

MANUFACTURING METHOD OF GLASS SUBSTRATE
FOR MAGNETIC DISC OR 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. 2006-237515 filed on September 1, 2006 and NO. 2007-225340 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 in 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 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 which 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 for a glass substrate to prevent generation of dust by removing convexity and concave portion and also to carry out high level cleansing for removing a foreign object.

[0004] In the above-mentioned condition, importance of smoothness of an edge surface of a substrate has been conventionally recognized. In the Patent Document 1 (Japanese Published Unexamined Patent Application No. H10-154321), an

explanation is given that when the surface of a chamfering portion formed on an edge surface of a substrate and side wall portion are rough, generation and absorption of a particle are occurred and when the particle is absorbed on the main surface of the substrate, a convex portion is formed (paragraph number 0010). Then, the Patent Document 1 says that by polishing the edge surface smoothly until it is mirror surfaced, the above-mentioned problem can be solved.

[0005] As a configuration for polishing an inner edge surface of a glass substrate, a polishing method by a rotary brush described in the Patent Document 2 (Japanese Published Unexamined Patent Application No. H11-221742) is known. According to this conventional polishing method, disc-shaped glass substrates 1 are laminated to form a column, a rotary brush 50 is inserted in a continued inner hole, and both the glass substrates 1 and the rotary brush 50 are rotated while polishing liquid is supplied to polish an inner edge surface.

[Patent Document 1] Japanese Published Unexamined Patent Application No. H10-154321

[Patent Document 2] Japanese Published Unexamined Patent Application No. H11-221742

[0006] 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.

[0007] 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.

[0008] 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.

[0009] Specifically, for example, as shown in FIG. 7 (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.

[0010] Here, as shown in FIG. 7 (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 lowered 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

[0011] 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.

[0012] To solve the above-mentioned problem, a typical manufacturing method of a glass substrate for a magnetic disc according to the present invention is a manufacturing method of a glass substrate for a magnetic disc with a polished inner circumference side chamfering portion and a continued inner hole formed in its center and is characterized by using an abrasive cloth which can be in contact with whole circumference of the chamfering portion simultaneously to cause the abrasive cloth and a glass substrate to be relatively moved for polishing while the abrasive cloth is pressed to the whole circumference of the chamfering portion on the inner circumference side.

[0013] Thus, it is possible to polish the whole circumference of the chamfering portion simultaneously. In other words, polishing can be carried out on the condition where the cloth is in surface contact with the chamfering portion and therefore whole of the surface of the chamfering portion can be mirror surfaced, and at the same time surface roughness of the chamfering portion (surface roughness of the chamfering portion in circumferential direction of the substrate) can be equalized. 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 smaller cutting edge. Here, "relatively move" means that either one 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 polishes one by one.

[0014] Moreover, another typical configuration of a manufacturing method of a glass substrate for a magnetic disc according to the present invention is a manufacturing method of a glass substrate for a magnetic disc with a continued inner hole in its center and a polished inner circumference side chamfering portion and is characterized by that at least a portion of the abrasive cloth in contact with the chamfering portion is a spinning body which polishes the substrate using an abrasive cloth by pressing the abrasive cloth to the whole circumference of the chamfering portion on inner circumference side while relatively moving the abrasive cloth and the glass substrate, the abrasive cloth having a dimension that gradually becomes large from a portion for cross-section smaller than an internal hole to a portion for cross-section larger than the internal hole.

[0015] That is, using an abrasive cloth having a shape of a spinning body, for example, a cone, a fusiform, a sphere, or the like having cross-section which gradually becomes larger, the chamfering portion is polished. Thus, it becomes possible to polish only the chamfering portion and therefore, it becomes possible to highly precisely mirror polish the chamfering portion with a small cutting stock.

