the substrate in a rotatable manner, an abrasive cloth having spherical shape including a spherical concave surface which can be simultaneously in contact with the whole circumference of a chamfering portion on one side surface of the glass substrate, an abrasive cloth supporting unit to support the abrasive cloth in a rotatable manner, and a polishing solution supplying unit for supplying polishing solution including abrasive grain between the chamfering portion and the abrasive cloth. According to the present invention, it is possible to polish only the chamfering portion and therefore, it is possible to mirror polish the chamfering portion highly precisely with small cutting stock.

[0023] A manufacturing method of a disc-shaped glass substrate for a magnetic disc according to the present invention includes a glass substrate having a chamfering portion on an outer circumference side which forms convex surface. As an example of the convex surface, the surface can have a shape that follows the spherical surface which can be simultaneously in contact with whole circumference of the chamfering portion. Thus, when the glass substrate is grasped by a latch or the like, retention capability, certainty, and handling property such as position accuracy can be improved.

[0024] A manufacturing method of a glass substrate for a magnetic disc according to the present invention is characterized by forming at least a magnetic layer on the surface of a glass substrate for a magnetic disc obtained by the above-mentioned manufacturing method of the glass substrate for a magnetic disc. Thus, it is possible to manufacture a magnetic disc which suppresses generation of sodium or potassium on the chamfering portion on outer circumference side.

[0025] A manufacturing method of a glass substrate for a magnetic disc according to the present invention is characterized by that at least a magnetic layer is formed on a disc-shaped glass substrate and a chamfering portion on outer circumference side of the glass substrate forms a convex surface following the spherical concave surface which can be simultaneously in contact with the whole circumference of the chamfering portion on one side surface of the glass substrate.

Thus, when the glass substrate is grasped by a latch or the like, retention capability, certainty, and handling property such as position accuracy can be improved.

[0026] A manufacturing method of a glass substrate for a magnetic disc including an edge surface polishing step for polishing a chamfering portion provided on outer circumference of a disc-shaped glass substrate according to the present invention is characterized by that an abrasive cloth which can be in contact with the chamfering portion from the edge of the main surface side to the edge of the edge surface side of the chamfering portion in radial direction of the glass substrate is used and the abrasive cloth and the glass substrate are relatively moved to polish the chamfering portion.

[0027] Thus, difference in surface roughness in the whole circumference of outer circumference of a chamfering portion of a disc-shaped glass substrate is within a range of 0.001 μm or less. Because chamfering portion can be uniformly mirror surfaced with such a high precision, it is possible to more surely prevent separation of sodium or potassium.

[0028] According to the present invention, for example, it is possible to highly precisely mirror polish the chamfering portion with small cutting stock even if the substrate is small. Therefore, it is possible to prevent separation of sodium or potassium to improve reliability and durability and at the same time possible to improve circularity of the outer circumference

and processing accuracy.

BRIEF DESCRIPTION OF THE DRAWINGS

The various features of novelty which characterize the invention are pointed out with particularity in the claims attached to and forming a part of this specification. For a better understanding of the invention, its operating advantages, and specific objects attained by its use, reference should be had to the accompanying drawing and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

[FIG. 1] A view for explaining a polishing apparatus.

[FIG. 2] A view for explaining relation between a glass substrate for a magnetic disc and an abrasive cloth.

[FIG. 3] A view for explaining an example of the other configuration of the abrasive cloth.

[FIG. 4] A view for explaining another configuration for expanding an area of an abrasive cloth which can be in contact with the chamfering portion.

[FIG. 5] A view for explaining a conventional outer circumference edge surface polishing apparatus.

[FIG. 6] An enlarged view of a contacting portion between the abrasive cloth and the glass substrate in FIG. 2 (b).

The Best Mode for Carrying Out the Claimed Invention

[0029] An embodiment of a manufacturing method of a glass substrate for a magnetic disc and a magnetic disc according to

the present invention will be explained using figures. FIG. 1 is a view for explaining a polishing apparatus and FIG. 2 is a view for explaining relation between a glass substrate for a magnetic disc and an abrasive cloth. Numerical values in the following embodiment are examples for easy of understanding of the invention and the present invention is not limited thereto unless any notice is added.

