

MANUFACTURING METHOD OF GLASS SUBSTRATE
FOR
MAGNETIC DISC

The present disclosure relates to subject matters contained in Japanese Patent Application No. 2008-059583 filed on March 10, 2008, which are expressly incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001]

The present invention relates to a manufacturing method of a glass substrate for a magnetic disc.

2. Description of the Related Art

[0002]

Along with advancement of information technology, information recording technology, especially magnetic recording technology has been significantly improving. As a substrate for a magnetic recording medium such as a hard disc drive (HDD), which is one of the magnetic recording media, aluminum substrate has been widely used. However, along with space saving, flattening, and high density recording of the magnetic disc, the aluminum substrate has been replaced by a glass substrate having superior flatness and substrate strength of the substrate surface to those of an aluminum substrate.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). Further, floating amount of a magnetic head from a substrate has been narrowed to about 6 nm. In a magnetic head mounting such a magnetoresistance element, there may be a case where a head crash or thermal asperity occurs as a trouble unique to such a head. Because such a trouble is caused by minute convex or concave portion on the magnetic disc surface, the magnetic disc is required to have highly superior smoothness and flatness on the surface thereof.

[0004]

Moreover, to efficiently use the area of the glass substrate surface, a load unload (LUL) method has been adopted instead of a conventional contact start stop (CSS) method. In the LUL method, a magnetic head passes through an edge portion of the glass substrate and therefore, accuracy of shape of an edge surface of the glass substrate (especially outer circumference edge surface) becomes an issue. If the edge portion of the glass substrate is misshaped (roll or droop in the edge portion), floating posture of the magnetic head is not stabilized and the magnetic head becomes prone to contact with the glass substrate when the magnetic head comes in from outside of the glass substrate or goes out. Therefore, there is a possibility that a crush trouble may occur.

[0005]

In addition, in a case where the magnetic head is caused to float fly with a narrow floating amount of 6 nm or less, there is a problem that fly stiction often occurs. Fly stiction is a trouble that causes abnormality in floating posture or floating amount of the magnetic head which is float flying on

the magnetic disc due to pressure change caused by a convex or concave portion on the magnetic disc and because of this, irregular replay power variation is generated. Further, if the fly stiction occurs, there may be a case where the head crush occurs and the magnetic head which is float flying comes into contact with the magnetic disc. Because of the above, smoothness of the substrate surface is especially important for a glass substrate for a magnetic disc.

[0006]

In a polishing step of a manufacturing step of the above-mentioned glass substrate for a magnetic disc, a glass substrate is held by a carrier for polishing and polishing is carried out by use of an abrasive pad while abrasive agent (slurry) including a loose grain is supplied between the glass substrate and the abrasive pad. Moreover, to prevent generation of polishing trace or deviation on the glass substrate, the abrasive pad is attached to a fixed platen, the glass substrate is sandwiched therebetween, a planetary gear mechanism is used, and the glass substrate and the abrasive pad are relatively moved so that the glass substrate can be evenly polished. Such a polishing method is a superior method from a viewpoint of production efficiency because a plurality of glass substrates can be simultaneously polished.

[0007]

In the above-mentioned polishing step, the carrier for polishing engages with a sun gear and an internal gear to carry out planetary gear operation. At this time, if the carrier for polishing includes a material with low rigidity, a gear portion of the carrier for polishing is galled or damaged by contacting with the sun gear and the internal gear when rotating.

[0008]

As a method to improve such a problem, a carrier for polishing having a dual structure in an outer circumference portion, which is a gear portion of the carrier for polishing made of glass fiber resin, is proposed. The outer circumference portion is strengthened by metal (e.g., Patent Document 1). Thus, it becomes possible to reduce gall or damage caused by contact between the gear portion and the sun gear and the internal gear when rotating. Moreover, it becomes possible to increase the speed of the fixed platen because strength of the gear portion is increased.

[Patent Document 1] Unexamined Japanese Patent Publication No. H6-55434

[0009]

However, there is variation in thickness of the glass substrate after polishing as another problem of the above-mentioned polishing step. Generation of such variation in substrate thickness shows that a uniform processing is not carried out in the polishing step, that is, chamfering amount cannot be controlled.

[0010]

In a case where a hard pad such as a urethane pad was used in the polishing step, variation in thickness of the glass substrate after polishing was between 2 and 3 μm , which was very small. However, in a case where a soft pad such as a swede pad is used under the same condition where the hard pad was used, variation in thickness of the substrate is generated. Although it is possible to reduce the variation in substrate thickness by lowering rotation speed of the fixed platen, there remains a problem that productivity is greatly lowered.