[0016] It is preferable that the abrasive cloth has a spherical shape at least for a portion which comes into contact with the

chamfering portion. Thus, even if relative positions of axis of rotation of the glass substrate and axis of rotation of the abrasive cloth are changed, it is possible to maintain the condition where the abrasive cloth is simultaneously in contact with the whole circumference of the chamfering portion. Here, the abrasive cloth may have any form as long as the portion which is in contact with the chamfering portion is spherical. For example, portions for tip or back part the axis of rotation of the abrasive cloth may not be spherical.

[0017] It is preferable that the spherical portion of the abrasive cloth is so large as to allow normal line of the chamfering portion passes the center of the spherical shape when the abrasive cloth is pressed to the chamfering portion. The chamfering portion is provided with a given angle to the main surface (or axis of rotation) of the glass substrate. Therefore, when the normal line of the chamfering portion passes the center of spherical shape of the abrasive cloth, 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.

[0018] Further, at least the abrasive cloth may be rotated and the normal line passing through the center 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.

[0019] Further, while the normal line which passes through the center of the glass substrate passes through the center of spherical shape 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 kept in a condition where the abrasive cloth is in contact with the chamfering portion for the whole circumference simultaneously. That is, trajectory of movement of the axis of rotation is circular conic or sector foam with the center of the spherical shape at the tip thereof. According to this configuration, it is also possible to expand the contacting area where the abrasive cloth and the glass substrate are in contact, to prevent decrease in polishing rate, and to improve durability of the abrasive cloth.

[0020] On a plain surface including one of axis of rotation of either the glass substrate or 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. This is an example where trajectory of the axis of rotation becomes sector foam.

[0021] Either the glass substrate or the abrasive cloth may be

supported to be 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.

[0022] A typical manufacturing method of a glass substrate for a magnetic disc according to the present invention is a manufacturing method of a glass substrate for a magnetic disc with a polished inner circumference side chamfering portion having and a continued inner hole created in its center and is characterized by including a substrate supporting unit for supporting the glass substrate in a manner that enables free rotation, an abrasive cloth having a spherical portion which can be in contact with the whole circumference of a chamfering portion simultaneously on one surface side of the inner hole, and an abrasive cloth supporting unit for supporting the abrasive cloth in a manner that enables free rotation. According to the present invention, it is possible to polish only the chamfering portion and therefore, it is possible to highly precisely mirror polish the chamfering portion with small cutting stock.

[0023] A typical manufacturing method of a glass substrate for a magnetic disc according to the present invention includes a glass substrate having a chamfering portion on an inner circumference side which forms concave surface. As an example

of the concave 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 typical 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 inner circumference side.

[0025] A typical 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 having an inner hole at the center and a chamfering portion on an inner circumference side forms a concave surface following the spherical surface which can be simultaneously in contact with the 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.

[0026] A typical manufacturing method of a glass substrate for a magnetic disc according to the present invention is a

manufacturing method of a glass substrate for a magnetic disc including an edge surface polishing process for polishing a chamfering portion on an inner circumference side formed between an edge portion of an inner hole formed in the center of disc-shaped glass substrate and main surface of the glass substrate, wherein 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, it is possible to polish all the area from the edge of the main surface side to the edge of the edge surface side of the chamfering portion in the radial direction of the chamfering portion without fail. In other words, it is possible to polish the chamfering portion while the abrasive cloth is in surface contact with the chamfering portion. Therefore, it is possible to mirror polish the surface condition of the chamfering portion and at the same time possible to equalize surface roughness of the chamfering portion in vertical direction of the substrate.

[0028] Moreover, an inner circumference polishing process for polishing the inner circumference edge surface of a cylindrical subject to be polished in which a plurality of glass substrates are laminated is further included. In the inner circumference polishing process, a polishing member having an axis of rotation and a polishing unit provided in the periphery of the axis of

rotation may be inserted into an inner hole of the subject to be polished to cause the polishing unit to be extended in the direction orthogonal to the axis of rotation of the polishing member to elastically press the polishing unit to the inner circumference edge surface and in a condition where the center of the inner hole of the glass substrate and the axis of the rod-shaped polishing member are matched, at least either one of the subject to be polished or the polishing member may be moved relatively to polish inner circumference edge surface of the glass substrate.