[0030] The polishing apparatus shown in FIG. 1 is a single polishing machine for polishing a glass substrate 1 one by one and includes at least a substrate supporting unit 10 and an abrasive cloth supporting unit 20. Moreover, when polishing solution is supplied to polish a glass substrate, the polishing apparatus may include a polishing solution supply unit 14. Polishing abrasive grain which is a polishing solution is not especially limited and any abrasive grain used for polishing a glass substrate such as alumina, cerium oxide, colloidal silica, or the like can be used.

[0031] A glass substrate 1 to be a target of polishing has a round inner hole 3 in its center and an outer circumference portion 2 also has a round shape. Therefore, the glass substrate 1 has a toroidal and discoidal shape, as shown in FIG. 2 (a). The outer circumference portion 2 includes an edge surface 2a which is virtually vertical to a main surface 1a of the glass substrate 1 and chamfering portions 2b provided on both sides of the edge surface 2a. The chamfering portions 2b are provided on both ends of the inner hole 2 with a given angle (e.g., 45°) to the main surface 1a (or to the axis of rotation)

of the glass substrate 1.

[0032] The substrate supporting unit 10 includes a holder 11 for supporting the glass substrate 1, an arm 13, and a torque converter 12 having predetermined load for connecting the holder 11 and the arm 13 in a rotatable manner. The holder 11 is configured by attaching a base body of hard resin such as Derlin (Registered Trademark of DuPont) to resin foam such as polyurethane. When liquid such as water is applied to this resin foam to attach the glass substrate 1, thanks to surface tension, the glass substrate 1 will not come unstuck and can be strongly maintained. The torque converter 12 keeps the holder 11 in a rotatable condition and also gives load to direction of rotation. The arm 13 is fixed to the rotation of the holder 11 but as a whole, can be wobbled, as described later.

[0033] The abrasive cloth supporting unit 20 supports an abrasive cloth 21 in a rotatable manner. The abrasive cloth 21 includes a spherical concave portion forming an inner surface of a sphere and is rotary driven by a motor 23. Shape of the spherical concave portion may be provided only to a portion which comes into contact with the glass substrate 1 and portion which does not come into contact with the glass substrate 1 may not be spherical as shown in, for example, a plain portion 22 supported by the abrasive cloth supporting unit 20 in FIG. 1, or abrasive cloth may not be provided for that portion. Moreover, a support shaft 24 for the abrasive cloth 21 has a height adjuster 24a so that the abrasive cloth 21 can be approached to or distanced from the substrate supporting unit

10. As material of the abrasive cloth 21, resin foam such as polyurethane can be used. As described later, the abrasive cloth 21 simultaneously comes into contact with whole circumference of a chamfering portion 2b on one surface side of the glass substrate 1 (refer to FIG. 2 (b)).

[0034] An explanation will be given of a case where polishing is carried out using the polishing apparatus having the above-mentioned configuration. First, the glass substrate 1 is attached to the holder 11 and the abrasive cloth 21 is raised. Then, the spherical concave surface 21 comes into contact with the outer circumference portion 2 in a fitting manner and is pressed to the whole circumference of the chamfering portion 2b. Then, while polishing solution (slurry) is supplied from the polishing solution supply unit 14, the motor 23 is driven to rotate the abrasive cloth 21 and the spherical portion 22 to polish the chamfering portion 2b.

[0035] Thus, by polishing on the chamfering portion 2b, it is possible to mirror polish the chamfering portion 2b with small cutting stock. Therefore, when a magnetic disc is produced by use of this glass substrate 1, it is possible to prevent separation of sodium or potassium from the chamfering portion. Moreover, in comparison with, for example, the case of polishing by use of a brush, processing time can be shortened because the cutting stock for mirror polishing the chamfering portion 2b is smaller and therefore, productivity can be increased. Further, circularity and processing accuracy of the edge surface 1a is not influenced because the spherical concave

surface 21 can polish only the chamfering portion 2b. Therefore, the circularity or processing accuracy is not decreased. Further, processing accuracy of the chamfering portion 2b itself is high and variability among substrates is quite low. Further, the polishing surface by the spherical concave surface 21 comes into contact with only the chamfering portion 2b. Therefore, droop of the chamfering portion which occurs in conventional brush polishing does not occur and the influence caused by the droop does not reach the main surface 1a, making it possible to clearly distinct between the chamfering portion 2b and the main surface 1a. Therefore, without eating away the saving area of the main surface 1a, designed memory capacity can be obtained as well as memory area can be expanded compared to the case of the conventional brush polishing.