[0011]

Moreover, in the manufacturing step of a glass substrate for a magnetic disc, a plurality of times of polishing processing are carried out to a disc-shaped glass substrate. Therefore, if chamfering amount cannot be controlled in each polishing step, especially in initial polishing step, variation in chamfering amount is generated in the following polishing step and thickness of final products also varies, which may as a result lead to decreased non-defective product rate.

SUMMARY OF THE INVENTION

[0012]

The present invention has been made taking the above problems into consideration and is aimed at providing a manufacturing method of a glass substrate for a magnetic disc enabled to reduce variation in thickness of a glass substrate after polishing step using a soft pad and to improve non-defective product rate while maintaining production efficiency.

[0013]

As the inventors of the present application keenly discussed to solve the above-mentioned problems, the inventors thought that generation of variation in glass substrate thickness after polishing step is caused by large amount of subduction of a glass substrate into a pad in case of using a soft pad and this leads to uneven load of the abrasive pad applied to the glass substrate. In the above-mentioned polishing step, the abrasive pad is pressed to the glass substrate by about 100 kg of load and it is assumed that load is unevenly applied to

each glass substrate at this time. Then, when variation of substrate thickness was observed, follows were confirmed.

[0014]

First, it was found out that in a case where a plurality of glass substrates are retained by one carrier, there is a variation in thickness between glass substrates retained on external side of the carrier and inside of the carrier. That is, if inside of the fixed platen is pressed harder (load is larger), the glass substrate retained inside (center portion) of the carrier for polishing is more easily polished and if external side of the fixed platen is pressed harder, the glass substrate retained on external side (outer circumference portion) of the carrier for polishing is more easily polished. A reason why load varies depending on the position in one carrier is that the soft pad has flexibility and the glass substrates are not evenly distributed when seen from the soft pad.

[0015]

Moreover, a plurality of carriers are retained by a polishing apparatus and planetary gear operation is carried out and it was found out that glass substrate thickness also varies for each carrier. Actually, because variation in each carrier is added to variation between carriers, variation is generated in a complicated manner.

[0016]

Therefore, the inventors focused on the thickness of the carrier for polishing. As a result of keen discussion, the inventors found out that variation in glass substrate thickness after polishing step is caused by variation in thickness of a glass substrate retention unit and a gear portion of the carrier for polishing. Therefore, the inventors further

discussed to reduce variation in glass substrate thickness and to improve non-defective product rate of the product while maintaining the production efficiency and completed the present invention.

[0017]

That is, a typical configuration of a manufacturing method of a glass substrate for a magnetic disc according to the present invention includes a polishing step for supplying abrasive agent including a loose grain between a glass substrate and an abrasive pad to polish a main surface of the glass substrate and for relatively moving a carrier for polishing which retains the glass substrate and the abrasive pad to carry out polishing, wherein the carrier for polishing includes a glass substrate retention unit having a retention hole for retaining the glass substrate and a gear portion provided on an outer circumference of the glass substrate retention unit, the glass substrate retention unit and the gear portion respectively include different materials, thickness of the glass substrate retention unit is between 0.45 and 0.63 times as thick as target thickness of the glass substrate, and thickness of the gear portion is between 1.00 and 1.84 times as thick as the glass substrate retention unit.

[0018]

Since the glass substrate retention unit and the gear portion include different materials, materials having properties required of each member, for example, appropriate rigidity for the glass substrate retention unit or durability for the gear portion, can be used.

[0019]

Moreover, since thickness of the gear portion and the

glass substrate retention unit are set within the above-mentioned range, it becomes possible to evenly apply load from the abrasive pad to the glass substrate in the polishing step. Therefore, it becomes possible to evenly polish a plurality of glass substrates retained by the carrier for polishing, to reduce variation in thickness, and to improve non-defective product rate of the final product.

[0020]

Here, it is preferable that permissible maximum value of variation in the above-mentioned thickness is 3 μm or less. If the variation in thickness after polishing step of the glass substrate exceeds the permissible maximum value, it may badly influence processing steps after the polishing step.