[0029] Thus, it is possible to cause the polishing unit to be in contact with the whole of the inner circumference edge surface and to be pressed with equal pressing force. Moreover, since it is not necessary to move the axis of rotation of the polishing member in a rotating manner, it becomes possible to achieve stable inner diameter circularity, concentricity, and low inner diameter tolerance. In addition, since it is possible to polish the inner circumference edge surface by surface contacting the polishing unit, it is possible to obtain better polishing speed, that is, high productivity, in comparison with the case of polishing inner circumference edge surface by, for example, conventional point contact or line contact.

[0030] According to the present invention, for example, it is possible to highly precisely mirror polish the chamfering portion with a 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 inner hole 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 an example of another configuration of the abrasive cloth.

[FIG. 5] A view for explaining another configuration for expanding a portion of a chamfering portion which comes into contact with the abrasive cloth.

[FIG. 6] A view for explaining a polishing apparatus for polishing an inner circumference edge surface.

[FIG. 7] A view for explaining an inner circumference edge

surface polishing apparatus.

The Best Mode for Carrying Out the Claimed Invention

[0031] 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.

[0032] A manufacturing method of a glass substrate for a magnetic disc according to the present invention is configured by a step of evenly polishing a chamfering portion formed between an edge surface (wall surface) of an inner hole formed in the center of a disc-shaped glass substrate and a main surface for the whole circumference of the inner hole. Specifically, the manufacturing method of a glass substrate for a magnetic disc according to the present embodiment is a manufacturing method of a glass substrate for a magnetic disc including an edge surface polishing process for polishing a chamfering portion on inner circumference side formed between an edge portion of an inner hole formed in the center of disc-shaped glass substrate and main surface of the glass substrate, wherein 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. Then, the glass substrate for a magnetic disc manufactured according to the above-mentioned manufacturing method has a difference of 0.001 μm or less in surface roughness of the chamfering portion formed between the edge surface (wall surface) of an inner hole formed in the center of disc-shaped glass substrate and main surface of the glass substrate in the whole circumference of the inner hole.

[0033] 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, in case polishing liquid is supplied to polish a glass substrate, the polishing apparatus may include a polishing liquid supply unit 14. Polishing abrasive grain which is a polishing liquid 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.

[0034] The glass substrate 1 to be a target of polishing has a disc-shape with an inner hole 2 in its center, as shown in FIG. 2 (a). The inner hole 2 has an edge surface 2a which is almost 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.

[0035] The substrate supporting unit 10 includes a holder 11 for supporting the glass substrate 1, an arm 13, and a torque converter 12 for connecting the holder 11 and the arm 13 with predetermined load in a rotatable manner. The holder 11 is configured by attaching a base body of hard resin such as Derlin (Registered Trademark) 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.

[0036] The abrasive cloth supporting unit 20 supports an abrasive cloth 21 in a rotatable manner. The abrasive cloth 21 includes a spherical portion 22 at the tip and is rotary driven by a motor 23. 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 spherical portion 22 simultaneously comes into contact with whole circumference of a chamfering portion 2b on one surface side of the inner hole 2 and whole area from an edge 2b1 of main surface 1a side to an edge 2b2 of an edge surface 2b side of

the chamfering portion 2b in radial direction (refer to FIG. 2 (b)).

[0037] An explanation will be given of a case where polishing is carried out using a 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 portion 22 of the abrasive cloth 21 comes into contact with the inner hole 2 in a fitting manner and is pressed to the whole circumference of the chamfering portion 2b. Then, while polishing liquid (slurry) is supplied from the polishing liquid supply unit 14, the motor 23 is driven to rotate the abrasive cloth 21 and the spherical portion 22 so that the chamfering portion 2b is polished.

[0038] Thus, by polishing on the chamfering portion 2b, it is possible to sufficiently 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 improved. Further, circularity and processing accuracy of the edge surface 1a is not influenced because the spherical portion 22 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 portion 22 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.