[0036] When the glass substrate 1 is rotated by the spherical concave surface 21, the glass substrate 1 is rotated in a delayed manner by the torque converter 12 and by this delay, the chamfering portion 2b is moved and pressed to the chamfering portion 2b. That is, although only the abrasive cloth 21 is rotary driven by one driving source, position (phase) of the glass substrate 1 to the whole of the apparatus can be changed and it is possible to evenly polish the whole circumference of the chamfering portion 2b on one surface side.

[0037] Moreover, when polishing, at least either one of the glass substrate 1 or the abrasive cloth 21 is moved while the perpendicular passing through the center of the glass substrate 1 passes through the center of the spherical concave surface

21 and condition where the abrasive cloth 21 is simultaneously in contact with the whole circumference of the chamfering portion is maintained. For example, by wobbling the arm 13, relative position of the axis of rotation of the glass substrate 1 and the axis of rotation of the abrasive cloth 21 are changed. In the present embodiment, on the plain surface including the axis of rotation of the abrasive cloth 21, the axis of rotation of the glass substrate 1 is repeatedly wobbled while the axis of rotation of the glass substrate 1 passes through center 27 of the spherical concave surface 21. Therefore, trajectory of the axis of rotation of the glass substrate 1 is sector form. Specifically, because centripetal force works between the inner hole 2 of the glass substrate 1 and the spherical concave surface 21, the axis of rotation of the glass substrate 1 is inevitably adjusted to pass through the center 27 of the spherical concave surface 21. Therefore, it is not necessary to control the position of the arm 13 and it is sufficient to have the arm 13 supported by the supporting shaft 13a to be enabled to freely rotate and to be wobbled so that the trajectory of the supporting shaft 13a describes an arc on the concentric circle of the spherical concave surface 21.

[0038] At this time, because a part of the abrasive cloth 21 which is in contact with the chamfering portion 2b is the spherical concave surface 21, even if relative positions of the axis of rotation of the glass substrate 1 and the axis of rotation of the abrasive cloth 21 are changed, it is possible to always maintain a condition where the abrasive cloth 21 is

simultaneously in contact with the whole circumference of the chamfering portion 2b on one surface side. Here, any form of the abrasive cloth 21 can be used only if the portion of the abrasive cloth 21 which comes into contact with the chamfering portion 2b is spherical and concave and forms inner surface of a sphere. The periphery of the axis of rotation of the abrasive cloth 21 does not come into contact with chamfering portion 2b and therefore, the periphery may be plain portion 22. Moreover, as shown in FIG. 1, the abrasive cloth 21 may have substantially hemispherical and bowl shape and spherical surface need not be provided to a portion which does not come into contact with the chamfering portion 2b.

[0039] As mentioned above, by expanding the area of the spherical concave surface 21 which comes into contact with the chamfering portion 2b, it is possible to prevent decrease in polishing rate and to improve productivity. Moreover, because durability of the abrasive cloth 21 (spherical concave surface 21) is improved, it is possible to reduce production cost.

[0040] Here, using FIG. 2 (b), an explanation will be given of relation between the outer circumference portion 2 and the spherical concave surface 21. First, radial r_1 of the circular cross-section of the spherical portion 21 is set to be larger than the radial r_0 of the outer circumference portion 2 so that the spherical concave surface 21 is simultaneously in contact with the whole circumference of the chamfering portion 2b on one side of the glass substrate 1.