[0021]

Further, if the thickness of the glass substrate retention unit is too thick when compared to the thickness of the glass substrate, load of the abrasive pad in the polishing step is mainly applied to the glass substrate retention unit. Therefore, it prevents polishing the glass substrate. Further, if the thickness of the glass substrate retention unit is too thin when compared to the thickness of the glass substrate, strength of the glass substrate retention unit becomes insufficient. Therefore, it is preferable that the thickness of the glass substrate retention unit is within the above-mentioned range.

[0022]

It is preferable that thickness of the gear portion is between 0.60 and 0.87 times as thick as target thickness of the glass substrate.

[0023]

If the gear portion is too thick when compared to the thickness of the glass substrate, load of the outer circumference portion of the abrasive pad is applied to the gear portion. Therefore, it prevents polishing a glass substrate retained on external side of the carrier for polishing. Therefore, it is preferable that the thickness of the gear portion is within the above-mentioned range.

[0024]

It is preferable that in the carrier for polishing, the glass substrate retention unit and the gear portion include different materials respectively and the glass substrate retention unit is jointly fixed so that the glass substrate retention unit cannot rotate to the gear portion.

[0025]

In case of a carrier for polishing in which a glass substrate retention unit and a gear portion are integrated, if, for example, the gear portion is damaged, the carrier for polishing itself must be replaced. However, a configuration in which the glass substrate retention unit and the gear portion include different materials enables to exchange only the glass substrate retention unit if the glass substrate retention unit galls and to exchange only the gear portion if the gear portion is damaged. Therefore, it becomes possible to reduce cost for the carrier for polishing.

[0026]

Moreover, since the glass substrate retention unit is jointly fixed to the gear portion, although the glass substrate retention unit and the gear portion include different materials, it becomes possible to cause the glass substrate retention unit to be rotated in response to rotation of the gear portion without

idly turning the glass substrate retention unit when the carrier for polishing carries out planetary gear operation in the polishing step.

[0027]

It is preferable that the glass substrate retention unit includes glass epoxy.

[0028]

If rigidity of the material of the glass substrate retention unit is too high, when the glass substrate and the glass substrate retention unit come into contact in the polishing step, the edge surface of the glass substrate is damaged. Moreover, if the rigidity is too low, the glass substrate retention unit galls by friction with the abrasive pad in the polishing step. Therefore, it is preferable that the glass substrate retention unit includes glass epoxy having appropriate rigidity (similar rigidity to that of the glass substrate).

[0029]

It is preferable that the gear portion includes stainless steel.

[0030]

The gear portion carries out planetary gear operation while engaging with a sun gear and an internal gear. Therefore, if the gear portion includes metal such as stainless steel, durability of the gear portion is improved and if the gear portion comes into contact with the sun gear and the internal gear when rotating, gall or damage of the gear portion can be reduced.

[0031]

It is preferable that thickness of the glass substrate

retention unit is 0.40 mm or less.

[0032]

If the glass substrate retention unit is too thick, load of the abrasive pad becomes difficult to be applied to the glass substrate in a polishing step. Especially, if thickness of the glass substrate retention unit is equal to or more than target thickness of the glass substrate, it becomes difficult for the glass substrate and the abrasive pad to be in contact and therefore it becomes difficult to polish the retained glass substrate to the thickness that is equal to or less than the glass substrate retention unit. Therefore, it is preferable that the thickness of the glass substrate retention unit is equal to or less than the above-mentioned thickness. Here, if the thickness of the glass substrate retention unit is 0.30 mm, the glass substrate cannot be retained by the glass substrate retention unit.

[0033]

It is preferable that thickness of the gear portion is 0.55 mm or less.

[0034]

As mentioned above, if the gear portion is too thick, load of the outer circumference portion of the abrasive pad is applied to the gear portion. Therefore, it prevents polishing a glass substrate retained on external side of the carrier for polishing. Therefore, it is preferable that the thickness of the gear portion is equal to or less than the above-mentioned thickness.

[0035]

It is preferable that Asker-C hardness of the abrasive pad is between 70 and 90.

[0036]

Even in a case where the abrasive pad is a soft pad having the above-mentioned hardness, it becomes possible to reduce variation in substrate thickness if the present invention is applied. If a hard pad having hardness 90 or more is used, because subduction of the glass substrate to the abrasive pad is small, variation of the substrate thickness is small. On the other hand, if an abrasive pad having hardness 70 or less, which is too soft, is used, it takes much time until desired chamfering amount is taken and operation efficiency is decreased.

[0037]

According to the present invention, it is possible to provide a manufacturing method of a glass substrate for a magnetic disc enabled to reduce variation in thickness of a glass substrate after polishing step using a soft pad and to improve non-defective product rate while maintaining production efficiency.