[0039] When the glass substrate 1 is rotated by the spherical portion 22, 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.

[0040] Moreover, when polishing, at least either of the glass substrate 1 or the abrasive cloth 21 is moved while the normal line passing through the center of the glass substrate 1 passes through the center of the spherical portion 22 and 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 positions 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 the center of the spherical portion 22. 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 portion 22, the axis of rotation of the glass substrate 1 is inevitably adjusted to pass through the center of the spherical portion 22. 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 portion 22.

[0041] At this time, because a part of the abrasive cloth 21 which is in contact with the chamfering portion 2b is the spherical portion 22, 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. Here, any form of the abrasive cloth 21 can be used only if the portion which comes into contact with the chamfering portion 2b is spherical. For example, tip or

back of the abrasive cloth to the axis of rotation need not be spherical.

[0042] As mentioned above, by expanding the area of the spherical portion 22 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 portion 22) is improved, it is possible to reduce production cost.

[0043] Here, using FIG. 2 (b), an explanation will be given of relation between the inner hole 2 and the spherical portion 22. First, radial r_1 of the circular cross-section of the spherical portion 22 is set to be larger than the radial r_0 of the inner hole 2 so that the spherical portion 22 is simultaneously in contact with the whole circumference of the chamfering portion 2b on one side of the inner hole 2.

[0044] Moreover, the spherical portion 22 of the abrasive cloth 21 has a sufficient size to cause the normal line of the chamfering portion 2b to pass through the center of the spherical portion when the abrasive cloth 21 is pressed to the chamfering portion 2b. Therefore, it becomes possible to cause the abrasive cloth 21 to be in contact with the whole area, which is from an edge of the main surface of the chamfering portion in radial direction of the glass substrate 1 (2b1 of FIG. 2(a)) to an edge of the edge surface side (2b2 of FIG. 2 (b)). 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 portion 22 of

the abrasive cloth 21 and the chamfering portion 2b largest when the normal line of the chamfering portion 2b passes through the center of spherical portion of the abrasive cloth 21. 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.

[0045] On the other hand, looking at the glass substrate 1, the chamfering portion 2b of the inner hole 2 after polishing has a concave surface following the surface of the spherical portion 22. 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 concave 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.

[0046] Further, for example, before and after cleansing process and chemical strengthening process, glass substrate is replaced to exchange a carrier case. The replacement of glass substrate at this time is carried out using a mandrel jig. The mandrel jig is inserted into the inner hole, radius of the mandrel is expanded to lock inner circumference edge surface, and the jig comes into contact with the chamfering portion of the inner hole. Therefore, when the chamfering portion has a concave surface as in the present embodiment, the jig comes into contact mainly

with the edge line of the chamfering portion (boundary between the chamfering portion and edge surface) to reduce trace of contact. Therefore, smoothness on the chamfering portion is improved, generation and absorption of a particle is prevented, and as a result, it is possible to prevent a convex portion from being formed on the main surface of the magnetic disc.

[0047]

[Embodiment]

Hereinafter, an embodiment of a 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 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.

[0048]

(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.

[0049] 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.

[0050]

(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).

[0051]

(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.

[0052]

(4) Edge polishing step

Next, by brush polishing method, outer circumference edge surface of the glass substrate is mirror polished. At this time, slurry including cerium oxide abrasive grain (loose grain) is used as polishing grain.

[0053] To the inner circumference edge surface, mirror polishing is carried out by the above-mentioned polishing method and the polishing apparatus on the chamfering portion 2b (refer to FIG. 2(a)).