[0041] Further, when the abrasive cloth 21 is pressed to the

chamfering portion 2b, the normal line of the chamfering portion 2b virtually passes through the center 27 of the spherical portion including the spherical concave surface of the abrasive cloth 21. Approximating on an assumption that the surface of the chamfering portion 2b is a truncated cone, it is possible to make the contacting area between the spherical concave surface 21 of the abrasive cloth 21 and the chamfering portion 2b largest when the normal line of the chamfering portion 2b passes through the center 27 of spherical portion. Thus, it becomes possible to evenly polish the chamfering portion 2b and to minimize the cutting stock thereof. Therefore, productivity can be increased. Moreover, if the contacting area is large, polishing rate can also be improved and in that sense, it is possible to improve the productivity.

[0042] On the other hand, looking at the glass substrate 1, the chamfering portion 2b of the outer circumference portion 2 after polishing has a convex surface following the surface of the spherical concave surface 21. Moreover, in a magnetic disc including the glass substrate 1 on which a magnetic layer is formed, a chamfering portion having the same shape is formed. Thus, because the chamfering portion 2b has a convex surface, it becomes easy to grasp it by a latch or the like and it becomes possible to improve handling property such as durability, assuredness, and positioning accuracy.

[0043] FIG. 6 is an enlarged view of a contacting portion between the abrasive cloth 21 and the glass substrate 1 in FIG. 2 (b). According to the manufacturing method of a glass substrate for

a magnetic disc of the present embodiment, it is possible to evenly polish the chamfering portion 2b formed between the edge surface (wall surface) of circumference of the disc-shaped glass substrate 1 and the main surface 1b (main surface opposite to a main surface 1a) for the whole circumference.

[0044] Specifically, as shown in FIG. 6, the abrasive cloth 21 can polish an entire area of edge surface 21 from an edge 30 on the main surface 1b side of the chamfering portion 2b to an edge 32 on the edge surface 2a side in radius direction of the glass substrate 1. This is because, although the abrasive cloth 21 has a spherical concave shape, when seen microscopically, it can be regarded as a virtually plain polishing member.

[0045] Thus, according to the present embodiment, it is possible to polish the chamfering portion while causing the abrasive cloth 21 to be in contact from the edge 30 of the edge surface 30 to the edge 32 without omission. Therefore, the chamfering portion on the edge surface of outer circumference of one glass substrate can be mirror surfaced evenly with high precision. Therefore, it is possible to more surely prevent separation of sodium or potassium from the chamfering portion.

[0046]

[Embodiment]

Hereinafter, an embodiment of manufacturing method of a glass substrate for a magnetic disc and a magnetic disc to which the present invention is applied will be explained. The glass substrate and for a magnetic disc and the magnetic disc are manufactured as a magnetic disc having a predetermined shape

such as a 0.8-inch disc (inner diameter 6mm, outside diameter 21.6mm, thickness of plate 0.381mm), a 1.0-inch disc (inner diameter 7mm, outside diameter 27.4mm, thickness of plate 0.381mm), or a 1.8-inch disc (inner diameter 12mm, outside diameter 48mm, thickness of plate 0.508mm). Moreover, the glass substrate and the disc may be manufactured as a 2.5-inch disc or a 3.5-inch disc.

[0047]

(1) Shape processing step and first wrapping step

First, aluminosilicate glass is cast into disc-shape by direct press using upper, lower, and body molds to obtain a plate-shaped amorphous glass. Here, as the aluminosilicate glass, glass for chemical strengthening is used. The disc-shaped glass substrate for a magnetic disc may be obtained by, other than the direct press, cutting the substrate out by a grinding wheel from a sheet glass formed by down draw method or float method. Here, as the aluminosilicate glass, chemical strengthening glass including; 58 to 75 percent by weight of SiO_2 ; 5 to 23 percent by weight of Al_2O_3 ; 3 to 10 percent by weight of Li_2O , and 4 to 13 percent by weight of Na_2O , is used.

[0048] Next, both main surfaces of the plate glass is wrapping processed to make a disc-shaped base glass material. The wrapping process is carried out by an apparatus for both surfaces wrapping using planetary gear mechanism and alumina system loose grain is used. Specifically, wrapping platen is pressed both from top and bottom of the plate glass, grinding fluid containing loose grain is supplied on the main surface

of the plate glass, and they are relatively moved to carry out the wrapping process. By this wrapping process, a glass base material having smooth main surface is obtained.