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]

An explanatory view of a drive mechanism unit of a both

surface polishing apparatus.

[FIG. 2]

An overall view of the both surface polishing apparatus.

[FIG. 3]

An explanatory view of configuration of a carrier for polishing.

[FIG. 4]

A view showing rotation direction of the drive mechanism unit.

[FIG. 5]

An explanatory view of relation between thickness of a glass substrate and the carrier for polishing in a polishing step.

[FIG. 6]

A view explaining comparison of polishing results by difference in a glass substrate retention unit and a gear portion.

The Best Mode for Carrying Out the Claimed Invention

[0038]

Hereinafter, a preferred embodiment of the present invention will be explained in detail with reference to attached figures. Dimension, material, and other specific numeric values are just examples for easy of understanding of the invention and the present invention is not limited thereto if not otherwise specified. Here, in the present application and drawings, same reference numerals are denoted to elements having substantially same function or configuration to omit redundant explanation thereof and an element which is not directly related to the present invention is not shown in the

drawings.

[0039]

FIG. 1 is an explanatory view of a drive mechanism unit of a both surface polishing apparatus. As shown in FIG. 1, the both surface polishing apparatus 100 includes a carrier mounting unit having a sun gear 130 and an internal gear 140 rotary driven with a predetermined rotation ratio respectively, and an upper fixed platen 150 and a lower fixed platen 160 rotary driven in opposite directions sandwiching the carrier mounting unit. On the surfaces of the upper fixed platen 150 and the lower fixed platen 160 which are facing a glass substrate 110, polishing pads 170 are attached. A carrier 120 is mounted so as to be engaged with the sun gear 130 and the internal gear 140.

[0040]

FIG. 2 is an overall view of the both surface polishing apparatus. The lower platen 160 is provided in a fixed manner in vertical direction and the upper platen 150 is configured to be enabled to move vertically and to be pressed to a glass substrate 110, which is retained by a carrier for polishing 120, sandwiching by the abrasive pads 170.

[0041]

In a polishing step, polishing is carried out while abrasive agent (slurry) including a loose grain is supplied. Abrasive agent 220 stored in a container 210 is supplied to the upper fixed platen 150 by a pump 230, used for polishing, collected from the lower fixed platen 160, and returned to the container 210 to be circulated. A filter 240 for collecting a grain having a large particle size or waste in polishing is provided at an outlet of the lower fixed platen 160 or an outlet

from a pipe to the container 210.

[0042]

FIG. 3 is an explanatory view of configuration of a carrier for polishing. As shown in FIG. 3, the carrier for polishing 120 includes a glass substrate retention unit 310 and a gear portion 320. The glass substrate retention unit 310 is a discotic member having a plurality of retention holes 312 for retaining the glass substrate 110 and an engagement concave portion 314 on an outer circumference surface for engaging with the gear portion 320. The gear portion 320 has a toric shape with a circular empty space in the center portion, a tooth 322 on an outer circumference surface for engaging with the sun gear 130 and the internal gear 140, and an engaging convex portion 324 on an inner circumference surface for engaging with the glass substrate retention unit 310.

[0043]

Then, the glass substrate retention unit 310 is inserted into the hole in the center portion of the gear portion 320 and the engaging concave portion 314 of the glass substrate retention unit 310 and the engaging convex portion 324 of the gear portion 320 are engaged to be fixed to form the carrier for polishing 120. Here in the present embodiment, the engaging concave portion 314 and the engaging convex portion 324 are engaged to be fixed. However, the present invention is not limited thereto and other fixing method, for example, fixing by use of an adhesive agent or the like may be used. Moreover, the glass substrate retention unit 310 and the gear portion 320 do not need to be engaged.

[0044]

FIG. 4 is a view showing rotation direction of the drive

mechanism unit. As shown in FIG. 4 (a), the glass substrate 110 is retained in the retention hole 312 of the carrier 120 on the lower fixed platen 160. Moreover, the upper fixed platen 150 is rotated with the sun gear 130 and the lower fixed platen 160 is rotated with the internal gear 140. The carrier for polishing 120 is engaged with the sun gear 130 and the internal gear 140 and the sun gear 130 is rotated in the direction of the arrow so that each of the carrier for polishing 120 is rotated in the direction of the arrow as a planetary gear while making an orbital motion. The sun gear 130 and the internal gear 140 may be rotated relatively and either or both of them may be rotated. If the speed of the internal gear 140 and the sun gear 130 differ, the carrier 120 is caused to make planetary gear operation and rotating the internal gear in a direction opposite to that of the sun gear 130 enables to rotate the carrier for polishing 120 efficiently and in high speed.