[0054] Next, mirror polishing is carried out on the edge surface 2a using a polishing apparatus shown in FIG. 6. The polishing apparatus shown in FIG. 6 laminates a plurality of glass substrates to form a cylindrical polishing target 30 and inserts a polishing member 31 into a continued inner hole. As shown in FIGs. 6 (b) and (c), the polishing member 31 can be extended or shrunk in radial direction and includes a fixing unit 33, a stick-shaped unit 34 as an axis of rotation having a conical

surface 34a having the same shaft as the fixing unit 33 and a radial which becomes smaller downward, and a plurality of polishing units 35 which can slide upward and downward relatively to the stick-shaped unit 34 and can move in radial direction (orthogonal to the axis of rotation) provided around the stick-shaped unit 34. Outer surface 35a of the polishing unit 35 configures cylindrical implosion and at the same time inner surface 35b thereof is in contact with the conical surface 34a of the stick-shaped unit 34 in whole and is biased by an elastic member (not shown) to inner side of radius direction. When the stick-shaped unit 34 slides downward relatively to the polishing unit 35, conical surface 34a of the stick-shaped unit 34 expands space between inner surfaces 35a of each polishing unit 35 and each polishing unit 35 is moved outer side of radius direction to increase radius of the polishing member 31 regulated by the outer surface 35a of the polishing unit 35. On the other hand, when the stick-shaped unit 34 slides upward relatively to the polishing unit 35, due to the bias by the elastic member, space between inner surfaces 35a of each polishing unit 35 is narrowed, each polishing unit 35 is moved inner side of radius direction, and radius of the polishing member 31 is reduced.

[0055] The polishing unit 35 of the polishing member 31 provides a plurality of abrasive clothes 32 formed by extending in shaft direction equiangularly. The plurality of abrasive clothes 32 are movable in radius direction in an interlocked manner with the polishing unit 35, can expand or shrink as the whole of the

polishing member 31, and can be in contact with the inner circumference surface of the polishing target 30 with equal pressure. Then, while polishing liquid is supplied between the inner circumference edge surface of the polishing target 30 and the polishing member 31, the polishing member 31 is rotated or moved to shaft direction with the shaft as center of movement to carry out polishing. In other words, polishing on the edge surface 2a is carried out by expanding the abrasive cloth included in the polishing member 31 to shaft direction of the polishing member 31 after inserting the polishing member 31 into the inner hole of the polishing target 30 and elastically pressing the abrasive cloth 32 to the edge surface 2a. Then, in a condition where the shaft of the polishing target 30 and center shaft of the polishing member 31 match, polishing liquid is supplied between the inner circumference edge surface of the polishing target 30 and the polishing member 31 to carry out polishing.

[0056] Moreover, the polishing member 31 is not limited to the one having the above-mentioned shaft structure and other structure for expansion and shrinking may be applied. As shown in FIG. 6 (d), the polishing member 31 may have a stick-shaped unit 36 having the same shaft at the fixing unit 33 and can be rotated in both directions and three polishing units 37 which can move in radius direction and provided in the outer circumference of the stick-shaped unit 36. The stick-shaped unit 36 includes three cam surfaces 36a as outer circumference surface (a surface having a cross trajectory which is a curve

which gradually recedes (approaches to) the shaft center of the stick-shaped unit 36). Cross surface of the polishing unit 37 is sector foam, outer circumference surface 37a configures cylindrical implosion, and a peak part 37b comes into contact with the cam surface 36a by bias from an elastic member (not shown). Then, when the stick-shaped unit 36 is rotated in the direction of arrow A in FIG. 6 (d), the polishing member 31 is expanded in the radius direction while when the stick-shaped unit 36 is rotated in the direction of arrow B in FIG. 6 (d), the polishing member 31 is shrunk in the radius direction.

[0057] According to the polishing method of such a configuration, it is possible to cause the abrasive cloth of inner circumference polishing unit to be in contact with the whole of inner circumference edge surface of the polishing target and also to make pressing force thereof equal. Because the abrasive cloth is surface contacted, polishing speed can be improved. Moreover, since pressing force is equalized in radius direction, circularity can be small and stable, while it is possible to maintain inner diameter size between substrates small since the pressing force is equalized in shaft direction.