[0049]

(2) Cutting step (coring, forming)

Next, using a diamond cutter, the glass base material is cut and a disc-shaped glass substrate is cut out from the glass base material. Next, using a diamond drill, an inner hole is formed in the center of the glass substrate to form a toric glass substrate (coring). Then, inner circumference edge surface and outer circumference edge surface are ground by a diamond grinder to carry out predetermined chamfering process (forming).

[0050]

(3) Second wrapping step

Next, on both surfaces of the glass substrate thus obtained, second wrapping process is carried out in a similar manner as the first wrapping process. By carrying out the second wrapping process, it is possible to remove minute convex or concave shape formed on the main surface in the cutting step or edge surface polishing step, which are precedent steps, in advance and it becomes possible to finish following polishing step of the main surface in a short period of time.

[0051]

(4) Edge surface polishing step

Next, edge surface of outer circumference 2 of the glass substrate is polished. First, the edge surface 2a is polished

independently before polishing the chamfering portion 2b. A polishing method may be, for example, the one described in the Patent Document 1 by which a plurality of substrates are polished by a brush simultaneously. However, this requires lots of cutting space. Therefore, a single polishing method described in, for example, the Patent Document 2 (Japanese Published Unexamined Patent Application No. 2002-219642) may be used.

[0052] Subsequently, the chamfering portion 2b is mirror polished by use of the above-mentioned polishing method and the polishing apparatus. As a result, difference in surface roughness in the whole circumference of the outer circumference on the chamfering portion of one glass substrate is 0.001 μm or less. Then, the glass substrate after edge surface step is cleansed with water. By this edge surface polishing step, the edge surface of the glass substrate is processed to have a mirror surface condition which can prevent separation of sodium or potassium.

[0053] Here, in the present embodiment, an explanation was given of a case where the edge surface 2a is polished first and the chamfering portion 2b is polished thereafter. However, the order is arbitrary and the chamfering portion 2b may be polished first and the edge surface 2a may be polished thereafter.

[0054] Next, the inner circumference edge surface may be polished, as described in the Patent Document 1, by forming a glass substrate block by laminating a plurality of glass substrates and simultaneously polishing the chamfered inner

circumference edge portion by a brush roll. At this time, slurry including cerium oxide abrasive grain (loose grain) is used as polishing grain.

(4) [0055] Main surface polishing step

As a main surface polishing step, the first polishing step was performed. The first polishing step is mainly aimed at removing crack or distortion remaining on the main surface after the wrapping step. In the first polishing step, main surface was polished by an apparatus for both surfaces wrapping using planetary gear mechanism, using hard resin polisher. As polishing solution, cerium oxide abrasive grain was used.

[0056] The glass substrate after the first polishing step was sequentially dipped in cleansing tanks of neutral detergent, pure water, and isopropyl alcohol (IPA) and cleansed.

[0057] Next second polishing step was performed as the main surface polishing step. The second polishing step is aimed at finishing the main surface to have a mirror surface. In the second polishing step, main surface was polished by an apparatus for both surfaces wrapping using planetary gear mechanism, using flexible resin foam polisher. As polishing solution, cerium oxide abrasive grain having finer grain than the cerium oxide abrasive grain used in the first polishing step was used.

[0058] The glass substrate after the second polishing step was sequentially dipped in cleansing tanks of neutral detergent, pure water, and isopropyl alcohol (IPA) and cleansed. Here, ultrasonic wave was applied to the tanks.

[0059]

(5) Chemical strengthening step

Next, chemical strengthening was conducted to the glass substrate after the above-mentioned wrapping and polishing steps. The chemical strengthening was conducted by preparing chemical strengthening solution in which 60% of potassium nitrate and 40% of sodium nitrate are mixed. The chemical solution was heated to 400°C and the cleansed glass substrate was heated to 300°C. Then, the glass substrate was dipped into the chemical strengthening solution for about 3 hours. To chemically strengthen the whole surfaces of the glass substrate, the dipping was conducted while the glass substrate was placed in a holder so that a plurality of glass substrates are retained by their edge surface.