[0045]

FIG. 4 (b) is a cross-sectional view of the carrier for polishing 120 taken along the A-A line in FIG. 4 (a). The upper fixed platen 150 can be moved vertically to the lower fixed platen 160 and as shown in FIG. 4 (b), the abrasive pad 170 is provided to a polishing surface of the upper fixed platen 150 and the lower fixed platen 160 respectively. The upper fixed platen 150 and the lower fixed platen 160 sandwich the carrier for polishing 120 from above and below and press the abrasive pads 170 to both the front and back surfaces of the glass substrate. Then, while supplying the abrasive agent including a loose grain (slurry), due to the planetary gear operation of the carrier for polishing 120 and rotation in opposite directions by the upper fixed platen 150 and the lower fixed

platen 160, the glass substrate 110 and the abrasive pads 170 are relatively moved to polish both the front and back surfaces of the glass substrate 110.

[0046]

The both surface polishing apparatus 100 having the above-mentioned configuration uses a plurality of sets, each of the sets including a loose grain included in the abrasive agent and the abrasive pad 170 which moves relatively to the glass substrate 110 while being supplied with the abrasive agent, to be used for polishing the main surface of the glass substrate 110 which is carried out a plurality of times by stages in the manufacturing step of the glass substrate 110. In the later-described embodiment, as a step for polishing the main surface of the glass substrate 110, two polishing steps, a preliminary polishing (first polishing) step and a mirror polishing (second polishing) step, are carried out. In these steps, configuration of the both surface polishing apparatus 100 has almost same configuration but loose grain included in the abrasive agent to be used and composition of the abrasive pad 170 differ. In general, particle size of the loose grain becomes smaller and the abrasive pad 170 becomes softer in the latter steps. With such a configuration, smoothness of the surface is gradually improved.

[0047]

FIG. 5 is an explanatory view of relation between thickness of a glass substrate and the carrier for polishing in a polishing step. FIG. 5 (a) is a view showing a plan view of the carrier for polishing. FIGs. 5 (b), (c), and (d) show cross-sectional views taken along X-X line in FIG. 5 (a). Hereinafter, target thickness of the glass substrate 110 will

be referred to as "Gt", thickness of the glass substrate retention unit 310 will be referred to as "It", and thickness of the gear portion 320 will be referred to as "Ot" in the following explanation of FIG. 5.

[0048]

FIG. 5 (b) is a cross-sectional view taken along the X-X line showing relation between the thickness of the glass substrate retention unit and thickness of the gear portion. FIG. 5 (b1) is a cross-sectional view of a case where value of O_t/I_t is smaller than 1.00 taken along the X-X line. At this time, because there is unevenness between the glass substrate retention unit 310 and the gear portion 320, if load is applied from the upper fixed platen 150 and the lower fixed platen 160 in the polishing step, the abrasive pad 170 cuts into the unevenness. Therefore, the abrasive pad 170 is pressed harder on the outer side of the carrier for polishing 120 and it becomes impossible to apply load evenly to the glass substrate 110. Therefore, variation in thickness of the glass substrate 110 exceeds a permissible value.

[0049]

FIG. 5 (b2) is a cross-sectional view of a case where value of O_t/I_t is larger than 1.84 taken along the X-X line. At this time, there is unevenness between the glass substrate retention unit 310 and the gear portion 320 similarly to the above-mentioned case. Therefore, if load is applied from the upper fixed platen 150 and the lower fixed platen 160 in the polishing step, the abrasive pad 170 cuts into the unevenness. Therefore, the abrasive pad 170 is pressed harder on the inner side of the carrier for polishing 120 and it becomes impossible to apply load evenly to the glass substrate 110 and variation

in thickness of the glass substrate 110 exceeds a permissible value. Moreover, because the gear portion 320 is too thick, it is conceivable that contact between the abrasive pad 170 and the glass substrate 110 is prevented.

[0050]

Therefore, to reduce variation in thickness of glass substrates 110 after the polishing step, it is required that the value of O_t/I_t which is relation between the thickness of the glass substrate retention unit and the thickness of the gear portion is within a setting range.