[0058] Moreover, with regard to the edge surface 2a, as shown in the conventional example in FIG. 7, polishing using a rotary brush 50 may be carried out. At this time, the rotary brush 50 does not need to polish the chamfering portion 2b and type of a bristle of the brush (diameter or material), density of the bristles, pressing force, etc. may be set appropriately so that the edge surface 2a can be polished. Moreover, the edge

surface 2a can also be polished by use of a columnar abrasive cloth instead of the rotary brush 50.

[0059] 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.

[0060] Here, in the present embodiment, an explanation was given of a case where the chamfering portion 2b is polished first and the edge surface 2a is polished thereafter. However, the order is arbitrary and the edge surface 2a may be polished first and the chamfering portion 2a may be polished thereafter.

[0061]

(5) 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 liquid, cerium oxide abrasive grain was used.

[0062] The glass substrate after the first polishing step was sequentially dipped in cleansing tanks of neutral detergent, pure water, and isopropyl alcohol (IPA) to be cleansed.

[0063] 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 liquid, cerium oxide abrasive grain having finer grain than the cerium oxide abrasive grain used in the first polishing step was used.

[0064] The glass substrate after the second polishing step was sequentially dipped in cleansing tanks of neutral detergent, pure water, and isopropyl alcohol (IPA) to be cleansed. Here, ultrasonic wave was applied to the tanks.

[0065]

(6) 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.

[0066] 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 .

[0067] The glass substrate after the chemical strengthening step is dipped into a water tank of 20°C to be rapidly cooled 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 to be cleansed.

[0068] 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.

[0069]

(7) 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.

[0070]

[Evaluation]

A magnetic disc having a chamfering portion single polished 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.

[0071]°

[Other embodiments]

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.

[0072] 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 portion 22. 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. FIG. 3 is a view showing other configuration of the abrasive cloth. 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_3 which is larger than the radius r_0 of the inner hole 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 and to polish only the chamfering portion. Therefore, it is possible to polish the chamfering portion with small cutting stock.

[0073] Further, 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 portion 22. However, the portion may have any shape

so long as the portion simultaneously comes into surface contact with the whole area from an edge of main surface side of the chamfering portion 2b to an edge of edge surface 2a side in radius direction of the chamfering portion 2b. FIG. 4 is a view for explaining the other configuration example of an abrasive cloth. FIG. 4 (a) is an external view of an abrasive cloth 27, FIG. 4 (b) is a view of the abrasive cloth 27 seen from above, FIG. 4 (c) is a view for explaining how FIG. 4 (b) is used.

[0074] In the abrasive cloth 27, the spherical portion 22 of the abrasive cloth 21 shown in FIG. 2 is equally divided into six in vertical direction and includes contact portions 27a (shown by blank in FIG. 4 (b)) and notch portions 27b (shown by diagonal lines in FIG. 4 (b)) are alternately provided.

[0075] Thus, the contact portions 27a of the abrasive cloth 27 come into contact with at least whole area from the edge of surface side of the chamfering portion 2b to the edge of the edge surface side 2a in radius direction of the chamfering portion 2b without fail (FIG. 4 (c)). Therefore, it is possible to polish the chamfering portion 2b in vertical direction without fail. Since a plurality of contact portions 27a simultaneously come into contact with a plurality of spots of the chamfering portion 2b, it is possible to polish equally. Therefore, since it is possible to polish the chamfering portion 2b while being in surface contact with the chamfering portion 2b, it becomes possible to mirror polish the surface condition of the chamfering portion 2b and at the same time, it is possible to equalize surface roughness of the chamfering portion 2b in

vertical direction of the glass substrate 1.

[0076] FIG. 5 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 portion 22 which is in contact with the chamfering portion 2b is expanded. However, as shown in FIG. 5 (a), each of axis of rotation of the glass substrate 1 and the abrasive cloth 21 may be crossed with a predetermined angle. By the present embodiment, it is also possible to expand the portion of the spherical portion 22 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.