[0060] By dipping the glass substrate into the chemical strengthening solution, lithium ion and sodium ion on the surface layer of the glass substrate are replaced by sodium ion and potassium ion in the chemical strengthening solution and the glass substrate is strengthened. Thickness of compression stress layer formed on the surface layer of the glass substrate was between about 100 μm and 200 μm .

[0061] The glass substrate after the chemical strengthening step is dipped into a water tank of 20°C to rapidly cool down and was kept in the tank for about 10 minutes. Then, the glass substrate after the rapid cool down is dipped in concentrated sulfuric acid heated to about 40°C to be cleansed. Moreover, the glass substrate after cleansing by the concentrated sulfuric acid is sequentially dipped into tanks of pure water

and IPA for cleansing. Here, ultrasonic wave was applied to the tanks.

[0062] As mentioned above, by carrying out the first wrapping step, the cutting step, the edge surface polishing step, the second wrapping step, the first and second polishing steps, and the chemical strengthening step, a flat and smooth glass substrate for a magnetic disc having high rigidity is obtained.

[0063]

(6) Magnetic disc manufacturing step

On the both surfaces of the glass substrate obtained through the above-mentioned steps, an attachment layer including Cr alloy, a soft magnetic layer including CoTaZr alloy, a ground layer including Ru, a vertical magnetic recording layer including CoCrPt alloy, a protection layer including carbon hydroxide, and a lubrication layer including perfluoropolyether are sequentially formed to manufacture a vertical magnetic recording disc. Here, the present configuration is an example of a vertical magnetic disc. However, a magnetic layer or the like may be included as an in-plane magnetic disc.

[0064]

[Evaluation]

A magnetic disc with a single polished chamfering portion by use of an abrasive cloth and a magnetic disc which was brush polished as in the conventional art explained in the section of "Description of the Related Art" were manufactured to conduct an acceleration test. Conditions of the acceleration test

were: Temperature 85°C; Humidity 85%; and 30 days. Then, separation of sodium and potassium was detected from the brush polished disc, while separation was not detected from the example of the present embodiment. Moreover, when glide test was conducted, hit (a head grazing convex portion on the surface of the magnetic disc) or crush (a head hitting convex portion on the surface of the magnetic disc) was not observed. Further, when replaying test was conducted using the magnetoresistive head, malfunction caused by thermal asperity was not observed. Further, surface roughness in the whole circumference of inner hole of the chamfering portion 2b of the glass substrate for a magnetic disc with polished chamfering portion 2b was 0.001 μm or less.

[0065] It was explained in the above-mentioned embodiment that the abrasive cloth 21 is rotary driven and the glass substrate 1 is caused to follow the rotary drive. However, the holder 11 of the glass substrate 1 may be rotary driven and the abrasive cloth 21 and the spherical portion 22 may be caused to follow the rotary drive. In this case, the torque converter 12 can be provided on the support shaft of the abrasive cloth 21.

[0066]

[Embodiment 2]

Moreover, in the above-mentioned embodiment, a portion of the abrasive cloth 21 which comes into contact with the chamfering portion 2b of the glass substrate 1 is set to be the spherical concave surface 21. However, the portion may have any shape so long as the portion simultaneously comes into

surface contact with the whole circumference of the chamfering portion 2b on one surface side of the glass substrate 1. An abrasive cloth 25 shown in FIG. 3 (a) has a conical shape (body of revolution). A circular cross section of the abrasive cloth 25 having radius r_2 which is smaller than the radius r_0 of the inner hole 2 becomes gradually larger to a circular cross section having radius r_1 which is larger than the radius r_0 of the outer circumference portion 2. Moreover, an abrasive cloth 26 shown in FIG. 3 (b) is fusiform-shaped and has a similar characteristic. Using such abrasive clothes, it is possible to simultaneously surface contact with the whole circumference of the chamfering portion on the one surface side and to polish only the chamfering portion. Therefore, it is possible to polish the chamfering portion with small cutting stock.