[0051]

FIG. 5 (c) is a cross-sectional view taken along the X-X line showing relation between target thickness of the glass substrate and thickness of the glass substrate retention unit. FIG. 5 (c1) is a cross-sectional view of a case where value of I_t/G_t is smaller than 0.45 taken along the X-X line. As shown in FIG. 5 (c1), if the thickness of the glass substrate retention unit 310 is too thin, due to inertial in rotation in the polishing step, the glass substrate retention unit 310 cannot retain the glass substrate 110 and it is conceivable that the glass substrate 110 falls out from the retention hole 312 and is broken.

[0052]

FIG. 5 (c2) is a cross-sectional view of a case where value of I_t/G_t is larger than 0.63 taken along the X-X line. If the thickness of the glass substrate retention unit 310 is too thick relatively to the target thickness of the glass substrate 110, load of the abrasive pad 170 is applied mainly to the glass substrate retention unit 310 in the polishing step and the load cannot be applied to the glass substrate 110. Thus, the glass

substrate retention unit 310 prevents the glass substrate 110 from being polished. Therefore, it is preferable that the value of t_t/t_g which is relation between the target thickness of the glass substrate 110 and thickness of the glass substrate retention unit 310 is within the above-mentioned range.

[0053]

FIG. 5 (d) is a cross-sectional view taken along the X-X line showing relation between target thickness of the glass substrate and thickness of the gear portion. FIG. 5 (d1) is a cross-sectional view of a case where value of t_t/t_g is smaller than 0.60 taken along the X-X line. As shown in the figure, if the gear portion 320 is too thin, strength thereof is decreased and there is a possibility that the gear portion 320 is broken when planetary gear operation is carried out.

[0054]

FIG. 5 (d2) is a cross-sectional view of a case where value of t_t/t_g is larger than 0.87 taken along the X-X line. As shown in FIG. 5, if the thickness of the gear portion 320 is too thick relatively to the thickness of the glass substrate 110, load of outer circumference portion of the abrasive pad 170 is applied mainly to the gear portion 320. Because of this, contact between the glass substrate 110 retained by the external side of the carrier for polishing 120 and the abrasive pad 170 is prevented and load from the abrasive pad 170 to the glass substrate 110 becomes uneven. Therefore, it is preferable that the value of t_t/t_g which is relation between the target thickness of the glass substrate and the thickness of the gear portion is within the above-mentioned range.

[0055]

Therefore, in the present embodiment, any of the

above-mentioned Ot/It, It/Gt, or Ot/Gt or a combination thereof enables to control the relation of thickness between the glass substrate 110, the glass substrate retention unit 310, and the gear portion 320 to be an appropriate value, to reduce variation in thickness of glass substrates after the polishing step while maintaining production efficiency, and to improve non-defective product ratio.

[0056]

(Embodiment)

Hereinafter, an embodiment of a manufacturing method of a glass substrate for 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.

[0057]

(1) Shaping step and wrapping step

In the manufacturing method of a glass substrate for a magnetic disc according to the present embodiment, surface of a plate glass was wrapping processed (ground) to produce a glass base material. Then the glass base material was cut to produce a glass disc. Various types of plate glass can be used as the plate glass. The plate glass can be manufactured by a heretofore known method such as a press method, a float method, a down-draw method, a redraw method, and a fusion method with,

for example, molten glass as a material. Among these methods, if press method is used, the plate glass can be manufactured at a low cost. Amorphous glass and glass ceramics (crystallized glass) can be used as quality of material of the plate glass. aluminosilicate glass, soda line glass, boronsilicate glass, or the like can be used as material of the plate glass. Especially, as amorphous glass, the aluminosilicate glass can be preferably used because it can be chemically strengthened and can provide a glass substrate for a magnetic disc having superior main surface flatness and substrate strength.

[0058]

In the present embodiment, molten aluminosilicate glass was 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, 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 , was used.

[0059]

Next, both main surfaces of the plate glass was wrapping processed to make a disc-shaped base glass material. The wrapping process was carried out by an apparatus for both surfaces wrapping using planetary gear mechanism and alumina system loose grain. Specifically, wrapping platen was pressed from top and bottom to both surfaces of the plate glass, grinding fluid containing loose grain was supplied on the main surface of the plate glass, and they were relatively moved to carry out the wrapping process. By this wrapping process, a glass base material having smooth main surface was obtained.