[0077] 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. Therefore, as shown in, for example, FIG. 5 (b), the trajectory of movement of the glass substrate 1 may be conical shape with the center of the spherical portion 22 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.

[0078] 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 liquid 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.

[0079] 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 shape 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.

[0080] 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 schematically hemispherical shape 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.

[0081] 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 inner circumference side of a glass substrate to the chamfering portion, to supply polishing liquid 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.

[0082] 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 shape on inner circumference side of a glass substrate to the whole circumference of a chamfering portion formed on one surface side of the glass substrate, to supply polishing liquid 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.

[0083] 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 having a hole in its center and a polished chamfering portion on an inner circumference side, comprising the steps of:

using an abrasive cloth which can be simultaneously in contact with the whole circumference of the chamfering portion; and

polishing the chamfering portion 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 inner circumference side.

2. A manufacturing method of a glass substrate for a magnetic disc having a hole in its center and a polished chamfering portion on an inner circumference side, comprising the steps of:

using an abrasive cloth having at least a portion which is a spinning body, comes into contact with the chamfering portion, and has a circular cross-section smaller than the inner hole which becomes gradually larger to be larger than the inner hole; and

polishing the chamfering portion 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 inner circumference side.

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

wherein the abrasive cloth has a spherical portion for at least a portion which comes into contact with the chamfering portion.

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

wherein the spherical portion of the abrasive cloth has a size which allows normal line of the chamfering portion to pass through the center of the spherical portion when the abrasive cloth is pressed to the chamfering portion.

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 normal line passing through the center 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 3,

wherein the normal line which passes through the center of the glass substrate passes through the center of spherical shape of the abrasive cloth and at least either one of the glass substrate or the abrasive cloth is moved while the abrasive cloth is kept in a condition where the abrasive cloth is in

contact with the chamfering portion for the whole circumference simultaneously.

7. 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 of the abrasive cloth.

8. 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.

9. A polishing apparatus for a glass substrate for a magnetic disc which polishes a chamfering portion on inner circumference side of a disc-shaped glass substrate with an inner hole which is formed in its center comprising:

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

an abrasive cloth including a spherical portion which can be simultaneously in contact with the whole circumference of the chamfering portion on the one surface side of the inner hole; and

an abrasive cloth supporting unit for supporting the

abrasive cloth in a rotatable manner.

10. A glass substrate for a disc-shaped magnetic disc with an inner hole in its center, wherein a chamfering portion on inner circumference side has a concave surface.

11. A glass substrate for a magnetic disc according to claim 10,

wherein the concave surface has a shape following a surface of spherical shape which can be simultaneously in contact with the whole circumference of the chamfering portion.

12. 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 8.

13. A magnetic disc, comprising:

a step of forming a magnetic layer on a disc-shaped glass substrate having a hole in its center wherein a chamfering portion on inner circumference side has a concave surface following a spherical surface which can be in contact with the whole circumference of the chamfering portion.

14. A manufacturing method of a glass substrate, comprising:
an edge surface polishing step for polishing a chamfering portion on an inner circumference side formed between an edge

portion of an inner hole formed in the center of disc-shaped glass substrate and main surface of the glass substrate,

wherein an abrasive cloth which can be in contact with the whole area 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.

15. A manufacturing method of a glass substrate for a magnetic disc according to any one of claims 1 to 8, further comprising:

an inner circumference polishing step for polishing an inner edge surface of a cylindrical subject to be polished formed by laminating a plurality of glass substrates,

wherein in the inner circumference polishing step, a polishing member having an axis of rotation and a polishing unit provided in the periphery of the axis of rotation is inserted into an inner hole of the subject to be polished to cause the polishing unit to be extended in the direction orthogonal to the axis of rotation of the polishing member to elastically press the polishing unit to the inner circumference edge surface and in a condition where the center of the inner hole of the glass substrate and the axis of the rod-shaped polishing member are matched, at least either one of the subject to be polished or the polishing member may be moved relatively to polish inner circumference edge surface of the glass substrate.