[0067] In the embodiment of FIG. 3 (a) and (b), as shown in FIG. 6, it is possible to polish the chamfering portion while the abrasive cloth 21 is in contact with an area from the edge 30 of the edge surface 2b to the edge 32 without omission. Therefore, the chamfering portion on the edge surface of outer circumference of one glass substrate can be mirror surfaced evenly with high precision. Therefore, it is possible to more surely prevent separation of sodium or potassium from the chamfering portion.

[0068]

[Embodiment 3]

FIG. 4 is a view for explaining another configuration for expanding a portion which contacts with the abrasive cloth. In

the above-mentioned embodiment, the arm 13 is wobbled so that a portion of the spherical concave surface 21 which is in contact with the chamfering portion 2b is expanded. However, as shown in FIG. 4 (a), each of axis of rotation of the glass substrate 1 and the abrasive cloth 21 may be crossed with predetermined angle. By the present embodiment, it is also possible to expand the portion of the spherical concave surface 21 which is in contact with the glass substrate 1. Therefore, while decrease in polishing rate can be prevented, it is also possible to improve durability of the abrasive cloth.

[0069] Further, in the above-mentioned embodiment, the arm 13 is wobbled so that the trajectory of the axis of rotation of the glass substrate 1 becomes sector foam. However, the axis of rotation of either the glass substrate 1 or the abrasive cloth 21 may be moved while being supported so that the axis passes through the center of the spherical portion of the abrasive cloth including the spherical concave surface. Therefore, as shown in, for example, FIG. 4 (b), the trajectory of movement of the glass substrate 1 may be conical shape with the center of the spherical concave surface 21 at its top. According to this configuration, it is possible to prevent decrease in polishing rate and also to improve durability of the abrasive cloth.

[0070] Further, a manufacturing method of a magnetic disc according to the present invention may be configured to press an abrasive cloth having schematically hemispherical shape to a chamfering portion on inner circumference side of a glass

substrate, to supply polishing solution between the abrasive cloth and the glass substrate, and to move the abrasive cloth and the glass substrate relatively so that the chamfering portion is polished.

[0071] Further, a manufacturing method of a magnetic disc according to the present invention may be configured to cause a glass substrate to be moved so that the glass substrate is displaced toward an abrasive cloth having schematically hemispherical inner surface (concave spherical surface (in the above explanation, explained as spherical concave surface)) to polish a chamfering portion on inner circumference side of the glass substrate. Thus, it is possible to cause the chamfering portion to be polished not by one portion of the concave spherical surface of the abrasive cloth but by a large area of the abrasive cloth.

[0072] Further, a manufacturing method of a magnetic disc according to the present invention may be configured to cause at least a glass substrate or an abrasive cloth to be moved so that the glass substrate is displaced but not rotated on the same plain surface toward the abrasive cloth having a concave spherical surface to polish a chamfering portion on inner circumference side of the glass substrate. Thus, it is possible to cause the chamfering portion to be polished not by one portion of the hemispherical abrasive cloth but by a large area of the abrasive cloth.

[0073] Further, a manufacturing method of a magnetic disc according to the present invention may be configured to press

an abrasive cloth having a shape which matches the shape of a surface of a chamfering portion on outer circumference portion of a glass substrate to the chamfering portion, to supply polishing solution between the abrasive cloth and the glass substrate, and to rotate at least one of the abrasive cloth or the glass substrate to polish the chamfering portion.

[0074] Further, a manufacturing method of a magnetic disc according to the present invention may be configured to press an abrasive cloth having a schematically hemispherical inner surface on outer circumference portion of a glass substrate to the whole circumference of a chamfering portion formed on one surface side of the glass substrate, to supply polishing solution between the abrasive cloth and the glass substrate, and to move the abrasive cloth and the glass substrate relatively so that the chamfering portion on the inner hole side is polished while the glass substrate and the abrasive cloth are in surface contact.

[0075] The present invention can be used as a glass substrate for a magnetic disc, a magnetic disc, and manufacturing method thereof.