[0060]

(2) Cutting step (coring, forming, chamfering)

Next, using a diamond cutter, the glass base material was cut and a disc-shaped glass substrate was cut out from the glass base material. Next, using a diamond drill having cylindrical shape, an inner hole was 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 were ground by a diamond grinder to carry out predetermined chamfering process (forming, chamfering).

[0061]

(3) Second wrapping step

Next, on both surfaces of the glass substrate thus obtained, second wrapping process was 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.

[0062]

(4) Edge surface polishing step

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

[0063]

Then, the glass substrate after edge surface polishing step was cleansed with water. By this edge surface polishing step, the edge surface of the glass substrate was processed to have a mirror surface condition which can prevent separation

of sodium or potassium. Especially, the inner circumference edge surface was in a good condition without decrease in tolerance or circularity of inner hole even in a case where a plurality of, about 200 to 300, substrates were laminated and polished.

[0064]

(5) Main surface first 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 according to the present embodiment, main surface was mirror polished by the both surface polishing apparatus which includes a planetary gear mechanism, using soft swede pad as an abrasive pad. As polishing agent (loose grain), colloidal silica was used.

[0065]

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.

[0066]

(Evaluation)

Effectiveness of the present invention in the first polishing step according to the present embodiment will be explained. In the present embodiment, number of the glass substrates polished per one batch was 100. Variation in substrate thickness was measured by sampling one substrate from inner side (center portion) and external side (outer circumference portion) of each of a plurality of carriers mounted on the both surface polishing apparatus. The total number of the glass substrate was 10. Variation between maximum

and minimum values of measured values of substrate thickness of the 10 glass substrates was set to be the variation in thickness. Here, to avoid bad influence to processing steps of the glass substrate 110 after the polishing step, permissible maximum value of the variation was set to 3 μm .

[0067]

The above-mentioned polishing rate (polishing efficiency) is the amount of glass substrate main surface which can be polished within one minute and is a value acquired by dividing chamfered amount by time. To maintain production efficiency of the glass substrate, permissible minimum value of the polishing rate was set to 0.8 $\mu\text{m}/\text{min}$. Here, target thickness of the glass substrate in the embodiment explained below is set to 0.636 nm. However, the present invention is not limited to this value.

[0068]

FIG. 6 is a view explaining comparison of polishing results by changing thickness of the glass substrate retention unit and the gear portion. FIG. 6 (a) is a view for explaining comparison of variation in thickness (normal distribution) caused by changes in thickness in the glass substrate retention unit and the gear portion and FIG. 6 (b) is a view for explaining comparison of polishing rates caused by changes in thickness of the glass substrate retention unit and the gear portion.

[0069]

If the glass substrate 110 was polished with the glass substrate retention unit 310 having fixed thickness of 0.55 mm, the gear portion 320 having the thickness of 0.60 mm (comparison example 1) and 0.40 mm (comparison example 2), in both the comparison examples 1 and 2, variation in thickness largely

exceeds 3 μ m, which was the permissible maximum value. Therefore, variation in thickness of the glass substrate of the comparison examples 1 and 2 would be larger in the following processing steps and would be defective as final products. Moreover, since the polishing rates of the comparison examples 1 and 2 largely fall below permissible minimum value, it is understood that production efficiency is extremely low.

[0070]

Next, the glass substrate 110 was polished with the glass substrate retention unit 310 having fixed thickness of 0.40 mm, the gear portion 320 having the thickness of 0.60 mm (comparison example 3), 0.55 mm (embodiment 1), and 0.40 mm (embodiment 2). As a result, variation in thickness and polishing rate of the embodiments 1 and 2 were within permissible ranges, while variation in thickness and polishing rate of the comparison example 3 was out of the permissible ranges.

[0071]

Further, the glass substrate 110 was polished with the glass substrate retention unit 310 having fixed thickness of 0.30mm, the gear portion 320 having the thickness of 0.60 (comparison example 4), 0.55 mm (embodiment 3), and 0.40 mm (embodiment 4). As a result, polishing rates of the comparison example 4 and the embodiments 3 and 4 were within the permissible range. However, variation in thickness of the comparison example 4 exceeded the permissible maximum value.

[0072]

From the above results, it is understood that controlling the values of I_t/G_t , O_t/I_t , and O_t/G_t , which show relation between the glass substrate 110, the glass substrate retention unit 310, and the gear portion 320 to be appropriate value,

enables to reduce variation in substrate thickness within permissible maximum value and to maintain polishing rate above the permissible minimum value. Therefore, according to the present invention, it is possible to reduce variation in thickness of the glass substrate after the polishing step using a soft pad and to improve non-defective product ratio of the product while maintaining production efficiency.