What is claimed is:

1. A manufacturing method of a glass substrate for a magnetic disc comprising an edge surface polishing step for polishing a chamfering portion on an outer circumference portion of a disc-shaped glass substrate,

wherein an abrasive cloth which can be simultaneously in contact with the whole circumference of the chamfering portion on one surface side of the glass substrate is used; and

in the edge surface polishing step, the chamfering portion is polished by relatively moving the abrasive cloth and the glass substrate while simultaneously pressing the abrasive cloth to the whole circumference of the chamfering portion on the one surface side of the glass substrate.

2. A manufacturing method of a glass substrate for a magnetic disc comprising an edge surface polishing step for polishing a chamfering portion on an outer circumference portion of a disc-shaped glass substrate,

wherein an abrasive cloth having a shape of inner surface of a body of rotation with a circular cross section that gradually changes from a circular cross section having a size smaller than a circle of an outer circumference to a circular cross section having a larger size as a portion which comes into contact with the chamfering portion on one surface side of the glass substrate is used, and in the edge surface polishing step, the abrasive cloth and the glass substrate are relatively moved

to polish the chamfering portion while the abrasive cloth is simultaneously pressed to the whole circumference of the chamfering portion on the one surface side of the glass substrate.

3. The manufacturing method of the glass substrate for a magnetic disc according to either claims 1 or 2,

wherein a portion which is a part of the abrasive cloth and comes into contact with the chamfering portion on one surface side of the glass substrate has a spherical concave surface forming an inner surface of a sphere.

4. The manufacturing method of a glass substrate for a magnetic disc according to claim 3,

wherein the normal line of the chamfering portion passes virtually center of the spherical portion including the spherical concave surface when the abrasive cloth is pressed to the chamfering portion on the one surface side of the glass substrate.

5. The manufacturing method of a glass substrate for a magnetic disc according to claim 3,

wherein at least the abrasive cloth is rotated, and the perpendicular passing through the center of main surface of the glass substrate and the axis of rotation of the abrasive cloth are crossed with a predetermined angle.

6. The manufacturing method of a glass substrate for a magnetic disc according to claim 6,

wherein the glass substrate and the abrasive cloth are enabled to rotate, and another axis of rotation is repeatedly wobbled while maintaining the axis of rotation to pass through the center of the spherical portion.

7. The manufacturing method of a glass substrate for a magnetic disc according to either of the claims 1 or 2,

wherein either the glass substrate or the abrasive cloth is supported to be enabled to freely rotate while rotary driving the other so that one follows the other and moves relatively.

8. A polishing apparatus for a glass substrate for a magnetic disc for polishing a chamfering portion on outer circumference portion of a disc-shaped glass substrate comprising:

a substrate supporting unit for supporting the substrate in a rotatable manner;

an abrasive cloth having spherical shape including a spherical concave surface which can be simultaneously in contact with the whole circumference of a chamfering portion on one side surface of the glass substrate;

an abrasive cloth supporting unit to support the abrasive cloth in a rotatable manner; and

a polishing solution supplying unit for supplying polishing solution including abrasive grain between the chamfering portion and the abrasive cloth.

9. A glass substrate for a magnetic disc which is disc-shaped and has a convex surface on a chamfering portion on outer circumference, wherein the convex surface has a shape that follows the spherical surface which can be simultaneously in contact with whole circumference of the chamfering portion on one surface side of the glass substrate.

10. A manufacturing method of a magnetic disc comprising a step of forming a magnetic layer on a glass substrate obtained by the manufacturing method of a glass substrate for a magnetic disc according to any one of claims 1 to 7.

11. A magnetic disc comprising a step of at least forming a magnetic layer on a disc-shaped glass substrate wherein a chamfering portion on outer circumference portion of the glass substrate has a convex surface following a spherical concave surface which can be in contact with the whole circumference of the chamfering portion on the one surface side of the glass substrate.

12. A manufacturing method of a glass substrate for a magnetic disc comprising an edge surface polishing step for polishing a chamfering portion provided on an outer circumference portion of a disc-shaped glass substrate,

wherein an abrasive cloth which can polish a whole area from an edge of a main surface side to an edge of an edge surface

side of the chamfering portion in radius direction in the glass substrate is used, and the chamfering portion is polished by relatively moving the abrasive cloth and the glass substrate.