[0073]

(6) Main surface second polishing step

Next, second polishing step was performed as the main surface polishing step. The second polishing step was aimed at finishing the main surface to have a mirror surface. In the second polishing step, main surface was mirror polished by the both surface polishing apparatus which includes a planetary gear mechanism, using soft swede pad as an abrasive pad. As polishing liquid (loose grain), cerium oxide abrasive grain was used.

[0074]

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.

[0075]

(7) Chemical strengthening step

Next, chemical strengthening was conducted to the glass substrate. The chemical strengthening was conducted by preparing powder chemical strengthening salt including mixture of 60% of potassium nitrate and 40% of sodium nitrate as solid chemical strengthening salt. The chemical strengthening salt was thrown into a container for salt infusion and was heated

and molten by an electromagnetic wave generator.

[0076]

Thus, lithium ion and sodium ion in the glass substrate were replaced by sodium ion and potassium ion in the chemical strengthening solution and the glass substrate was strengthened.

[0077]

The glass substrate after the chemical strengthening step was 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 was dipped in concentrated sulfuric acid heated to about 40°C to be cleansed. Moreover, the glass substrate after cleansing by the sulfuric acid was sequentially dipped into tanks of pure water and isopropyl alcohol (IPA) to be cleansed.

[0078]

As mentioned above, by carrying out the wrapping step, the cutting step, the chamfering step, the edge surface polishing 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 was obtained.

[0079]

(8) Magnetic disc manufacturing step

An adherent layer including Cr alloy, a soft magnetic layer including CoTaZr base alloy, a foundation layer including Ru, a perpendicular magnetic recording layer including CoCrPt base alloy, a protection layer including carbon hydroxide, and a lubrication layer including perfluoropolyether (PFPE) were sequentially deposited on both surfaces of a glass substrate manufactured through the above procedures to manufacture a

perpendicular magnetic disc. Here, the present configuration is an example of a perpendicular magnetic disc. However, the above example may include a magnetic layer or the like as a longitudinal magnetic disc.

[0080]

A preferable embodiment of the present invention has been explained with reference to attached figures. However, it is needless to say that the present invention is not limited to the embodiment shown here. As will be understood by the skilled persons, various modifications and variations of the present invention are possible in the light of the scope of the subjoined claims and therefore all the modifications and variations fall within the technical scope of the present invention.

[0081]

The present invention can be used for a manufacturing method of a glass substrate for a magnetic disc.

What is claimed is:

1. A manufacturing method of a glass substrate for a magnetic disc comprising a polishing step in which an abrasive agent including a loose grain is supplied between a glass substrate and an abrasive pad for polishing a main surface of the glass substrate and a carrier for polishing retaining the glass substrate and the abrasive pad are relatively moved to carry out polishing, wherein;

the carrier for polishing includes a glass substrate retention unit having a retention hole for retaining the glass substrate and a gear portion provided on an outer circumference of the glass substrate retention unit,

the glass substrate retention unit and the gear portion include different materials,

thickness of the glass substrate retention unit is between 0.45 and 0.63 times as thick as target thickness of the glass substrate, and

thickness of the gear portion is between 1.00 and 1.84 times as thick as the glass substrate retention unit.

2. The manufacturing method of a glass substrate for a magnetic disc according to claim 1, wherein thickness of the gear portion is between 0.60 and 0.87 times as thick as target thickness of the glass substrate.

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

the glass substrate retention unit and the gear portion include different materials respectively, and

the glass substrate retention unit is jointly fixed so that the glass substrate retention unit cannot rotate to the gear portion.

4. The manufacturing method of a glass substrate for a magnetic disc according to any one of claims 1 to 3, wherein the glass substrate retention unit includes glass epoxy.

5. The manufacturing method of a glass substrate for a magnetic disc according to any one of claims 1 to 4, wherein the gear portion includes stainless steel.

6. The manufacturing method of a glass substrate for a magnetic disc according to any one of claims 1 to 5, wherein thickness of the glass substrate retention unit is 0.40 mm or less.

7. The manufacturing method of a glass substrate for a magnetic disc according to any one of claims 1 to 6, wherein thickness of the gear portion is 0.55 mm or less.

8. The manufacturing method of a glass substrate for a magnetic disc according to any one of claims 1 to 7, wherein Asker-C hardness of the abrasive pad is between 70 and 90.